Executive Summary of WP 4: Feasibility on Demo of “Other Vehicles”

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1 Objective

In the first phase of the project a listing of current “other vehicle” applications with main focus on Europe and basic information about US fleets were compiled. Some of the applications could be directly supported on a high level of details due to the participation of industrial partners in NextHyLights. Other applications are based on voluntarily provided data arising from direct interviews conducted with stakeholders. In this way comprehensive information to the different application areas of “other vehicles” was collected and received data sheets were assessed in detail. The results and assessments were presented in a project meeting and it was commonly agreed among the project partners to investigate in further details the three vehicle segments material handling vehicles (Deliverable 4.2), boats/ships and municipal sweepers (Deliverable 4.3).

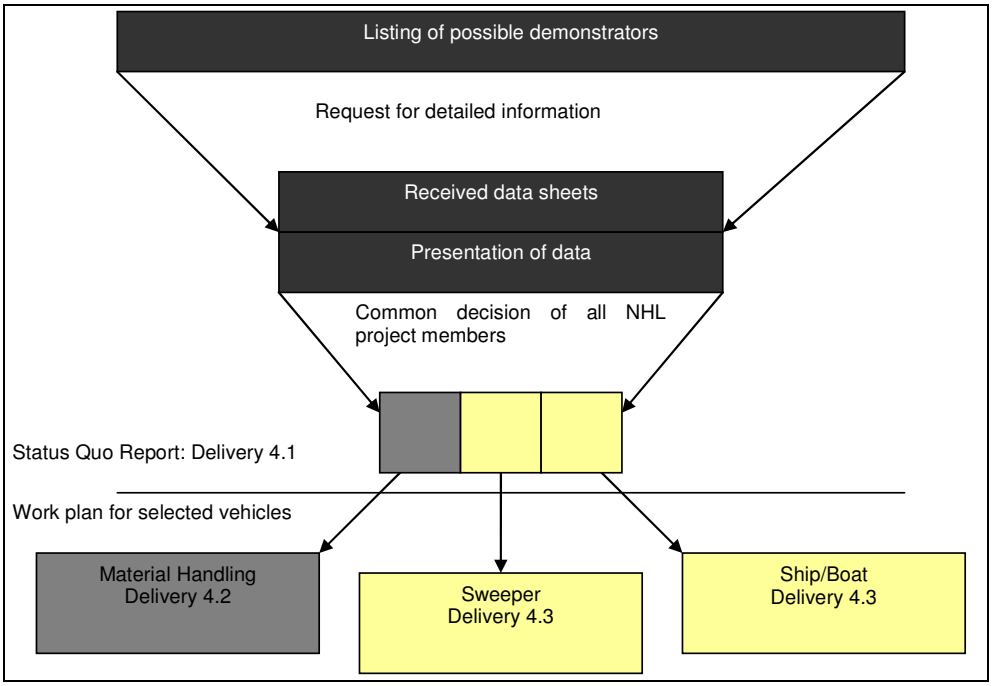

Figure 1: Process of WP4

The largest vehicle groups in the other vehicle segment are forklifts, material handling applications, scooters and boat/ships (ref. Fig. 2). The motivation for the development of fuel cell (FC) applications are in view of extended driving range compared to pure battery vehicles (e.g. forklifts) and zero emission technology versus internal combustion engines (ICE) especially at locations where strong emissions restrictions exist (e.g. on lakes).

Potential customers are industries, municipal institutions and private enterprises.

The most common hydrogen storage system is the 350 bar compressed gas tank. Additionally 200 bar and 700 bar gas tanks are used. Only some of the applications like e.g. scooters or municipal sweepers can benefit from public bus or car hydrogen refuelling stations. Material handling vehicles or forklifts, boats and ships need on-site refuelling stations preferably close to the location of daily operation.

