



Annex XIII: “Fuel cells for vehicles”

Abstract

The International Energy Agency plays a key role in the worldwide efforts to satisfy the growing energy demand in a sustainable and efficient way. As the booming road transport depends nearly to 100 percent from oil resources the IEA supports the development and market introduction of new vehicle technologies. A new annex on fuel cells for vehicles started in 2006 complementing ongoing activities on battery and hybrid vehicles in the Implementing Agreement on Hybrid and Electric Vehicle Technologies and Programs (IA-HEV).

IA-HEV and its new Annex have direct access to national, industrial and scientific representatives. The results of the Annex will therefore guide their R&D activities and initiate coverage of missing research areas. Internal information available for participants will facilitate their decisions on how to organize their fuel cell research in the most efficient way and how to embed it in international research co-operation. Another public target group are users of these new technologies like communal or regional authorities, transport service providers or tourist areas.

The cost for these activities will be strongly reduced compared to independent investigations by each country, due to shared costs and broader data records. This international co-operation reduces the danger to overlook regional technological trends or results in the global development process and allows combining the strengths of different partners in a coordinated R&D process.

Keywords: International Cooperation & Networking; Public Policy & Promotion; R&D and market introduction of fuel cell in vehicles; Sustainable Mobility & energy efficiency for the automotive industry.

1. IEA as platform for USA, Europe and Asia to introduce fuel cells

The International Energy Agency plays a key role in the worldwide efforts to satisfy the growing energy demand in a sustainable and efficient way. As leading institution in the field of international cooperation the IEA pools the knowledge of its member states all over the world and supports them in maintaining security of energy supply, improving energy efficiency and mitigating negative environmental effects of energy use.

The International Energy Agency (IEA) is an autonomous body that was established in November 1974 within the framework of the Organisation for Economic Co-operation and Development OECD to implement an international energy program.

It carries out a comprehensive program of energy co-operation among twenty-three of the OECD's twenty-four member countries. The basic aims of the IEA are:

- co-operation among IEA participating to reduce excessive dependence on oil through energy conservation, development of alternative energy sources and energy research and development
- an information system on the international oil market as well as consultation with oil companies
- co-operation with oil producing and other oil consuming countries with a view to developing a stable international energy trade as well as the rational management and use of world energy resources in the interest of all countries
- a plan to prepare participating countries against the risk of a major disruption of oil supplies and to share available oil in the event of an emergency

Transport continues its steep increase in its share of the energy demand in the last years. As the booming road transport depends nearly to 100 percent from oil resources the IEA tries to reduce the dependency from fossil fuels by the development and market introduction of new vehicle technologies. The IEA Implementing Agreement for Hybrid and Electric Vehicle Technologies and Programs (IA-HEV) began already in 1993 is now already in its third five-year phase.

The IA-HEV started in 1993 with the aim to produce and disseminate balanced, objective information about advanced vehicle technologies including electric, hybrid and fuel cell vehicles. It is a working group of Governments and research organizations of member countries of the International Energy Agency. Since 1993 Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, Korea, the Netherlands, Sweden, Switzerland, South Africa, the United Kingdom and the United States participated in this Agreement. At present, eight countries are active.

2. Benefit of fuel cells for electric vehicles

The tremendous success of hybrid vehicles in recent years has strongly boosted the interest for electric vehicles in the vehicle industry as well as in the research community. Electric drive trains offer unique advantages in torque, power output and starting behavior. The enhanced comfort of the electric mode of hybrid vehicles -like silent standstill or the shutdown of the internal combustion engine when waiting at traffic lights- has motivated vehicle producers to strongly increase their R&D efforts for the development of other alternative propulsion systems, such as vehicles powered by fuel cells, batteries, biofuels, natural gas (CNG) or synthetic fuels (GTL).

Fuel cells as electrochemical systems are not limited by thermodynamic restrictions of combustion processes. Therefore they offer unique advantages concerning energy efficiency and the reduction of noise and exhaust emissions. Considered by many scientists as optimal long-term solution for clean and efficient energy conversion for mobile and stationary applications, the transport industry, energy utilities and producers of portable consumer products invest strongly in the development of this technology.

