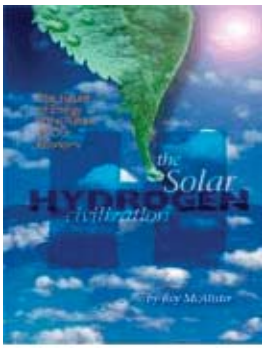
Building a SEED Park: Part VI – Solar Hydrogen

With the exception of nuclear and geothermal, all forms of energy are ultimately derived from the sun. Petroleum, coal and biomass are all forms of solar energy captured by plants through photosynthesis. Biomass and these fossil fuels are composed principally of carbon, hydrogen, nitrogen and oxygen.

When fossil fuels and biomass are burned for energy, the carbon is converted into carbon dioxide and lost to the atmosphere. The hydrogen is combined with oxygen to produce water vapor and is similarly discharged to the atmosphere.



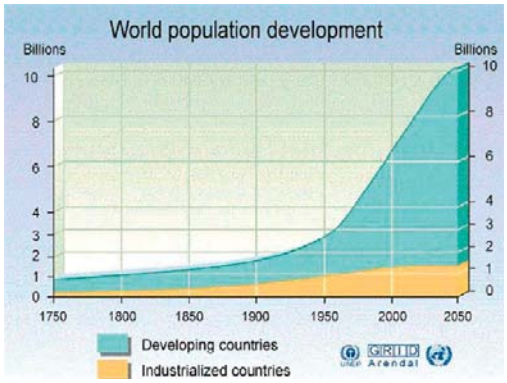
An alternative use of fossil fuels and biomass would be to convert them into gases that can be synthesized into an array of organic products, including plastics, polymers, and carbon fibers. Refineries today produce a series of petroleum-based products, including plastic bottles for beverages and water. Bio-refineries could produce a similar line of products from biomass. The book "The Solar-Hydrogen Civilization" by Roy McAlister provides a view of a solar-hydrogen-based economy.

The San Luis Valley is home to one of the largest (if not the largest) photovoltaic array in the US. Electricity produced by photovoltaics can be used on-site, delivered to off-site users via the electrical power grid or stored in batteries or capacitors. An alternative method of power storage is through production of hydrogen and oxygen gases from electrolysis of water. Hydrogen and oxygen gases can be recombined in a fuel cell to produce electricity and water. Each conversion of energy from one form into another, for example from photovoltaic electric power to hydrogen and from hydrogen back to electrical power, introduces new inefficiencies, yet still provides a way of capturing the energy of sunlight and using it when the sunlight is unavailable. Electricity produced from wind power can similarly be used to produce hydrogen and, therefore, store energy.

Hydrogen can be pressurized, stored in tanks and used as fuel for internal combustion engines. Alternately, hydrogen can be added to liquid fossil fuels to increase energy content of diesel, biodiesel or gasoline.

The exhaust emissions of internal combustion engines operating solely on hydrogen fuel are cleaner than the air taken into the engine. The only emission from hydrogen-fueled engines is water vapor. Condensing this vapor produces distilled water.

Many people often have negative feelings about hydrogen based on perceptions regarding the Hindenberg blimp, the difficulty of transport, the fear of explosions, etc. First, some steel tanks built before, or shortly after, 1900 to store hydrogen at 2000 psi are still being safely used today. The carbon fiber tanks of today safely store hydrogen in excess of 20,000 psi. In the event of an accident and release of hydrogen, it would dissipate up and into the atmosphere, presenting far less danger than a spill of gasoline flowing down and across the ground. Unquestionably, the hydrogen in the Hindenberg burned, but the cause of the fire is believed to be the highly flammable coating on the outside of the blimp that initiated the blaze.



With all of the concerns for the safety and the perceived problems with hydrogen, why do we now consider hydrogen as a fuel? We only need to look at the global supply and use of fossil fuels to see the critical need for a sustainable energy supply. As the global human population has increased from 1 billion in 1810, to 3 billion in 1960, to 6 billion in 2000, and a projected 10 billion in 2050, the world's demand for fuels has increased accordingly. In one year, the world today consumes the fossil fuels deposited over a 1-million year period. The world's known oil reserves are estimated to be

866 billion barrels, of which over 75% are held by OPEC members. The US has only 22 billion barrels of oil, or 2.5% of known oil reserves. The world demand for transportation has doubled every decade since 1900. Clearly, the world cannot continue on its present course of increasing consumption of non-renewable fuels.

Hydrogen is a renewable fuel resource. It can, and most likely will, be used as a fuel for transportation. The annual US subsidies for fossil fuels are estimated to be $26 billion/yr and for nuclear power to be $19 billion/yr. The true cost of gasoline, when the energy subsidies are factored in, was $5.50/gal before the Iraq war, and $11/gal since the Iraq war. These calculations were based on oil at about $60/barrel and not the current $90+/barrel of today. Hydrogen could be used on-site as fuel for internal combustion engines at the San Luis Valley SEED Park. On-site use of hydrogen would offer an educational demonstration, reduce the SEED Park's dependency on fossil fuels and provide an opportunity to refine and mature the hydrogen technology.