

/ Perfect Welding / Solar Energy / Perfect Charging



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**RESULTS FROM FLEET OPERATION OF HYDROGEN  
FORKLIFTS AND INDUSTRIAL TRUCKS**  
ECO-MOBILITY 2017  
VIENNA, 9 – 10 NOV. 2017

# CONTENT

/ The Fronius Company

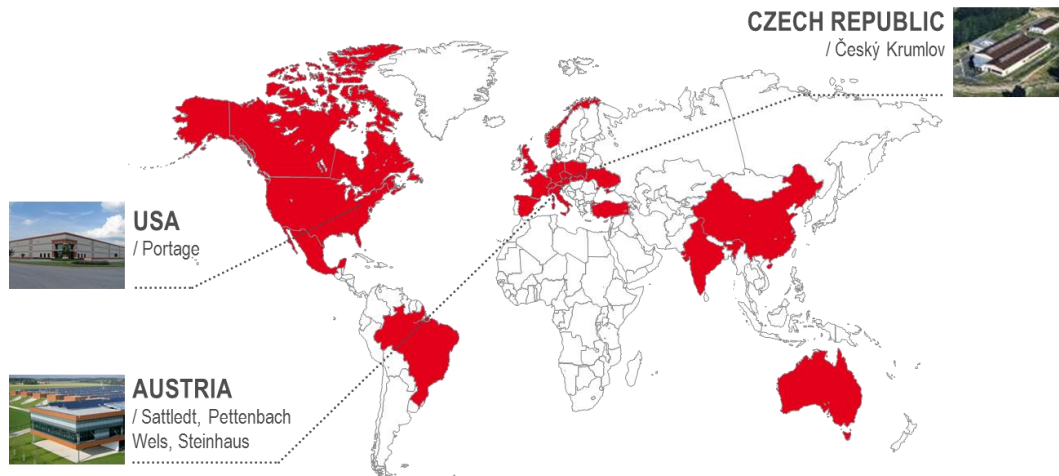
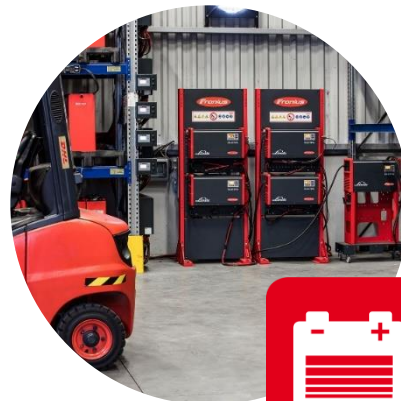
/ Status & results H2 forklift fleet operation

/ Next generation fuel cell technology

/ HRS based on 350bar compressorless PEM Electrolysis

/ Summary

# FRONIUS INTERNATIONAL GMBH



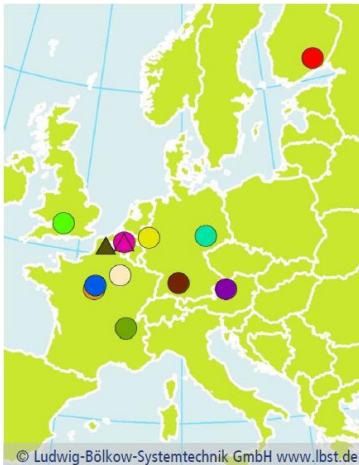
## KEY FIGURES (2016)

Employees worldwide:	3.817
International subsidiaries:	28
Export share %:	89
Turnover in Mio €:	538
Active Patents:	1.242

