EHA contribution to the EU Consultation on a European Strategy on Clean and Energy Efficient Vehicles

The European Hydrogen Association, EHA, representing 16 national associations and the main hydrogen infrastructure development companies, promoting the use of hydrogen as a clean energy carrier and hosting the offices of the European Regions and Municipalities Partnership for hydrogen an fuel cels, HyRaMP, welcomes the opportunity to contribute to the consultation on the EU Strategy on Clean and Energy Efficient Vehicles.

The proposed "mediumterm orientation" (up till 2020) to successfully restructure and maintain Europe's competitive edge in clean car technologies however can not be complete without addressing the need for a coordinated development of a sustainable recharging and refuelling infrastructure making the best use of primary energy sources. The need for an *optimum allocation of resources, high level synergies*, *better regulation* and *involvement of all stakeholders* is equally true in developing an efficient electric transport infrastructure, without which the proposed strategy's objective of "a fully functional Internal Market" with respect to "green vehicles" will not be achieved. This paper therefore particularly addresses key issues regarding the necessary *infrastructure build-up* for clean and energy efficient vehicles, in particular fuel cell electric vehicles (FCEV) and offers suggestions for EU policy measures to facilitate an accelerated roll-out of these vehicles.

Over the last decade the joint efforts of European hydrogen and fuel cell industries, with the support of the EU and national and regional programmes, have demonstrated the potential of this sector to contribute to the main drivers of the EU 2020 strategy:

1. *Accumulating knowledge* on a new energy and transport technology and produce commercial applications; Europe's automobile and hydrogen industry are market leaders in this sector;
2. *Inclusive growth;* many hydrogen and fuel cell design-to-product development takes place in Europe's small and medium sized companies, creating high skilled new jobs;
3. Facilitating a step change to a *clean and efficient use of primary energy sources* including renewable sources: hydrogen produced by renewable electricity could cover all road transport fuel needs by 2020 (see table below).

Source: TES (Transportation Energy Strategy) Report 2007

In order to fully leverage this potential with regards to the deployment of FCEV the EHA is observing six key areas of EU policy support that cover the topics of the six questions that the Commission poses with regards to the new strategy:

1. Should the vision agreed in the CARS 21 mid-term review be now adjusted?

Although the EHA agrees with the CARS 21 mid-term review with regards to the perspective for FCEV, in order to seriously consider mass market roll out of hydrogen vehicles in the medium and long term, ***short term action*** is needed to adapt current and future EU legislation to the potential needs of an efficient hydrogen refuelling infrastructure.

Two examples:

a. In view of the Review of the Integrated Pollution and Prevention and Control Directive, the EHA has asked to adjust the authorisation of small hydrogen reformers that currently have to follow the same lenghthy authorisation procedures as large scale industrial reformers. Europe has an important hydrogen reformer industry and in building the first local refuelling infrastructures these hydrogen reformers will become an interesting first market with global potential. The current authorisation process will delay infrastructure roll-out and affect the deployment of the first FCEV fleets.

b. The Review of the Seveso II Directive offers a similar opportunity to support the build up of hydrogen refuelling stations in that the new Directive could include a larger hydrogen storage treshold than the current 5 tons that could hamper the normal functioning of even a small sized public hydrogen refuelling station.

These examples illustrate the need to include a review on the effects of current and future EU legislation on the perceived medium to long term perspective for the roll-out of FCEV.

2. What is the potential of different clean automotive propulsion technologies?

The use of hydrogen as a transport fuel is not new: the first combustion engine, vehicles ran on hydrogen. In developing their first hydrogen infrastrucutures some regions and cities in Europe, but also in developing countries like India, have been experimenting with the use of hydrogen in mixtures with compressed natural gas (CNG), used in internal combustion engine cars, as a cost effective and low carbon transition to the development of a pure hydrogen infrastructure. The use of CNG/H2 mixtures, with up to 30V% of hydrogen, according to some car companies, can significantly improve the CO2 reduction levels of CNG vehicles without costly modifications to the engine.

