

**International Public Hearing
of the
U.S. Secretary of Energy's
Hydrogen Technical Advisory Panel
at the
12th World Hydrogen Energy Conference
Buenos Aires, Argentina**

The meeting convened at 2:20pm on June 23, 1998

Dr. Alan Lloyd - Chairman
Mr. David Nahmias - Co-Chairman

An attendee list was circulated. Over 40 persons from 16 countries attended.

Panelists in attendance included Juan Carlos Bolcich (Argentina); Nick Beck (Canada); Bao Deyou (China); Carl-Jochen Winter (Germany); Reinhold Wuster (Germany); O.N. Shrinavasta (India); Kazukiyo Okano (Japan); Sig Gronich (USA); Nejat Veziroglu (USA)

Welcome and Introduction - Alan Lloyd

Chairman Alan Lloyd began the hearing by expressing his hope that the hearing will be worthwhile. He acknowledged the attendance of the distinguished visitors from around the world and introduced the panel. Dr. Lloyd explained that this hearing was the second International Public hearing that the Hydrogen Technical Advisory Panel (HTAP) has held and he briefly reviewed the history of HTAP. As outgoing chairman of HTAP, Dr. Lloyd took this occasion to pass the chairmanship of HTAP over to Mr. David Nahmias. Dr. Patrick Takahashi, Mr. Addison Bain, Mr. Frank Lynch, and Dr. Mounir Kamal were introduced as HTAP members attending the hearing.

Statement of Purpose - David Nahmias

The Hydrogen Future Act of 1996 requires that HTAP submit a report to Congress that analyzes the effectiveness of the DOE hydrogen program and makes recommendations to DOE regarding the hydrogen program. International coordination and collaboration is being evaluated by HTAP for the report and HTAP hopes to gather information on that topic from this panel. DOE's National Energy Strategy lists international cooperation on energy issues as one of its five goals. The President's Committee of Advisors on Science and Technology (PCAST) report on federal energy R&D recommends the formation of government/industry/university partnerships to engage strongly in international R&D, especially in developing countries.

Panel Discussion on International Coordination and Collaboration in Hydrogen Energy

HTAP expects to learn more about the international climate from the panelists including the most important R&D goals in each country; promising markets (government driven or industry driven); opinion of panelists as to the best markets; most pressing issues; status of international partnering; and ideas for improvements.

Each panelist was asked to respond to a series of questions on hydrogen energy systems and international collaboration. Individual responses are given below.

1. What are the most important R&D goals in your hydrogen program, short and long term?

Dr. Juan Carlos Bolcich, Association Argentina del Hidrogena

Long term goals are the continuation of basis research on metal hydrides (batteries and hydrogen storage) and also the electrochemical studies (electrode reactions) at La Plata University. Application: embrittlement in the heavy water plant; the ICE is more feasible in the short term because the cost is more affordable than fuel cells (small applications in isolated places). Buses are another application of the ICE using hydrogen and NG blends. A demo plant was planned for this conference but was not completed in time.

Mr. Nick Beck, Natural Resources Canada

The short term goal is industrial growth, i.e. creating jobs by developing products with industry. Long term goals are climate change, sustainable development, environment, economic development.

Professor Bao Deyou, General Research Institute for Non-Ferrous Metals, Beijing, China

China produces large amounts of hydrogen from underground coal gasification. There are 30 billion tons of coal underground that cannot be recovered by standard mining technologies. China can produce hydrogen by UCI. It is a low investment because they can use the original investment of mine. Sequestering CO₂ is being considered. Hydro power stations and electrolysis are also under consideration. There is a lot of desire to have automobiles but pollution is a big problem. China is looking at fuel cell/electric autos through internal or imported technology for PEM fuel cells (mass production to reduce costs is needed). Waste materials and biomass can be used for hydrogen production.

