Integration of a Fuel Cell Range Extender in Warehouse Logistic Vehicles

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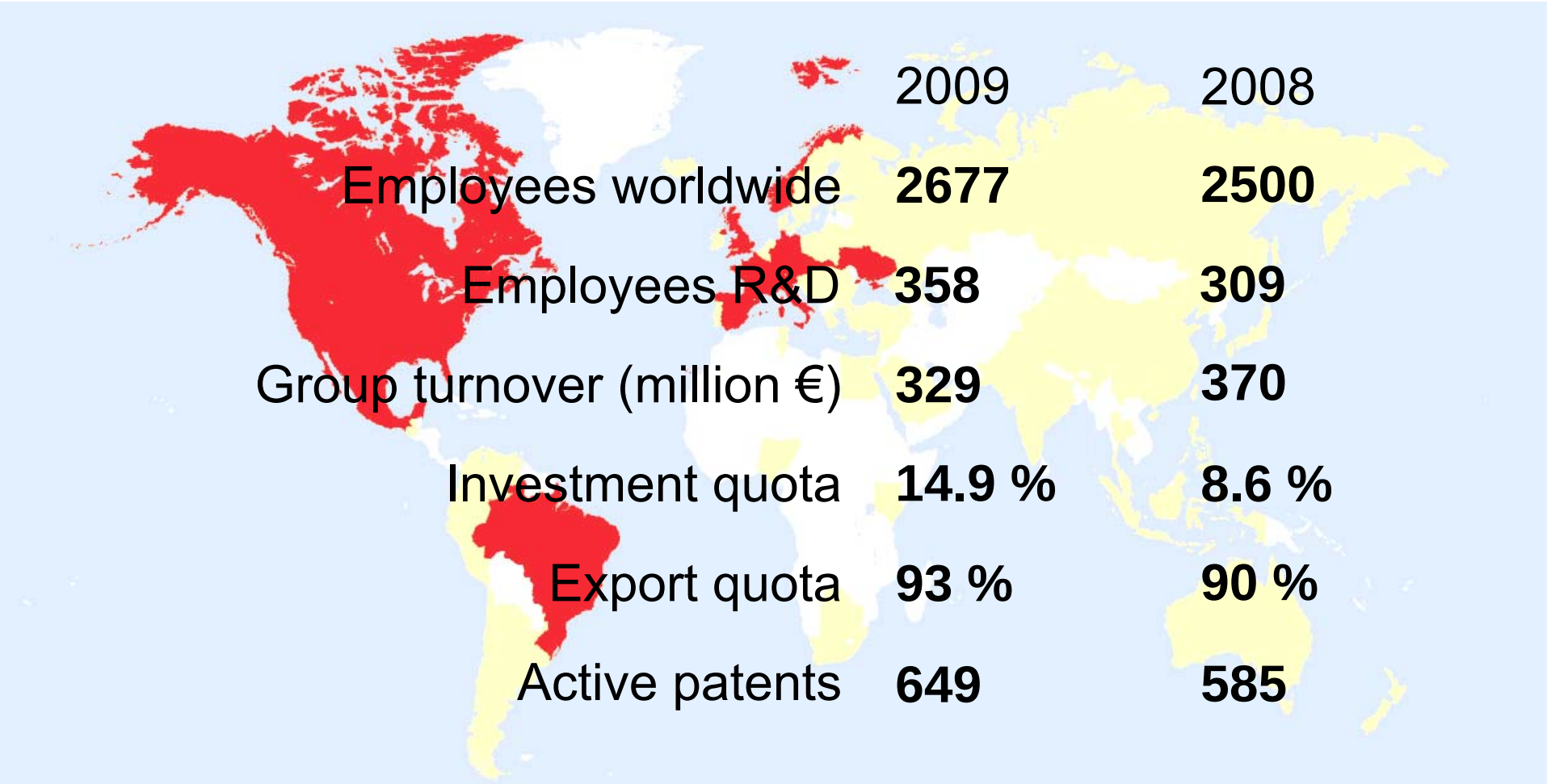
Fronius Company

Division Battery Charging Systems

Division Welding Technology

Division Solar Electronics

A closer look at the Fronius Group



	2009	2008
Employees worldwide	**2677**	**2500**
Employees R&D	**358**	**309**
Group turnover (million €)	**329**	**370**
Investment quota	**14.9 %**	**8.6 %**
Export quota	**93 %**	**90 %**
Active patents	**649**	**585**

