Global Warming Up to a Hydrogen Economy

by: George Gorski posted on: April 14, 2008

"Exxon (XOM) has taken the most skeptical line of any major oil company towards alternative fuels," said Exxon's senior vice-president Stephen Simon, testifying before the Select Committee of Energy Independence and Global Warming in Washington, D.C. on April 2, 2008. "The company did not believe that existing technologies in this area were viable - and the company was hoping to 'leapfrog' to a new generation of techniques."

Some scientists say that man is responsible for global warming, causing the atmospheric temperature to rise and glaciers and polar ice caps to melt. It has been estimated that the earth's average atmospheric temperature has risen about 0.8 degree C over the last 200 years. The Arctic region's temperature over the same period of time has risen about 1.5 degree C. Some scientists say this is attributed to the absorption of solar radiation caused by particulate in the snow. Instead of reflecting solar radiation, dirty snow is absorbing it. It has been estimated that this effect has contributed to about 19% of global warming or about 0.15 degree C. As more layers of snow melt, more particulate is exposed causing the rate of ice and snow to melt exponentially. Scientists say that if global warming is not reversed, all the world's polar ice caps may melt over the next 500 years and the sea levels may rise about 90 meters. Many countries in the Caribbean along with USA eastern seaboard states, as well as Florida and Louisiana, Canada's east coast, South Viet Nam and Bangladesh may be under water along with the majority of world cities currently located along ocean coast lines.

It is not clearly understood all of the chemical reaction mechanisms that occur in the earth's upper atmosphere. It is known that gases such as water vapor, carbon dioxide, methane, ozone, nitrous oxide and chlorofluorocarbons absorb infra red light. The absorption of infra red light generates heat and is what scientists say contributes to global warming. Water vapor in the upper atmosphere accounts for about 36% of the heat absorbed from the sun followed by 9% attributed to carbon dioxide. As more heat is generated, more water is evaporated from bodies of water and remains in the atmosphere in equilibrium. Perhaps that is why the Great Lakes water levels are declining. It is also why land is becoming drier, fewer crops are being harvested and more people are starving. Note: Sulfur dioxide forms aerosols, and does not absorb infra red radiation. It scatters light, thereby having the opposite effect of global warming.

Common opinion is that man's production of carbon dioxide is the main contributor to global warming. The concentration of carbon dioxide in the upper atmosphere has increased 31% over the last 200 years. In recent studies of rainwater composition, scientists have found concentrations of carbonic acid ions from dissolved carbon dioxide as high as 355 ppm, nitric acid ion concentrations from dissolved nitric acid of 0.01 ppm and sulfuric acid ion concentrations of 0.01 ppm.

This seems to contradict scientific theory that carbon dioxide remains for centuries in the upper atmosphere and increases global warming. When carbonic acid rain falls to the earth, it dissolves calcium which eventually finds it way to lakes and oceans. Most living creatures require calcium to develop protective shells and bones. The by-product of this reaction is carbon dioxide and water.

Some scientists say that to reduce the impact of global warming requires the reduction of carbon dioxide in the upper atmosphere. However, simply collecting carbon dioxide from the stacks of power plants and vehicle exhausts and pumping it underground or into the oceans is not the long term solution. By disposing of it this way does not replenish the oxygen used to produce carbon dioxide in the first place. Without planting an equivalent number of trees, the concentration of oxygen in the earth's atmosphere may eventually be reduced to the point of suffocating all living things on earth. Methane also accumulates in the upper atmosphere and absorbs infra red light as well. Because of its molecule size in comparison, it absorbs 21 times more infra red radiation than carbon dioxide. The residence time of methane in the upper atmosphere is about 12 years, eventually absorbing enough infra red radiation to react with oxygen to form carbon dioxide and water. 71% of atmospheric methane is directly or indirectly produced by man. The atmospheric concentration has increased by 100% over the last 200 years. Because of these facts, some scientists believe methane indirectly contributes to 50% of global warming.

