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RECORD WEATHER EXTREMES OF 2003 KILLED 35,000 PEOPLE

Roy McAlister
President of American Hydrogen Association

European health authorities estimate that 35,000 persons lost their lives due to the record heat wave in August of 2003. France reported the most casualties including 14,802 deaths due to searing temperatures. Germany reported over 7,000 deaths from the heat. Spain and Italy suffered heat-related losses of nearly 4,200 lives. London recorded its first triple-digit (Fahrenheit) day as heat-related death reports in the United Kingdom reached 2,045. Health officials in the Netherlands said the heat caused about 1,400 deaths. Portugal reported at least 1,300 lives were lost due to the soaring temperatures.

Health officials noted that deaths due to the record heat wave in August of 2003 caused more than 19 times the death toll from the worldwide SARS epidemic. It is indeed startling to note that deaths from the August 2003 heat wave caused more than 10 times the "9-11" death count in the U.S. due to terrorist attacks.

August 2003 was the warmest August on record in the Northern Hemisphere. The record high August temperatures revealed shortcomings in the long-standing practice of generating electricity by large nuclear and coal power plants. Such central power plants are thermodynamically limited to about 30 or 40% efficiency. Overheated homes in Europe could not get sufficient electricity to cool their occupants because power plants had trouble rejecting the 60 to 70% of the heat they generated.

European rivers that have long been used to cool the enormous central power plants could not absorb the heat rejected without causing fish and other aquatic life to die. The heat wave coincided with drought conditions that reduced river flows to record low-levels. Danube River records show that flow had not been so low in 120 years. A nuclear power plant in Romania shut down completely in August and numerous other central power plants had to reduce power production because of the inability to reject approximately two units of energy for each unit of electricity produced.

More extreme weather events are expected as a result of greenhouse gas warming. Greenhouse gases cause energy to be trapped in the atmosphere. Carbon dioxide causes the greatest amount of greenhouse gas warming of the global atmosphere and closely follows a century of exponential increases in fossil fuel combustion. Garbage disposal in landfills produce more methane contamination of the global atmosphere than all the leaks from the natural gas industry. Methane ranks second to carbon dioxide regarding greenhouse gas contamination of the air.

By the end of the century, the global average temperature is projected to increase by 2.5-10.4 degrees Fahrenheit (1.4-4.8 degrees Celsius). The global atmosphere acts like a giant heat engine. Accumulation of energy in the atmosphere allows it to do more work. With more energy in the atmosphere, move frequent and more severe weather including heat waves are expected. The World Meteorological Organization estimates the heat-related fatalities could double in less than 20 years.

Although heat waves receive scant attention because they cause little property destruction, heat extremes actually cause more deaths each year than floods, tornadoes, and hurricanes combined. Heat waves are generally quiet killers and (like the SARS epidemic) mostly affect elderly, very young, or persons with chronic illnesses. In general, when summer temperatures range 10 degrees Fahrenheit or more above the norm, incidences of heat-related illness increase dramatically. When excessive heat is maintained for more than two consecutive days, the risk of heat stroke, sickness and death escalates. Health and social services may be quickly overwhelmed.

Heat waves take the greatest human toll in crowded cities. Where heat-absorbing buildings and pavement exceeds the area covered by vegetation, notably higher death rates are recorded. These "heat islands" often measure 10 degrees Fahrenheit warmer than the surrounding country side. Persons in rural areas generally get some relief at night when temperatures fall but heat islands remain noticeably warmer throughout the night. Air pollution, which usually is worse in cities than in the countryside, has also been shown to exacerbate the health-damaging effects of high temperatures by further stressing respiratory and circulatory systems.

In correlation with greenhouse gas build up in the atmosphere, heat waves have been occurring more frequently and with greater severity. Several of the previous severe heat waves that were reported in the 20th century occurred in the U.S. After eight days of temperatures over 100° F, Los Angeles health officials reported 946 deaths in 1955. New York City suffered a two-week heat wave in 1972 that claimed 891 lives. Extreme temperatures in Chicago killed 739 in 1995. But public leaders are reluctant to discuss the problem.