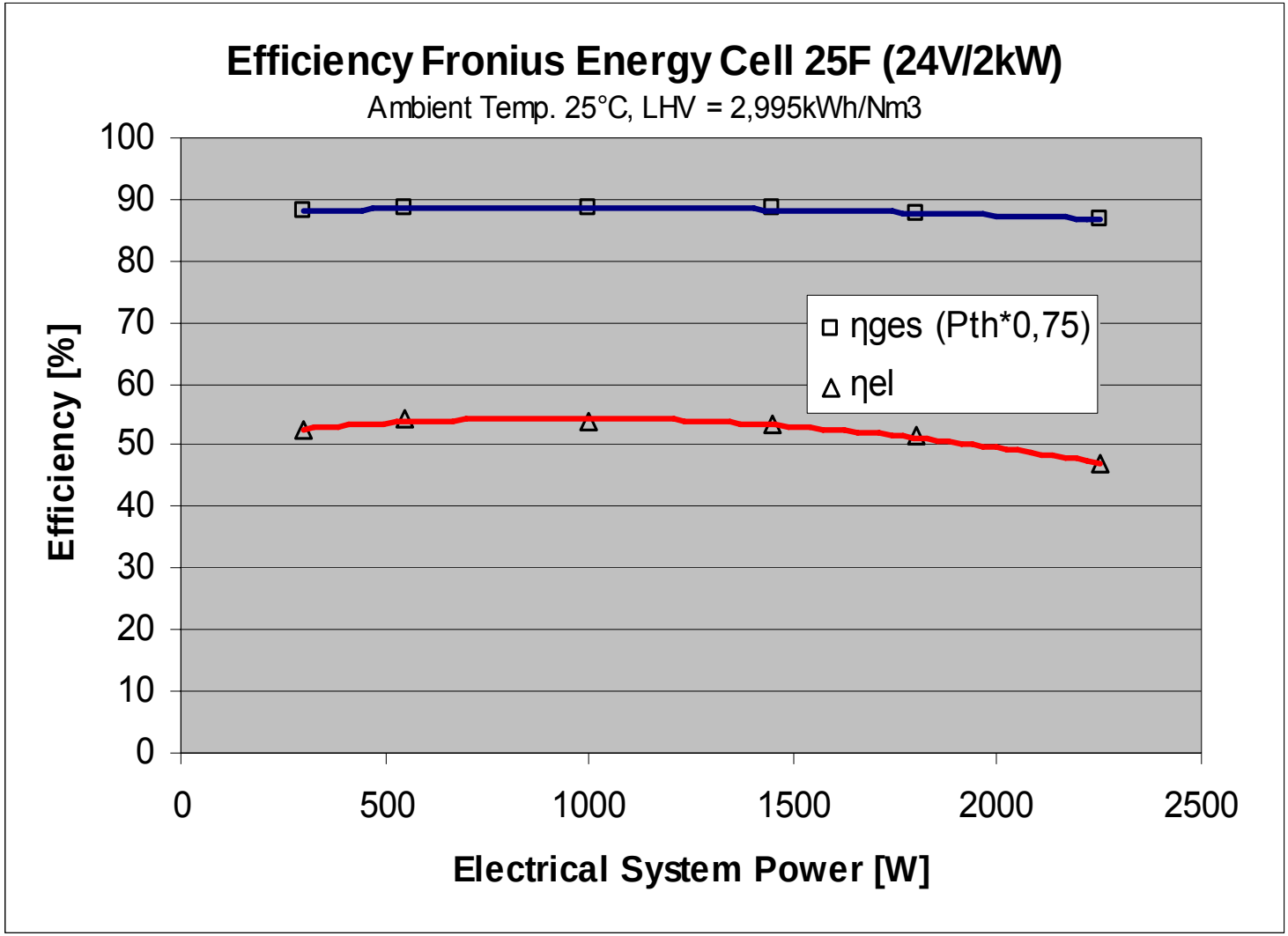
Fronius Energy Cell

Available for Projects

Power	4 kW	2 kW	1 kW
Voltage	48VDC	24VDC	
IP Protection Compliance	IP20 (upgradable to IP54)		
Certification	EN62282-5-1:2007		
Fuel Supply	Standard Compressed Hydrogen 30 – 700 bar Hydrogen Gas Grid Electrolyser		
Applications	DC/AC Power Generator Mobile Applications		