Dr. Carl-Jochen Winter, Energon/Dr. Reinhold Wurst, L-B Systemtechnik GmbH, Germany

German power coal production will run out (170 million tons down to 35 million tons in 2005); energy is running out. Germany is an energy importer for 2/3 of its needs. The remainder will have to be imported if indigenous resources are no longer available. 8% reduction of CO₂ for Europe was distributed to the countries - Germany has to reduce 21% (government decided on 25% in 1997 for 2005). Germany will need an energy system which is freed of more and more carbon. For now, decarbonization is underway. Germany has had 30% less carbon for energy over the last 100 years (coal - NG - hydrogen)

Dr. O.N. Srivastava, Banaras Hindu University, India

India has very little indigenous resources (oil); importation is costly - with costs of hard currency. Pollution is confined to urban India. Hydrogen is being considered to replace oil for transportation. India is doing PEM fuel cell R&D. Urban India has three times more pollution than is considered healthy. People are buying vehicles including 2 and 3 wheelers and India needs R&D to develop hydrogen-fueled ICEs (and FC) for these vehicles.

Mr. Kazukiyo Okano, Engineering Advancement Association of Japan

WE-NET targets were originally long term but Japan wants to have some near term goals of hydrogen systems in 2003. The long term goal is to develop technologies using renewable energy to achieve the environmental goals. Japan would like to offer technologies to the world.

Dr. Lloyd asked Mr. Okano why WE-NET is changing to short term goals. Mr. Okano explained that the long term of 20 years is too far out and Japan needs to develop markets sooner.

Dr. Sig Gronich, U.S. Department of Energy

The DOE Strategic Plan lists three short term goals including \$6-8/MMBtu. Natural gas is a competition for all technologies to beat. Storage is vital for transportation systems. Collaboration with other DOE programs is needed on fuel cells. \$50/kW fuel cells is needed for transportation. Transition to sustainable energy is important. There is a need for more emphasis on electrolysis (solid oxide electrolysis). Refueling stations will be built as a short term infrastructure goal.

Dr. Nejat Veziroglu, University of Miami (U.S.)

The short term goals are inexpensive hydrogen from coal and other fossil fuels; transportation and distribution; refueling stations; and the reduction of costs of fuel cells. The Clean Coal Program may be a source of funding for the hydrogen program (which is the only way to get clean coal).

Long term goals are producing inexpensive hydrogen from renewables; fuel cells for electric power production for vehicles to improve efficiency and reduce costs; and catalytic combustion applications for appliances and heating/cooling. R&D on hydride storage, refueling technologies need to be continued.

Dr. Veziroglu feels that the government must not spend public money on producing hydrogen on board vehicles via gasoline reforming. (Applause).

2. What are the most promising market opportunities for hydrogen energy applications? Are these government-driven or industry-driven, or both?

Dr. Juan Carlos Bolcich, Association Argentina del Hidrogena

The isolated communities of Argentina has about 6% of the population over a large area. The government gives priority to renewables for these communities with some funds from the World Bank and local governments. The Patagonia wind project needs to store energy as hydrogen for world markets. The large cities need to improve the pollution situation. Buses are mostly diesel and emissions are very high. There is not enough capital to replace old buses with more efficient diesel buses. Costs are the handicap at this time. Costs must be reduced through investment and maintenance. Competition is gasoline at \$1/liter (super); regular is \$0.75/liter; diesel is \$0.45/liter; and CNG is \$0.30/Nm³.

Mr. Nick Beck, Natural Resources Canada

There is a market opportunity for fuel cells for transportation, including refueling. Canada has expertise in fuel cells and electrolytic hydrogen production. This work is done with industry in partnership.

Professor Bao Deyou, General Research Institute for Non-Ferrous Metals, Beijing, China

Transportation is China's biggest need and is now an oil importer. Even in the rural areas, power is not available. Solar cell or batteries are offered as dowry in China so that families can watch color TV. Cooking is another application that would have a big market opportunity.

