16th WHEC DAILY REPORT

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Fatih Birol delivers IEA views on the three major challenges in global energy

On Tuesday, **Fatih Birol**, the Head of Economic Division of the **International Energy Agency (IEA)** reviewed the evolution of world energy demand in the 21st Century. First of all, he asserted that the primary oil demand is increasing at an astonishing rate. With only few major oil producers and high-risk countries such as Saudi Arabia, Iran and Iraq, consumers are confronted with serious security supply issues. Iran, for example, is a very important player with 4 bbl/day of oil production while Iraq struggles under a complicated political situation, leaving its future unclear. Natural Gas (NG) importance is also increasing rapidly and alone two countries, Russia and Iran, possess 50% of the world's reserves. Considering the disputes between Russia and Ukraine, NG supply security has become a highly debated and sensitive theme worldwide. Secondly Birol addressed some of the environmental issues that are plaguing the entire globe. He touched on a few European topics such as the effort to close 80% of all coal-fired power plants in Europe over the next few decades. The third challenge he discussed was energy and the poor. Worldwide more than 1.6 billion people (one out of four) live daily without access to electricity.

To summarize, humanity faces three major challenges: oil & NG supply security, environmental issues and energy and the poor. IEA believes that World Alternative Policy Scenarios (WAPS) must be set into action in order to improve the energy-environmental situation worldwide. Better efficiency of energy utilization, less tension in and around the countries at risk, and greater investments in the New Energy Policy must be the initial steps towards change.

Industrial executives discuss hydrogen supply chain

According to **François Jackow**, Vice President of R&D and Advanced Technologies at France's **Air Liquide**, the industrial gas companies have the essential background for hydrogen production, distribution and safe handling and uses of hydrogen in general. They will obviously play a major role in the emerging hydrogen energy market, which benefits from already existing infrastructures, logistics and technical know how. Nevertheless, hydrogen energy will raise specific challenges related to the end customer who must be provided with intrinsically safe and user-friendly solutions. The other major challenge is the need for technological as well as scientific breakthroughs in terms of products and infrastructures.

Discussing the future means of hydrogen production, **Alain Bugat**, CEO of the **French Atomic Energy Commission (CEA),** summarized present obstacles and opportunities within this field. As current production methods rely on natural gas or other hydrocarbons, reforming is clearly impacted by two main issues: the increase of hydrocarbon prices and CO2 emissions. Alternative solutions like electrolysis with inexpensive and pollution-free electricity (nuclear or hydraulic) could soon become viable solutions. Other breaking ideas such as high temperature water-splitting by nuclear or solar energy, biomass gasification or decentralized production by photo-electrochemical and photo-biological processes are in great need of international support - most specifically in the fields of R&D, technological research, prototypes, small scale demonstration, etc.

Worldwide hydrogen programs & projects

The number of international hydrogen programs and projects is increasing dramatically. The **US Hydrogen Program** and projects have been described by **Dr. Sunita Satyapal**, a Team Leader in the **Department of Energy Hydrogen Program**. In 2003, President Bush announced the Hydrogen Fuel Initiative for $1.2 billion over five years to accelerate research, development and demonstration of hydrogen and fuel cell technologies. In addition, Congress

passed the Energy Policy Act of 2005, showing that "The national leaders are in agreement that a hydrogen economy can lead to energy and environmental security. " In 2006, President Bush announced the Advanced Energy Initiative providing a 22 % increase in funding for clean-energy technology.

The US program on hydrogen is extensive and also intensive in this present R&D phase and Dr. Satyapal presented an overview of most recent results in hydrogen storage, fuel cell cost and durability, hydrogen production and delivery, safety and learning/demonstration activities.

According to **Prof. Ken-Ichiro Ota** of **Yokohama University**, Asian countries tremendous demand for energy requires the implementation of new energy schemes. The **Chinese Hydrogen Program** will cost nearly 380 million RMB by the end of the proposed 5-year plan. Twenty-seven "frontier technologies" compose this new energy plan including fuel cells, fuel cell power stations, hydrogen & FC vehicles and more. According to the forecast, in 2020 about 20,000 fuel cell buses will be in full operation in 20 Chinese cities. The **Republic of Korea's Hydrogen & Fuel Cell Program** has established a four-phase plan up till the year 2040. In the Experimental Phase 1 (present - 2012), as many as 50 H2 fueling stations, 300 FCs for industrial application, 3,200 FCs for passenger cars and 200 FCs for buses will be introduced. The figures for Phase 2 (by 2020) are: 2.4% of H2 in energy mix and 5% of automobiles with FCs; by Phase 3 (by 2030) an increase to 8% of H2 in energy mix and 15% of automobiles with FCs is expected. By 2040 the Republic of Korea intends to have 15% of H2 in energy mix and 50% of automobiles with FCs. **Canada**'s involvement in H2/FC technologies began in 1978. The scope of its programs has broadened substantially. They consist of 3 areas: R&D, H2 infrastructure development and early market introduction of H2/FC technologies. In 2003 Canada published its "Roadmap to a Hydrogen Economy." The most important demonstration programs include the "Hydrogen Village," the Vancouver FC Vehicle Program, and the "Hydrogen Highway" between Vancouver and Whistler. Should all go as planned, the highway will be fully implemented by the Olympic & Paraolympic Winter Games in 2010.

