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Glimpses of hydrogen's future role

An interview with Shannon Miles
of the International Energy Agency Hydrogen Implementing Agreement

Hydrogen and fuel cells clearly have the potential to become important components in tomorrow's portfolio of energy options. While it is still hard to talk about timelines for deployment around the globe, wide-ranging demonstration projects in North America, Europe and Asia are showing chinks of light at the tunnel's end. The IEA Hydrogen Implementing Agreement programme (HIA) works on all aspects of accelerating advances toward widespread use of hydrogen. Its Annex 18 provides information on efforts to integrate hydrogen into energy systems around the world. Annex 18 conducts analysis and assessment of key demonstration projects. Shannon Miles of Natural Resources Canada leads Subtask C, which synthesises lessons learned from case studies and demonstration projects. She answers some questions from the *OPEN Bulletin* about Annex 18 and its findings to date.

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To start with, could you recap for us why hydrogen has such a high profile today?

Shannon Miles, Sub-Task C Leader, Annex 18 of IEA Hydrogen Implementing Agreement

Shannon Miles
In a world where energy demands are ever increasing and the need to combat climate change is becoming increasingly urgent, hydrogen technologies offer many solutions.

What I have found interesting in my travels and research with the IEA and Natural Resources Canada is that not only are many people talking about hydrogen – from celebrities

* The IEA *OPEN Energy Technology Bulletin* is a web-based periodical newsletter published by the International Energy Agency (IEA).

to presidents – but most developed countries and many developing countries around the world are actually working on hydrogen and fuel cell technologies.

Hydrogen and fuel cells are technologies whereby people can not only see environmental benefits but also see that the technology can offer improvements in many applications. From cell phones to forklifts, to system-critical backup power, to cars and buses and to stationary power for buildings, hydrogen technologies offer real business solutions. As we move forward, we need multiple energy options, and hydrogen is definitely one of these options to get excited about.

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Roughly how many demonstration projects have now been initiated around the world? And in which countries are those that you have been monitoring?

Shannon Miles

There are hundreds of hydrogen and fuel cell applications in use around the world now. A number of them started in the 1980s, then more in the 1990s, and they have really taken off this decade. Canada had a number of "world firsts" in the 1990s, such as the world's first fuel cell bus in 1993 and the first bus fleet operation in 1997.

Fuel Cell Bus Fleet
Source: Natural Resources Canada

The IEA Hydrogen Implementing Agreement (HIA), through its various projects, has monitored a number of the demonstration projects. In fact, the HIA was formed in 1977 so member countries could collaborate on research and development and exchange information. This is still happening today. Now, not only do we look at R&D, but the demonstration projects are far more numerous.

There is some exceptional work going on in all the IEA HIA projects on hydrogen, including: Safety; Photoelectric production; Biohydrogen; Storage; Small Reformers; Wind/hydrogen integration; High Temperature production; Large-scale storage and infrastructure; and Biomass production.

In the first phase of Annex 18, which began in 2004, we evaluated demonstrations in seven countries. These have all been documented and several have led to exciting expansions and optimised use. Now into our second phase, which began this year, we are evaluating an additional eleven projects located in countries from Denmark to New Zealand and including one joint United States/United Kingdom project. Our Annex 18 website provides a detailed list of our projects.

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Can you point to a couple of key demonstrations that have marked major strides ahead with deployment?

Shannon Miles

There are a number of demonstrations that really stand out for me. In Canada, I think the BC Hydrogen Highway and the Hydrogen Village are key demonstrations where the technology is being used in real-world applications. Internationally, two outstanding projects that our IEA Annex 18 team has visited are the hydrogen fuelling station in Iceland and a wind hydrogen desalination plant on the island of Gran Canaria in Spain. I will describe these projects.

Fuel Cell Bus
Photo courtesy of BC Transit

The Hydrogen Highway is a collection of demonstration and deployments projects ranging from fuelling stations, micro-hydrogen and transportation to stationary power applications. The demonstration that is receiving the most attention at the moment – and for good reason – features the BC Transit 20 hydrogen fuel cell buses.