# FUEL CELLS FOR MATERIAL HANDLING WORLDWIDE

Source: Hubert Landinger / LBST

## Europe: ~260 Units



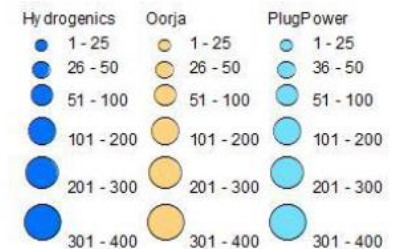
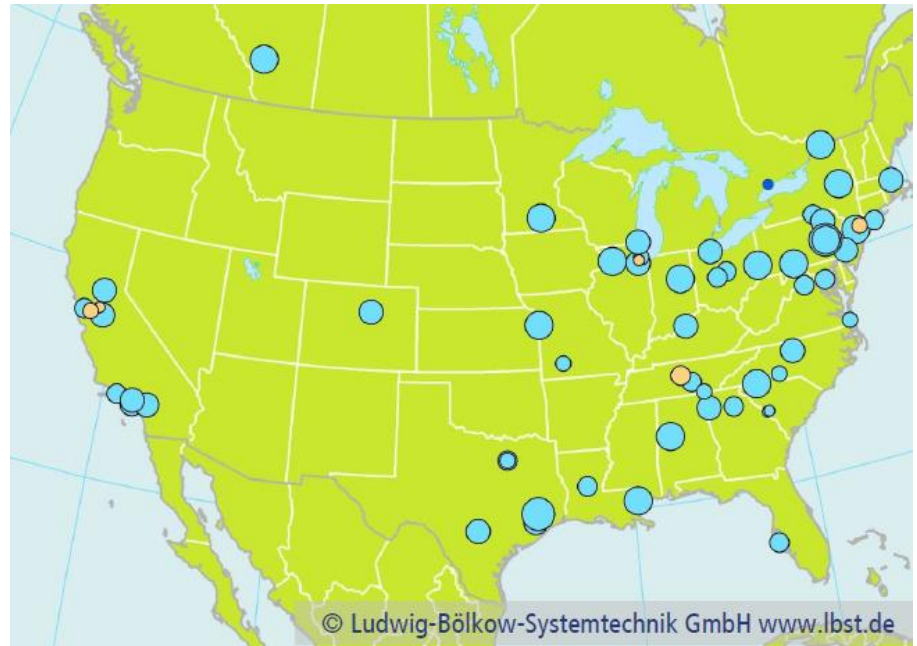
- Colruyt Testflotte (11)
- E-Log-BioFleet (10) update?
- FM Logistics (46)
- H2IntraDrive / BMW (11) update?
- HONDA (2)
- IKEA Frankreich (20)
- Mercedes Benz (2)
- Prelocentre (46)
- Seifert Logistics (1)
- Woikoski (1)
- ▲ Carrefour (150 in Umsetzung)
- ▲ Colruyt (200 in Umsetzung)

## Japan: ~14 Units



- Kansai Airport (2)
- ▲ Central Wholesale Market (3)
- ▲ Nakamura Logistics Inc. (3)
- ▲ Kirin Brewery Co. Ltd. (3)
- ▲ Nichirei Logistics Group Inc. (3)

## North America: 16000 Units (130 Units / Fleet)



# E-LOG-BIOFLEET @ DB SCHENKER

02/2017+

Duration: 06/2010 – 05/2016

## / Application characteristics

/ Location: DB Schenker cross-docking terminal Hörsching (AT)

/ Truck fleet: 10 Linde T20-24 AP/SP stand-on pallet trucks

/ Hours of operation: 24/5

/ Ambient temperature: 0 to +25°C

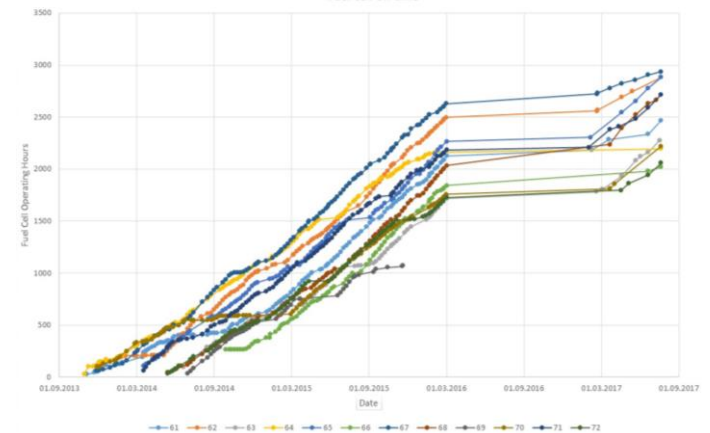
/ Indoor H<sub>2</sub> refuelling and on-site generation

from biogas: 0.45 kgH<sub>2</sub>/h @ 200bar

10+2x Fronius HF26F



Fuel cell on time



## / FC fleet statistics (June 2013 – June 2017)

/ Truck on-time: 49345 h

/ FC on-time: 26497 h

/ Start/stop cycles: 62566

/ Truck power demand: <750W

/ FC system drive cycle efficiency max: 53%

/ Number of refuellings: ~7105

## H2 IntraDrive

Project duration: 12/2012 – 04/2016

BMW Fahrzeugproduktion in  
Leipzig

i3 Elektrofahrzeug

i8 Elektrofahrzeug



↓  
Clean Production  
Philosophie



Gefördert durch:

