



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

10th International Colloquium Fuels – Conventional and Future Energy for
Automobiles

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MHV's with hydrogen powered fuel cell drive train



forklift

- Converted battery electric forklift
- Often first OEM-product for fuel cell implementation



Source: STILL GmbH

airport tow tractor

- Combustion engine replaced by fuel cell
- Application scenario: airport
- Outdoor operation



Source: MULAG GmbH

pallet mover

- Converted battery electric vehicle
- Application scenario: Commissioning of goods for delivery



Source: Linde Material Handling GmbH

reach truck

- Converted battery electric truck
- Application scenario:
 - high rack warehouses
 - Indoor
 - Outdoor
 - Operation in small aisles



Source: EnergieRegion.NRW

Operation sites of FC MHVs worldwide



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In total about 5,500 MHVs in operation (status 2013):



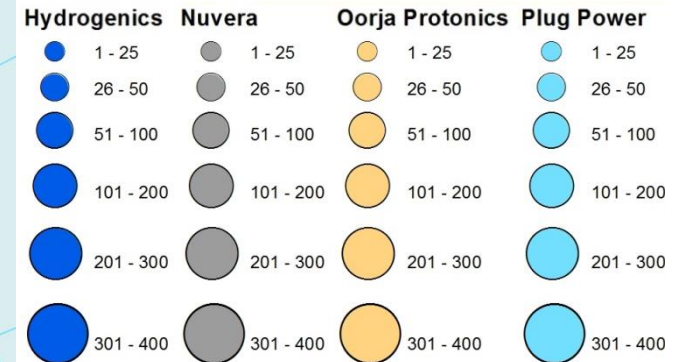
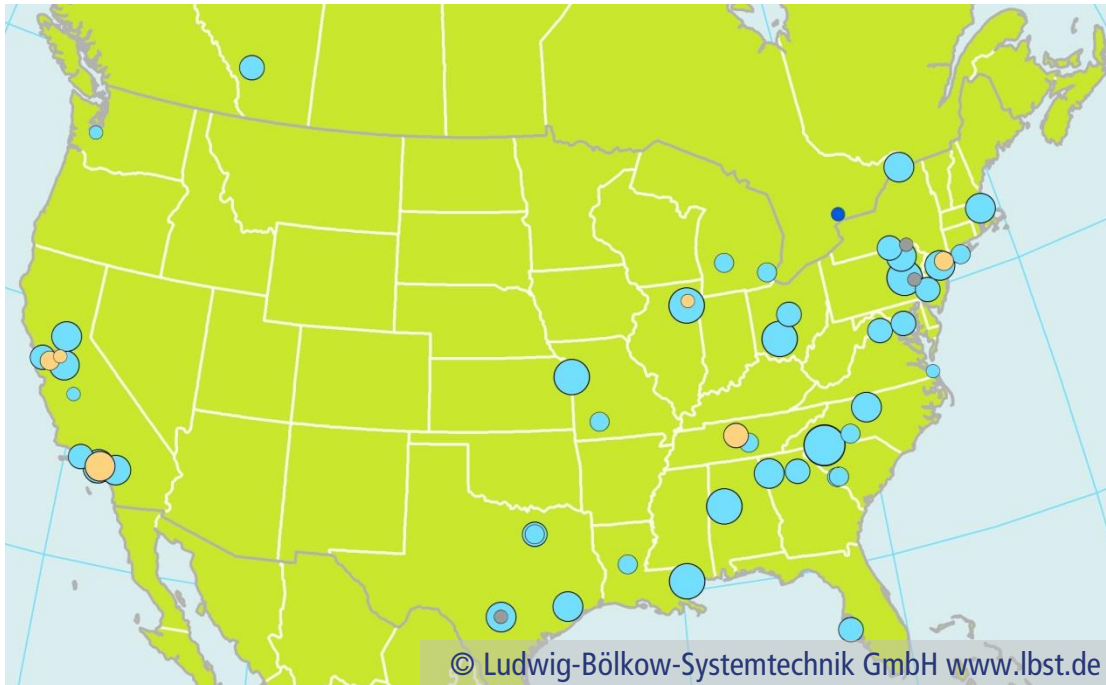
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Operation sites of FC MHVs in North America