Nevertheless, limited lifetime as well as high production costs due to noble metal catalysts have impeded until now the broad market introduction of fuel cells beyond specialized niches like space applications. But in the last years cheaper and more stable materials for separators and electrodes have achieved major improvements for fuel cell technologies. Rising costs for aftertreatment of internal combustion engine emissions -due to tightening emissions standards- will bring fuel cell vehicles nearer to competitiveness.

3. Objectives of the Annex “Fuel Cells for vehicles”

Fuel cells are a highly relevant technology for an Implementing Agreement dedicated to hybrid and electric vehicles, as they complement battery or other energy storage devices by silent, clean and efficient energy conversion technology with the capability to substitute the noisy, polluting and poorly efficient internal combustion engine. An ‘all-electric vehicle’ will exploit the full potential of the electric drive train. The recuperation and peak power capacity of batteries and supercapacitors fits nicely to the efficient base load capability of fuel cells.

The different types of fuel cells actually under development dispose of an extreme variety of technical properties. Considering the strong differences in power demand and dynamic behavior necessary for auxiliary power units, passenger, light duty or heavy duty vehicles, it seems clear that this variety of physical characteristics are an asset of fuel cells. Therefore a thorough analysis of all kind of fuel cells regarding their capability to fulfill propulsion requirements of different vehicles is the first task in this new Annex. The strong expertise on electric drive trains and battery technology available in the HEV Implementing Agreement will enable its participants to investigate new and innovative combinations of energy storage and energy conversion technologies. The detailed knowledge of hybrid and electric vehicle characteristics and their specific needs for

complementary propulsion properties already existing in the Implementing Agreement will allow to attain a much more comprehensive evaluation of fuel cell technologies and their potential fields of application. Therefore the new Annex will enable a much broader view for the optimization of the electric drive train than the isolated development of pure fuel cell vehicles pursued in many R&D institutions.

The specific demands for power, cost, lifetime and range of vehicles powered by fuel cells, batteries and all kind of hybrid solutions are the main reason why the Executive Committee of the Hybrid and Electric Vehicle Implementing Agreement (IA-HEV) of the International Energy Agency decided in fall 2005 to expand its activities and to prepare a new Annex on 'Fuel cells for vehicles'. Nevertheless, IA-HEV aims for a strong tie and co-operation with the IEA Implementing Agreement on Advanced Fuel Cells (IA-AFC). This could even lead to a joint Annex of both Implementing Agreements where IA-HEV will bring in its expertise in user requirements in order to smoothen the way of these new technologies into the market.

The HEV Implementing Agreement will not concentrate its activities in this new Annex on the development of fuel cells, but on tuning their properties as well as using their high potential for their successful application in vehicles. The main focus will be on road vehicles, but other means of transport will be considered as well if their specific needs could be an interesting intermediate step for the market introduction of fuel cell road vehicles. In this respect boats, airplanes and mining vehicles could be an interesting niche preparing the market introduction of fuel cell, electric and hybrid road vehicles.

Given the broad range of technical requirements for the propulsion of passenger, light-duty or heavy-duty vehicles, auxiliary power units or even other means of transport, the new Annex will not only concentrate on PEM fuel cells as dominating technology for fuel cell research for vehicles today, but the Annex will analyze the potential of other fuel cell types as well. Because many scientists believe that auxiliary power units (APUs) might be the first economically viable niche for the market introduction of fuel cells in vehicles, this new Annex will study the potential of fuel cells for this market segment, after the preliminary investigation of all fuel cells mentioned above. The relatively stable power demand of auxiliary power units in the vehicle could enable for example the use of solid oxide fuel cells (SOFCs). The SOFC might be an option not only for APU in passenger cars, but also for boats or even trucks.

Another important issue with specific importance for the transport sector is the quick cold start capability. On the other hand, overheating can threaten the performance of fuel cells and batteries. Therefore thermal management of fuel cells and batteries will play an important role in the new Annex.