Hydrogen & Fuel Cells need global regulations, codes & standards

One of the challenges that the H2/FC industry is facing is the development of international regulations, codes & standards (RCS), as explained by **Randy Dey**, President of the **CCS Global Group** (Canada). It is certainly not too early to deal with this question. A standard language is mandatory in order to ensure that the new technologies will provide the same level of safety or higher than today's equivalent technologies.

Hydrogenics' Chairman shares current successes

Hugo Vandenborre is the Co-Founder & Chairman of **Hydrogenics**, a leading developer of clean energy, commercializing hydrogen and fuel cell products. Hydrogenics employs 270 persons and has a portfolio of 67 patents and 550 other pending. He stressed the advantages of OnSite Generation, which is cost competitive even outside the gas network, provides hydrogen and power where and when it is needed, improves supply reliability and minimizes volume of stored hydrogen. Hydrogenics offers two types of products with multiple technology options to meet the needs of energy and industrial customers: HySTAT hydrogen stations produced by electrolysis based on proprietary IMET and PEM technologies and HyPM Fuel Cell Power modules, which can be added to HySTAT stations or a hydrogen powered Internal Combustion Engine to generate electrical power. Hydrogenics has integrated a fuel cell battery hybrid system into a mid-sized bus which is actually **on display at the 16th WHEC** and they have contributed to the successful development of **Formula Zero** fuel cell cart.

Hydrogen, environment and sustainable development

During Tuesday morning's plenary session chaired by **Olivier Appert**, Chairman and CEO of the **Institute Français du Petrole** (IFP), the main issues linked with energy, climate change and sustainable development brought several viewpoints to light. During a first presentation, **Jean Jouzel**, CEO of **Pierre Simon Laplace Institute** and **Research Director of CEA**, gave his conclusion on the climate change, based on the research and data collected by the **IPCC** (International Panel for Climate Change). Extreme events such as hurricanes, cyclones and droughts have become more prevalent, supporting the conclusion of human activities' undeniable influence on global climate.

Amory Lovins, CEO of the **Rocky Mountain Institute** (USA) proposed a complete set of actions for curbing CO2 emissions, based on the

use of innovative technologies. As a first step he recommended to improve the efficiency in the energy end use. In the area of transport, he advocated to reduce the weight of vehicles by using new materials such as light alloys, light steel and carbon composites. As a second step, a further reduction in CO2 emissions can result through the use of alternative fuels, biofuels first and hydrogen later on. In his view such a strategy cannot only result in reducing risk of climate change but also help to build a competitive industry.

During the Round Table which followed, two further participants gave their vision of the future. **Giorgio Simbolotti** from the **International Energy Agency** was less optimistic than Amory Lovins about the real potential of the technology and the possibility to introduce rapid changes. He believes that concrete energy policies are needed for making real progress.

David Sanborn Scott, Funding Director at the Institute of Integrated Energy Systems at the **Canadian University of Victoria**, insists upon the catastrophe which climate changes may represent in the future. For him, hydrogen as a energy vector will be critical for the future. Although he shares many of the views expressed by Amory Lovins, Scott considers that nuclear energy is needed. Fuel cells are to be considered as an embedded technology, which can find a market if it incorporates progresses similar to those which have been accomplished with computer silicon chips, especially by miniaturizing the equipment, according to Scott. Yet for Amory Lovins, our visions for the future should take into account innovation and not only rely upon econometrics.

In conclusion Olivier Appert stated that because this issue of climate change is so immediately crucial, we have to take into account all options which could help to reduce CO2 emissions.

Poster Session: Tidal power could change the global energy outlook

The new Tidal Power Plant (TPP) proposed by the Russian firm **Elegaservice LLC** and **Clean Energy Co.**, USA, (Poster 8-704) is composed of stationary or floating hydropower units, fixed on the seafloor, which can convert tidal flow energy into electricity and furthermore into hydrogen (in the case that direct supply of electric power is impossible). The power production of these TPP units is obtained with "orthogonal turbines" consisting of counter-rotating vertical rotors, each of which bears the blades oriented in opposite directions, ensuring the release of central pylone from torque and high relative speed between the inductors and the conducting plate.

