

IEA Hybrid and Electric Vehicles

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A word from the Chair

Urs Muntwyler

Chairman

The fuel cell workshop which was held in Berlin on June 28,29 turned into an important event, with about 120 participants from industry, government, academia, and the IEA. It had originally been intended as a CCT (Coordinating Committee for Transportation) roundtable for about 35 persons, but there was a lot of interest on the part of the German Government and industry, and it turned into something much bigger. This issue of the newsletter will describe some of the topics which were covered.

Secondly our Executive Committee meeting will take place in Montreal in about a month, and there will also be a workshop on Wednesday afternoon, October 18 on continuing the Battery and Supercapacitor Annex, and an Experts' Meeting for the Information Exchange Annex on Thursday, October 19. I look forward to seeing you all at EVS-17 and at these meetings.

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Are Fuel Cell Vehicles necessary for clean air?

From the paper by U. Höpfner

ifeu – Institute for Energy and Environment Research, Heidelberg

No, fuel cell vehicles are not necessary to reach the internationally accepted clean air standards. This was the view expressed by Mr. U. Höpfner of ifeu, and most other speakers at the Berlin workshop on June 28,29, 2000 agreed. The stricter emission standards which will enter into force in Europe and North America during the next five years will bring air quality up to - and beyond - widely accepted international standards, and this can be done with improved ICE and with hybrid vehicle technology. In Europe, improvements in air quality have already started, and will mainly be a function of the rate of fleet renewal. Fuel cell vehicles, which would only arrive on the market in large numbers in about ten years, would not make a significant contribution.

The important fact that there are zero noxious emissions from a fuel cell vehicle was acknowledged by all speakers and in some specific locations this may be very useful. However, fuel cell vehicles are not entirely pollution free because of the upstream emissions in producing hydrogen fuel, and because of SO₂ emissions related to the production of platinum for the catalyst. ◆◆

What does a drivetrain cost?

Richard Smokers

Operating Agent

Annex VII on Hybrid Vehicles has done quite a bit of work on analysing the costs of a drivetrain, and comparing this with the cost of the remainder of the car (usually called the "glider"), and this was the basis for my paper at the Berlin workshop. Other speakers,

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What does a drivetrain cost?

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such as Mr. Noreikat and Mr. Eberle also discussed this topic. The cost of the drivetrain is of the order of 12 % of the total cost of a car to the consumer. There has been a consistent relation in per capita GNP and the cost of cars, in other words car prices go up as the GNP per capita increases because consumers buy more options and features. Over time, the cost of the drivetrain has seen a slow but steady decrease as a proportion of the overall cost of the car. With growing GNP, consumers could easily afford innovative power trains and clean vehicles, but we would have to make sure consumers wanted them. ♦♦

How much energy does a passenger car need?

from the papers by K.E. Noreikat and M.K. Eberle
Daimler Chrysler and Paul Scherrer Institut respectively

At the Berlin fuel cell workshop, Mr. K.E. Noreikat of Daimler Chrysler pointed out that today's passenger cars need 3 kinds of energy, mechanical energy to drive the wheels (about 8 kW), thermal energy to heat the passenger cabin and defrost the windows (about 3 kW), and electrical energy for the lights and convenience items (about 3 kW). Discussions about drivetrain technologies should always take into account the need for all 3 kinds of energy, and not focus narrowly on just driving the wheels of the car. In a comparison among technologies, hybrid vehicles and fuel cell vehicles could conveniently supply all three types of energy, whereas battery electric vehicles do not have enough waste heat to supply the required amount of thermal energy. Mr. M.K. Eberle presented

information on the estimated energy consumption of a 960 kg vehicle in 2010. To travel 1 km might take less than 0.1 kWh of mechanical energy applied to the wheels, but this increases to 0.4 – 0.6 kWh/km, if the whole "well-to-wheel" energy chain is taken into account. ♦♦

What will Fuel Cell Vehicles do to reduce greenhouse gas emissions?

Several Speakers

Berlin Fuel Cell Workshop – June 28,29, 2000

All speakers agreed that the fairest way to compare among emissions of the different drivetrain technologies was to use "well-to-wheel" comparisons. Mr. Eberle showed that greenhouse gas emissions from a fuel cell vehicle using hydrogen generated by hydropower were about the same as those of a combustion engine vehicle using hydrogen. A fuel cell vehicle running on methanol would emit more greenhouse gases than a combustion engine vehicle running on compressed natural gas. However, a fuel cell vehicle using hydrogen derived from natural gas would be slightly better than a combustion engine vehicle running on compressed natural gas. Mr. R. Matthé of GM-Opel also showed GHG emission figures for fuel cell vehicles running on fossil fuel derived hydrogen, which were of the order of 100 – 150 gm CO₂ per km, which is about equivalent to a combustion engine vehicle running on compressed natural gas. The only exception was a fuel cell vehicle running on hydrogen derived from renewable sources. Mr. A. Douaud, of the French Petroleum Institute (IFP) presented a very extensive analysis of CO₂ emissions from fuel cell and other vehicles which also showed that emissions from fuel cell vehicles were comparable to advanced ICE vehicles. Only Fuel Cell vehicles running on hydrogen derived from renewable or nuclear energies had significantly lower emissions, but Mr. Douaud did not estimate the emissions from an ICE vehicle running on hydrogen. Mr. Douaud concluded that hydrogen from fossil fuels produces large amounts of CO₂ and poor energy efficiency, and that despite the high efficiency of the fuel cell power plant, the overall CO₂ advantage from well to wheel is questionable.