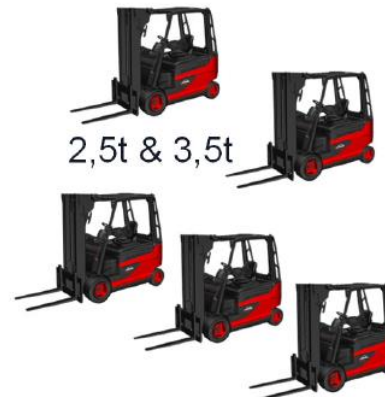


Bundesministerium  
für Verkehr und  
digitale Infrastruktur

Koordiniert durch:



BMW  
GROUP



2x Fronius HF26F

### Objectives

- / Development and operation of H2 forklifts and H2 tow tractors
- / Implementation of first H2 indoor refueling in Germany
- / Research on operation of H2 material handling vehicles and Infrastructure
- / Socio-economic and environmental research

# FRONIUS HYLOG FLEET 24/48V

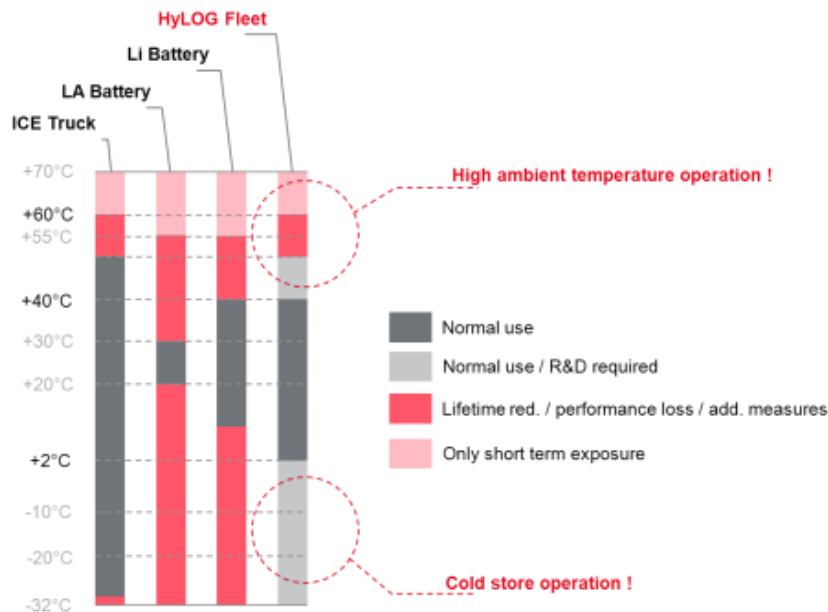
## MORE PRODUCTIVITY & SUSTAINABILITY

- + high safety standards
- + simple truck integration (safety, interfaces, weight)
- + fast 350bar refueling without communication
- + high driving range (efficiency, H<sub>2</sub> capacity)
- + detached display incl. data recording
- + stack lifetime >10.000h @ high start/stop cycle numbers
- + compact, robust & silent
- + low maintenance



# FRONIUS HYLOG FLEET VS STATE OF ART

		Battery	HF26F	HF24015F
Type		Lead Acid	H2-200bar	H2-350bar
Dimension tray 4PzS L/W/H	[mm]	786/310/630	786/310/630	786/310/630
Voltage	[V]	24	26,4	25,6
Current max.	[A]	450	450	500
Charging / H2 refueling time	[min]	>500	<3	<2
Battery / Stack lifetime	[h]	4.400	>5.000	>10.000
Energy content	[kWh(el)]	9,6	6	11
Weight	[kg]	360	180	234
Ambient temperature	[°C]	-10 to +60	+2 to +40 (60)	+2 to +40 (60)