BC Transit, in partnership with the Province of British Columbia and the Government of Canada, will purchase 20 hydrogen fuel cell buses and the hydrogen infrastructure to fuel them. The buses will be showcased in the Resort Municipality of Whistler during the 2010 Olympic and Paralympic Winter Games, and then integrated into the BC Transit fleet. This is the first time that such a large order has been placed and the buses will be a regular part of the BC Transit fleet for over 20 years.

Fuel Cell Forklift
Source: Natural Resources Canada

The Hydrogen Village in Toronto is another example of hydrogen and fuel cell applications being used in real-world settings. The demonstrations here include backup power for a telecommunications switching station, fuel cell-powered forklifts at a General Motors facility and a FedEx facility, and an uninterruptible power supply/backup power system. The market has really started to take off for some of these applications. With forklifts, because of the continuous power and because

no battery storage area is required, businesses are saving time and money. There are over 300 Canadian-built fuel cell forklifts in operation this year and another 1200 are expected to be in operation by the end of 2008. We have also seen an increase in orders for backup power and stationary power applications. More than 500 Canadian-built fuel cell back up power units were ordered for 2007; by the end of this year, we expect to have over 900 Canadian fuel cell stationary units in operation.

Shell Hydrogen Fuelling Station, Reykjavik, Iceland
Source: Icelandic New Energy

Internationally, there are many fascinating projects that give us great hope for the future. Since it would take too long to describe all of them, I will describe two. Our IEA Annex 18 group visited Iceland a few years ago and saw that this country is definitely making a difference to the potential for a hydrogen economy. At the time, there were only three hydrogen fuel cell buses running, fuelled from the local hydrogen filling station, but with the amount of renewable energy on the island the potential for growth in hydrogen applications is enormous. Most of the island's energy needs are met by geothermal energy. Fuel for transportation applications, however, needs to be imported. This makes Iceland particularly vulnerable where energy security is concerned. Given the availability of geothermal energy, which can be used for sustainable hydrogen production, hydrogen is an obvious solution and something that public research studies have shown the Icelandic people will embrace.

Annex 18 recently visited Gran Canaria. While the island has very limited traditional natural resources, it has abundant sunshine and abundant wind. The island has a large tourist industry and the demands for fresh water are great. The desalination process uses a lot of energy, which gives Gran Canaria a big incentive to get the most out of the energy they do have. A hydrogen component added to the system helps regulate and maximise the intermittent wind resource. For example, when there is too much wind, hydrogen is produced from the wind-turbine systems, and when there is not enough wind that hydrogen is used to meet energy needs. This is a truly integrated system in that the water used to create hydrogen comes from the desalination process. Excess hydrogen will also be used to fuel clean vehicles, which are currently in procurement.

Photo courtesy of Institute of Technology, Gran Canaria, Spain

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What has the Canadian experience shown about the benefits of government partnerships with industry to advance progress with hydrogen and fuel cells?

Shannon Miles

In Canada, we have had a good working relationship with industry and we feel this is one of the reasons our industry has had a head start in its development.

Natural Resources Canada partnered with industry in the 1980s on some of their earliest R&D work, and this government department has worked closely with industry to provide technical expertise and funding. Government involvement has also helped with the creation of clusters of hydrogen and fuel cell-related companies and academia. Targeted and leveraged funding, along with incubation and test facilities, have all helped in the development of the industry.

IEA Hydrogen Implementing Agreement (IEA HIA)

The IEA Hydrogen Implementing Agreement was created in 1977. Its mission is to accelerate hydrogen implementation and widespread utilization. Its vision for a hydrogen future is one based on a clean sustainable energy supply of global proportions that plays a role in all sectors of the economy.