The general lack of public recognition of health dangers due to air pollution and high temperatures increases the lethality of heat waves. Heat wave warnings seldom are reported to indicate the relative significance compared to other natural disasters. Few governments are willing to openly publish records of heat and pollution related deaths. Asian cities where the world's ten most polluted cities fight air pollution and heat island conditions may have experienced even larger death tolls during the last century than those reported in Europe during August of 2003. But economic development committees and travel promoters insist that such deaths are quietly listed as "death due to natural causes." Similarly, Chicago's mayor denied the severity or the significance of the city's 1995 heat wave. In 2003, more than a month passed before France's government released heat wave fatality reports that corroborated records from overwhelmed undertakers. Several European governments continue to challenge and delay reporting of heat-related death totals by medical examiners.

SOLUTIONS FROM AHA:

American Hydrogen Association mentors provide courses at universities, colleges, trade schools and scientific institutions. We teach how to overcome the growing problem of greenhouse gas accumulations in the global atmosphere. Generally students are surprised to do the chemistry and learn that burning a gallon of oil or gasoline produces approximately 20 pounds of carbon dioxide. An ordinary automobile probably expels carbon dioxide equal to the weight of the vehicle each year. Students learn how to sequester carbon from hydrocarbon fuels and other substances that ordinarily rot or burn to release carbon dioxide into the atmosphere.

$$HxCy + HEAT \Longrightarrow 0.5Y\ H_2 + X\ \text{Carbon Products}$$

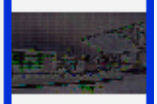
AHA provides courses on how to build, maintain and apply fuel cells and electrolyzers. We also teach how to convert ordinary engines to operation on hydrogen to accomplish *greater power production when needed. Operation on hydrogen extends engine life and tests show that hydrogen combustion actually cleans the air that enters the engine* by rapid oxidation of tire particles, diesel soot, carbon monoxide, pollen, and other objectionable substances into water vapor and traces of carbon dioxide.

By operation on hydrogen, ordinary engine-powered generators with heat recovery systems enable farms, homes, schools, factories and municipal buildings to accomplish two-times greater energy utilization efficiency than central power plants. Doubling the energy utilization efficiency while virtually eliminating carbon dioxide emissions offers a practical solution to the dilemma of weather extremes due to greenhouse gas accumulations.

(*See how we can eliminate CO_2 emissions and double efficiency with TESI technology on page 14)*