This constructive design has several other advantages: modular concept enabling progressive investment, practically no wear parts, no impact on ecological situation in the basin, fish can pass freely through the installation, a power production independent of the flow direction and a cost of installed kW in case of calculated flow speed of 3m/s for units of average capacity of about 2-5 MW or more is evaluated at $500-600/kW. Implementation of these TPP's could begin in Canada in the bay near St John. Many favorable locations with a huge energetic potential exist throughout the world (Australia, Iceland, Russia, etc.). For example, in the northern part of the Penzhinskii Bay (Russia), the basin has an area of 5650 km2, the width of the strait for potential TPP location is of 26.5 km and the maximum rise in tide is 13.4 m and 10 m on average. In these conditions the maximum power of TPP is 165 GW and the maximum power output is estimated at 312 TWh/yr.

A glance in the exhibition hall

Our first stop was at the **Swiss Village**. Swiss R&D efforts leading towards realizing the vision of the hydrogen economy are very strong. Switzerland is well-poised to undertake the required innovation on account of its first-class research environment and excellent cooperation between universities and industry. The **Swiss Hydrogen Association Hydropole** serves as a platform for research, development, industry and other public and private organizations. The Swiss Village exhibit is a common initiative of this network. Presented are the companies Bieri Engineering GmbH, Weka AG, Industrie Hautes Technologie as well as the University of Applied Sciences Bienne, the Swiss Federal Institute of Technology, the Swiss Federal Institute for Material Science and Technology (EMPA).

Bieri Engineering GmbH engineers and manufactures equipment for specialized applications such as cryogenics, space research, liquefied gases, high temperature and high pressure applications, nuclear etc. The main products are vacuum and pressure vessels and various types of heat exchangers. The company is specialized in welding of sophisticated materials as aluminum, titanium, nickel base materials, copper etc. Engineering includes development of optimized concepts, complete engineering and design using advanced tools.

Weka AG is a leading manufacturer of cryogenic components and level measurement systems for liquids. Its strengths are

development, manufacturing and testing of tailor-made solutions. WEKA cryogenic components provide optimal solutions for handling of low-temperature liquefied gases under extreme operating conditions and are used in applications involving liquid and gaseous media below 120K (-153°C).
The **EMPA** investigates the interaction of hydrogen with different materials such as metal hydrides and complex hydrides. The structure and thermodynamic properties are investigated with different methods. To determine the structure XRD, Synchrotron- and Neutron-Diffraction are used. The thermodynamic properties are investigated with PCT instruments. More about Swiss hydrogen research at www.hydropole.ch .

After visiting the Swiss Village, we made our way over to the **Shell Hydrogen** booth. Shell believes hydrogen - an abundant, clean energy vector - will be an essential part of the world's future energy mix. Shell is collaborating with key stakeholders to make hydrogen a practical, safe and globally accessible fuel. The company invests significant resources in greener, more efficient production of hydrogen and in CO2 management. They believe that it is an evolution, not a revolution that will lead us to a hydrogen economy. And that means governments, businesses, society and individuals have to make that choice right now, in order to ensure that our children have a choice in how they power the world of tomorrow. www.shell.com/hydrogen

A look into the Parallel Sessions

HYDROGEN STORAGE, DELIVERY & SAFETY

Afternoon sessions took a look at new developments in liquid hydrogen storage on board of vehicles; Sections S01 and S02 focused on safety aspects and programs and Section S11 on hydrogen delivery systems. A fascinating presentation on safety measures for hydrogen vehicles with liquid storage was given by BMW (S13-448); they demonstrated an H2 discharge through a safety line, a hydrogen car driving through water, and an H2 car after a crash test. GDF (Gaz de France) presented durability and transport properties of polyethylene pipes for the distribution of hydrogen and natural gas mixtures (S11-481) while the Loughborough University illustrated the possibility of hydrogen distribution using existing natural gas infrastructure (S11-651).

HYDROGEN ICE IN TRANSPORTATION

While the FCs industry gradually progresses, an Internal Combustion Engine (ICE) using hydrogen may be a transitory alternative. However more fundamental data (S22-417) will be needed to understand the combustion characteristics of hydrogen within ICEs. Hydrogen may also offer considerable potential as a marine fuel (S22-039), due to its comparably lower fuel mass which can effectively increase payload and virtually eliminate pollution problems.

WHEC2008 – ANNOUNCEMENT 17th World Hydrogen Energy Conference in Queensland, Australia

All WHEC2006 participants are cordially invited to attend the 17th World Hydrogen Energy Conference at the Brisbane Convention and Exhibition Center in Queensland, Australia, June 15-19, 2008. The Conference theme - *Supplying Energy to A Changing World* - will focus on how hydrogen can be used to deliver clean power to a world that is both hungry for energy but yet recognizes that traditional sources such as oil for transport are in decline. The meeting will bring together leading speakers from governments, industry and academia from around the world.
They will come to Brisbane to share their knowledge, initiatives, insight and experience through keynote and plenary sessions. An exhibition will also form an integral component of the WHEC2008, showcasing the latest in technology from leading developers in the global hydrogen and fuel cell industry.

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