Dr. Carl-Jochen Winter, Energon, Germany/Dr. Reinhold Wurst, L-B Systemtechnik GmbH, Germany

Research was government driven, but industry has taken over the lead. There is market opportunity for stationary power generation in cities and transportation applications with the automobile industry for ICE (hydrogen and hydrogen-blends or methanol) and FC. The German government lacks money for R&D because a lot of money is required to rehabilitate eastern provinces which is expected to take another 20 years. Coal will not be used to produce hydrogen because it would damage the clean image. Only centralized power plants will be coal. Deregulation will result in smaller units that are not

coal fired (efficient use of natural gas). Off-peak electricity is not nuclear or hydro: it is gas, oil and hard coal which results in hydrogen that is not clean.

Government funding is generally from provincial governments (Bavaria, and the Free City of Hamburg have taken the lead) as would be expected in a distributed system.

Dr. O.N. Srivastava, Banaras Hindu University, India

Transportation will be needed in 5-10 years in India where 100 million tons of oil is imported. There is a need for FC vehicles soon, or ICEs will need to be converted to hydrogen. Decentralized electrolyzers are the best opportunity for producing hydrogen for distribution. Storage as hydride is perhaps safer for the general public.

Mr. Kazukiyo Okano, Engineering Advancement Association of Japan

The most promising hydrogen energy applications for Japan are vehicles and refueling stations, which are industry and government driven. Public transportation is the first priority and then taxis. Refueling stations are subsidized by the Japanese government. Japan wants to exploit the byproduct hydrogen, build onsite FC power plants, and develop the infrastructure.

Dr. Sig Gronich, U.S. Department of Energy

Research is an industry-led effort for FC vehicles with billion dollars of development which is all private and millions for residential FC applications. The government role in the short term is to develop an infrastructure for demonstration. There is currently a Solicitation under development for Nevada to build stationary systems for coproduction of hydrogen and electricity.

Dr. Nejat Veziroglu, University of Miami (U.S.)

The most promising markets are producing inexpensive hydrogen from coal, FC vehicles, power plants driven by incentives from the government for clean fuels.

3. From a worldwide perspective, what are the most promising markets for hydrogen energy in your opinion? In the industrialized countries? In the developing countries?

Dr. Juan Carlos Bolcich, Association Argentina del Hidrogena

Large cities are just getting worse. There is a big need to improve the transportation sector. One third of the population is without electricity. The development of a full chain is important.

Mr. Nick Beck, Natural Resources Canada

The biggest markets are heavy duty and light duty transportation; distributed power generation; and urban transportation in the developing world.

Professor Bao Deyou, General Research Institute for Non-Ferrous Metals, Beijing, China

The development of infrastructure.

Dr. Carl-Jochen Winter, Energon/Dr. Reinhold Wurster, L-B Systemtechnik GmbH, Germany

Exporters of energy need to prepare for cleaner fuel exportation. NG costs are going up. Developing countries need to improve transportation sector. Bring the technology to market first in developed countries. Remote applications using batteries could be replaced with hydrogen.

Dr. O.N. Srivastava, Banaras Hindu University, India

Dr. Srivastava had no additional comment.

Mr. Kazukiyo Okano, Engineering Advancement Association of Japan
Developing countries are good markets for FC vehicles.

Dr. Sig Gronich, U.S. Department of Energy

In the industrialized nations the needs are transportation, buildings, and residences with cogeneration - combined heat and power. In the developing nations, the markets are renewable systems through PV-electrolysis for production of hydrogen; motor scooters on hydrogen; remote power systems; use of wind and solar for hybrid systems with diesel and batteries.

Dr. Nejat Veziroglu, University of Miami (U.S.)

In the industrialized countries, it is the automotive market and power generation. The developing countries need transportation and power for residential areas, farming, and small industries.

4. In your opinion, what are the one or two most pressing issues or barriers facing the successful implementation of hydrogen energy systems? In your country? Worldwide?

Dr. Juan Carlos Bolcich, Association Argentina del Hidrogena

Dr. Bolcich listed costs and education as the barriers. He added that codes and standards (ISO TC197) should be available soon and the regulators need the information.