Hydrogen Refueling Stations

Courtesy of FuelCells 2000
www.fuelcells.org

Location	Fuel	Project	Dates	H2 Production Technique	Specifics/ Comments	Picture
Davis, California	Compress. H2	University of California, Davis Hydrogen Bus Technology Validation Program	In operation	Air Products delivered LH2	N/a	N/a
Riverside, California	Compress. H2	University of California, Riverside, College of Engineering – Center for Research and Technology with SCAQMD	1992 (1st of its kind)	Electrolyser Corp. (now Stuart Energy) Uni-polar electrolyzer capable of using PV array or grid operation for 5,000 psi H2.	"Solar-Hydrogen Production and Vehicle Refueling Station"	
El Segundo, California	Compress. H2	Xerox Corp., DOE, UC Riverside, Matrix Engineers, City of West Hollywood, Kaiser Engineering, SCAQMD, CAN	Opened in 1995	Praxair fueling system; PVI Corp. photovoltaics; Stuart Energy hydrogen fueling station: electrolyzer	Electrolytic H2 generation "Clean Air Now Solar Hydrogen Vehicle Project"	N/a
Thousand Palms, California	Compress. H2	SunLine Transit Agency and Ballard P4 Bus Demo.	Opened April 2000	Stuart Energy hydrogen fueling station	Electrolytic H2 generation and compression to 34.5 Mpa; 1,400 standard cubic feet per hour	
Sacramento, California	Liquid to Compress. H2	Ca Fuel Cell Partnership BP, Shell, and Texaco helped in the design	Opened 11/2000	Air Products and Praxair delivered LH2	LH2 Stored on site in 4500-gallon tank. Can deliver CH2 to vehicle at 3600 and 5000 psi under 4 minutes. Uses Linde LH2 cryogenic nozzle and controls technology.	
Torrance, California	Compress. H2	American Honda Motors Co., Inc., Research and Development center	Opened July 20, 2001	N/a	PV-electrolysis with grid electricity back-up	
Torrance, California	Compress. H2	As part of Toyota's efforts to establish California fuel cell "communities" with the leasing of 6 FCHVs to 2 UC campuses, it plans to open 5 more refueling stations in addition to this one by mid-2003	Opened early 2003	Toyota will work with Stuart Energy and Air Products and Chemicals, Inc.	Toyota USA headquarters in Torrance uses a Stuart Energy hydrogen fueling station. It uses onsite electrolysis powered by renewable energy to generate 24 kg hydrogen/ day.	
Oxnard, California	Liquid H2	BMW North America Engineering and Emission Test Center	Opened July 12, 2001	Air Products delivered LH2	Manual power assisted refueling station. Also has a Linde LH2 mobile refueling station.	
Chula Vista, California (mobile station)	Compress. H2	City of Chula Vista	To be delivered early 2003	Stuart Energy hydrogen fueling station	A CFP-1350 generates 60 kg of H2/day, can fuel 3 buses a day, and dispenses at 3,600 and 5,000 psi.	
Thousand Palms, California	Compress. H2	Schatz Hydrogen Generation Center at SunLine Transit	Opened 1994; retro fit in 2001-2	Teledyne Energy electrolyzer System	3600 psi hydrogen generation via electrolysis powered by renewable PV; produces up to 42 standard cubic feet per hour of H2	
Richmond, California	Compress. H2	AC Transit facility	Opened Oct. 30, 2002	Stuart Energy hydrogen fueling station	"Intelligent" hydrogen fueling station, using PEM electrolyzer: first satellite hub for CaFCP vehicles. Has 47 kg H2 storage capability.	
San Jose, California	To Be Determined (TBD)	VTA, San Mateo Transportation District, CaFCP, and CARB	2004 readiness target	Air Products delivered LH2	Current fueling station at VTA's San Jose division will be enhanced with hydrogen capabilities	N/a
Chicago, Illinois	Liquid to Compress. H2 at station	Chicago Transit Authority – Ballard Bus Demo.	03/98 – 02/2000	Air Products delivered LH2	N/a	
Dearborn, Michigan	Liquid H2 & Liquid to Compress. H2 at Station	Ford Vehicle Refueling Station	Opened in 1999	Air Products and Chemicals delivered hydrogen	N/a	
Ann Arbor, Michigan	LH2 to Compress. H2	EPA's National Vehicle and Fuel Emissions Laboratory (NVFEL), DaimlerChrysler, UPS	Late in 2003	Air Products and Chemicals Inc. will design and build this H2 fueling station.	This station will support a fleet of DaimlerChrysler FCVs used by UPS located at EPA's NVFEL. It will store up to 1,500 gallons of LH2	