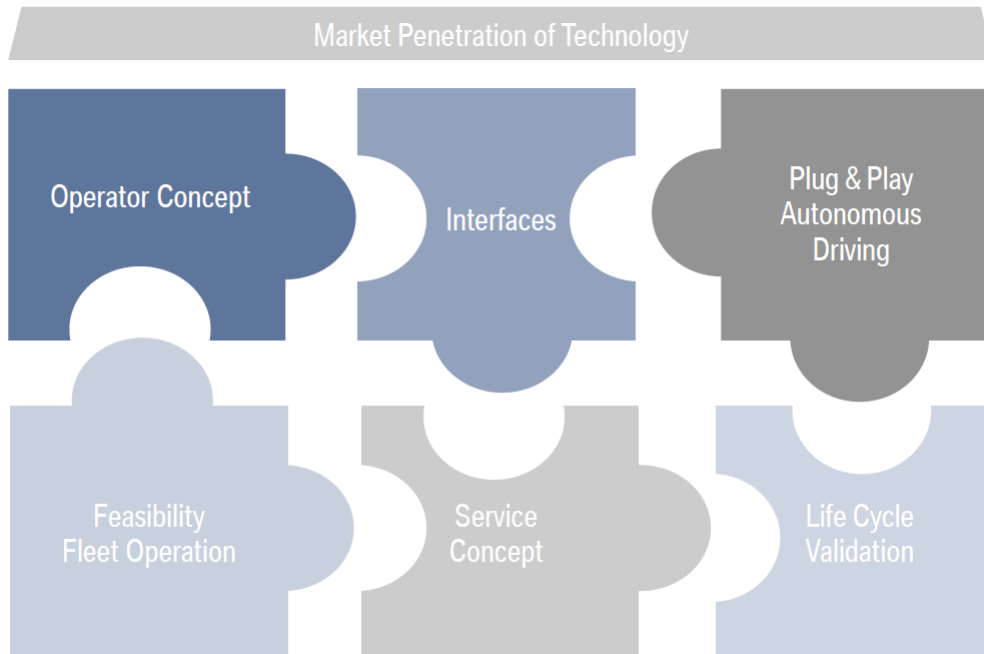




# FFZ 70 – APPLICATION OF 70 HYDROGEN TOW TRACTORS AT THE BMW PRODUCTION FACILITIES LEIPZIG

Project duration: 1.4.2017 – 30.9.2019

## MOTIVATION OF PROJECT IDEA FFZ70.



SHIFTING THE LIMITS



GÜNSEL

Fördertechnik und Fahrzeugbau



# → IN LINE →



## An innovative design of a flexible, scalable, high quality production line for PEMFC manufacturing

Project start: 2017-02-01  
Project end: 2020-01-31

The project aims at the development of a design of a flexible, scalable, high quality production line (process steps) for the manufacturing of PEMFC's (Proton Exchange Membrane Fuel Cells). The spectrum of automation in fuel cell manufacturing tasks investigated in the project includes tasks that require:

- The design of a flexible production process that allows a scale-up to 50.000 parts per year.
- The definition of automatic quality control strategies and processes to ensure quality for high-volume production, including the organization of necessary re-work.
- The development of flexible assembly stations that allow a gradual transition from manual operation to fully automatic processes.
- Data collection, documentation and tracking methods that fulfill traceability requirements.

The design of the production line that will be considered in the project includes the manufacturing of parts of smaller quantity as well as very large quantities of PEMFC's.

**Objective (A):** Redesign of the media supply unit as part of the end plate assembly to decrease cycle time and manufacturing costs. The media supply unit requires manual steps that are currently difficult to automate.



**Objective (B):** Development of automated quality inspection methods to improve the end of line test and to ensure traceability of critical components. A reduction of the need for making time-consuming measurements will take place by using predictive models and data acquired through inline quality control along the supply chain.

**Objective (C): Scalability of the manufacturing process.** A proper integration of automatic and manual process steps through assistance systems will ensure that the production process can be scaled up to a level of 50.000 pcs/year. A specific manufacturing process of the 350 bar H<sub>2</sub> tank valve will be developed to produce large quantities with high quality and safety requirements.