It is interesting to note that nitrous oxide (produced naturally, by the combustion of hydrocarbons in power plant and car tail pipe exhausts) reactions in the upper atmosphere produce ozone. The atmospheric ozone layer absorbs UV radiation protecting humans from skin cancer and eye damage. The question remains why the ozone layer is being depleted.

Since the advent of space satellites, scientists have recorded increases of 0.05% per decade in solar activity since the 1970s, which in turn causes global warming. Prior to satellites, tree rings were used to determine world temperature trends. Examination of tree rings, indicate that the earths temperature has risen about 0.6 degree C since the 1800s.

There would appear be many reasons for global warming. Special interest groups appear to have successfully lobbied to persuade the general public and all levels of world governments that something must be done to reverse global warming and in particular the reduction of carbon dioxide emissions. Nations with foresight, stand to gain from the development of new technologies that eliminate the sources of carbon dioxide emissions and at the same time replacing foreign sources of petroleum derived energy with hydrogen. These changes will not occur over night. To eliminate price shock to consumers, maintain multi-national cash flow, minimize the disruption of existing fuel supplies and infrastructure, the hydrogen economy may be staged over time.

The four main steps in the process may be:

a) **Carbon Dioxide Elimination.** No change to existing industrial and domestic energy requirements from complex petroleum products, but capture and storing of carbon dioxide.

b) **Energy Diversity.** As sources of oil supply are depleted, conversion of industrial and domestic energy requirements from complex petroleum products may be replaced with solar, nuclear, wind turbine with methane, propane and hydrogen sources for the wide spread fuel cell use for electrical generation, heating and vehicle transportation.

c) **Conversion to Hydrogen Society.** As the earth's surface area becomes saturated with solar panels and wind turbines and the depletion of uranium supplies, hydrogen will fill new growth areas for industrial and domestic energy requirements.

d) **Hydrogen Technology Dominance.** Electrolysis of water is energy intensive.

A new generation of catalysts may be developed to convert water to hydrogen and oxygen. The first nation to develop this technology may "leapfrog" today's and near future technologies by a few generations.

Carbon Dioxide Elimination

The reduction of carbon dioxide emissions can be achieved by the chemical reaction of carbon dioxide to produce oxygen and carbon. This involves catalytically reducing the products of hydrocarbon combustion in-situ or remotely after collecting and transporting it to a central processing location. In the short term, multi-nationals (for example, Suncor (SU) and Enbridge (ENB)) may pass on the expense of capturing, transporting and disposing carbon dioxide to consumers. To achieve carbon dioxide chemical reduction [CDCR] in motor vehicles requires a new generation of catalysts, for example common magnetite, installed in the existing exhaust systems to produce oxygen and carbon. Uses of carbon dioxide collected from power plants exhausts can be catalytically treated to produce carbon black and oxygen economically. Carbon black is currently used to make rubber products such as tires and printer toner or added to agricultural soils as an important nutrient facilitating improved plant growth and replacing existing practices of plant stock burning, thus reducing atmospheric particulate generation. Producers (such as Cabot Carbon (CB)) currently deriving carbon black from oil could benefit from this inexpensive source of carbon dioxide feedstock, by modifying their existing process. The oxygen produced from the process can be used in the existing production of bottled oxygen for welding and medical purposes or steel production (for example, US Steel (X)).

A Sabatier Reactor using a catalyst such as alumina-ruthenium compound, can convert water and carbon dioxide to methane. Multi-nationals would be required to buy ruthenium from mining companies (for example, Anglo Platinum (AGPPF.PK) and Impala Platinum (IMPUY.PK)) to produce these new catalysts.

To eliminate the natural anaerobic digestion of hydrocarbon materials into methane and carbon dioxide, legislation may one day soon require all municipalities and land fill operators (example Waste Management (WMI)) to collect, recycle and / or convert all carbon materials and hydrocarbons to hydrogen, methane, intermediate hydrocarbons and carbon black. Refineries, power plants, manufacturers and hydrogen fuel dispensing companies may also be legislated into using these feedstock sources for fuel.

Long term, collecting and reacting carbon dioxide to produce oxygen and carbon is not efficient and requires infrastructure creating more sources of carbon dioxide.