Although there is no consensus in the car and hydrogen supply industry on the contribution of the use of mixtures in accelerating the roll-out of pure hydrogen fuel cell vehicles, in countries with a well-developed natural gas infrastructure (Italy) or a with high biogas potential (Sweden) the development of the first CNG/H2 networks is being explored. As the EU Regulation 2009/79 on the Type Approval of hydrogen powered vehicles includes a reference to CNG/H2 mixtures, the potential contribution of these type vehicles could be further explored under the strategy’s Pillar 1.

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What is the decarbonisation potential of the complementary measures in the short, medium and long term.

Recently Smart Grids development have been mostly linked to the roll-out of electric battery vehicles, while hydrogen, as an energy carrier and potential grid balancing medium could be considered as well. Further research is needed to identify the full potential of the use of hydrogen as a large scale storage medium of electricity to balance grids and buffer the electricity influx of large scale offshore wind parks. This would be an excellent topic for joint collaboration of the respective Europan Industrial Initiatives that will be set up this year (Wind, Smart Grids) and the Joint Undertaking for fuel cells and hydrogen (FCH JU).

3. What are the implications of new propulsion technologies in a lifecycle analysis perspective as regards vehicles, and in a well-to-wheel perspective as regards energy supply chains? What are the resource implications in introducing innovative propulsion technologies?

As for battery electrical vehicles (BEV's) the impact on CO2 emissions of using hydrogen to fuel cell electric vehicles (FCEV) will depend mostly of the carbon content of the primary energy used (factored by the efficiency of the conversion to hydrogen) :

- with hydrogen produced from natural gas, the well-to-wheel (WTW) GHG emissions of FCEV is approximately 53% of the emissions of current conventional internal combustion vehicles of equivalent performance[i],
- with hydrogen produced from electricity generated from carbon free sources (wind, solar, nuclear power – by water electrolysis), or from biogas or biomass, there are no GHG emissions.

It is to be noted that the WTW efficiency (and hence environmental performance) of FCEV using hydrogen produced from natural gas is superior to that of BEV's using electricity generated from natural gas, even when a combined cycle is used. This advantage becomes much more significant when the actual European mix of energy sources used to produce electricity is considered.

As hydrogen is already produced in large quantities across the world (about 600 Bm3/yr - enough to fuel more than 250 million FCEV) mostly from natural gas, it can be expected that the reduction of GHG emissions from transport will be achieved immediately using FCEV's. This is not generally the case with BEV's where a significant shift towards low carbon sources of the primary energy mix used to produce electricity is required first.

Fossil energy sources will be gradually substituted by green electricity and green hydrogen for vehicle propulsion in a 10-15 year transition period, as soon as the new vehicle propulsion concepts will conquer the markets (earliest after the average vehicle age of 12 years has led to accelerated replacement of old vehicles). This will also be the timeframe in which larger volumes of fluctuating renewable energies will have to be fed into electric grids in Europe. Large volumes of excess electricity can only be stored for longer than 48 hours via pumped hydro or by hydrogen underground storage. This stored hydrogen will then only have to be re-electrified in peak demand times by combined cycle power plants or used in fuel cell vehicles as vehicular fuel. In current large transport and energy infrastructure planning, supply chains that include requirements for hydrogen production and distribution are not yet considered.

**4. What are the state of play and the future scenarios of technological developments in alternative powertrains (electric and hydrogen) and their market penetration? What are major risks and opportunities associated for different stakeholders?
What will be the economic, societal, employment and environmental impacts brought by these developments?**

1. Risks and opportunities with regards to the development of battery and fuel cell electric vehicles:

As battery electric vehicles BEV will be expensive during the next 10 years, the more affluent first customers usually own houses or apartments where they can charge overnight. This reduces or eliminates the need for expensive fast charging and thus public recharging units. Furthermore, these vehicles will be the 2nd or 3rd car in these customer groups. If fuel cell electric vehicles (FCEV) can achieve infrastructure and vehicle roll-out aggressively during the next 7 years, the need for large numbers of expensive 50kW or 100kW fast recharging systems will be reduced or eliminated since vehicles driving 200km + would be fuel cell vehicles (and plug in hybrides in a transition phase).

