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Hydrogen: Fueling the future

- Sustainable energy carrier for future mobility
- Potential to cut EU road transportation CO₂ emissions by over 50% by 2050
- Strong political support necessary

Berlin. Hydrogen is the most abundant element in the universe. It is a colorless, odorless and non-toxic gas that is 14 times lighter than air. It is also set to be a key alternative fuel of the future that can simultaneously displace fossil fuels used in transportation and reduce greenhouse gas emissions.

HyWays, an EU-funded research project on hydrogen infrastructure build-up in Europe, concluded that by introducing hydrogen, CO₂ emissions from road transport could be reduced by more than 50 percent by 2050 in a cost effective way. Total oil consumption from road transport could be cut by about 40 percent if 80 percent of all vehicles were operated on hydrogen on a well to wheel basis.

A critical hurdle for using this innovative fuel is providing fueling stations. The HyWays study concludes that fueling stations are economically feasible at scale and ultimately achievable. Providing the infrastructure however, will require a strong joint commitment from industry stakeholders and the public sector.

“Studies like HyWays show that the initially shared financial burden of developing a hydrogen refueling infrastructure by 2020 far outweighs the gains for everyone – customers, industry and society,” says Dr. Ulrich Bürger from Ludwig-Bölkow-Systemtechnik GmbH, the coordinator of HyWays.



Sustainable and clean

Although hydrogen molecules do not naturally occur on our planet, hydrogen is commonly found in a wide range of compounds and substances, including water and all forms of biomass and fossil fuels.

That is what makes it an attractive and universal source of fuel: Because it can be produced from a wide range of feedstock, production can be adapted to the energy sources available in any given region. Today, more than 56 million tons of hydrogen are produced globally each year, enough to theoretically fuel 180 million Fuel Cell Electric Vehicles (FCEVs). Most of the world's hydrogen is currently used for industrial purposes, such as in oil-refining and fertilizer production. It is produced and handled safely through well-established industrial processes, mainly from natural gas.

Hydrogen's viability as a fuel at scale, in terms of availability, sustainability and production processes, is widely acknowledged. This means a supply of hydrogen fuel for automobiles – initially from natural gas – can kick-start a supply infrastructure.

However, in the medium to longer term, there is great potential to extract hydrogen from water through electrolysis – the fuel cell process in reverse – using electricity generated renewably from wind, solar or hydro-power. In this way, any renewable pathway to zero-emissions electricity is also a renewable pathway to hydrogen.

Highly efficient gasification of biomass to hydrogen for fuel cell vehicles can become an efficient alternative to the direct use of biomass-based fuels in internal combustion engines. Thus, hydrogen is no longer just a chemical produced for specific industrial processes. Instead, it becomes a universal energy carrier with huge potential to transport and store fluctuating electricity from renewables.

Production costs ultimately low compared to societal costs of oil

The HyWays study, carried out over three years among stakeholders in 10 EU member states, concluded that the development of hydrogen end-use technologies is a sustainable investment well worth the long-term societal benefits.



A kilogram of hydrogen contains about the same amount of energy as 3.7 liters of gasoline. Because a fuel cell propulsion system typically is twice as efficient as a gasoline engine, one kilogram of hydrogen could be sold at twice the price of gasoline and still cost about the same per kilometer for consumers as petrol.

The U.S. study, “Hydrogen Fueling Infrastructure Assessment,” from December 2007 by General Motors and Shell indicated that using today’s known technologies, hydrogen at scale can be produced, transported and dispensed at a cost of \$4 – 6 per kilogram. This implies that hydrogen – on a cost-per-kilometer basis – can be competitive with a gasoline retail price at \$2 – 3 per gallon.

The study points out, production of hydrogen sufficient to fuel 10 million FCEVs would only require an increase in US natural gas consumption of about 2%, giving sufficient lead time to develop alternative feedstock and produce pathways to supplement natural gas-based steam methane reforming.

The challenge ahead for the introduction of hydrogen is not, ultimately, one of scale or even cost, but one of enacting a commitment from all stakeholders, public and private, to make it happen.

Kick-starting a supply Infrastructure

To start the growth of a retail infrastructure, the GM/Shell study anticipates targeting a few specific geographical regions. It is essential that the deployment of FCEVs and the installation of filling stations develop simultaneously.

HyWays also foresees the initial roll-out of hydrogen filling stations in a few select population centers. Tank trucks will carry hydrogen from production centers to filling stations, but these would be progressively replaced by pipelines as hydrogen demand increases. In addition, on-site production of hydrogen from natural gas or through electrolysis of water can become an option, depending on the European region.



Both studies and experts agree that a careful balance needs to be struck between the volume of vehicles in use and the availability of stations to fuel them. To minimize capital costs, there should be enough stations to meet demand while ensuring a reasonable rate of utilization. At the same time, to encourage the growth of FCEV sales, consumers need to be confident that there are sufficient stations covering a large enough area for adequate mobility.

The GM/Shell study concludes that at scale, a hydrogen infrastructure for automobiles “is economically viable and doable.” However, it requires “a collective will by automakers, energy suppliers, and the government to overcome initial capitalization risks, motivate early movers and manage the transition.”

Governments play key role

Governments play a key role in helping to ensure such early growth does not stall, by providing financial and regulatory support. Clear strategies must define the role of hydrogen and develop codes and standards for the siting and permitting of stations, the GM/Shell study says.

Indeed, the HyWays Action Plan calls for a European-wide hydrogen-specific support framework, including: increased R&D budgets for hydrogen production and end-use applications, an initial zero tax rating for hydrogen fuel and a tax exemption, or subsidy, for hydrogen vehicles.

Contacts:

Uwe Deller

+49 6142 7 60178 (office)

+49 160 368 5913 (mobile)

uwe.deller@gm.com

Andrew Marshall

+49 6142 7 73815 (office)

+49 171 221 3605 (mobile)

andrew.marshall@gm.com

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