What will Fuel Cell Vehicles do to reduce greenhouse gas emissions?

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Mr. R. Kolke of the German Environment Ministry gave a presentation with similar conclusions, and with the addition of an economic comparison of how much it would cost to reduce CO₂ emissions from vehicles. An efficient ULEV drivetrain would reduce emissions and save about 100 German Marks for the owner. All Fuel Cell technologies would have increased costs to the owners, ranging from 50 to 500 German Marks. ♦♦

How does the energy efficiency of FCV's compare with other technologies?

Several Speakers

Berlin Fuel Cell Workshop – June 28,29, 2000

On a “well-to-wheel” basis, the energy efficiency of fuel cell vehicles is roughly equivalent to that of an ICE-Diesel engine. Depending on how the hydrogen is produced, it is 10 or 20 % less in some cases and 10 or 20 % more in others. The only exception is the case where the hydrogen is produced from hydroelectricity, in this case fuel cell vehicles are about 25 % more energy efficient than an ICE-Diesel vehicle.

If a life cycle comparison is made, and production of the car body, and the powertrain, maintenance, and fuel are all included in the energy calculation, then by far the most efficient technology is to use hydropower to produce compressed hydrogen, and to use this fuel either in a combustion engine or in a fuel cell. In this case, the fuel, including the fuel production chain, accounts for less than 25 % of the lifetime energy consumption, and the maintenance and production of the body and power train for more than 75 %. As a result, whether the drivetrain is an ICE or a fuel cell makes relatively little difference. ♦♦

What was not said

Frans Koch

Secretary – IEA Hybrid and Electric Vehicle Agreement

Only one of the participants at the Berlin workshop (Mr. Eberle) talked about an aspect of fuel cell vehicles which might make the energy efficiency and greenhouse gas emission comparisons somewhat

more favorable. Regenerative braking is easier to do in a fuel cell vehicle which also has supercapacitors than it is in a conventional vehicle. This would improve energy efficiency and reduce greenhouse gas emissions. There also was little discussion on the possibility that a hydrogen fuel tank, fuel cell, controller, and electric motor might weigh considerably less than a conventional drive train, and that these weight savings would translate into energy efficiency and reduced greenhouse gas emissions. ♦♦

When will Fuel Cell Vehicles be on the mass market?

Several Speakers

Berlin Fuel Cell Workshop – June 28,29, 2000

The answer, according to Mr. T. Kawai of the Toyota Motor Corporation is in 20X0, where X is at least one, and could also be 2 or 3. Mr. J. Reers of the international management consulting firm Roland Berger & Partners showed a “realistic scenario” projection where 50,000 fuel cell vehicles would be sold in W-Europe, Japan, and the USA in 2010, and 1 million in 2020. (for comparison, at the end of 1999 there were about 25,000 Toyota Prius’ on the road in Japan). All speakers agreed that fuel cell vehicles should be expected on the market in large numbers in the decade from 2010 to 2020, rather than the present one. Many speakers also cautioned against “overselling” fuel cell vehicles. If expectations are raised too high, and then cannot be met, there is a risk that the market can collapse. ♦♦

Why does industry want Fuel Cell vehicles?

Several Speakers

Berlin Fuel Cell Workshop – June 28,29, 2000

Speakers from Daimler-Chrysler, GM-Opel, and Toyota all expressed their company’s wish “to take automobiles out of the environmental debate”, in other words in the long term to produce cars with either zero or very low levels of emissions. They also mentioned energy security and energy availability issues both at the present time due to political risks, and in the long

Why does industry want Fuel Cell Vehicles?

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term due to depletion of oil and gas resources. It was mentioned that a hydrogen economy where the hydrogen is derived from domestic resources would be the ultimate in energy security. If these domestic resources were renewable, it would also meet environmental goals, and fuel cell vehicles would be clean, and efficient users of such hydrogen. ♦♦

Should Governments want Fuel Cell Vehicles?

From the papers by R. Kolke and J. Mc Callum

German Ministry of the Environment and UK Department of the Environment, respectively

Mr. Kolke from the German Ministry of the Environment and Mr. Mc Callum from the UK Department of Environment had reservations about the desirability of fuel cell vehicles. The former had concerns about the energy and environmental rationale of FCV's, and the latter stated that Governments would reserve judgment until more information about advantages and disadvantages is available.

Mr. Kolke agreed with other speakers that fuel cell vehicles only have strong advantages if they are fuelled by "renewable hydrogen". However, he pointed out that if additional renewable energy facilities become available, it is about four times as efficient to use them for the production of electricity as it is to use them to produce hydrogen as a motor fuel.

Other speakers had stated that producing hydrogen from "new" renewable sources, such as waste wood or solar, is from 7 to 15 times as expensive as conventional fuels at the present time. ♦♦

What is the Government role in Fuel Cell Vehicles?

