International Perspectives for Fuel Cells for Materials Handling Vehicles (MHVs)

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# MHVs with hydrogen powered fuel cell drive train

<table>
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<tr>
<th>Forklift</th>
<th>Airport Tow Tractor</th>
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<td>Converted battery electric forklift</td>
<td>Combustion engine replaced by fuel cell</td>
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<td>Often first OEM-product for fuel cell implementation</td>
<td>Application scenario: airport</td>
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<td>Outdoor operation</td>
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<td>![Forklift Image](source: STILL GmbH)</td>
<td>![Airport Tow Tractor Image](source: MULAG GmbH)</td>
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<tr>
<th>Pallet Mover</th>
<th>Reach Truck</th>
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<td>Converted battery electric vehicle</td>
<td>Converted battery electric truck</td>
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<td>Application scenario: Commissioning of goods for delivery</td>
<td>Application scenario:</td>
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<td></td>
<td>– high rack warehouses</td>
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<td>– Indoor</td>
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<td>– Outdoor</td>
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<td>– Operation in small aisles</td>
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<td>![Pallet Mover Image](source: Linde Material Handling GmbH)</td>
<td>![Reach Truck Image](source: EnergieRegion.NRW)</td>
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Operation sites of FC MHVs worldwide

In total about 5,500 MHVs in operation (status 2013):
Operation sites of FC MHVs in North America

In total about 5,400 MHVs in operation (status 2013):

Selection of companies operating FC materials handling vehicle fleets:

Walmart, Bridgestone, Firestone, Mercedes-Benz, P&G, BMW, Coca-Cola, FedEx Freight, Whole Foods Market
Operation sites of FC MHVs in Europe

In total about 70 MHVs in fleet operation (status 2014):

- E-Log-BioFleet (10)
- H2IntraDrive (11)
- HyLIFT-DEMO (11)
- IKEA France (20)
- Air Liquide Welding (8)
- Colruyt (11)*

* + 2 from HyLIFT-DEMO
FC MHVs: success factors in USA

**Operational**
- Elimination of space for charging and storing swapping batteries
- USA: many big logistic centres with large turnover in 24/7 operation
- Europe: distributed, smaller logistic centres

**Technical**
USA today:
- Power decrease at BEVs within one work shift
- Battery swapping procedure not optimized timewise
  ➔ Leapfrogging

**Financial**
USA:
- Increasing sensitivity on labour costs
- Availability of cheaper hydrogen
- Significant governmental financial support:
  - Demonstration projects via (DOE, DLA)
  - tax credits for FC systems until end 2016

Successful roll-out in the USA
2013: about 5,400 vehicles
Example for a FC MHV fleet

- **Operation site:**
  - Central Grocers grocery warehouse facility
  - USA: Joliet in Illinois
- **182 vehicles**
- **In operation since 2009. In 2014 new units will be replacing the original fleet after operating for more than two million hours**

Source: Plug Power Inc.
Unique Selling Proposition (USP) of FC MHVs

Advantages in comparison to Diesel Operated MHVs
- No local emissions
- Low noise emissions
- Indoor operation
- Low OPEX
- Low time and cost efforts for maintenance and repair

Advantages in comparison to Battery Operated MHVs
- About 3 min refuelling instead of time consuming battery swapping
- No power decrease
- All hardware in use; no replacement / swapping hardware required
- Reduced demand of floor space

Optimal application scenario
- 3 shift operation
- Large fleets
- heavy utilization
- Indoor and outdoor operation
- High productivity requirements
- High electricity costs / low H₂ costs
- High labour costs
FC MHVs: perspectives for Europe

HyLIFT-EUROPE
- Demonstration of 200 materials handling vehicles (~150 forklifts & warehouse trucks, ~50 airport tow tractors)
- Fleet sizes 10 – 50 vehicles each
- Partners: STILL, MULAG, Air Liquide, Element Energy, EHA, JRC, Heathrow Airport, H2 Logic
- Coordination: LBST

HAWL
Hydrogen At Warehouse Logistics
- Demonstration of 200 MH vehicles
- Demonstration of FC systems in 6 different power classes / applications incl. product certification
- Partners: Toyota MH EU, Crown, FM Polska, HyPulsion, Diagma
- Coordination: Air Liquide

MAWP
Multi Annual Work Program (FCH JU)
Practical targets for FC materials handling vehicles
- spec. costs FC system
- spec. costs H₂ storage
Demo projects in a scale to allow for a competitive technology implementation
- fleet sizes >50 vehicles at each site

Successful roll-out also in Europe?
Summary and Outlook

- The right time to start the roll-out is now.
  - Technology is there and reliably operating.

- From an economic point its application is not reasonable everywhere.
  - Large fleets, multi shift operations, etc.

- Financial support is still required at this point in time.
  - Is available for demo projects at European level

- Appropriate market deployment mechanisms still need to be developed.
  - Challenge: there is no strong lobby

- Networking of European actors is urgently required.
  - E.g. Vehicle User Group in the framework of HyLIFT-EUROPE

- Commercialisation efforts need to be enforced.
  - Full-service packages with attractive TCO (incl. H₂ supply) for customers need to be developed

- European manufacturers are not as far developed as the ones from N.A.
  - Immediate and consequent actions are required
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