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Dr. Barbir is on of the world leading experts for hydrogen energy technologies, particularly for fuel cells. Since 1989. he has been actively involved in research and development of fuel cells, working in the U.S. in industry (Energy Partners, Proton Energy Systems) and in academia (University of Miami, University of Connecticut). He was the leader in many fuel cell related R&D projects for U.S. Department of Energy, U.S. Army, Ford Motor Company, 3M Company, etc.

He is the author or a co-author of more than 150 publications on hydrogen and fuel cells in journals, books, encyclopedias, and proceedings, as well as a co-author at 7 U.S. patents on various aspects of fuel cell design and operation. He is the author of the book PEM Fuel Cells: Theory and Practice published by Elsevier/Academic Press in 2005. He is an associate editor of the International Journal of Hydrogen Energy, responsible for fuel cells related papers.

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VIZIJA ULOGE VODIKA U OPSKRBI ENERGIJOM U BUDUĆNOSTI

Sažetak

Europa će u budućnosti biti u vrlo teškom položaju što se tiče opskrbe energijom jer većinu svojih potreba zadovoljava uvozom nafte i prirodnog plina. Osim toga, zbog problema zagađenja okoliša, globalnih klimatskih promjena, konačnih rezervi fosilnih goriva u Zemljinoj kori i geopolitičkih implikacija rasporeda tih rezervi, takav energetski sustav je neodrživ. Sve više raste svijest o neophodnim promjenama, ne samo u izvorima energije, nego i u energentima i tehnologijama za pretvorbu tih energenata u korisne oblike energije te u načinu korištenja energije. Prema sadašnjim saznanjima, jedini izvori energije koji zadovoljavaju uvjete održivosti su obnovljivi izvori energije su direktni i indirektni oblici Sunčevog zračenja. S obzirom da se obnovljivi izvori energije ne mogu koristiti direktno, u mnogim primjenama su potrebni energenti koji se mogu proizvesti iz njih i koji mogu zadovoljiti sve potrebe za energijom, uz zadovoljavanje uvjeta održivosti. Jedan takav energent je i električna energija koja se može koristiti u mnogim, ali ne i u svim primjenama. Za primjene gdje se električna energija ne može koristiti potreban je i drugi energent u obliku goriva koje se može skladištiti i koristiti, kao na primjer u transportu. Upravo je to uloga vodika u budućem energetskom sustavu - gorivo koje zadovoljava uvjete održivosti, može se proizvesti iz obnovljivih izvora energije i zajedno s električnom energijom može zadovoljiti sve energetske potrebe.

Iako se uloga vodika kao goriva u dalekoj budućnosti može relativno lako predvidjeti, problem je u tranziciji - kako prijeći sa sadašnjeg energetskog sustava na energetski sustav budućnosti. Naravno da se energetski sustav ne može promijeniti preko noći, ali pitanje je kako i gdje započeti i kojom dinamikom. Inzistiranje na kratkoročnim ekonomskim rezultatima favorizira “status quo,” pogotovo bez internalizacije svih eksternih prošlih, sadašnjih i budućih troškova. Iako bi masovno korištenje obnovljivih izvora energije (i energenata proizvedenih iz njih) moglo izazvati poremećaje u globalnoj ekonomiji, moguće je da bi ti poremećaji bili manji od onih koji bi nastali ako bi se nastavilo sa sadašnjim energetskim sustavom koji se temelji na fosilnim gorivima (uzevši u obzir ne samo stalan rast cijena nafte i plina kako se njihove globalne rezerve iscrpljuju nego i ekonomske posljedice globalnih klimatskih promjena koje prema nekim procjenama mogu poprimiti katastrofalne proporcije). Odluka o prijelazu na novi energetski sustav morat će se donijeti na svjetskoj razini, a i tranzicija će se morati koordinirati. Samo u jednoj takvoj dugoročnoj i globalnoj tranziciji vodik kao gorivo ima budućnost.