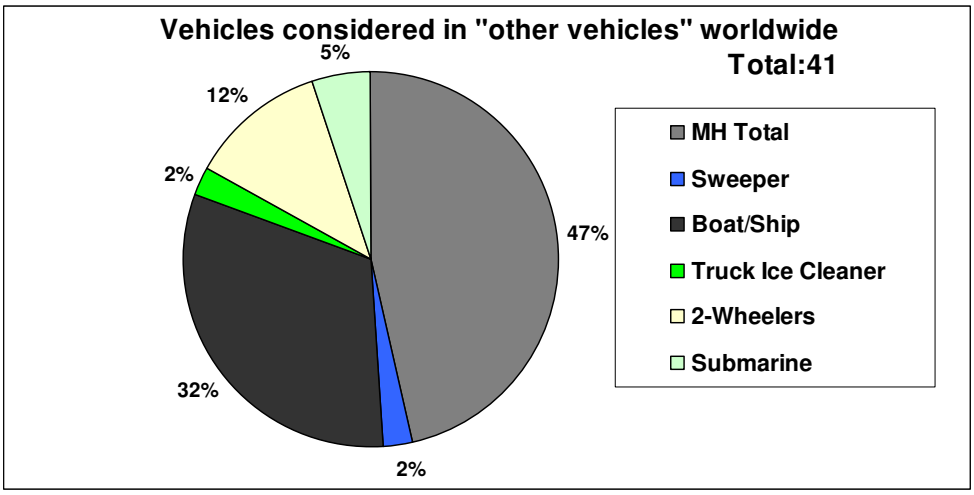

Figure 2: Vehicles considered in "other vehicles" worldwide

2 Material Handling (Forklifts)

a. State of the Art

The number of fuel cell (FC) forklifts has been reached about 1000 vehicles in US and less than 20 vehicles in Europe until end of 2010. Larger fleet numbers are operated only in US whereupon European projects have small scale character.

In US and Canada fuel cell manufacturers highly promote fuel cell forklifts and prospect near cost benefits substituting battery forklifts. The main arguments for battery substitution can be summarized to faster refuelling time, no power loss in vehicle performance, higher lifetime and better utilisation of commercial space. Finally fuel cell and hydrogen infrastructure purchasers get on an unbureaucratic way 30% direct tax credits.

Europe has a high commitment from infrastructure providers for fuel cell forklifts but large material handling companies are less active than in US. Discussions with forklifts operators lead to the conclusion that battery vehicles work quite well and the customers are satisfied with the technology. Better energy management in the vehicles and advanced battery changing solutions are available and obviously avoid productivity disadvantages at battery forklifts. Thus, end user motivation is rather limited regarding fuel cells even due to higher financial risks and additional project efforts.

b. Economy

The driving motivation for operators of large fuel cell forklift fleets is the beneficial total cost of ownership (TCO) potential of fuel cells. A better TCO in comparison to battery vehicles is expected for 2015. Today the fuel cell vehicle costs are twice as much as conventional ones and thus cost reductions in all components including hydrogen supply and maintenance are needed. Hence, fuel cell forklifts can currently not compete against conventional technologies. Early fuel cell forklift demonstration projects are depending on financial supports.

Case studies show that high fleet numbers, high operating grades and use of synergies positively affect the TCO (time horizon until 2015). For 2015 and beyond

commercial cost targets for stacks, fuel cell systems, maintenance, provided hydrogen and entire vehicles were defined.

The prospected further cost reduction confirmed by European companies could make fuel cells in material handling applications an economic option in the next years.

c. Energy and Emission Analysis

Fuel cell fork lifts meet clearly the common goals of less emissions and lower energy consumption if internal combustion engine (ICE) forklifts are substituted.

The equivalent energy consumption of fuel cell forklifts is considerably higher than at battery vehicles but significantly lower than at ICE vehicles.