- PEM fuel cell power generator
- High overall efficiency
- Silent operation
- Perfect safety strategy
- Easy to use and service, user-friendly
- Complete remote system monitoring

Energy Efficiency Fronius Energy Cell



The HyLOG Project

① Fronius Facility Sattledt, Central Production & Logistics:
Employees: 650, Production Space: 37.000 m²
615 kWp Photovoltaic Power Plant

② Fronius IG500 Inverter

③ Biovest / Proton Energy
HOGEN® S40 Elektrolyser

④ Hydrogen Refuelling Station
Air Products S100, 350 bar

⑤ H_2 Bitter Tank
STS 26 l, 350 bar, 0,7 kg H_2

⑥ Fronius Energy Cell 25F

⑦ Linde P30 Tow Truck Tractive Force 3000 kg
Range-Extender Drive, 2 x range / 7 x refuelling /week

Status Demonstration / Results

- Since May 2009: 5 days/week 2-shift operation
- 4 – 5 shifts / cartridge exchange

- Key advantages
  - Fast refuelling increases system flexibility and availability
  - Increased productivity through constant power, reduced maintenance, reduced space demand
  - Energy management capability
  - No emissions

- Improvement potentials / critical aspects
    - Minimum vehicle fleet size for economic operation required
    - Competitive price for hydrogen as an energy carrier
    - Replacement of cartridge by indoor / onboard refuelling
    - System cost reduction through volume manufacturing

Future of Warehouse Logistics

Schenker Facility Sofia, Bulgaria (Photo courtesy of Schenker & CO AG)

Gazeley Park Blue Planet Chatterly Valley (Photo courtesy of Gazeley UK Ltd.)

Fronius Facility Sattledt, Austria

Kühne+Nagel Hub Chaponnay, France (Photo courtesy of Kühne+Nagel Int. AG)