2. Risks and opportunities with regards to the development of a sustianable hydrogen refuelling infrastructure:

Introducing hydrogen as an energy carrier enables the use of biogas and biomass as a primary energy source for transport applications, as the conversion efficiency from these sources to hydrogen is greater than to electricity.

Using hydrogen to store intermittent energy production when production exceeds consumption allows to increase the production capacity usage ratio. The electricity-to-hydrogen conversion losses are more than compensated by the extra market value of hydrogen produced from carbon-free sources for use as a vehicle fuel, in comparison to energy from the electrical grid. The supply of hydrogen to the transport sector will significantly strengthen the business case for the use of intermittent energy sources by covering a strong share of the costs of the highly needed storage function.

When electrical power is used to produce hydrogen (by water electrolysis) - as would be the case when using photovoltaic or wind power - the electricity production and distribution capacity required to power an FCEV is larger than what is required to for a BEV. The electricity generation and distribution (mean) capacity required to produce the required hydrogen to power an FCEV is larger than the capacity required to support a BEV (due to the hydrogen-to-electricity conversion energy losses taking place in the vehicle). However the cost of this extra per vehicle production and distribution capacity is smaller than the extra cost of the BEV compared to the FCEV (due to the cost of the BEV batteries required to achieve the same driving range as the FCEV)[1].

It can therefore be concluded that the solution consisting in producing hydrogen from an intermittent energy source for running an FCEV is more cost-effective than producing electricity from the same renewable source to run a BEV (with the same range).

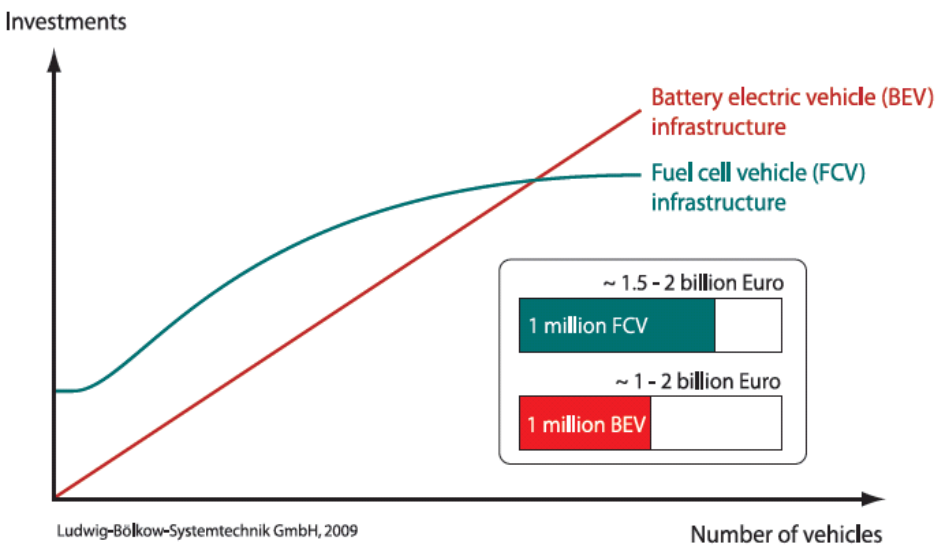
This is a further indication of the competitiveness of FCEV's under the currently applied road vehicle duty specifications (payload, driving range, auxiliary energy).

3. The cost of developing a hydrogen refuelling infrastructure is relatively modest:

As hydrogen vehicles are fuelled like conventional vehicles, establishing a fuelling infrastructure consists in adding hydrogen dispensing systems to existing stations and developing means of transport and delivery to these stations, as has been done for previously introduced alternative fuels (such as LPG or CNG). As far as production is concerned, hydrogen is already produced in large quantities from natural gas for mature industrial activities such as refining. As for electricity generation in general, there will be a drive to develop the production of hydrogen from renewable energy sources for transport applications.