Transition to Hydrogen

With hydrocarbons becoming more difficult to find and the cost of production prohibitively high, electrical energy from nuclear reactors, solar panels, wind turbines, fuel cells and batteries may become economical eventually replacing petroleum, coal to liquids, coal gasification, LPGs and natural gas as energy sources. Based on current thinking, before hydrogen technology can be fully developed nuclear, solar, wind turbine, methane/propane fuel cells and battery energy sources must be fully exploited. A flurry of nuclear plants are being planed and built to eliminate the global warming threat. Uranium Miners (for example, Cameco (CCJ), Paladin (PALAF.PK), Uranium One (SXRZF.PK)) will benefit from the new interest in nuclear energy as users are currently attempting to lock up long term supply contracts. Nuclear energy producers (for example, Cameco, TransCanada Pipelines) are also reaping the benefits. Also, currently benefiting from the energy diversity are silicon producers and solar panel manufacturers (for example, Timminco (TIMNF.PK) and Canadian Solar (CSIQ)).

Emerging groups currently benefiting from energy diversity are wind turbine manufacturers (example, General Electric (GE), Games Corp (GCTAF.PK) and Vestas (VWSYF.PK)) and wind mill farm operators (Western Wind Energy (WNDEF.PK), CrestStreet Power (CEPWF.PK)).

Hydrogen fuelled vehicles may not appear overnight. In the short term, sources of fuel for vehicle fuel cells may be a combination of methane and propane before settling with hydrogen. Production of carbon black as a by-product by the catalytic reaction of carbon dioxide exhausts may be perceived to be an issue. Currently a variety of fuel cells are being developed and manufactured using a variety of Rare Earth Elements, including Yttrium, Samarium, Gadolinium and Lanthanum. Lanthanum currently used in hydrogen fuel cells and NiMH batteries may become the norm. Neodymium-iron-boron (NdFeB) motors (with small quantities of dysprosium) currently used in hybrid electric vehicles may also become the norm.

Miners (Avalon , Great Western Minerals (GWMGF.PK), MolyCorp (MLYFF.PK), (Kings Bay (KBGCF.PK)) currently developing and producing these Rare Earth Elements may some day benefit or be bought out by present day vehicle multi-nationals (for example, Ford NYSE (F), General Motors (GM), Daimler-Chrysler (DCX), Toyota (TM)).

In the short term, large scale production of hydrogen may come from the reforming of natural gas. Eventually the high cost of exploration companies (for example, Diamond Ensco international (ESV), Trans Ocean (RIG), Offshore (DO)) new production by current natural gas producers (example, ENCANA, ExxonMobil, Talisman) from deep sea underwater and deep land sources in remote areas of the world may become uneconomical.

Hydrogen Infrastructure may look much the same as today's, but the power plants behind the walls of those familiar looking buildings may have changed. Hydro lines and pipelines rights of way may more or less remain the same. The existing natural gas transmission system infrastructure (for example TransCanada Pipelines, Enbridge) hydrogen resistant pipelines may be carrying hydrogen rather than natural gas and oil. Instead of natural gas and oil furnaces to heat our homes, it may be hydrogen converted by fuel cells into electrical heat energy.

Almost simultaneously the Gasification of Coal may be used to produce hydrogen. Current coal producers (example, ARCH (ACI), Peabody (BTU), Fording) may eventually surpass natural gas producers as the source of hydrogen due to the low cost of coal.

Multi-nationals (example, GE, Sasol (SSL)) that currently sell Coal Gasification & Natural Gas (or Syn Gas) Steam Reforming Technologies may most likely be the first commercial manufacturers of hydrogen equipment. Some of these industries may eventually fail to survive if they are unable to manufacture equipment that economically eliminates carbon dioxide generation.

Existing Natural gas and coal fired power plant owners (examples, Peabody, TransAlta (TPERF.PK), TransCanadaPipelines) may be legislated to eliminate the carbon dioxide by-product and may be forced out of business, if the technology in unavailable or uneconomical.