Arizona (mobile station)	Compress. H2	Ford Motor Company	Delivered in 2001	Stuart Energy hydrogen fueling station – CFP-450	This is a full Stuart Energy hydrogen fueling station installed on a flatbed trailer (H2 generation, compression, storage, and dispensing). It generates 24 kg of H2 per day, stores about 47 kg, and dispenses at both 3,600 and 5,000 psi.	
Phoenix, Arizona	Compress. H2, CNG, & H2/CNG blend	Arizona Public Service (Vehicle Testing Center – part of DOE Field Operations Program)	Opened in 2001	Proton Energy's HOGEN PEMFC electrolyzer	Only DOE / private sector H2 station	
Northern Nevada (65 miles north of Las Vegas)	Compress. H2	Nevada Test Site Development Corp., DOE, Corporation for Solar Technologies and Renewable Resources and city of Las Vegas	Opened 11/15/02	Air Products and Chemicals	First multi-purpose station: H2 production via NG reformation; electricity production (for sale) using 50kW PEMFC; H2/CNG blends & pure H2 vehicle dispensers (uses Plug Power PEM fuel cell)	
Washington DC	LH2 & Compress. H2	General Motors Corp. and Shell Hydrogen	To be opened Oct. 2003 until 2005	Shell Hydrogen	US's 1st H2 pump at a Shell retail gas station. Will support a GM fleet of 6 H2 FCVs.	N/a
Penn State, PA	Compress. H2	APCI, H2Gen, Penn State, Department of Energy	Fall 2004	Onsite reformed natural gas	Will H2 refuel up to 7,000 psi.	N/a
Munich, Germany	Liquid H2	BMW Company Refueling Station	Opened in1989	Linde	N/a	N/a
Hamburg, Germany W.E.I.T. phase I	Compress. H2	W.E.I.T. hydrogen project Services hydrogen vehicles for: Hamburg Hermes Versand Service, HEW, and HHA	Opened on 12/01/99	Delivered Compressed H2 by m-tec Gastechnologie and Messer Griesheim	On-site electrolysis using 'Green' electricity and 100% fuel cell powered vehicles is the current goal/direction of this project	
Hamburg, Germany W.E.I.T. phase II	Compress. H2	CUTE Bus Demo. PLANET from EUHYFIS in charge of H2 station	2003 target	Hamburgische Electricitätswerke AG subsidiary, GHW	On site hydrogen from electrolysis via renewable wind power. This is the second phase of the W.E.I.T project, which will incorporate the Hamburg CUTE project	
Nabern, Germany	LH2 and LH2 to Compress. H2	DaimlerChrysler Company Refueling Station	Opened in1998	LH2 delivered by Linde.	Uses Linde H2 refueling technology.	N/a
Munich, Germany	Compress. H2 & Liquid H2 & Liquid to Compress. H2	Munich Airport Vehicle Project Bavaria's minister for economics, transportation and technology and Linde	05/99	Hamburgische Electricitätswerke AG subsidiary, GHW LH2 and Compress. H2 delivered by Linde.	Uses Linde H2 refueling technology. Public Accessible.	
Wolfsburg, Germany	Liquid H2	On-site fueling for VW hydrogen vehicles	N/a	LH2 delivered by Linde.	Uses Linde refueling technology.	N/a
Russelsheim, Germany	Liquid H2 & Compress. H2	On-site fueling for Opel hydrogen vehicles	N/a	LH2 and Compress. H2 delivered by Linde.	Uses Linde LH2 and Compress. H2 refueling technology. This station can refuel Compress. H2 at 10,000 psi (700 bar).	N/a
Sindelfingen, Germany	Compress. H2 & Liquid H2	DaimlerChrysler	planned	H2 delivered by Linde.	Uses Linde H2 refueling technology. Can refuel to 5,000 psi.	N/a
Berlin, Germany (CEP)	H2 & LH2 & Convent. fuels	Aral, BMW, BVG, DaimlerChrysler, Ford, GHW, Linde, MAN and Opel: Clean Energy Partnership (CEP)	2003 target	LH2 delivered by Linde to Aral station.	World's 1st public hydrogen gas station Linde supplied all LH2 refueling technology.	
Berlin, Germany (BVG)	Liquid and Compress. Hydrogen	TotalFinaElf, BVG, Linde, MAN and Opel: Hydrogen Competence Center Berlin. Station was opened under the framework of the Berlin, Copenhagen, Lisbon fuel cell bus Program	Opened 10/23/02	Uses Linde supplied LH2 & Proton Energy Systems' HOGEN® PEM electrolyzer for Compress. H2	1st permanent hydrogen fuel station in Berlin; will fuel H2 ICE buses from MAN & fuel cell buses Uses Linde LH2 refueling technology & includes a Linde AG mobile filling station	
Copenhagen	Mobile LH2	Station was opened under the framework of the Berlin, Copenhagen, Lisbon fuel cell bus Program	2002/3 target	Will use Linde supplied liquid hydrogen	The Linde mobile filling station is a part of the Total Fina Elf station in Berlin; and will be used in Copenhagen and Lisbon as part of this fuel cell bus demonstration program	

