Excerpts taken from a ***White Paper***

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Solar Hydro-gen (H_2) Generator™

This white paper is addressed to all those interested in making a difference in the United States' energy sources by producing energy from renewable and sustainable sources and promoting the hydrogen economy. This includes all energy consumers who want to produce it where it is consumed: individuals, residence owners, small business owners, commercial businesses, industrial business enterprises, kiln operators such as cement and fertilizer manufacturers and lumber drying, bakeries, farms that use tractors and operate water pumps, heating plants that consume natural gas, oil or coal, hospitals and hotels that have idle (made idle by government regulation about pollution prevention) backup diesel electric generators, local government agencies, state and federal government agencies, schools, military and defense branches of government as well as investors and others who want to help promote the hydrogen economy.

Major questions arise: Where will the hydrogen come from? and How will the hydrogen be generated?

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"Whoever Controls Energy Wins !"
Thomas W. Oakes, PhD

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In the Nineteenth Century, at about the same time scientists identified the hydrogen (H2) element as the most abundant element in the universe and discovered that it could be used as an energy source, the American public was making use of the horse and buggy for transportation. The major source of pollution in places like New York City was the daily deposition of 1,200 tons of horse manure on the streets; but soon, the goal of some visionaries to reduce that pollution was to progress from horse power to gasoline power.

The beginning of the Twentieth Century found automobiles (and even the Wright Brothers' airplane) powered by gasoline engines. Use of cars and trucks proliferated and the industrial revolution spread throughout the world. With these developments the demand for hydrogen grew in many chemical applications and fossil fuel refining industries, with essentially none for direct public use. Widespread use of fossil fueled vehicles culminated in great convenience for the general public, but resulted in major pollution problems for cities and the people living therein. Today, the consumption of gasoline in combustion engines – about 360 million gallons per day -- has yielded new and far more virulent pollution in cities across the country and throughout the world.

It is pointed out by Pinkerton and Wicke in Industrial Physicist, Feb/March 2004, that as the 21st century unfolds, we stand on the threshold of another energy revolution: the transformation from usage of dwindling petroleum resources to clean and abundant hydrogen power. They indicate that the success of the hydrogen economy depends on three critical elements:

1. The development of a clean, efficient, cost-effective hydrogen fuel source.
2. A means to store useful quantities; and
3. An infrastructure to deliver that hydrogen to consumers.

Development: The problem facing the growing hydrogen industry is that most research has been focused on what is called "reformation" of natural gas. Hydrogen production primarily consists of steam reforming of natural gas at oil refineries. Complete success has not been achieved despite great sums spent on reformation technology for smaller applications and it is not entirely ready for commercial use today on a distributed basis. Reformation of natural gas by steam has been used in industrial refineries for making bulk hydrogen that is mostly consumed in such producing factories. Major problems exist for distribution to local sites. Reformation of natural gas to produce hydrogen further accelerates looming fuel shortages, because it is commonly based on consumption of the already dwindling fossil fuel resource.

Most hydrogen sources today are based on production from limited fossil fuel supplies. Oil refineries presently use most of this hydrogen in petrochemical plants to refine fuel and to make industrial commodities. Comparatively little hydrogen is currently used as fuel or as an energy carrier. Yet, making a transition to a hydrogen-based economy will include the expectation that, in the long term, hydrogen will join electricity as a major energy producer and that much of the hydrogen will be derived on-site from renewable energy sources.

Storage: Market penetration of advanced technologies to produce, store, and use hydrogen will herald the establishment of the hydrogen energy economy. In the mid- to long-term, a large and growing renewable-based hydrogen-to-electric power system will require significant storage capacity. Hydrogen will stand as a perfect storage medium. Throughout the transition period, scientists, engineers, and systems designers will advance the technologies for safe hydrogen production, storage, and utilization.

Delivery: In the last five years, the technological development of fuel cell powered vehicles and stationary generators has brought to the forefront the need for a widely distributed on-site source of available hydrogen fuel. Further need for local availability of on-site produced where it is consumed hydrogen is seen in the application of these fuel cells for home, government and military use. Terrorist turmoil in the United States and in oil-producing regions and foreign opportunistic manipulation of energy markets by business and governments demands a shift to the hydrogen economy.

The State of California and the city of Los Angeles recently took delivery of eight automobiles powered fully by hydrogen. University of California-Irvine also took possession of two vehicles powered by hydrogen. GM and Anuvu of Sacramento, California, have delivered hydrogen vehicles to the United States Postal Service. The City of San Francisco is building a fleet of hydrogen automobiles delivered by Honda of North America. On April 24, 2004, Governor Arnold Schwarzenegger of California signed an executive order creating by the year 2010 the "Hydrogen Highway" with 200 hydrogen fueling stations, one every

twenty miles on California's major highway, I-5, running from the border with Mexico throughout California to the Oregon border on the north. South Coast Air Quality Management District in California opened its first hydrogen fueling station to the public at Diamond Bar, California, on August 13, 2004.