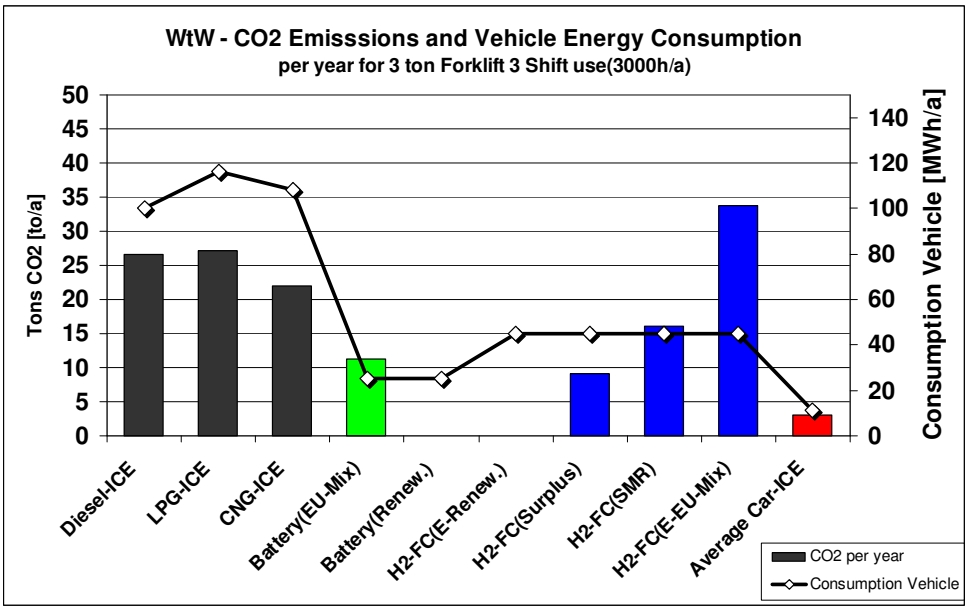

Figure 3: WtW-CO2emmissions and Vehicle Energy Consumption

Assuming 7.5kWh energy consumption per hour of a 3ton class 1 battery forklift, a fuel cell forklift consumes 55-100% more (target 2020 and today) and an ICE forklift 350% more energy.

Both, fuel cell and batteries are zero emission technologies. Thus the direct substitution of battery vehicles does not automatically contribute to a sustainable CO2 reduction. Exceptions are given for applications with surplus, by-product or renewable hydrogen. The highest potential for CO2 reduction is given by substitution of ICE forklifts - which are mainly in load areas greater 2.5 t.

d. Market Potential

Boundary conditions limit the market. Depending on the price drop in the next years the market will be limited to a few thousand vehicles a year but will be increased if further price reductions can be reached - especially at the purchase price for the fuel cell vehicle.

e. Technical Maturity

Currently forklift demonstrations did not prove the set targets so far. Thus, technical maturity regarding lifetime, reliability, fuel economy and productivity advantage is neither accurate nor validated. Lifetime is one challenge and is targeted to reach 10.000h until 2015 and finally 15.000h. An important user requirement is the reliability of forklifts which is targeted to >95% until 2015 and finally >99% (today's data not yet validated).

The current fuel cell forklift demonstrator is typically a class 1 forklift in the 2.5 t range and substitutes a battery system. For easier installation the fuel cell power pack is designed for same size and dimensions as the lead acid power pack. The PEM fuel cell has a typical power range of 10kW and operates with hydrogen from a 35MPa tank.

f. Recommendation

Recommendations for fuel cell forklift demonstrators providing as a whole the best arguments regarding economic aspects, market potential, energy and emission saving requirements, end user expectations (i.e. motivation to apply FCs) and supporting the European fuel cell industry were worked out and reported in Deliverable 4.2.

3 Municipal Sweepers

The municipal sweeper is currently demonstrated in Switzerland and will be ready to high fleet demo in the next years. Customers will be public institutions. The fuel cell sweeper can fairly eliminate noise, exhaust and greenhouse gas emissions which is important especially in the sensitive inner-urban area. The efficiency advantage of the fuel cell prototype in comparison to standard Diesel vehicle already safes 30% energy per operating hour. However, only one fuel cell sweeper prototype exists and projections are not yet accurate.

Compact sweepers are mainly sold in Europe due to the historical growth of the cities and the smaller roads. On average about 6-10 vehicles per 100.000 inhabitants are operating in European cities.

Recommendation is to implement the sweeper in other demonstrations where capacities from infrastructure are available. Sweeper demo projects can be integrated in car or bus projects as well and could be serviced by the same hydrogen refuelling station.

4 Boats and Ships

Boats are currently very promising applications and can well benefit from synergies to on road fuel cell vehicles and hydrogen infrastructures. However, the current prices of fuel cell boats and ships can not yet compete with conventional technologies.

The fuel cell versions are more expansive than ICE boats. But several synergies to automotives are given. Boats require approximately the same power outputs as fuel cell cars, have minor packaging requirements and could use 70MPa fuel technology. This could make the boat market to a very early follower of the automotive industry

and could generate additional volumes. However, the boat branch itself is too small for having significant impacts on the fuel cell prices.

Recommendation is to support current research activities and infrastructure, especially if the hydrogen refuelling station could be used for boats and on road vehicles.