Lisbon	Mobile LH2	Station was opened under the framework of the Berlin, Copenhagen, Lisbon fuel cell bus Program	2002/3 target	Will use Ariliquido (in Portugal) supplied liquid hydrogen	The Linde mobile filling station is a part of the Total Fina Elf station in Berlin; and will be used in Copenhagen and Lisbon as part of this fuel cell bus demonstration program	
Erlangen, Germany	Mobile Liquid H2	MAN, Linde (several Bavarian funded bus programs)	4/12/96 – 8/98 (ICE) & again in 10/2000 – 04/2001 (fuel cell)	Linde AG produced and supplied the LH2 to their mobile station	Linde AG supplied LH2 from their large central H2 production & Liquification plant and transported it to the Linde mobile fueling station	
Oberstdorf Spa, Germany	Compress. H2	Neoplan fuel cell bus at Oberstdorf; funded by Bavarian State	1999 – 2001	Linde AG produced and supplied the LH2 to their mobile station	Linde AG supplied LH2 from their large central H2 production & Liquification plant and transported it to the Linde mobile fueling station	N/a
Stuttgart, Germany	Compress. H2	CUTE Bus Demo. PLANET from EUHYFIS in charge of H2 station	2003 target	BP affiliated	On-site Natural Gas steam reformation	N/a
Stockholm, Sweden	Compress. H2	Clean Urban Transport for Europe (CUTE) Bus Demo. PLANET from EUHYFIS in charge of H2 station	2003 target	Stuart Energy's 'intelligent' hydrogen fueling station	Central Hydro Powered electrolysis, then transported to fueling site	N/a
London, United Kingdom	Compress. H2	CUTE Bus Demo. PLANET from EUHYFIS in charge of H2 station	2003 target	BP affiliated	Centralized production via excess hydrogen from crude oil, then transported to fueling site. Uses BOC H2 refueling technology.	N/a
Amsterdam, The Netherlands	Compress. H2	CUTE Bus Demo. PLANET from EUHYFIS in charge of H2 station	2003 target	Hydrogen System's IMET® powered water electrolyzer and Hoekloos (a Linde Co.) delivered Compress. H2	On site Hydrogen production via electrolysis from green energy	N/a
City of Luxemburg	Compress. H2	CUTE Bus Demo. PLANET from EUHYFIS in charge of H2 station	2003 target	N/a	On-site Methanol steam reformation	N/a
Oporto, Portugal	Compress. H2	CUTE Bus Demo. PLANET from EUHYFIS in charge of H2 station	2003 target	BP affiliate	Centralized production via excess hydrogen from crude oil. Uses a Linde High Booster Compressor System for high pressure H2.	N/a
Madrid, Spain	Compress. H2	CUTE Bus Demo. & CITYCELL PLANET from EUHYFIS in charge of H2 station	Opened April 28, 2003	Steam reforming of natural gas	Consorcium AIR LIQUIDE gasNatural	
Barcelona, Spain	Compress. H2	CUTE Bus Demo. PLANET from EUHYFIS in charge of H2 station	2003 target	BP & Vandenborre Hydrogen Systems: IMET® powered water electrolyzer	On-site production via renewable solar and grid electricity powered electrolysis. Uses a Linde High Booster Compressor System for high pressure H2.	N/a
Europe	Compress. H2	EU, Bauer Kompressoren, Casale Chemicals, PLANET (EUHYFIS Project)	R&D phase complet, 1st demo station in 2004	N/a	On-site electrolysis of water from a renewable electrical source (solar or wind) Currently contributing to the CUTE program	Hydrogen Filling Station Consortium EUHYFIS Arbeitsgemeinschaft Wasserstoff-Tankstelle
Reykjavik, Iceland	Compress. H2	ECTOS Bus Demo.	Opened April 2003	Shell Hydrogen/Iceland	World's 1st Commercial Hydrogen Station. On site Geothermal and Hydro Powered Electrolyzer.	
Perth, Australia	Compress. H2	DaimlerChrysler, BP, UNEP Similar to the CUTE program	2004 target	Centrally produced H2 at BP's refinery in Kwinana	This is a 'least-cost' solution for the purposes of the trial only. In the long term the intention is to use steam reformation of natural gas for H2 production. Uses a Linde High Booster Compressor System for high pressure H2 with BOC refueling technologies.	N/a
Victoria, Australia	Compress. H2	One H2 fueling station to service several hydrogen fuel cell buses taking passengers to and from the Victorian Fast Train (program is under review)	TBD	TBD	Reviewing electrolysis via solar and reforming natural gas	N/a
Beijing, China	To be determined (TBD)	Global Environment Facility (GEF) and United Nations Development Program (UNDP): commercial demonstrations of 6 fuel cell buses	2003 target	N/a	N/a	N/a