Problems in Energy Supplies: There exists a set of problems dealing with energy supplies and consumption of energy that face the United States and all countries and peoples of the world. The key energy problems include:

1. Diminished domestic and foreign supplies of oil and gas. According to the Associated Press, in July 2004 Iraqi oil-line breach by sabotage cuts Iraqi exports in half. On August 25, 2005 the San Diego Union-Tribune announced the price of oil passed the price of $67,32 per barrel; Natural gas in '99 was $2 MMBTU and in '05 it reached $9.98 MMBTU. These prices may became somewhat lower for a while, but will probably continue to rise.

2. Severe atmospheric and air pollution from heavy consumption of fossil fuels by coal- and gas-fired plants for the production of electricity and by automobile and truck transportation. Such fossil fuel pollution has a deleterious effect on the earth itself as well as on human health and well-being.

3. World terrorism has made all sources of oil for the United States problematic and always subject to price increases due to the manipulation by Arabic, Venezuelan and other unstable, foreign oil-supplying countries, where much of this nation's oil originates.

FUEL CELL POWER

On August 20, 2004, BBC News reported that Ford's Chairman, William Clay Ford, Jr., went so far as to predict that fuel cells would end the reign of the internal combustion engine; General Motors said it planned to be the first to sell a million fuel cell vehicles in the next decade; and DaimlerChrysler, Ford and GM have spent about $2Bn on fuel cell cars, trucks and buses; and many UK cities have deployed hydrogen buses.

In the last five years, the technological development of fuel cell powered vehicles, internal combustion engines fueled by hydrogen, and stationary hydrogen generators has brought to the forefront the need for a widely distributed on-site source of available hydrogen fuel. Further need for local availability of on-site produced hydrogen is seen in the application of these fuel cells for home, government and military use. The pressure for shifting to the hydrogen economy is strongly evidenced by the terrorist turmoil in the United States and particularly in oil-producing regions and by foreign opportunistic manipulation of energy markets by business and governments.

A report from the U. S. Department of Energy in 2004 prepared by TIAX, "Platinum Availability and Economics" indicates that the annual projected installation of electrical capacity for stationary PEM Fuel Cells will include one gigawatt for the year 2009, 12 gigawatts for 2025 and 16 gigawatts for 2050. Platinum is an integral part of fuel cells, so the source of supply is of interest. In addition, this report indicates that by the year 2050 fifty percent of all USA vehicles will be fuel cell powered. Europe expects eighty percent of all vehicles to be fuel cell powered by 2050.

Advantages of Making Electricity by Hydrogen Fuel Cell

Fuel cells have been developed to convert hydrogen into electricity. Depending on the source of hydrogen utilized, this energy source may reduce fossil fuel

usage and subsequent pollution of the atmosphere and water sources. Fuel cells work like batteries, yet while batteries operate as batch reactors, fuel cells function as continuous electrical generators as long as hydrogen is available and as demand for electrical service is required. The fuel cell produces electrical energy to be converted into mechanical energy for cars and trucks by electric motors.

There are three major types of fuel cells available.

Phosphoric acid fuel cells --- represent a near-term application for stationary power generation.

Solid-oxide and molten carbonate fuel cells --- have potential for highly efficient combined heat and power applications. This, however requires very high operating temperatures.

Proton Exchange Membrane (PEM) fuel cell is the prime candidate for near- to mid-term applications, especially in automobiles, buses, light duty vehicles, stationary generators and in the distributed power applications for residence, government, and military.

The PEM Fuel Cell is most feasible for home, vehicular, and on-site generation use and appears to be a promising option for vehicles and stationary distributed power sources. The cell uses two flow-field plates sandwiched together with a plastic membrane or electrolyte. Hydrogen and oxygen (air) are fed through channels in the plates on either side of the membrane --- hydrogen on one side and air on the other. Hydrogen atoms flow through the channels to the anode, where they are separated into protons and electrons.

The electrons are conducted through an external circuit, creating a flow of electricity. The protons migrate through the membrane where they combine with oxygen from the air and with electrons from the external circuit. This produces water and heat.

Single cells are combined into a fuel-cell stack to produce the required level of power. In this modular manner, fuel cells can be made to power almost any size application – from laptop computers to cars to entire buildings.

THE HYDROGEN ECONOMY

The steering committee of the U.S. Department of Energy's National Renewable Energy Laboratory at Golden, Colorado, projects that the hydrogen-based energy economy will be made gradually in phases.

