Outlook for hybrid and electric vehicles

1
Introduction and context

Hybrid and electric vehicles can contribute to meeting the challenges in road transport regarding CO_2 and pollutant emissions, energy efficiency, noise and even congestion. This outlook presents the expectations for the future of hybrid and electric road vehicles of a group of experts (IA-HEV) collaborating under the framework of the International Energy Agency (IEA).

IA-HEV is the Implementing Agreement for co-operation on Hybrid and Electric Vehicle Technologies and Programmes of the IEA. Current member countries are Austria, Belgium, Canada, Denmark, France, Italy, the Netherlands, Sweden, Switzerland, Turkey and the United States. The participants in the Agreement are governmental bodies and research institutes that are appointed by their governments. This outlook is a synthesis of inputs of IA-HEV member country delegates; it does not necessarily represent the views or policies of the IEA Secretariat or of all its individual member countries.

The target audience for this outlook are predominantly governmental policy makers and governmental bodies, but it is also meant for research institutes working in the area of road transport, energy and environment, and the energy sector. This is the first joint outlook of IA-HEV members, and to avoid being too speculative the time period under consideration is until the year 2015.

This outlook is structured as follows. First, it presents a brief overview of the characteristics that distinguish hybrid and electric vehicles from conventional vehicles, and how they can contribute to achieving objectives regarding energy security, CO_2 emissions and pollutants. Next are the barriers for their deployment and the options for governments to help overcoming these barriers. Based on this information and building on the expertise of the IA-HEV members, expectations for hybrid and electric vehicle deployment are formulated in the final section of this outlook.

2
Hybrid and electric vehicles

Hybrid and electric vehicle have certain characteristics that may contribute to achieving governmental objectives regarding energy, environment and road transportation. In this section the vehicle characteristics are presented first, followed by how these vehicles can contribute to achieving governmental objectives.

Vehicle characteristics

Three types of hybrid and electric vehicles are distinguished here: hybrid electric vehicles, battery electric vehicles and fuel cell vehicles.

Hybrid electric vehicles (HEVs) show improved fuel economy compared to conventional vehicles, especially in stop-and-go traffic. They may also be designed to offer improved performance. Additionally, a limited range of silent operation with zero tailpipe emissions is possible when HEVs drive in electric mode. The operating range in electric mode may be extended by mounting larger batteries and/or by plugging into the electricity grid when the vehicle is parked (plug-in hybrid electric vehicle - PHEV). PHEVs can also be perceived as battery electric vehicles that have a range extender in the form of an internal combustion engine.

Battery electric vehicles (BEV) operate with zero vehicular emissions and very low noise. Their range is smaller than for conventional vehicles, although it is for example sufficient for about most of the commuter trips in Europe and North America.

Fuel cell vehicles only emit water vapour and they have the potential to be energy efficient. However, they are in an early stage of development and before the year 2015 fuel cell vehicles are not expected to gain a significant share in the road vehicle fleet, so they are not discussed in detail in this outlook. The box on page 3 gives an example of factors that play a role in reaching an answer to the question whether battery electric cars or fuel cell vehicles are closest to lasting success in the commercial market.

Application of hybrid and electric vehicles

Because of their characteristics, hybrid and electric vehicles can contribute to achieving country objectives for energy independency, reducing CO_2 emissions and a clean environment. Important examples are:

- For hybrid vehicles running on gasoline or diesel, improved fuel efficiency reduces oil demand and reduces CO_2 emissions.
- Hybridization of vehicle drivetrains can also be combined with low CO_2 emission fuels such as biofuels, to further reduce CO_2 emissions from road transport and to become independent from fossil oil.
- When electricity is produced with renewable sources such as solar, hydro and wind power, hybrid (PHEV) and electric (BEV) vehicles that are recharged from the electricity grid will run on renewable and clean energy.

Q: Which zero emission vehicle is closer to successful introduction in the commercial market: the pure battery electric vehicle or the hydrogen fuel cell vehicle?

Background

A pure battery electric vehicle is an electric vehicle with batteries as the only form of onboard energy storage and no propulsion system other than the electric motor. This kind of vehicle has been on the market for decades, but has never been able to gain a substantial share of the road vehicle market against conventional offerings.

Hydrogen fuel cell vehicles have for over a decade been considered a promising option to eliminate road vehicle pollution, but their expected market introduction date keeps moving back.