		and hydrogen refueling stations.				
Shanghai, China	TBD	Global Environment Facility (GEF) and United Nations Development Program (UNDP)	2003 target	N/a	N/a	N/a
Cairo, Egypt	TBD	Global Environment Facility (GEF) and United Nations Development Program (UNDP)	2003 target	N/a	N/a	N/a
Mexico City, Mexico	TBD	Global Environment Facility (GEF) and United Nations Development Program (UNDP)	2003 target	N/a	N/a	N/a
New Delhi, India	TBD	Global Environment Facility (GEF) and United Nations Development Program (UNDP)	2003 target	N/a	N/a	N/a
Sao Paulo, Brazil	TBD	Global Environment Facility (GEF) and United Nations Development Program (UNDP)	2003 target	N/a	N/a	N/a
Osaka, Japan	Compress. H2	PEMFC Vehicle Demo. by WE-NET	Fall 2001 – end of 2003	N/a	Natural Gas Reforming	
Takamatsu, Japan	Compress. H2	PEMFC Vehicle Demo. by WE-NET	Fall 2001 – end of 2003	N/a	PEM electrolyzer	
Tsurumi, Japan	Compress. H2	PEMFC Vehicle Demo. by WE-NET	Opened Aug. 2002	N/a	N/a	N/a
Yokohama, Japan	Compress. H2	Cosmo Oil JHFC	Opened FY2002	N/a	Part of Japan Hydrogen and Fuel Cell Demonstration Project, which will build 5 H2 stations in Tokyo Desulfurized-gasoline Reformation	N/a
Yokohama, Japan	Compress. H2	Nippon Oil JHFC	Opened FY2002	N/a	Part of Japan Hydrogen and Fuel Cell Demonstration Project, which will build 5 H2 stations in Tokyo Naphtha Reformation	N/a
Japan	Compress. H2	Company Filling Stations for Honda	Opened in 2001	N/a	N/a	N/a
Japan	Compress. H2	Company Filling Station at Toyota	Opened in 2001	N/a	N/a	N/a
Tokai, Japan	Compress. H2	Toho Gas Co. owned. Will sell the hydrogen fuel at a price similar to gasoline	Opened 10/2002	N/a	Located at Toho Gas Co.'s research laboratory in Aichi Prefecture	N/a
Tokyo, Japan	Liquid H2 & Compress. H2	Iwatani International Corporation; Tokyo Metropolitan Government, Showa Shell Sekiyu KK JHFC	Target: April 2003 – 2 year operation	LH2 from Iwatani and high pressure Compress. H2 from Linde Hydrogen Cryo-Compressor.	Tokyo's first hydrogen station Part of Japan Hydrogen and Fuel Cell Demonstration Project, which will build 5 H2 stations in Tokyo Uses Linde LH2 refueling technology.	N/a
Kawasaki City, Japan	Compress. H2	Air Liquide Japan JHFC	FY2003 target	N/a	Part of Japan Hydrogen and Fuel Cell Demonstration Project, which will build 5 H2 stations in Tokyo Methanol Reformation	N/a
Tokyo, Japan	Compress. H2	Tokyo Gas & Nippon Sanso JHFC	N/a	Senju	Part of Japan Hydrogen and Fuel Cell Demonstration Project, which will build 5 H2 stations in Tokyo LPG reforming	N/a
Vancouver, Canada	Compress. H2 & H2/Natural Gas blend	British Columbia Hydro's Powertech Labs	Opened in 2001	Stuart Energy hydrogen fueling station: electrolyzer	Used for Coast Mountain Transit's fuel cell bus demonstration from '98-00. It now supplies H2 as well as a blend of H2/Natural Gas to a variety of vehicles.	
Montreal, Canada	Compress. H2	Montreal Urban Transit Authority	Opened & Closed in 1994	Stuart Energy hydrogen fueling station: electrolyzer	Electrolytic H2 generation and compression to 34.5 Mpa; 1,400 standard cubic feet per hour	N/a
Surrey, BC Canada	Compress. H2	BC HydroGen	Opened Fall of 2001	N/a	70 Mpa hydrogen via electrolysis from renewable energy	N/a
Torino, northern Italy	Compress. H2	Irisbus PEMFC City Bus Demo.	2002/3 target	N/a	Hydrogen from hydropower via electrolysis	N/a