Three phases are outlined as follows:

Near-term: Hydrogen may be used in transportation by mixing it with natural gas in internal combustion engines. Another approach calls for producing hydrogen at central locations and distributing it to refueling stations. During this time, most of the hydrogen will be produced by steam reforming of natural gas, either at central or distributed facilities. This, of course, ties the hydrogen economy to fossil fuel and all related problems.

Mid-term: Restructuring of the electric utility industry will present opportunities for distributed generation where hydrogen-powered fuel cells will provide an on-site generation of electricity. In addition to electricity, such fuel cells will also produce thermal energy for hot water, space heating and industrial process. Hydrogen for these applications will be increasingly

produced from coal and from pyrolysis or gasification of biomass, and reformation of natural gas. In the mid-term, an increasing number of hydrogen-fueled zero-emission vehicles will also be on the road due to improvements in on-board and stationary hydrogen storage technologies.

Long-term: In the long-term, strong hydrogen markets and growing hydrogen infrastructure will launch opportunities for renewable hydrogen systems. Intermittent energy sources such as wind turbines or photovoltaics will power electrolysis to produce hydrogen for fuel cells. Fuel cells can then use the hydrogen to provide electricity during higher demand periods or to supplement intermittent energy sources. Bio-oil platforms offer possibilities, but often remain tied to petroleum's limited supplies. Major efforts also continue to clean up coal and oil, but these efforts have many of the same problems.

The Transition: During the transition in these eras, there will occur an emergence and growth of advanced technologies that split hydrogen from water by sunlight and store hydrogen in high-energy-density systems.

Market penetration of advanced technologies to produce, store and use hydrogen will herald the establishment of the hydrogen energy economy. In the mid- to long-term, a large and growing renewable-based hydrogen-to-electric power system will require significant on-site generation and storage capacity. Hydrogen will stand as a perfect storage medium. Throughout the transition period, scientists, engineers and systems designers will advance the technologies for safe hydrogen production, storage and utilization.

Hydrogen By Splitting Water Using Only Renewable Sources

A proposed solution as outlined by NREL in //Denver, CO focuses on a renewable and sustainable energy system known as photoelectrochemical water splitting to make hydrogen.

Dr. Thomas W. Oakes of Solar Hydrogen Co. in La Mesa, California, is developing such a renewable system that focuses on renewable and sustainable energy known as "*hydrogen by direct photoelectrochemical water splitting*". Dr. Oakes system omits the traditional electrolyzer and employs a solid-state photo-electrolyzer that is immersed in water. When exposed to sunlight the system generates hydrogen directly. The photovoltaic cells and semiconductors combine to generate enough electricity from the sunlight to break the chemical bonds in water molecules by electrolysis yielding hydrogen. No separate traditional electrolyzer is used. The hydrogen is then processed and stored for use in fuel cells to generate electricity or for other energy purposes. Preliminary estimates for hydrogen cost using the proposed photoelectrochemical system can possibly be $2.08/kg. This is based on an 8-panel unit, each costing $1,250.00, including 10% depreciation per year with a ten-year life cycle and maintenance per year and capitalization per year of 15%. Yearly production of hydrogen is estimated to be 1,200 kilograms, enough for annual operation of a household and two full hydrogen vehicles.

Dr. Oakes worked full time from October 2001 to the present to scientifically develop the concepts, demonstrate feasibility, and document the technology for solar direct photoelectrochemical water splitting for hydrogen generation. The first prototype was undertaken in response to certain potential federal and state research and development requests for proposals (RFP) that insisted on seeing a prototype which would verify the concept.

This independent work was undertaken by Solar Hydrogen Company as an effort to bring out to public use this photoelectrochemical process for generating hydrogen that has had extensive development work at the National Renewable Energy Laboratory (NREL). By November 14, 2002, a prototype was constructed that produced both hydrogen and oxygen using only solar exposure, and no other fuel. On February 24, 2004 a patent was applied for by Dr. Thomas W. Oakes, in the United States Patent and Trademark office. Work is continuing during 2005 to construct a second larger prototype that will have the potential for more measurable yields of hydrogen.

The greatest benefit from this hydrogen generation device will be for individual residence owners, small business owners, and military and government operations. The system is designed to produce enough hydrogen fuel with on-site storage for the needs of a home and two cars. This on-site hydrogen energy generator will make possible energy independence from utility grid ties and release the person from ties to the fossil fuels of oil, natural gas and coal, and especially free them from the unstable foreign monopolistic oil cartels. This self-contained energy generation system that produces it where it is consumed fills a universal need of people not only in the United States, but people throughout the world for low-cost on-site energy.

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