Mr. Nick Beck, Natural Resources Canada

Mr. Beck said that cost is the obvious barrier. Infrastructure issues are also a concern. The choice of fuel for the vehicle, and how to get the fuel to the vehicle can be overcome.

Professor Bao Deyou, General Research Institute for Non-Ferrous Metals, Beijing, China

Dr. Deyou stated that financial support is required for implementation of "future energy." Transportation, storage and distribution are essential. Losses in high voltage transportation are 10% in China. Further research and propaganda (for education) are needed.

Dr. Carl-Jochen Winter, Energon/Dr. Reinhold Wurster, L-B Systemtechnik GmbH, Germany

Education is needed because of the Hindenburg Effect including education in the policy arena with broad conviction of public officials and the public in general. The infrastructure - will it be reforming on board? There is a barrier in thinking that says energy services have to be cheap. Hydrogen buses are not competitive with CNG buses.

Dr. O.N. Srivastava, Banaras Hindu University, India

The barriers are decentralized production and distribution of hydrogen. One possible solution is exchange of tanks. Diesel is currently subsidized (40%) and the government of India will subsidize hydrogen when it is available. Off-peak electricity needs grid sensing electrolyzers. Currently, excess hydropower is not used for 6-7 months and it could be used to make inexpensive hydrogen.

Mr. Kazukiyo Okano, Engineering Advancement Association of Japan

The challenge is to reduce cost of fuel and conversion devices. Infrastructure is also a barrier for distribution of hydrogen over a wide area. There is the general belief that hydrogen is dangerous which creates a need to educate people that hydrogen is a clean and safe fuel.

Dr. Sig Gronich, U.S. Department of Energy

Reducing costs is the biggest challenge and at some point the government will look for a technological solution in which an incentive will make the technology acceptable. Niche markets for green

technologies need to be considered. The establishment of government and industry partnerships need to continue and grow. The infrastructure problem can be solved with coproduction of fuel and electricity. Education is another major barrier.

The use of natural gas is an important aspect of the program. Working with the natural gas industry addresses the issue of working with a powerful industry. In time the program, will work with the petroleum industry.

Dr. Nejat Veziroglu, University of Miami (U.S.)

The costs and the aloofness of petroleum industry are the barriers. A possible solution would be to initiate cost sharing projects with the petroleum industry for production and delivery. Other solutions would be to reduce CO₂ emissions further during future UN Climate Change meetings, establish a CO₂ tax and ZEV laws.

5. Please comment briefly on your country's current level of international collaboration and partnering in hydrogen R&D and commercialization activities. With other governments. With industry. Can you suggest ways in which collaboration can be improved?

Dr. Juan Carlos Bolcich, Association Argentina del Hidrogena

This meeting is the main activity for Argentina, but there is also involvement in ISO TC197. Reconversion of nuclear and military infrastructure is needed, but it is difficult to finance this conversion. Cooperation with other countries is needed. Armed forces are interested in hydrogen. South American Common Market participation is needed to develop priorities - hydrogen is considered. Duplication of effort must be limited. Demonstrate the benefits of hydrogen with international collaboration.

Mr. Nick Beck, Natural Resources Canada

Canada is involved with IEA collaborations (Hydrogen Agreement) storage (hydrides and carbon) and integrated systems. Canada is also involved in the PEM annex for IEA Fuel Cells; the Memorandum of Understanding with the US Department of Energy; and ISO TC197. More participation in IEA would be good with additional bilateral efforts. Canada is open to new efforts.

Professor Bao Deyou, General Research Institute for Non-Ferrous Metals, Beijing, China

China needs include cooperative R&D activities; large investments; and international conferences for exchange of viewpoints and information.

Dr. Carl-Jochen Winter, Energon/Dr. Reinhold Wurster, L-B Systemtechnik GmbH, Germany

National hydrogen associations have annual meetings and maybe it would serve to make sure that there is someone from each country at the other's meetings. HYFORUM 2000 will be held in Munich on September 11-15, 2000 to focus on policy, business, and technology. BMW is a major supporter. Petroleum and gas industry are also on board. Energy is an international venture. Little mention was made in this meeting about the large international project, Euro Quebec Hydro Hydrogen Pilot Program. Communication is vital, particularly in multi-country projects.