Bi-cocca (near Milano)	Compress. H2 & Liquid H2	Hydrogen and fuel cell demonstration project	Opened in 2002	AEM, SOL, and others	Hydrogen liquefier and vehicle refueling	N/a
Oostmalle, Belgian	Liquid H2	Belgian Bus Demo.	Opened in1994	Messer Griesheim GmbH	LH_2 storage system of 125 L, an electric LH_2 evaporation system as well as all necessary connecting supply infrastructure and relevant control and safety components	N/a
Leuven, Belgium	Compress. H2	NexBen Fueling—a division of Chart—has won a contract from Citensy	2003	NexBen Fueling	Europe's first combined liquefied natural gas (LNG) and liquid compressed natural gas (LCNG) and hydrogen fueling station "First of Many"	
South Korea	Compress. H2	Hyundai Motor Company fuel cell vehicle research	Opened in 2001	Pressure Products Industries, Inc. & Doojin Corporation	The heart of the fueling station is a PPI two stage compressor, model 4V104068 designed for 6,000 psig	N/a
Singapore	Compress. H2	Part of BP's joint venture with the Economic Development Board to develop the infrastructure to support environmentally-friendly vehicles.	1st quarter 2004	Air Products	This will be the 1st H2 refueling station in Southeast Asia. Will be able to supply 20kg of compress. H2 per day (~11 vehicles per day). This will support a small fleet of DaimlerChrysler F-Cell FCVs	N/a
Submarine – mobile infrastructure		Class 212 submarine: driven by hydrogen fuel cells dependent on outer air.	Finished in 2002	Air Products (USA)	World's 1st installed complete hydrogen infrastructure in a non-nuclear hydrogen driven submarine.	

Rapidly Emerging Hydrogen Refueling Stations

By
Byron Anderson

As shown in these charts kindly provided by Fuel-Cells 2000, numerous hydrogen stations have been built and more are planned. (See www.fuelcells.org/h2duelingstations.pdf) The growth in hydrogen distribution facilities has started an exponential rise. Frequent news releases and developments add to the list. Current trends are reminiscent of the birth of personal computers in the late 70's and early 80's. In 1975 if someone had told you that a couple of guys in Seattle were forming a company called Microsoft, would you have predicted the ".com" boom? Well friends, it's 2003 and in the immortal words of Yogi Berra, "This is like deja vu all over again."

Hydrogen refueling stations of today are characterized by expedient demonstration. Expedient in the sense that almost all projects anticipate additional infrastructure and opt for liquid or gaseous hydrogen deliveries. Some projects take a more studied approach to demonstrate various methodologies for on-site production of hydrogen. These stations use reformation of fossil fuels or renewables in various combinations.

The exciting fact is that there is much progress in the race to provide clean fuel. Each refueling strategy is very busy staking out a technology base and dreaming up business schemes. Operations currently depending on truck transported hydrogen will almost certainly be the first replaced with second tier solutions.

Onsite reformation of fossil fuels is certainly technology that will be used as oil companies make their bid to address hydrogen needs. Eventually renewables will develop and surpass other methods, if simply for the reason that fossil fuels will become too expensive to compete.

In a recent news report on diminishing fossil fuels researchers stated gave a dire warning. "The world's oil reserves are up to 80 percent less than predicted" noted a team from Sweden's University of Uppsala. "Production levels will peak in about 10 years' time... Non-fossil fuels must come in much stronger than it had been hoped," Professor Kjell Alekett told CNN. "

Meanwhile, renewable technology is improving rapidly. Another recent CNN story "Discovery may spur cheap solar power" - "The French-Italian company (STMicroelectronics) expects cheaper organic materials such as plastics to bring down the price of producing energy. Over a typical 20-year life span of a solar cell, a single produced watt should cost as little as $0.20, compared with the current $4."

Similar announcements regarding dramatic improvements in photovoltaic technology have been announced in California and Australia over the past year.

Continued page 20

Bio-Mass to Bio-Gas

Ed Burton Uses Wood "Chunkettes" to Produce a Hydrogen Rich Bio-Gas.

by

Byron Anderson

Mr. Burton shows what a concerned citizen can do!