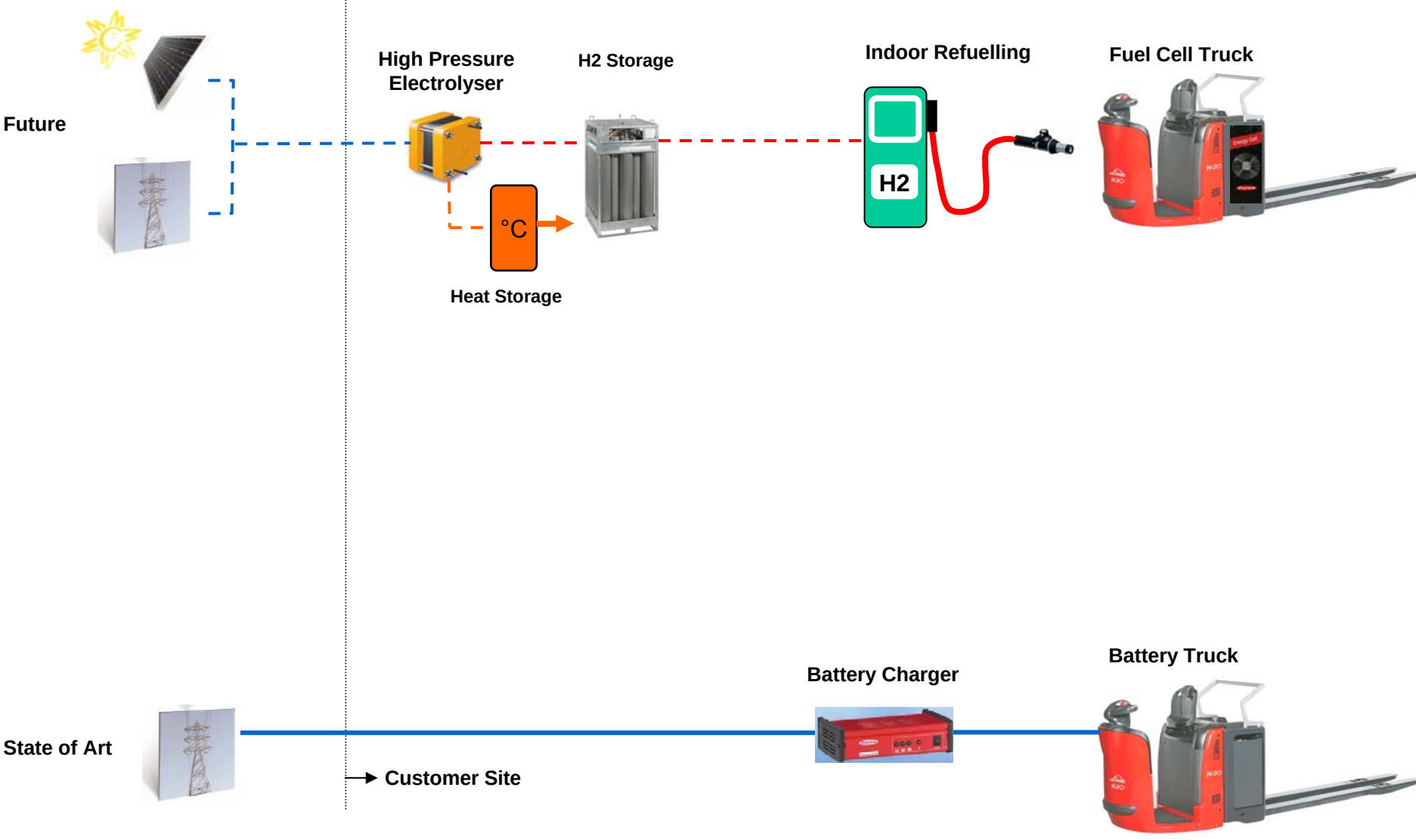
Energy Costs in Warehouse Logistics

Energiekostenaufteilung eines Logistikzentrums

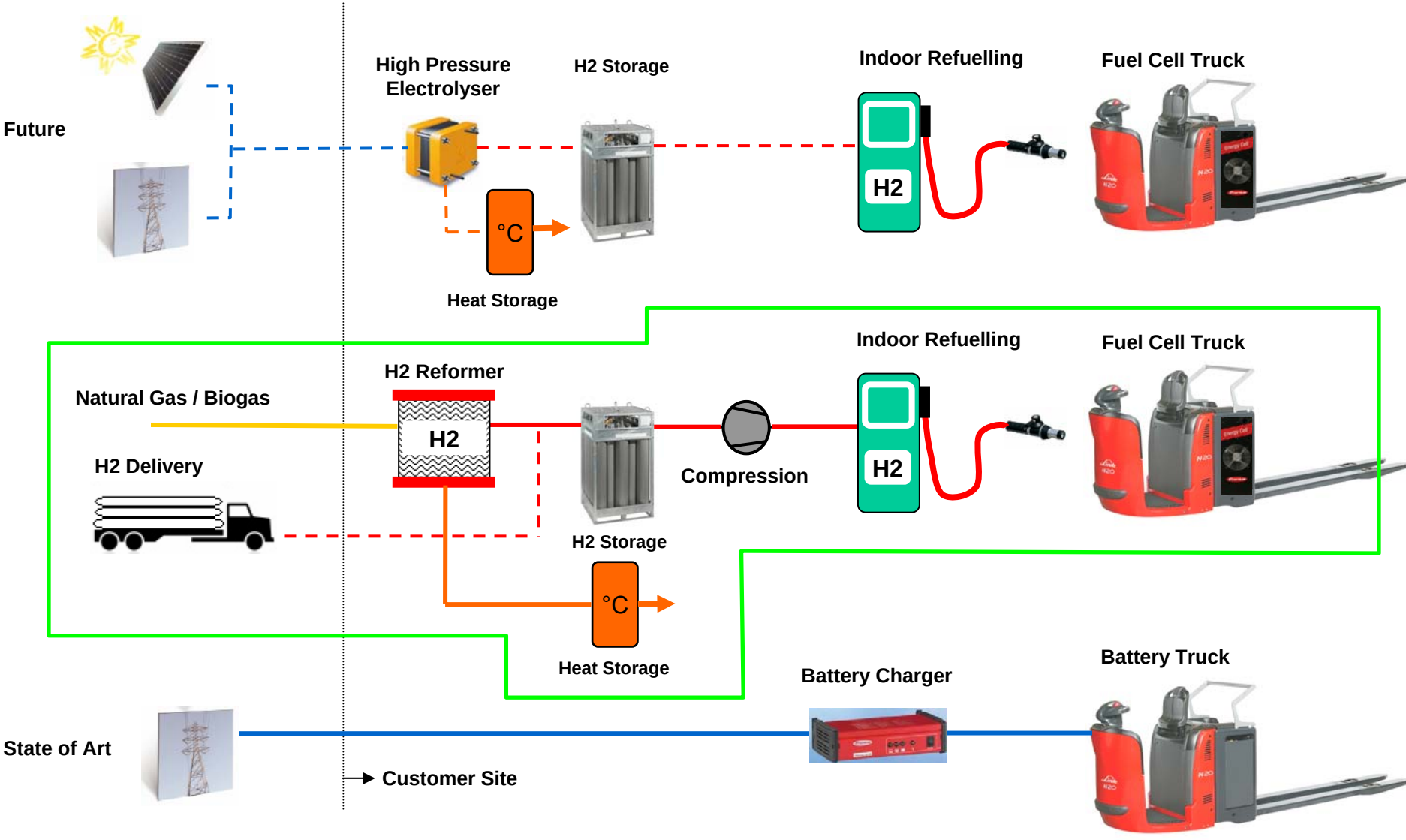
Quelle: Kramm, M.: Der Energieausweis für Distributionszentren