Common vehicle technology issues

The battery is a key component that needs further improvement in energy density and costs.

Vehicle manufacturing and maintenance infrastructures need to be established.

Battery electric vehicle technology

Limited range is a handicap that needs improvement and/or user acceptance.

Fuel cell vehicle technology

The fuel cell needs further development, especially to reduce its costs.

Hydrogen onboard storage needs improvement of energy density and costs.

Energy infrastructure

In large parts of the world, an electricity distribution grid is already in place.

A hydrogen distribution and refuelling infrastructure needs to be constructed.

Energy and environment

It should be kept in mind that vehicle energy and environmental issues are most appropriately compared on a well-to-wheel basis. Pure battery electric vehicles and fuel cell vehicles make most sense when electricity and hydrogen are produced in a renewable manner with near-zero pollutant emissions.

Vehicle manufacturers

Manufacturers need to be dedicated and willing to invest resources to make new vehicle technologies a success.

Vehicle users

It seems difficult for users to accept a shorter driving range and longer refuelling times compared to conventional vehicles. The option that comes closest to conventional vehicles regarding these attributes will most easily gain market acceptance. Additionally, costs of use will have to be competitive with other energy carriers on the market.

A: The answer is dependent on how the issues mentioned above develop. However, advanced, pure battery electric vehicles (BEVs) seem to be closer to becoming a significant player in the commercial vehicle market than do hydrogen fuel cell vehicles. The first generation of advanced BEVs might still be small, limited range vehicles for use in urban areas.

- PHEVs and BEVs can even serve as enablers for high shares of renewable energy in electric power production. This can be explained as follows. The electric energy that is produced by renewable sources such as solar and wind power is intermittent and the amount varies over time. In general, these variations are not synchronous with the variations in electricity demand. To overcome this mismatch in time between production and demand, electricity temporarily needs to be stored. The batteries of (a large number of) PHEVs and BEVs that are plugged into the electricity grid may serve as such a storage buffer.
- Given their low vehicular emissions and low noise production, hybrid and electric vehicles can advantageously be applied in sensitive areas such as inner city centres. When driving in electric mode, distribution trucks may even be allowed to operate during the night for example, and thus contribute to reducing congestion during daytime.

To achieve hybrid and electric vehicle sales figures that are large enough to contribute significantly to energy independency and reducing pollutants and CO_2 emissions, market segments must be found in which they offer clear advantages for their users. This is the subject of the following sections.

3
Barriers for the deployment of hybrid and electric vehicles

In spite of the advantages that hybrid and electric vehicles can bring to their users and the possible contributions to achieve governmental objectives, their market share is still small. This section highlights some of the barriers for the deployment of hybrid and electric vehicles, seen from three different angles: the general public (vehicle users), vehicle manufacturers and utilities.

There still is a lack of public awareness regarding alternatives to conventional gasoline and diesel cars. Three major hurdles exist for vehicle buyers:

- For a large proportion of the vehicle-buying public, purchase price is the most important criterion when choosing a vehicle. The general public is not aware of the vehicle life cycle costs and how these costs compare among different propulsion alternatives. Because of the higher price of hybrid and electric vehicles, most buyers choose a conventional vehicle.
- The range of electric vehicles is perceived as being too small, even though it would be sufficient for the majority of vehicle trips.
- In certain markets there is a lack of confidence in electric powered vehicles that is the result of battery problems in the past, and despite the fact that these problems have been successfully eliminated.

Hybrid and electric vehicles are significantly different from conventional vehicles. This means that vehicle manufacturers have to break new ground

regarding vehicle components, drivetrain systems, production facilities, safety issues and vehicle maintenance infrastructure.

- As for any new technology, standardization of hybrid and electric vehicle components and test methods are not as mature as for conventional vehicles. This is a barrier for industry to build up an efficient profit chain.
- Because it takes time to develop new vehicles and to build up the production and maintenance infrastructure, manufacturers are not yet always able to supply sufficient numbers of vehicles to meet the demand of surging markets.

Utilities are among the parties displaying significant recent interest in plug-in hybrid electric vehicles (PHEVs), because these vehicles may serve as enablers for high shares of renewable energy in the grid (see section 2) and because they are a substantial potential electricity market. However, before large numbers of PHEVs can be used some technical problems must still be overcome, such as the possibilities and safety issues of connecting the vehicle to the electricity grid, and the ability of utilities to meet electricity needs on demand.