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



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Selection of companies operating FC materials handling vehicle fleets:

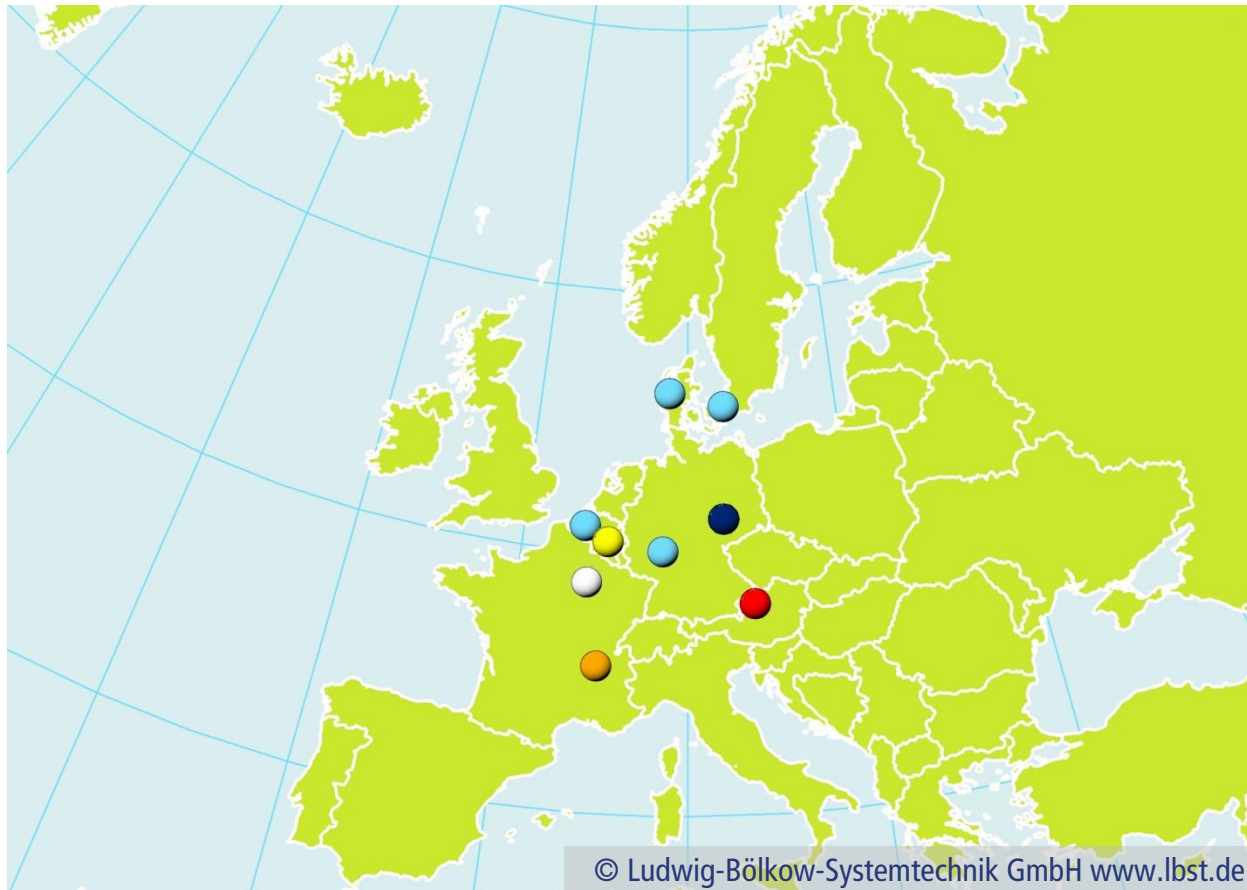


Operation sites of FC MHVs in Europe



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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



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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



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- 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



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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



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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



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- 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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