Dr. O. N. Srivastava, Banaras Hindu University, India

India is working with Japan on electrolyzer development and Germany with photobiology. India is also working with ECD. India is in need of assistance with gas turbines, PEC, PV. Multi-country participation in programs is desirable.

Mr. Kazukiyo Okano, Engineering Advancement Association of Japan

Japan is involved in the IEA and ISO TC197. Also WE-NET program has cooperative research projects with US, Canada, UK, France and Germany.

Dr. Sig Gronich, U.S. Department of Energy

The US Hydrogen Program is involved with the IEA, cooperative R&D, analysis, new cost-shared efforts; hydrogen as a chemical feedstock; from carbon-containing fuels; and market studies. The US has visiting scientist programs and photobiological collaboration with Italy, and Japan. There is a need for the US to expand to other areas.

Dr. Nejat Veziroglu, University of Miami (U.S.)

The US should establish binational and multinational cooperative R&D programs. The US government needs to increase the DOE hydrogen budget by ten times over the next 2-3 years. There would be more visibility to DOE hydrogen programs if all programs were under the same assistant secretary.

Questions and Comments

Questions and comments were taken from the audience after the panelists responded to the questions posed to them prior to the meeting.

Venki Raman - Air Products and Chemicals, Inc.:

Regarding international cooperation, industry is way ahead of any governments with respect to cooperation. Government needs to recognize that this is happening and either help or get out of the way. Government assistance with demos need to be routed on basic business opportunity. The Hythane project is an example - it was a technical success but did not have a commercial basis. The government needs to make sure the demos have a strong commercial foundation.

Pierre Benard - Canada (government):

The bus project is not dead yet. The bus emissions are excellent and the bus is efficient, but money is the problem.

James Provenzano - Clean Air Now!:

Collaborations could be fostered - renewable and hydrogen industries should be talking.

Response from Sig Gronich - US Department of Energy:

DOE has made effort in that regard - the PV program has been contacted and is somewhat interested. RAFCO involves the Wind program. Batteries and diesels are the current technology of choice for Wind (and PV). Biomass Power collaboration is possible.

Christoph Huss, Germany:

How many years is short term and long term?

Response from Sig Gronich:

Short term is within 5 years. Long term is 10-20 years.

Krishna Sapru - ECD:

On the issue of barriers, the political barrier is very large. There is a need for high level persons from each country to be involved. In respect to the markets for India, are we able to communicate to the energy minister? We need political leaders and the energy minister should be present at these meetings.

Response from Carl-Jochen Winter:

We are not the masters of our ministers. A report of this meeting will be useful to pass on to the minister.

Robert Zweig:

Cost is defined incorrectly. We need to internalize the external costs - air pollution problems are affecting the public health.

Rolf Ewald, Germany:

The Hydrogen Association in Germany was established a few years ago. There are a number of Hydrogen Association in other countries.

Giampiero Tartaglia, EU:

The Italian Hydrogen Association was just recently formed. France has an association. These are supported by the EU/EC. We need an EU association with representation of all of the member country groups. Technology is not the issue; education and awareness are the issue.

E.A.M. de Nie, Netherlands:

The government made wind energy possible through tax credits. Politicians can help get the costs down in other ways.

Closing Comments - Alan Lloyd

This is a critical juncture for hydrogen. Fuels for FC vehicles are being selected now. We need to pull in all parameters to emphasize the need for hydrogen. Threatening the petroleum industry works. We need to influence the selection of fuels. We are underestimating the difficulties of putting reformers on board the vehicle; this is extremely costly for the auto manufacturers. Government should look at high risk technologies and not assist petroleum industry in selling more fuel, or assist the auto industry to make better use of diesel.

Dr. Lloyd thanked all of the participants and adjourned the meeting at 5:00pm.