4
The role of governments in the deployment of hybrid and electric vehicles

The previous sections have shown that governmental objectives may differ from vehicle buyers' interest and that hurdles may need to be overcome to achieve the objectives. However, governments have means -such as awareness campaigns, legislative power, taxation schemes and supporting research- to influence activities in society, so they can play an important role in overcoming the barriers for the deployment of hybrid and electric vehicles. Important governmental options are given below.

Technical developments may help in reduce the price premium for hybrid and electric vehicles. Governments can support technical developments by funding research projects that aim at advancing propulsion systems and components. Research and development (R&D) can also be stimulated by supporting cross-linking activities as well as supporting the foundation of technology platforms.

Governments have many different options to encourage the demand and deployment for clean and fuel efficient vehicles. Examples are:

- Demonstration projects to promote innovation.
- Fiscal measures such as tax incentives for clean vehicles, or taxation of CO_2 emissions.
- Subsidies that may help overcome the price premium of hybrid and electric vehicles. (Although it should be kept in mind that market niches based on subsidies alone are not sustainable. Niches where these vehicles offer clear advantages for their users must be found and/or created.)

- Non-monetary measures such as parking lots with free recharge for electric vehicles, or entry rules for certain areas such as 'car free' zones that are accessible only for zero emission vehicles.
- Heightening of public awareness and sensitivity to environmental issues, for example through promotion programmes.
- Stimulation of fleet renewal programmes to remove polluting older vehicles from the in-use population.
- Directives for ever more stringent emission levels.

Different measures may be combined and can reinforce each other. For example, parking privileges for electric vehicles also contribute to raising awareness by the public.

Consistency among different countries with respect to regulations creates larger vehicle markets with similar requirements, and this helps vehicle manufacturers develop products that meet all regulatory requirements. In a complementary manner, local governments are in a position to enforce regulations -such as entry rules for urban zones- in smaller geographical areas.

5
Expectations for hybrid and electric vehicle deployment until 2015

Based on the elements that are presented in the previous sections and enriched by their expertise, the IA-HEV members formulate the following expectations for hybrid and electric vehicle deployment.

Environmental awareness is increasing in society, including awareness of the impact of road transport on the environment, but this has not yet resulted in a large fleet share of hybrid and electric vehicles. However, some regulations that stimulate the use of clean and energy efficient vehicles are already in place and -combined with surging oil prices- have caused the hybrid electric vehicle market to take off (see figure 1). Independent from that, also the use of public transport and sales of smaller cars are both increasing. In this generally positive climate, it is expected that the markets for hybrid and electric vehicles will develop towards self-sustaining markets.

Hybrid electric vehicles

Today, the share of hybrid electric vehicles (HEVs) in car sales is small. It is below 1% in for example Austria, Belgium, Denmark and the Netherlands, about 1.1% in Sweden and 2.2% in the United States. The number of HEV car models available on the market is expected to grow substantially until 2015 and this will boost the HEV sales. The global market for hybrid vehicles could more than triple by 2012, compared to 2007 sales. Important factors expected to influence the eventual 2015 HEV market share are:

- Regulatory and other governmental measures to overcome the barriers for large deployment of hybrid and electric vehicles.
- The difference in purchase price between HEVs and standard vehicles (HEVs are likely to remain more expensive).
- The quantity of HEVs that manufacturers will be able to supply.

Although the impact of these factors is not yet known, the HEV percentage share of the 2015 car market is expected to remain within the single digits.