The investment cost of the hydrogen refueling infrastructure can be estimated at 1700 € per vehicle in 2020, decreasing to 1000 € per vehicle with increasing fuelling capacity usage[1]. This cost is not significantly higher than that of a BEV recharging infrastructure[1] (despite much shorter "recharging" times for FCEV's).
The cost of the hydrogen fuel at the dispenser will be determined mostly by the primary energy source and the means used to transport the hydrogen to the points of fuelling (an alternative being to produce the hydrogen on the site of dispensing). Overall, the cost for the end-user of using hydrogen as a fuel is not expected to be significantly higher than the cost of using gasoline;

	Estimated fuel cost per 100 km (see note[2])			
	2010	2030 Optimistic	2030 Pessimistic	2030 Average
Gasoline (without tax)	2.1 €	3.1 €	6.3 €	4.7 €
Hydrogen	3.5 €	1.2 €	4.6 €	2.9 €



The EHA recent strategy paper "Energy Infrastructure 21, the Role of Hydrogen in Addressing the Challenges in the new Global Energy System", to be presented on March 23, 2010 in Brussels, describes a likely electrification scenario of future tranport systems in view of the depletion of fossil fuels, both oil and gas, and the small potential of biofuels.
Given the long investment and construction cycles, rapid action is needed to adapt the electricity network and management systems to electric transport to avoid a costly and energy ineffcient patchwork of recharging and refuelling stations in the future.

5. How can a trade-off situation be avoided where electrifying the power train would reduce or reverse improvements made in conventional technologies in the framework of existing and upcoming legislation on the CO2 emissions of road vehicles?

Negative implications of this trade-off can be avoided by introducing targets for captive fleets to facilitate an increase in the number of cars with certain low carbon quota. For example it has been proposed to accompany the introduction of CNG/H2 mixtures vehicles in local fleets in Italy with a quota for introducing fuel cell buses and cars alongside these vehicles to facilitate their market introduction and hydrogen refuelling infrastructure construction. The proposed website with information that the Commission is setting up under the Directive for the promotion of clean and energy efficient vehicles could include guidelines and procurement models on how to link current acquisitions of conventional carbon lean cars with the acquisition of small numbers of zero emission cars.

As many regional and local governments are outsourcing the management of their fleets to private companies the effect of such measures should not be underestimated. The upcoming Climate and Transport proposal that was annoucned by DG Climate Action at the Hearing of March 11 could include measures to couple acquistions of public authorities of more conventional cars with zero emisssion cars.

The announcement of the EU Taxation Commissioner on March 9, 2009 to overhaul the Energy Taxation Directive with a CO2 and energy content tax, could be another measure that would accelerate consumer choice towards zero emission vehicles.

6. What actions should be best taken at regional/ national /European or international level to promote technology development and market uptake of alternative powertrains (electric and hydrogen)?

Regional level.
In 2008, with the support of the EU Commission, the European Regions and Municipalities Partnership for hydrogen and fuel cells, HyRaMP, was established to facilitate the development of the first markets for hydrogen and fuell cell applications by hosting and co-funding big demonstration projects under the FCH JU programme and setting up joint procurement and local supply and maintenance chains. HyRaMP is now representing 30 regions. The first experiences indicate that concrete action is needed in the following areas:

1. In-depth reviews of current and potential research and developments budgets at local level to leverage EU, national and local funding;
2. Increased efforts to synchronize multi level budget cycles and topics;
3. Development of comprehensive joint procurement schemes at National and International level that facilitate access of local actors to global markets;

4. Adaptation and harmonisation of local authorisation requirements;
5. Identification of key local stakeholders of new industrial value chains;
6. Integrated approach to environmental and economical sustainable development of electric transport at local level with regards to ensure the efficient use of primary energy to power battery vehicles or produce hydrogen for use in fuel cell vehicles.

Those actions will only be effective if regional and local organisations active in clean energy technology deployment are involved at an early stage in the development of new funding frameworks and relevant programmes at national, EU and international level.

National level

The market roll-out challenge of FCEV has often been described as a chicken and egg problem of vehicles needing refuelling infrastructure and infrastructures needing the cars. As 9 major car companies on September 9, 2009 jointly announced their commitment to put hundred of thousands of fuel cel cars on the roads annually by 2015[3], large hydrogen infrastructure developers responded a day later presenting their H2 Mobility[4] initiative that will facilitate the infrastructure build-up in Germany necessary for these numbers.

