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WASSERSTOFF-TECHNOLOGIE FÜR LOGISTIK UND INDUSTRIELLE MOBILE ANWENDUNGEN AUS EUROPA

15. BRENNSTOFFZELLEN FORUM HESSEN – INNOVATIONEN FÜR EINE NACHHALTIGE LOGISTIK
FRANKFURT/MAIN 13. SEPT. 2016
CONTENT

/ Fronius Company
/ Fronius H2 Solutions & Status of Application
/ Customer Benefits & Business Case MH
/ Green Logistics Terminal
/ Summary & Outlook
FRONIUS INTERNATIONAL GMBH

WELDING TECHNOLOGY
We master the arc like no other

SOLAR ELECTRONICS
We must revolutionize the energy supply of our planet

BATTERY CHARGING SYSTEMS
Economical, flexible, unique

KEY FIGURES
- Employees worldwide: 3,385
- International subsidiaries: 21
- Export share: 92%
- Turnover 2014 in Mio €: 414
- Active Patents: 928
THE ROLE OF HYDROGEN

- H2 is the **most abundant element** in the universe
- H2 can **bridge from fossil to RE based energy** system
- H2 is applicable **small & large scale**
- H2 is **safe & enables high efficient & zero emission** utilisation
- H2 enables **fast refueling**
### FRONIUS H2 TECHNOLOGIES

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energycell 32.0E</td>
<td>HPEM Electrolyser</td>
<td>32kW/400VAC, 8,7kg/d, 350bar, 80°C, L/W/H 1100/700/1900 mm, ISO 22734-1:2008, PED, EMC</td>
</tr>
<tr>
<td>HyLOG Fleet 24015F</td>
<td>PEM FC – Battery Hybrid</td>
<td>1.5kW/11kWp, 24VDC, H2 tank: 27L, 350bar, 11kWh(el), Temp. range (target): -10 to +40°C, L/W/H 786/310/630 mm, EN62282-4-101:2014, PED, EMC</td>
</tr>
<tr>
<td>HyLOG Fleet 48025F, -15F</td>
<td>PEM FC – Battery Hybrid</td>
<td>2.5 (1.5)kW/20kWp, 48VDC, H2 tank: 27L, 350bar, 11kWh(el), Temp. range (target): -10 to +40°C, L/W/H 827/310/630 mm, EN62282-4-101:2014, PED, EMC</td>
</tr>
<tr>
<td>HyLOG Fleet 80100F</td>
<td>PEM FC – Battery Hybrid</td>
<td>10kW/30kWp, 80VDC, H2 tank: 80L, 350bar, 35kWh(el), Temp. range: -20 to +50°C, L/W/H 1028/855/771 mm, EN62282-4-101:2014, PED, EMC</td>
</tr>
</tbody>
</table>

Product development: Demonstration / Pilot production
WORLD IMPLEMENT AND TRACTOR MARKET

Material Handling
By Courtesy of Linde MH GmbH

Municipal Services
By Courtesy of LADOG-Fahrzeugbau u. Vertriebs-GmbH

Construction
By Courtesy of Construction Machine Blog

Global Market
~ 260 Billion €

Agricultural
New Holland NH2 Tractor, by Courtesy of Landwirt Agrarmedien GmbH Graz / Austria

Forestry
By Courtesy of LBX Company LLC

15% Production in Germany
30% Global market share of German suppliers
E-LOG-BIOFLEET: TRUCK AFTER 1500H HARSH CROSS-DOCKING
E-LOG-BIOFLEET @ DB SCHENKER

/ Application characteristics
/ Location: DB Schenker cross-docking terminal Hörsching (AT)
/ Truck fleet: 10 (+2) Linde T20-24 AP/SP stand-on pallet trucks
/ Hours of operation: 24/5
/ Ambient temperature: 0 to +25°C
/ Indoor H2 refuelling and on-site generation from biogas: 0.45 kgH2/h @ 200bar

/ FC fleet statistics (June 2013 – Feb. 2016)
/ Truck on-time: 42801 h
/ FC on-time: 22983 h
/ Start/stop cycles: 51241
/ Truck power demand: <750W
/ FC system drive cycle efficiency max: 53%
/ Number of refuellings: ~ 6167
E-LOG-BIOFLEET WTW-GREENHOUSE GAS EMISSIONS

- FC Vehicle H2 Biomethane: 437 g CO2-eq/h
- FC vehicle H2 Hydropower: 579 g CO2-eq/h
- FC vehicle H2 Natural gas: 1699 g CO2-eq/h
- Battery vehicle UCTE-Mix: 1787 g CO2-eq/h
- Battery vehicle Austria-Mix: 1211 g CO2-eq/h
- Battery vehicle Hydropower: 440 g CO2-eq/h

- Vehicle (TTW)
- Electricity Hydropower
- Electricity UCTE-Mix
- Hydrogen Biomethane *(Reform)
- Hydrogen Natural gas (Reform)
- Hydrogen Hydropower (Ely)
MH CUSTOMER BENEFITS

/ <3 min refuelling vs. 8-10h LA battery charging
/ No battery swap (ergonomy, collateral damage)
/ +30% driving range vs. LA battery
/ Less space demand (2nd battery, battery charging room)
/ Longer lifetime
/ Zero emission, less hazardous materials and waste
/ Energy management capability on system level (storage, grid services, etc.)

⇒ More productivity and sustainability
FC FOR MH: SYSTEM PRODUCTIVITY IMPROVEMENT

Operation efficiency improvement

Down-time reduction

- Battery change (10-15min)
- Battery water filling (15min x 2 per week)

Operation (8h) → Battery charge (6~8h) → Operation (8h) → H2 dispense (3min) → Operation (8h) →...

Continuous operation

Source: Fuel Cell Truck Development Status, Toyota Industries Corporation, March 27, 2015
FRONIUS ENERGYCELL 10.0E

- 163bar H2 product gas pressure without mechanical compression
- >60% (HHV) hydrogen generation efficiency
- Best H2 quality for PEM fuel cells
- Modular system concept for high availability, dynamic load following and partload operation
- 80°C operation temperature for by-product heat utilisation
- Integrated safety concept at European standards

Energycell 10.0E
8kW/400VAC
1,2Nm³/h, 160bar, 80°C
L/W/H 1000/380/990 mm
ISO 22734-1:2008, EMC
FRONIUS 163BAR PEM ELECTROLYSIS FOR 100KW WIND2HYDROGEN PILOT PLANT @ OMV GAS STATION AUERSTHAL / AUSTRIA
GREEN LOGISTICS TERMINAL

- PV Generator
- 400VAC 3~
- Wind Farm
- Fresh Water
- Byproduct Water
- Byproduct Heat
- Compressor 300 – 900bar
- H2 Storage 0 – 350bar
- H2 Storage 350bar
- H2 Storage 850bar
- Indoor Dispenser 1 350bar
- Indoor Dispenser 2 350bar
- Outdoor Dispenser 350 / 700bar
- Fronius EC 450E
- Fronius HF24015F
- Fronius HF80100F
- Fronius HF48025F
- Fronius HF48015F

Pictures used by courtesy of project partners
SUMMARY & OUTLOOK

/ Hydrogen is a promising solution for RE integration in mobile applications

/ H2 & FC technologies have the potential not only to green mobility and transport but also to improve performance and economics of industrial applications

/ Large scale field evaluation of H2 & FC technologies is required to confirm customer benefits and identify barriers in EU member states

/ Cost reduction by economies of scale and continuous RTD go hand-in-hand with business model and market development