Finally, the question how to choose the most suitable fuel and how to store it on board is probably the most important question for fuel cell vehicles. Therefore all fuel options like hydrogen, methanol or even liquid fossil fuels for SOFCs will be investigated, taking the specific limitations of a mobile application in vehicles into account. The special requirements for the on board low temperature liquid or the high-pressure gaseous storage of hydrogen demands for specialists in vehicle technologies such as present in the HEV Implementing Agreement.

A special added value of this Annex will be to analyze technological solutions that are outside the mainstream of fuel cell development. Exotic fuels like ammonia or other liquid or gaseous fuels will be examined for their practical relevance as fuel for fuel cells. Because the Annex is not financing research directly but providing advice for the orientation of national R&D activities and industrial research investments, the costs for these technology foresight and assessment activities are moderate and allow with limited financial resources the consideration of technical solutions beyond mainstream R&D. This could open up interesting niches and the chance for a unique selling position for Annex participants. To minimize development risks, the Annex will also address components that offer multiple benefits for other areas of technology (such as efficient electric motors), regardless of the success of fuel cells.

4. Advantages of international cooperation for the members of the IA-HEV

In IA-HEV highly committed research institutes and national representatives of R&D programs from Europe, America and Asia co-operate to pave the way for the development and market introduction of hybrid and electric vehicles. The market introduction of alternative propulsion systems and fuels needs a more active technology policy to overcome the 'chicken and the egg problem' between automotive and fuel industry, each waiting for first steps and investments from the partners. Therefore the vehicle and fuel industry together with research institutions developing alternative propulsion systems will strongly benefit from the achievements of this Annex.

For public authorities the market introduction of fuel cells not only offers brilliant employment opportunities for their industry, but it also offers solutions for suppressing ecological and transport problems. Therefore the Annex will provide national representatives with advice for designing R&D programs. Another public target group are users of these new technologies like communal or regional authorities, transport service providers or tourist areas.

5. Working method

The activities in this Annex will predominantly exist of foresight studies and technology assessments. The cost for these activities will be strongly reduced compared to independent investigations by each country, due to shared costs and broader data records. The danger to overlook regional technological trends or results in the global development process is much lower in this international co-operation than in single country investigations.

This shared activity allows combining the strengths of different partners in a coordinated R&D process. The huge task of changing the transport system surpasses the resources of even the biggest countries or companies. Therefore the international split of labor not only saves large amounts of money to the participants, but it also saves a lot of time by developing tasks in parallel and by assigning responsibilities to partners with the highest expertise related to a specific problem. IA-HEV and its new Annex have direct access to national, industrial and scientific representatives. The results of the Annex will therefore guide their R&D activities and initiate coverage of missing research areas. Internal information available for participants will facilitate their decisions on how to organize their fuel cell research in the most efficient way and how to embed it in international research co-operation.

In parallel to this Annex, some IA-HEV member states strongly support fuel cell research in their national R&D programs and participate in regional multilateral activities like the technology platform 'Hydrogen and fuel cells' of the European Union.

6. Status and how to join

During its meeting in October 2005 in Rome, the IA-HEV Executive Committee (ExCo) decided to develop a working plan for a new Annex on 'Fuel cells for vehicles' and appointed the Austrian delegate in the Agreement, Mr. Andreas Dorda, as the Operating Agent of this annex. In April 2006 the proposal for objectives and working method of the Annex was discussed in the ExCo and is now tuned to the specific priorities of member states with interest for participation (like USA, Italy, Switzerland, Austria, Belgium, France, Sweden and the Netherlands).

In November 2006 the ExCo decided officially to start the new Annex as Annex XIII of the Implementing Agreement.

Organizations that are interested in the work on fuel cells for vehicles in this new Annex are invited to contact the interim Operating Agent as author of this paper to discuss their possible role in this Annex. As the annex is still in its starting phase there is still room to tune it to the needs of new participants.

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