Consortium:



# ELRINGKLINGER PEM BZ STACK NM5



/ Metal BPP Stack technology

/ Large scale industrial production confirmed

/ >8000h Stack (cont. Operation) lifetime confirmed

/ High power density (2,5bar, 340A @ 0,6V/Cell)

/ 7,2 kW/l (active area)

/ 6,4 kW/l (CCM area)

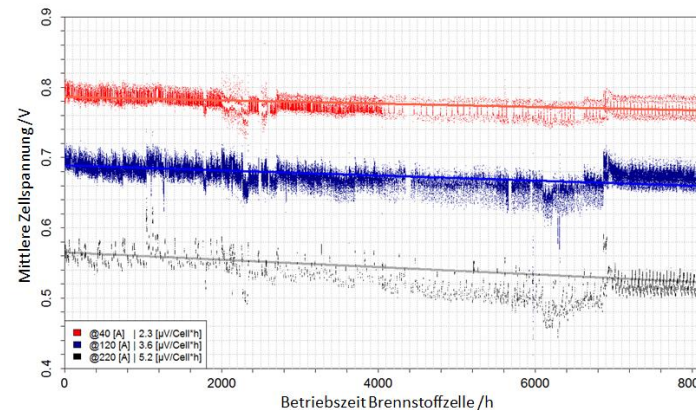
/ 4,0 kW/l (Stack without endplates)

## NM5-100Cells

20kW @ 2,5 bara

13kW @ 1,2 bara

L/W/H (mm): 243/161/146(without endplates)