Although the good example of Germany will inspire many other Member States to follow suit, more coordination at EU level is needed to secure that other Member States and especially new Member States will be able to catch up quickly and benefit from the emission reduction and market potential of these vehicles.

Leveraging of funding at all government levels could greatly enhance overall budgets for clean technologies but will need not only coordination of *funding programmes* but also coordination of *budget cycles*. A lot of additional support for new technology development and innovation at local level is not put to use at national and EU level because local budget cycles do not match EU programmes calls for proposal timelines. As being in the *middle* between local and EU funding, national governments usually have an up-close overview of financing an funding possibilities at EU and local level. National governments therefore should take more action on making sure that the current possibilities of funding clean technologies in Structural Funds and State Aid are put to use to effectively enhance markets for European clean and energy efficient vehicles.

European level

Hydrogen as an electric transport carrier will only be able to contribute to the three drivers of the EU 2020 strategy if the following enabling actions are taken on in a concrete manner at EU level:

1. Decarbonisation of transport will not happen in a sustainable way if *interdependence between Members States, national and local government*, is not leveraged to ensure the most efficient use of available primary energy sources.
The new European Industrial Initiatives (EII) that are currently being set up under the EU Strategic Energy Technology Plan should therefore contribute to the establishment of a sustainable infrastructure for clean and energy efficient vehicles. An *EU Clean and Energy Efficient Vehicle Platform* in addition to the information website that the Commission is currently setting up, could facilitate EU policy and programme coordination and could provide and act as a clearinghouse for communities that want to integrate zero emission vehicles in captive fleets.

2. *Exploiting the single market;* EU's single market efforts with regards to energy have mainly dealt with conventional electricity and gas infrastructures. Decarbonisation of EU's transport system will however need an indepth review of large energy and infrastructure programmes including TEN-T and the European Energy Recovery Package and their links with clean and energy efficient transport infrastructure build-up. For example pipeline construction for hydrogen disitribution could be integrated now in new transport corridor planning (Green Corridors programme) avoiding costly reconstruction works that disrupt traffic later.

3. *Reflecting political priorities in our public budgets;* the EU in recent years has put great emphasis on the creation of Public Private Partnerships to facilitate new market opportunities and to create the right infrastructures for new technology deployment. The potential role of these PPP's in lowering barriers and leveraging funding should not be underestimated. However as the first PPP's in energy technology have shown, (FCH JU), to make PPP's work effectively industrial and political goals will have to find a common denominator at local level, like reinforcement of the market position of involved industries, higher skilled work force, that will also attract other private investors etc. The EU could stimulate the development of collaboration models between different government levels (EU, national and local) that include the definition of these common denominators to ensure larger success rates of PPP's.

International level

The UN Climate Change Conference in Copenhagen has demonstrated the increasing importance of defining the concrete contribution of new technologies to reduce emissions in developing countries. Effective deployment of climate adaption and mitigation technologies, will dominate future global climate negotiations. The new industrial sectors, including clean car technologies, that the EU 2020 strategy seeks to build, will need EU's pro-active assistance to ensure that they will be part of the global market for clean technologies. Even more than established technologies, new technology companies will greatly benefit from industrial collaboration with emerging economies and from incentive schemes that ensure that these products can be deployed quickly in areas where they will have the biggest impact. The EU could take the lead in establishing a "World Clean Technology Deployment Organisation" that creates a global platform for clean tech market opportunities for companies in developed and developing countries.

Respectfully submitted,

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[1] C. E. Thomas, Fuel Cell and Battery Electric Vehicles Compared, International Journal of Hydrogen Energy 34 (2009) 6005-6020

[2] Offer, G.J., et al., Comparative analysis of battery electric, hydrogen fuel cell and hybrid vehicles in a future sustainable road transport system. Energy Policy (2009)

[3] http://fuelcellsworks.com/news/2009/09/09/major-car-manufacturers-sign-letter-of-understanding-on-fuel-cell-electric-vehicles/

[4] H2 Mobility Initiative

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