The IEA HIA's Five Year Plan (2004-2009) targets three major goals:

- Science and technology - advancing science via pre-commercial collaborative R,D&D (hydrogen production, hydrogen storage, hydrogen systems)
- Assessment of the market environment - non-energy and industrial processes, safety foundation for codes & standards, infrastructure
- Outreach programme - increasing knowledge of hydrogen and comfort with hydrogen (membership and participation, information and dissemination, synchronization worldwide)

Participating countries are: Australia, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Italy, Japan, Korea, Lithuania, Netherlands, New Zealand, Norway, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States, European Commission.

Another key area where governments play a role is in the development of codes and standards. This is important to make sure technologies are developed with a common set of codes, standards and safety procedures in mind. Canada is also involved in HIA Annex 19 on Hydrogen Safety, where this information is shared internationally.

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Could you tell us about the freely accessible HIA Annex 18 database, and what information this provides about technology, policy and regulation issues relating to hydrogen energy systems?

Shannon Miles

We are at the stage now in our work where a lot more information is being made public. The final reports of the first phase of our Annex 18 are available on the HIA Annex 18

website and I have found them to be quite comprehensive. This database presently has some of the most important national documents from each member country as well as selected case studies. The national documents are a good place to start if you have questions about a particular country. The case studies are an excellent resource to get more information about all aspects of a demonstration project. All new projects we look at in Annex 18 will be accompanied by a case study. All of the new case studies will be made public. Also to be found on the website is a description of our work on developing an information base, entitled "Final Subtask A Report".

Furthermore the national organisations data base, including suppliers and vendors and the national projects data base, will become public on December 31st, 2007 on our Annex 18 website.

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What methods are used by Annex 18 to evaluate demonstration projects in progress?

Shannon Miles
Annex 18 has used a number of methods to evaluate demonstration projects. As I mentioned, most projects will complete a case study; this is a more general evaluation of the demonstration project, which includes the qualitative as well as quantitative analysis. We also use modeling and analysis tools to evaluate hydrogen demonstration projects, or to guide their design and assessment, and to validate models and assumptions. In Phase 1, we calibrated and applied a number of models on renewable systems, which are described in the newly published Phase 1 report, "Hydrogen Demonstration Project Evaluations", to be found on our website. In this phase, we are adding optimisation and economic analysis tools. We have also recently added a learning and synthesis portion to our work because we discovered a lot of valuable information coming from the demonstration projects that would not otherwise be captured.

We are presently evaluating integrated hydrogen demonstration projects in ten countries; they focus on hydrogen fuelling stations and renewable power stations.

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Is your work addressing the need to quantify CO_2 emissions reductions achievable by using hydrogen and fuel cells instead of other options in use today?

Shannon Miles
Most hydrogen demonstration projects have CO_2 reduction emission goals already set in place by each host country's respective governments. Our IEA work has not focused on quantifying the CO_2 reduction in these projects. Generally, we have found that countries set up these projects with the following drivers in mind; air quality and health, climate change mitigation, industrial growth, wealth generation and diversity of energy supply.

There is clearly much potential for CO_2 emissions reduction to be realised through use of hydrogen and fuel cells. Modeling conducted by Natural Resources Canada and others has shown that hydrogen and fuel cells play an important role in reducing emissions. This is especially true for the transportation sector, where forecasts show that demand for transportation services will only increase. Fuel cell vehicles are zero-emission vehicles and, over a life cycle, as much as 85% less polluting than gasoline vehicles, depending on the hydrogen fuelling pathway. Looking at the operations of a typical diesel bus, it will emit between 140 to 150 tonnes of CO_2 per year. A bus powered by fuel cells using renewable hydrogen would displace all (100%) of these GHG emissions (www.ballard.com).

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Thank you, Shannon Miles, for answering our questions.

Shannon Miles
It has been my pleasure. For their help in providing comprehensive responses to these interview questions, I am grateful to: Susan Schoenung, Operating Agent of HIA Annex 18, supported by the United States Department of Energy; and Nick Beck, Chair of the IEA HIA and S&T Director at Natural Resources Canada.

Here are some websites that readers may find useful.
www.port-h2.com/IEA-Annex-18
www.ieahia.org
www.h2fcc.ca
www.h2.ca
www.ghgenius.ca