# ELAAN PROJECT

10/2013 – 06/2017



60kW 80V electrical engine



20kW PEM FC system

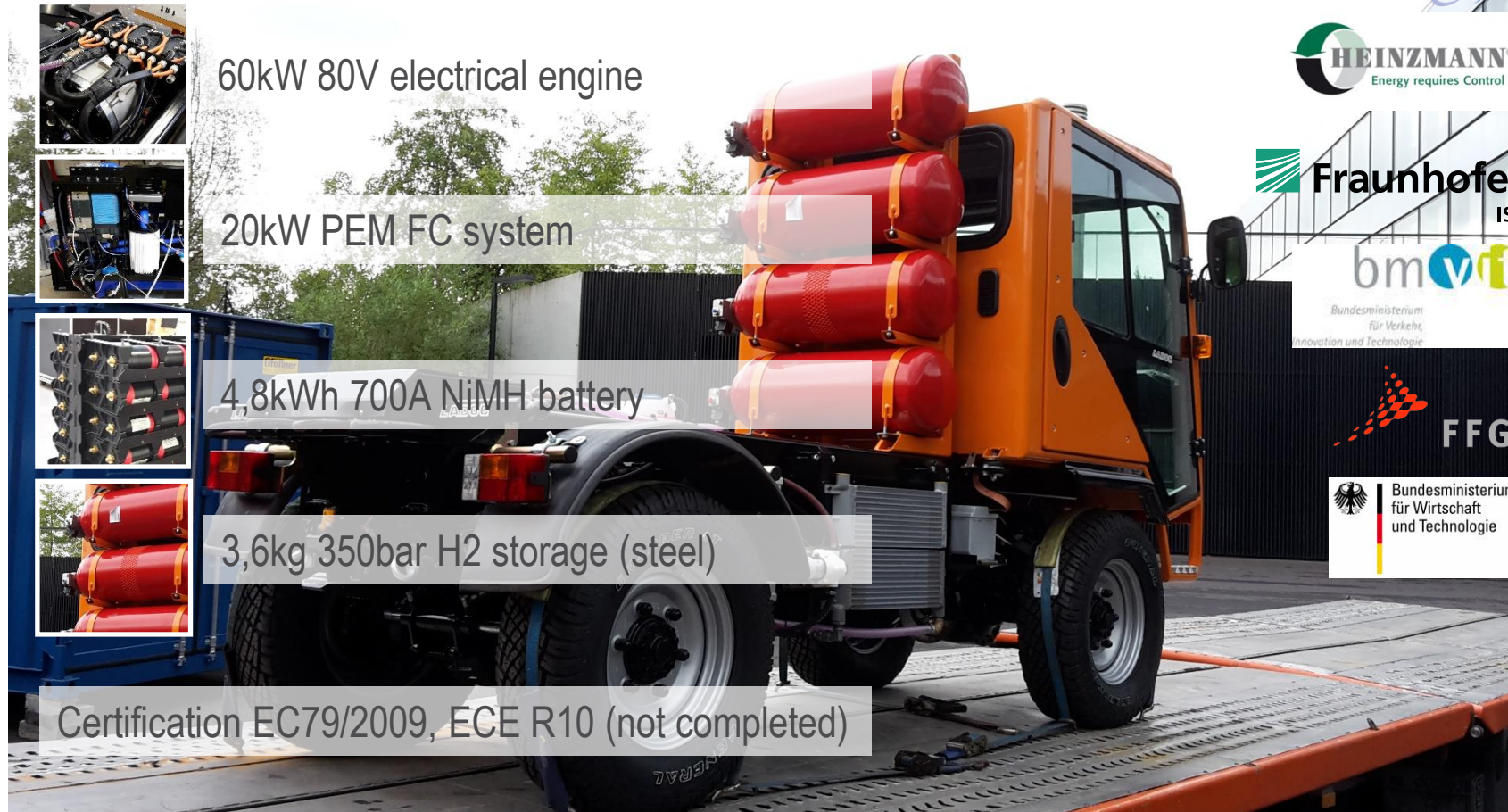


4,8kWh 700A NiMH battery



3,6kg 350bar H2 storage (steel)

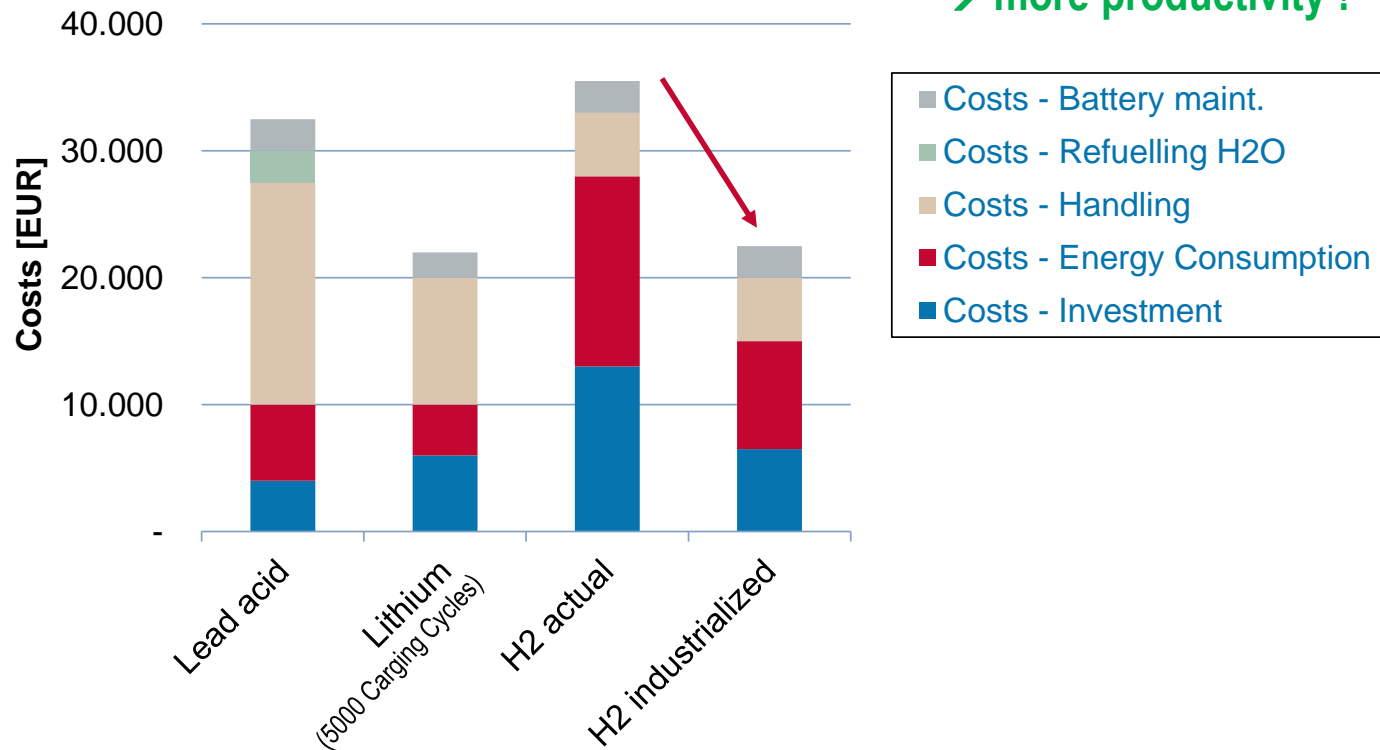
Certification EC79/2009, ECE R10 (not completed)