Microwave technology (example, Global Research (GBRC.PK), Chevron (CVX)) may become a means of hydrogen production in the future. It may replace those processes that produce hydrogen, but are unable to eliminate carbon dioxide by-products economically or legally. Microwave technology may be used some day to convert depleted oil wells, methane, tires, plastic, oil sands, crude oil, wood chips and most all carbon hydrocarbons into a source hydrogen and carbon black.

Multi-nationals (Suncor, PetroCanada) currently processing oil sands using from conventional methods may one day be legislated into using non carbon dioxide producing processes, such as microwave technology, or face extinction.

Existing natural gas and coal fired power plants producing electricity may one day be replaced with multiple banks of large scale fuel cells. Manufacturers (examples, Siemens (SI), ABB (ABB), GE) of a combination of HVAC and HVDC power grids may one day benefit by interfacing their hardware into the existing and new infrastructure. HVDC may

replace HVAC for those applications requiring long transmission lines because of easier control of power flow, lower losses, higher transmission capacity, and lower cost due to fewer lines. Connection of fuel cell sources to the power grid require the use of a DC-DC converter from certain manufactures (for example, American Semiconductor (AMSC)) that are used to first boost the voltage to the correct level and an inverter to convert the DC power to AC for connection to the power grid.

The current sell-off of manufacturing technology licences to Middle East, Asian interests and others may provide the development funds for new hydrogen technologies and elemental compound building block nano-technology.

Conversion to Hydrogen Society

Hydrogen may emerge as the cleanest, most self generating, most abundant and pollution free of all energy sources.

It has been demonstrated that vehicles can be powered with a combination of hydrogen fuel cells and electrical batteries.

Homes and businesses may be the main centres for recharging car batteries and refuelling personal vehicles. New hydrogen fuel dispensing companies (for example Air Products (AIR)) may replace present day multi-nationals (for example, Suncor, Petro Canada, ExxonMobile). Highway service centre infrastructure may look the same but modified to include battery recharge and hydrogen fuel dispensing facilities. Re-charging and re-fuelling highway vehicles may not be an issue. The time taken may be no longer than the time to have a leisurely meal.

Hydrogen may also be produced by manufacturers of water electrolysis equipment (example, Distributed Energy (DESC)). Non potable sources of water and sea water shall be first purified using reverse osmosis technology equipment (example, H2O Innovation, Consolidated Water Company (CWCO)). Sources of electrical energy for electrolysis and hydrogen production may be generated by equipment made by fuel cell manufacturers (example, Ballard Power (BLDP)).

Electrolysis of water taken from seawater may offer other benefits. Ocean water (example, San Francisco, CA) is generally cold and can be used for a heat exchange medium in commercial buildings. The seawater may be returned clean to the sea in a location where it can be mixed and allowed to return to its original salinity after partial separation, to be considered environmentally friendly. Some of the water may be used for agriculture in semi-arid areas (US southwest).

Hydrogen Technology Dominance

Because of the great deal of energy required, water electrolysis technology may eventually be replaced with a new generation of catalysts used to convert water to hydrogen and oxygen.

Purdue University researchers are currently developing an aluminum-rich alloy catalyst made up of five percent of gallium, indium and tin to convert water to hydrogen and oxygen.

Gallium and indium are currently mined in North America (example, Geodex Minerals (GXMLF.PK)) and it is unknown which multi-national may secure these minerals for future hydrogen production from water.

It is unknown which of the major multi-national companies (GE, XOM, COP, Marathon (MRO)) will finance hydrogen technologies and capitalize on breakthroughs. Conclusion

With profits high, resources available, no competitive energy sources and vast amounts of capital invested, there appears to be no incentive for multi-national oil companies or users to switch to hydrogen energy technologies. The question becomes, “Which multi-nationals will have the leadership to "leapfrog" to a new generation of Hydrogen technology, distribution and hybrid vehicle manufacture?”

Will it be General Electric? TransCanada Pipelines? Toyota?

Which nation will ban carbon dioxide emissions and force multi-nationals to invest in Hydrogen technology?

Disclosure: I have shares in Suncor, Great Western Minerals, General Electric, Cameco, Denison Mines and BFI Canada.

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