Several Speakers

Berlin Fuel Cell Workshop – June 28,29, 2000

The Government role in Fuel Cell Vehicles (FCV's) was seen as :

- Maintain an open public debate about environmental and energy issues related to cars, and avoid "rough and ready" decision making. Obtain more objective information, as it becomes available, on the advantages and disadvantages of fuel cell vehicles, and eventually reach a decision on Government policy towards FCV's.
- Continue to support, and augment, pre-competitive research and development not only of fuel cell technology, but also of the technologies of generating hydrogen from renewable sources.
- Provide the environmental legislative framework. For clean air, this would mean continuing to monitor the improvements in air quality over the next decade, and if these improvements fall below expectations to enact corrective measures. It would also mean possible regulation of presently unregulated air pollutants. For greenhouse gases, this would mean monitoring progress towards the Kyoto targets, and enacting legislation or regulations as required. For energy security, this would mean continuing to encourage diversification of fuels and sources of supply, and encouraging energy efficiency.
- If it becomes evident that FCV's are a superior technology compared to other options, or are a desirable technology alongside the other options, support the same kinds of measures and programmes that were implemented for hybrid and electric vehicles:
 - first small and then large scale demonstration projects
 - fiscal incentives
 - subsidies
 - emission free city centres
 - support of infrastructure development
- Continue to monitor, and modify if necessary, test procedures for the environmental performance and energy efficiency of vehicles. To the extent possible, collaborate internationally so that new technologies do not have to be tested and proven in every country.
- Address safety issues related to FCV's and their fuels, and make regulations as appropriate. ♦♦

Summary of the Fuel Cell Workshop

Frans Koch

Secretary

So much information was presented at the workshop that a selection from it, and a summary of the highlights, always becomes somewhat subjective. This summary should be seen as a personal impression; a complete overview would require much more space than is available in a newsletter.

There was a consensus that it will require about ten years to solve the technical problems and make a fuel cell drive train which meets automotive requirements and is cost competitive. Such an FCV would use fossil fuels or hydrogen derived from fossil fuels, and would not have any significant greenhouse gas or energy efficiency advantages.

The most optimistic market penetration prediction was that fuel cell vehicles would have a market share of 15 % of new vehicles sold in 2020, and hence would represent less than 5 % of the total vehicle fleet at that time. For this reason alone, they could not make a significant contribution to urban air quality until after 2020. Several forecasts were presented that at least in Europe air quality would improve by 70 % to 80 % by the year 2010 due to stricter emission standards (Euro 4), and would then remain relatively constant. If this is true, then by 2020 urban inhabitants will have lived in clean air for 10 years and one would not expect clean air to be an issue any more.

There was a strong consensus that FCV's would only have strong advantages if they were fuelled by "renewable hydrogen". Some examples of interesting new technologies to produce "renewable hydrogen" from solar power and from waste wood were shown, their costs were estimated to be about 7 to 15 times the cost of gasoline today. At some point in time these technologies may be adopted, either because of a "paradigm" shift or because the era of "cheap oil" will come to an end. A paradigm shift can occur at any time, whereas estimates for the end of cheap oil vary from 40 to 100 years from now.

There are, of course, alternative scenarios for the evolution of the energy economy. From the purely economic viewpoint, "cheap coal" and hence "cheap electricity" can be expected for several centuries.

During this time, "renewable electricity" can gradually become more competitive and increase its share of total production. Hybrid vehicle technology seems to have a 10 year lead, and bio-fuels could be used when fossil fuels are depleted. Battery technology could advance during the next 10 years to the point where hybrid vehicles use a much larger share of electric energy and a smaller share of fuels.

There was a strong sense in the meeting that the hydrogen economy will come eventually, and so it is wise to prepare for it now. If this is true, fuel cell vehicles will have a bright future, if it is not, alternative technologies such as hybrid vehicles may well predominate. At the meeting, industry seemed to be strongly committed to FCV's, and for this reason they are likely to appear on the market. Governments appeared to be more reserved. ♦♦

CALENDAR OF EVENTS:

EVS-17

OCTOBER 15-18, 2000 – MONTREAL, CANADA

ANNEX 5 – (BATTERIES & SUPERCAPACITORS) WORKSHOP

OCTOBER 18, 2000 – (AFTERNOON) MONTREAL, CANADA

ANNEX 1 – EXPERTS' MEETING

OCTOBER 19, 2000 – MONTREAL, CANADA

HYBRID AND ELECTRIC VEHICLE EXECUTIVE COMMITTEE MEETING

OCTOBER 20,21, 2000 – MONTREAL, CANADA

Enquiries and Correspondence:

Enquiries and correspondence about this newsletter may be addressed to:

Mr. Frans Koch

Secretary

Implementing Agreement for Hybrid and Electric Vehicle Technologies and Programmes

5450 Canotek Road, Unit 53

Ottawa, Ont. K1J 9G3 CANADA

Tel: +(1) 613 745 7553 Fax: +(1) 613 747 0543

E-mail: f k o c h @ g v s c . o n . c a