# TCO 3/5 SHIFT CLASS 3 TRUCK (5 YEARS)

H2 Forklift Trucks  
+ more flexibility & driving range  
+ less handling & maintenance

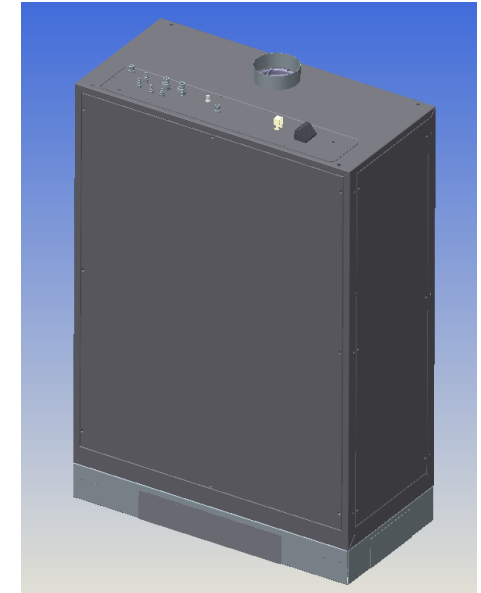
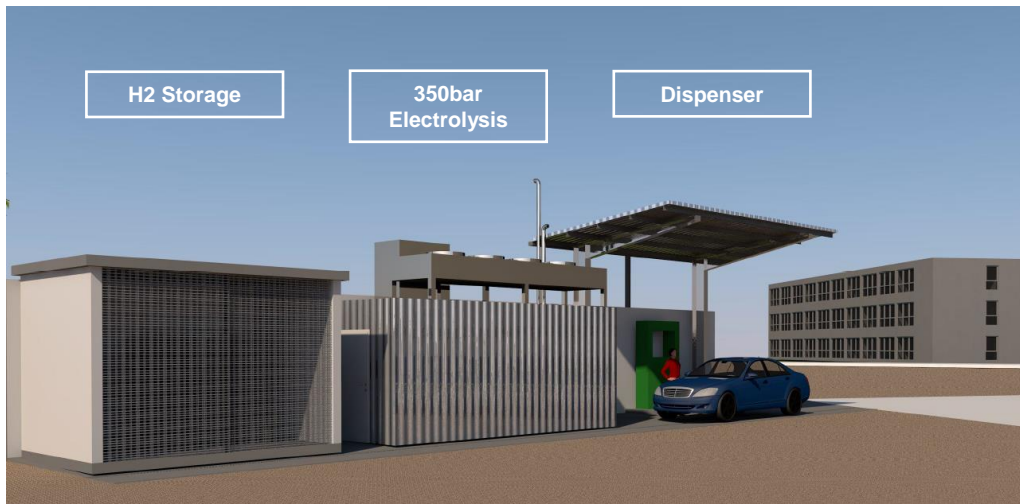
→ more productivity !



# 350BAR COMPRESSORLESS HRS THALHEIM, AT

## Advantages:

- + Modular, scalable system & integrated safety
- + High partload and dynamic load cycle capability
- + High 350bar system efficiency
- + No mechanical compressor needed (investment, service requirement, efficiency)
- + Perfect product gas quality for PEM fuel cells
- + 60 – 80°C byproduct heat



## Energycell 32.0E

350bar PEM Electrolyser

Power Supply: 32kW / 400VAC

H<sub>2</sub> Production: 8,7kg/d

DI Water Supply: 150l/d

Process Temperature: 80°C

Dimensions L/W/H: 1100/700/1900

# SUMMARY

- / Increased **productivity** and better **sustainability** are the **main drivers** for fuel cells for forklifts and industrial mobile applications
- / H2 & fuel cell technology is in an **early stage of industrialization** but **performance and cost reduction develops rapidly** towards marketability
- / **New concepts and technologies for hydrogen generation and refueling** are needed for **solving availability and price challenges of hydrogen as a fuel** at the point of use

/ Perfect Welding / Solar Energy / Perfect Charging



**SHIFTING THE LIMITS**

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