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Changes in automotive industry - moving toward hydrogen economy

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Abstract

Hydrogen becomes more and more popular as key energy vector (carrier) in sustainable energy economy. Because of the innovative nature of the implementation of H_2 into the automotive industry, it becomes a real challenge not only for the car manufacturers but also for the R&D and public area. This paper concentrates on current base for transition into the hydrogen economy.

Keywords: economy, hydrogen drive, sustainable energy

Zmiany w przemyśle samochodowym w odniesieniu do zastosowania napędu wodorowego

Streszczenie

Wodór staje się coraz bardziej popularnym źródłem napędu w zrównoważonej ekonomii energetycznej. Z powodu innowacyjnego charakteru zastosowanie H_2 w przemyśle samochodowym jest prawdziwym wyzwaniem nie tylko dla wytwórców samochodów ale także dla sfery badawczo-rozwojowej. Niniejszy artykuł przedstawia obecny stan tego zagadnienia, a jednocześnie próbuje zarysować perspektywy rozwoju dla ekonomii wodorowej.

Słowa kluczowe: ekonomia, napęd wodorowy, zrównoważona energia

1. Introduction

Increase of interest in hydrogen economy began in the early 70s, together with oil crisis. First attempts connected with transition of drive types were result of concerns of energy security and independency of external suppliers. This trend continued and became more intense supported by adherents of climate change and air quality.

The long-term vision of hydrogen economy aims at solving the problem of negative effects concerning use of conventional fuels in mobile applications. It is therefore based on two expectations: (1) that hydrogen can be produced from domestic energy sources in a manner that is affordable and environmentally benign, and (2) that applications using hydrogen - fuel cells, for example - can gain market share [1].

The task is not easy to achieve, although in the R&D work on H2 innovations and their implementation in global scale are involved researchers e.g. from the European Union, North America and Asia. The public contribution to the issue of hydrogen economy is not only needed but necessary. The US Federal budget for hydrogen has grown from 10 000, 000 $ in 1998 to over 80 000, 000 $ in recent years. EU support to fuel cell and hydrogen RTD in Framework Programmes - only in the 6th edition - amounts to 300 000, 000 EUR.

But still, about the transition to the implementation of alternative fuels will decide the private sector that have experience in technology development, infrastructure, marketing, and other aspects required for market success.

Almost all of the major car companies have active programmes to develop hydrogen vehicles. Overall private spending on hydrogen energy R&D dwarfs spending by governments [2]. Strategic alliances and technical agreements among car companies help to share information and collaborate in order to advance the technology. This is the reason why very important role are playing incentives bringing together main stakeholders as e.g. the integrated project StorHy carried out within the 6th Framework Programme, consisting of 34 partners, among which the automotive industry is heavily represented by such companies as BMW, DaimlerChrysler, Ford, MSF, PSA and Volvo.

2. Hydrogen as sustainable energy

Hydrogen and electricity together represent one of the most promising ways to realise sustainable energy, and fuel cells provide the most efficient device for converting hydrogen, and possibly other fuels, into electricity. Although the potential benefits of hydrogen and fuel cells are significant, many challenges, technical and otherwise, must be overcome before they will be able to offer consumer a competitive alternative [3].

Classification of hydrogen as sustainable energy source is related to its specific features. A key characteristic of hydrogen is that it is not primary source of energy, but likely electricity it must be manufactured. Hydrogen can be generated from a variety of energy sources and by several different methods.

Since the potential for zero CO_2 emissions from hydrogen use is one of its key advantages it is vital that the energy feedstock and conversion technology be carefully assessed. Hydrogen can be made by stripping H atoms out of fossil fuels or biomass, or by using electricity generated from fossil or carbon-free energy sources to electrolyze water [4].

Hydrogen is key energy vector (carrier) in future sustainable energy economy. The introduction of alternative fuels - together with drastic energy efficiency gains - will be the key to sustainable mobility, nationally as well as globally. The use of hydrogen as a fuel has the advantage that hydrogen-driven vehicles will produce hardly any emissions but vapour [5].

3. Hydrogen in automotive applications

Automotive industry presents different types of hydrogen powered vehicles depending on fuel system design. Temporary mobile applications comprise internal combustion engines and fuel cells, implemented in passenger cars, but also in vans and urban buses. There are also combined solutions as e.g.: hydrogen vehicles powered by bifuel internal combustion engine being able to use either gasoline or hydrogen.

H_2 automotive applications vary also because of the storage type. Hydrogen can be stored in compressed form: in high-pressure tanks at 350 or 700 bar; in liquid form: in super isolated tanks at - 253˚C; in bonded form: in solid or fluid compound [6]. All of the three storage types are implemented. As the most important indicators by choice of a given system by car producers to mention are: efficiency, price and safety of a given application. Therefore defined targets on H_2 storage are connected with increase of energy density and storage system cost.

The biggest challenge considers not only overcoming of negative aspect as high cost of H_2 cars but also adjusting to standard users' requirements. Most of the drivers of fuel cell vehicles have a positive impression on the car [7]. For most of them vehicle with pressure tank is not a problem but safety is playing an important role.

Safety shall be considered in all phases of hydrogen facility life cycle, beginning with its initial design and continuing through its fabrication, construction, operation, maintenance and ending with its decommissioning [8]. Safety issues cut across all segments of the hydrogen economy and become operational in two forms: concern with loss of human life and property, and codes and standards that shape the configuration and location of hydrogen facilities and vehicles [9].

The number of hydrogen vehicles existing currently is estimated for 1 percentage of total sales. Such low reckons are caused by the innovative or even experimental nature of H_2 cars on the market. However future possibilities are estimated much higher. According these expectations the number of hydrogen vehicles will increase 1 percentage point per year for the next 10 years and 5 percentage points per year of the following 10 years. These data are more optimistic for the German case. Some of the analysis project transition to hydrogen economy until 2050 or even 2035 [10].

Of course popularization of H_2 cars, highlighting their strengths and liberalization of the market will enable fair competition resulting in decreasing prices. A major barrier is the slow progress of commercialization of fuel cells which are the key to a hydrogen economy. The current costs of hand-made FC systems are around € 3000-5000 kW^{-1} and it may be difficult to lower the cost. Although mass production may strongly reduce the price of fuel cells [11].

4. Commercialization of hydrogen vehicles

Hydrogen economy comprises not only end-use energy markets and therefore solving the technological challenges of hydrogen production, distribution, storage and provision of the necessary infrastructure, at a competitive cost, requires a major concerted global effort. Apart from pure technological development, the introduction of new technologies to the market necessitates an appreciation of the “non-technical barriers” which, if not fully addressed, may hinder or delay the market deployment of the new technologies [12]. Relevant with regard to this problem will be support and implementation of new solutions by the automotive industry. It is needed that car companies commercialize the idea of hydrogen vehicles for regular public users considering parallel long-term strategies [13]. Any future hydrogen energy system will be subject to market preferences and to competition from other energy carriers and among hydrogen feed stocks. The choices that a market economy makes about its energy services will influence the utilization of hydrogen and hydrogen feed stocks and the attributes of the hydrogen end-use technologies [14].

All of the optimistic reckons concerning widening of market share for H_2 cars will depend on liberalization of the market and the ability to convince drivers that hydrogen vehicles are advantageous in a way of comfort and terms of sustainable energy.

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