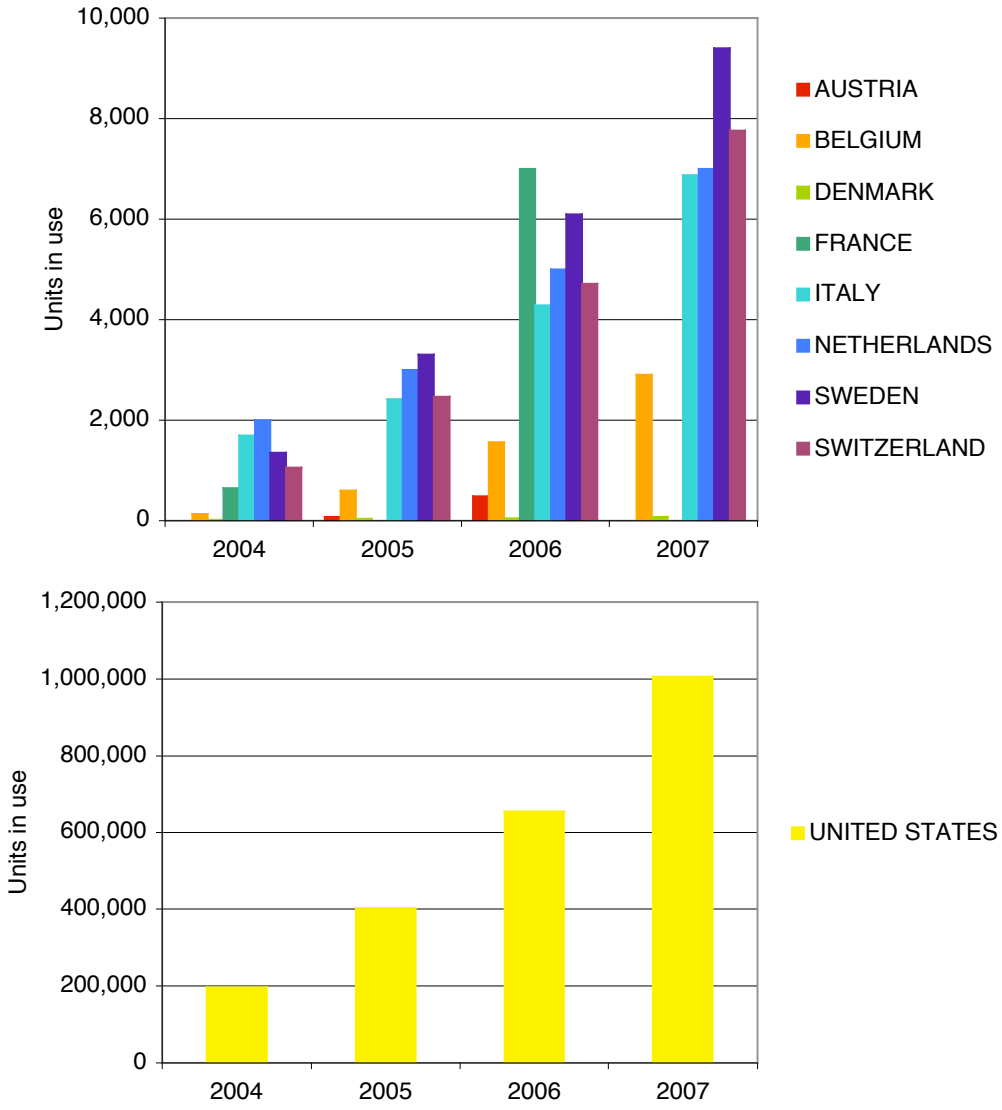

Fig. 1 Hybrid vehicle fleet size growth in IA-HEV member countries. Data for Canada and Turkey are not yet available.

Given the small market share, it can be concluded that the share of hybrid cars in the total vehicle fleet in both Europe and North America will remain low over the next five years, thus limiting their salutary effect on energy and environment.

Nevertheless, by 2015 they may be expected to have a quantifiable positive impact on the local air quality in urban areas.

The development and deployment of heavy-duty hybrid electric vehicles is lagging behind those of the light-duty sector. Trucks and buses -with a few commercial exceptions- are in the prototype and demonstration phase today and their fleet share in 2015 is expected to be small.

Increased interest in plug-in hybrid electric vehicles has recently emerged. In the coming years, work on PHEVs will focus on demonstration of these vehicles in practical use, and on the development of vehicle-to-grid technologies.

Battery electric vehicles

The market for battery electric cars and battery electric heavy-duty vehicles is small. However, sales of e-bikes, e-scooters and electric power-assisted bicycles are surging and this trend might continue. Acceptance of electric vehicles in the two-wheeler market might prepare the market for advanced electric purpose designed vehicles such as the Th!nk.

Final remark

Hybrid electric vehicles and battery electric two-wheelers have gained a firm position in the road vehicle market and are expected to continue increasing their share in the vehicle fleet. This outlook has shown that the actual growth rate is dependent on many different factors, often interrelated. These factors give hints for the focus of governmental policies that are aiming to increase the deployment of clean and energy efficient vehicles.