Energy Infrastructure Perspective

Energy Infrastructure Perspective



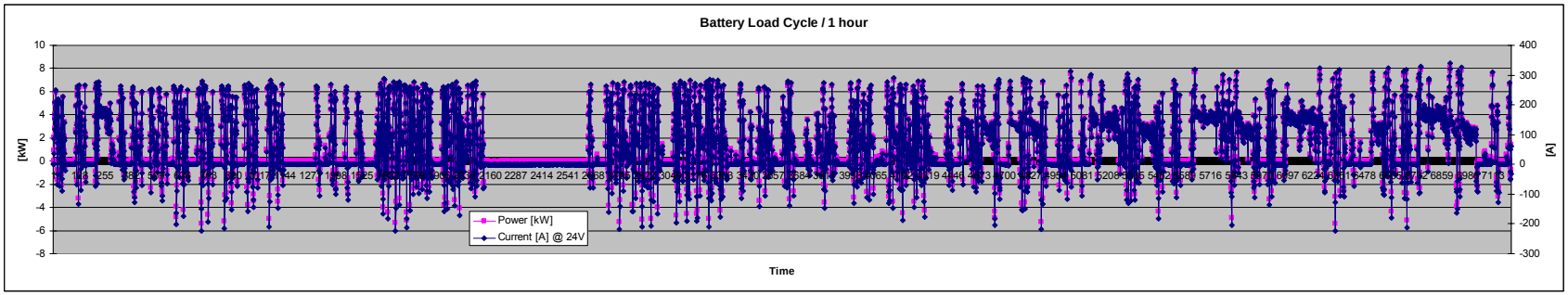
Energy Infrastructure Perspective



Warehouse Vehicle Requirements

- Onboard energy 5,2 – 9,6 kWh
- Driving range (net) >4 hours
- Refuelling time (indoor / onboard) <3 min
- Temperature range -10 to 70°C
- Water / dust protection IP53
- Extreme vibration and shock load

Load Cycle



Average power drive cycle: **0,4 to 3,1 kW**
Average power shift / recharging cycle: **0,2 to 1,9 kW**

