PATH Visioning – An Early View

By Robert Mauro, General Manager, PATH

PATH has begun to gather information and some perspective on the vision that its members have for their energy future and the role that hydrogen and fuel cells may play in that future. The intent of the effort is to characterize, in summary form, each countries current energy situation, and then this likely future that their current circumstances, economic climate, and domestic energy resources will lead to.

There are several considerations for prioritizing the each country's options. The first is environment and the development of "greenhouse gases". Approaches that minimize environmental impacts of fuel production and use are given priority over other technologies. It is also assumed, although not critical to the overall vision, that at some point in the future all known fossil resources will be depleted and our inhibitions on nuclear, for good or ill, will be overcome. How, and under what circumstances, this will occur is not specified. Finally, it is assumed that large sinks for energy are most easily served by large centralized sources. This does not mean that these energy sinks can not be served by distributed sources, but that the current infrastructure will be utilized indefinitely. The paper also assumes that electricity will play a major role in every country's energy future and the key consideration in developing that future is the rapid, cheap and efficient transformation of electricity to hydrogen and hydrogen to electricity.

A look at the current energy sources and uses mix of Canada shows hydrogen power could provide for all of Canada's energy needs renewably. This suggests that Canada could follow an Icelandic model using only renewable resources to meet their energy needs. This would allow Canada to reduce its CO2 emissions and sell credits under the Kyoto Agreement while expanding its industrial sector. Most likely, with its extensive oil and gas reserves, Canada will deviate from the Icelandic model. Canada is more likely to supplement its hydropower with nuclear, which it could again develop into an export market for reactors and fuel. It has a strong incentive to shift its transportation sector from petroleum to hydrogen powered fuel cell vehicles. This shift will help Canada to meet its commitments under the Kyoto Agreement, and to free up CO2 credits for expansion of the industrial sector with the potential to sell remaining credits internationally. After satisfying internal requirements it will likely sell oil and gas to other markets.

The Japanese situation is considerably different. The limited domestic resources mean that the vast majority of the energy that they consume is imported, making the need to reduce energy requirements Japan's highest priority. Their next priority is to determine how much renewable energy they can produce domestically. Japan will also develop a nuclear industry since it involves the smallest quantity of imported fuel and, if it would be politically acceptable, could be developed into a sustainable power source. Finally, Japan will produce hydrogen off-shore and import it either as hydrogen, LNG or methanol.

The U.S. energy situation is far more complex than either Japan's or Canada's. Rather than trying to characterize the U.S. energy situation, it is better to discuss the influential factors that are being addressed. The first is the distinction between those with access to pipeline natural gas and those without access. Those without pipeline natural gas have certain priorities similar to Japan, and will use distributed generation sources for to generate hydrogen. Those with access to the natural gas infrastructure will rely on it for hydrogen delivery. Another relevant factor is US petroleum consumption. In 2001 the U.S. produced 12 Quads of petroleum and consumed 37 Quads. The U.S. has extensive fossil resources, but their production and use tend to be in environmentally sensitive areas. This will lead to constant conflict over their development. Therefore, the U.S. demand for petroleum must be addressed in any vision. The most obvious way to address this issue is to remove the largest petroleum consumer use, road vehicles, from the demand equation. The

transportation sector uses almost no electricity while other end-use sectors use 33% to 60% of their primary energy to produce electricity that is used in that sector. A fuel cell hydrogen car would integrate the transportation sector into that energy mainstream and make it similar to the other energy sectors.

There is one concluding thought that I want to leave you with. Perhaps our definition of renewables is too narrow. In addition to solar, wind, biomass and other traditional sources perhaps we should add renewably produced natural gas and nuclear power from either breeder reactors or fusion.

Let me first discuss renewable methane. Before there was oxygen, bacteria operated on a CO2, methane cycle. If CO2 is sequestered in aquifers, organic waste products in combination with anaerobic bacteria could produce methane on a continuous basis. The more or less continuous production of methane could justify sequestration and keep at least a portion of the gas pipeline system operating. The amount of production that could be result from these methods would be speculative. It depends on the availability and transport cost of the organic material.

Before renewables were defined by solar, wind and biomass, the energy future was conventional nuclear reactors, breeder reactors and fusion. Fusion is truly renewable based on the amount of tritium and deuterium in the oceans, and breeder reactors are nearly renewable. The vision paper does not take us quite that far because there are extensive untapped hydrocarbon resources in the world in forms such as methane hydrates. The issues revolve around controlling the environmental impacts associated with recovery, production and use while providing energy at a cost that does not undermine national economies.