Planiranje energetske opskrbe do 2030. godine i poslije ne može se raditi samo ekstrapolacijom dosadašnjih energetskih potreba, tehnologija i trendova. Tranzicija ka nekom novom energetskom sustavu do 2030. već bi trebala biti u punom jeku. Zbog toga treba staviti naglasak na racionalno korištenje energije i na sve veće korištenje obnovljivih izvora energije. U pogledu mogućnosti korištenja obnovljivih izvora energije Hrvatska

ima bolje prirodne geoklimatske uvjete nego većina zemalja Europe. Teoretski, Hrvatska bi takvom orijentacijom mogla postati energetski neovisna, a vodik kao gorivo bi imao značajnu ulogu u tome. Proizvodnja vodika bi služila za ublažavanje utjecaja promjenjivosti intenziteta obnovljivih izvora energije na stabilnost elektroenergetskog sustava. Vodik bi se koristio kao gorivo za transport te za pokrivanje potreba za električnom energijom u razdobljima kad obnovljivi izvori nisu dostatni. U kojoj mjeri će se vodik koristiti do 2030. godine ovisit će o globalnim trendovima. Hrvatska bi zbog svoje veličine, geografskog položaja i klimatskih uvjeta mogla postati Europski i regionalni lider u korištenju novih energetskih tehnologija.

THE VISION OF THE ROLE OF HYDROGEN IN ENERGY SUPPLY IN THE FUTURE

Abstract

Europe is in a very difficult situation regarding the future of energy supply because it is highly dependent on import of oil and natural gas. In addition, because of environmental pollution, global climate changes, finite World reserves of fossil fuels and geo-political implications of distribution of those reserves, such an energy system is not sustainable. The need for inevitable changes in energy supply is becoming more and more obvious. This includes not only a change of the energy sources, but also in energy carriers and technologies for their conversion into useful forms of energy, as well as a change in the ways energy is used today. Based on present knowledge, the only energy sources that satisfy the sustainability requirements are the renewable energy sources - direct solar insolation and its consequences (wind, hydro, biomass). As the renewable energy sources cannot be utilized directly in most of applications there is a need for such energy carriers which can be produced from renewable energy sources and which can satisfy all the energy needs at the end use, again satisfying the sustainability requirements. Electricity is one of such energy carrier which may be used in most but not in all applications. There is a need for other energy carriers in the form of fuels which can be stored and used, for example, in the transportation sector. This is a role that hydrogen can fulfill in a future energy system - hydrogen satisfies the conditions of sustainability, can be produced from renewable energy sources and together with electricity can satisfy all energy needs.

Although the role of hydrogen in a future energy system can be envisioned with some certainty, the problem is the transition, i.e. switching from the present energy system based on fossil fuels to the future energy system based on renewable energy sources. Of course, such transition cannot happen overnight, but the question is where and how to start and at which pace to proceed. Insistance on short term economic results favors “status-quo,” particularly without internalization of all external, past, present and future costs related to energy supply. Although a large scale use of renewable energy sources (and their energy carriers) may cause economic hardship, such disturbances could be of minor size compared to a havoc that continuous use of finite and polluting fossil fuels will most likely eventually bring. A decision to switch to a new energy system must be made on a global level, and so must be the monitoring and managing of the transition process. Only in such long-term global transition hydrogen as fuel has a future.

Planning of energy supply in 2030 and afterwards cannot be done solely on extrapolation from the past energy needs, technologies and trends. By 2030, transition to a new energy system should be in full swing. Because of that the emphasis of energy plans and strategies must be put on rational use of energy and on greater use of renewable energy sources. Croatia has more favorable natural geo-climatic conditions than most of Europe. Theoretically, with such strategy Croatia could become energy independent. In such strategy, hydrogen could have a significant role. Hydrogen would be used as transportation fuel and for covering needs for electricity in the periods when the renewable energy sources are not sufficient. At which extent hydrogen would be used depends agreat deal on the global trends. Croatia, because of its size, geographical position and climate could become European and regional leader in the application of new energy technologies.