Max. Current **-270 to 550A @ 19V (~10,5 kW)**

N20-24

P30C

T20-24 AP/SP

Standards System Safety

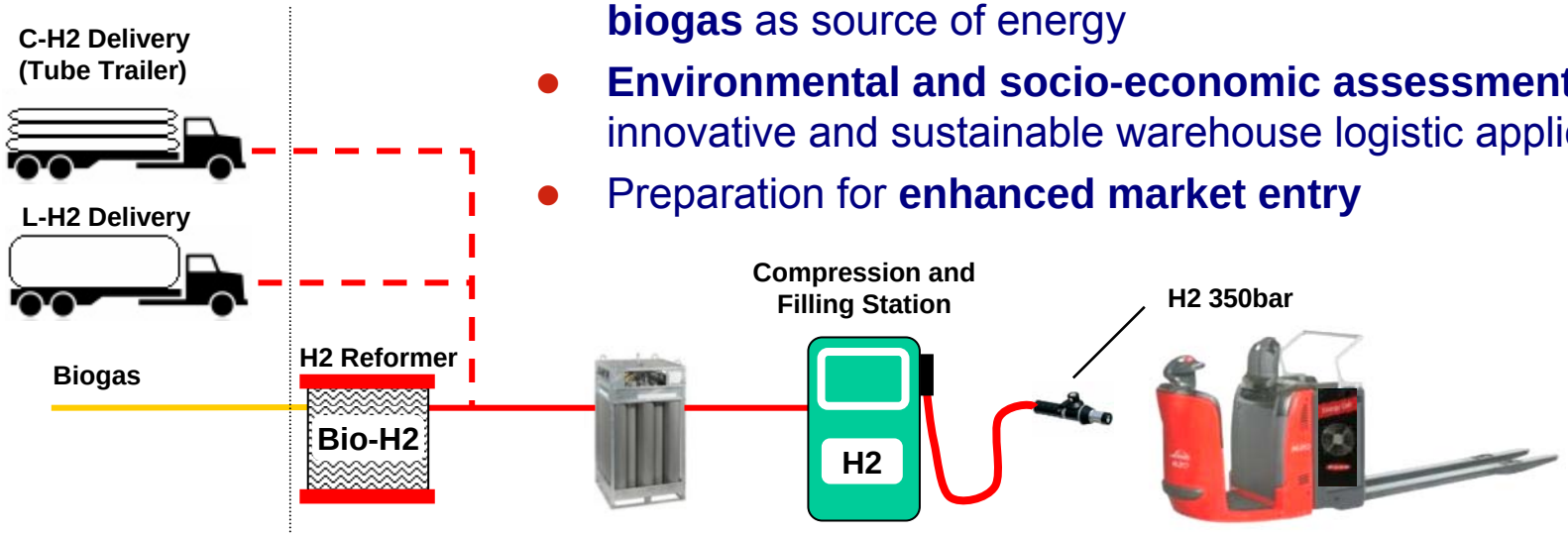
- **New Machinery Directive 2006/42/EC, active since 29 Dec 2009**
  - System safety functions (pneumatic, electronic, hydraulic, mechanical functions on sub- and total system level) require qualitative AND quantitative reliability assessment
  - Assessment according to
    - EN62282-5-1:2007 Fuell cell technologies - Part 5-1: Portable fuel cell power systems - Safety
    - EN ISO 13849-1 Safety of machinery (Replaced: EN 954-1 Safety of machinery, Safety related parts of control systems)
    - EN 61508 Functional safety of E/E/PE electronic safety-related systems
  - **Challenges:**
    - Low availability of safety related data (SFF, PFH values) of components of the safety function causes demanding and costly engineering solutions
    - High documentation effort
- **Standards gas vehicle refuelling (incl. indoor)**
  - ÖVGW G97 NGV filling stations - Design, production, installation and operation
  - VdTÜV MB514 / 04.2009: Compressed gases, Requirements for hydrogen fueling stations

E-LOG-Bio-Fleet

This project is selected for funding by the
Austrian Climate and Energy Fund
within the program
„Technologische Leuchttürme der Elektromobilität“

Objectives

- Development, certification and demonstration of a warehouse tow **truck fleet (15 vehicles)** with fuel cell range extender
- Installation, authority approval and demonstration of **indoors and onboard** bio-hydrogen **refuelling** of the warehouse truck fleet
- CO2 neutral generation of **bio-hydrogen using reformed biogas** as source of energy
- **Environmental and socio-economic assessment** of the innovative and sustainable warehouse logistic application
- Preparation for **enhanced market entry**



Summary

- The **HyLOG** project demonstrates a **safe and zero emission solution for warehouse logistics**
- Key **benefits of fuel cells** for warhouse logistics are **fast refuelling**, **constant performance, reduced maintenance and less space demand @ zero emission**
- A **Fuel Cell Range Extender** enables both high **peak current capability** and **drive cycle efficiency**
- **Compliance with EU safety standards** is evident but costly
- The **E-LOG-Bio Fleet** project will further **enhance market entry** of the innovative technology

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