Reducing Fire Dangers In Forested Areas

California's coastal and Sierra foothills are home to many kinds of brush and so-called 'trash trees' which pose fire hazards for property owners. During the summer and fall fire seasons, California is plagued with grass and brush fires up and down the state. When fires start in brushy country they are often exacerbated by high winds which create a very dangerous situation.

Damage to forests and property is staggering. The California Department of Forestry estimates for 2001 totaled 6,223 fires in the state, burning some 90,985 acres. The costs of fire suppression for that year ran about $109 million. Dollar damages for CDF districts totaled $87,295,001 with 389 structures destroyed, which included homes, outbuildings and commercial businesses.

Reducing fire risk by keeping brush cleared around structures and homes is an important part of a property owners' fire preparedness plan. (For more information see the Resources guide at the end of the article.)

Trip to Willits

In November of 2002 I traveled to Willits, California to meet Mr. Ed Burton and learn about his wood chip bio-mass project. Ed is a retired forester who has developed a system of brush clearing and fire prevention. In the process he has put together a practical collection of off-the-shelf and invented devices that generate useful products and ultimately provide enough hydrogen rich bio-gasses to run an engine. As I soon discovered, Ed has used his engineering bent to turn a troublesome problem into an economic opportunity.

As a result he has developed a compliment of technologies that are environmentally sound, engineered for hilly terrains and provide ease of handling.

1. Central to Ed's 'field arsenal' of equipment is a self-propelled tractor, which has been customized for brush clearing. He calls it his "Hill Climbing Brush Converter." Ed starts the process by cutting brush

and small trees down to manageable size.

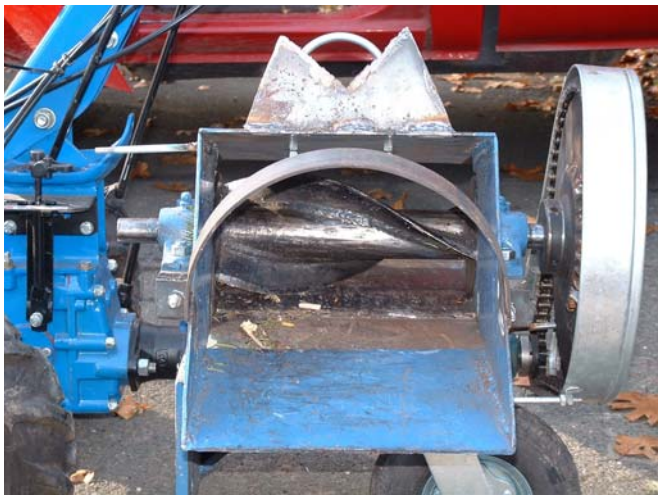
2. The "Branch Clamp" is a simple but handy holding system used to keep small stock steady as Ed trims

and cuts them to length with his electric chain saw.

3. Small limbs under 1.4" in diameter are fed into a "Spiralshear", an attachment of his own design.

The unit is a slowly revolving, self-feeding shearing blade, which shears small material into 2” chunks. The resulting "chunkettes" are then bagged for transport.

4. The need to process wood to specific dimensions gave rise to Ed’s self-designed spiral blade that took



many months of experimentation and refinement.

5. A second piece of equipment is the self-propelled “Jergensen Cart”, developed by Ed's colleague, Phil Jergenson. The 'Jergenson Cart' is designed to handle larger salvageable wood. The unit is powered by 12-volt batteries and features an inverter, which is handy for larger electric chainsaws. Ed is a big fan of electric chainsaws, which are quieter, lighter, cheaper and have fewer mechanical problems. The 'Jergenson Cart' also features a bin for tools and a built-in wood bundler. All necessary equipment “drives itself” into the back of a pickup for easy transport.

6. Here Ed has dropped in the fireplace size 16” sections into an electric powered bundler and is binding them together with a very tough adhesive backed strapping tape. Note the handy fire extinguisher.

7. Bundles are now ready for transport to the fireplace, wood stove or barbeque. Bundles can also be sold on the local market.

8. Once the days hard work is done to reduce brush to a size suitable for drying, Ed bags them in onion sacks and transports them to his “bio-mass” station. The 'chunkettes' are then thrown into a modified trash container where they will be dried out using a solar hot water heat exchange system of his own design.

9. These home-made water heater solar panels provide the necessary heat for drying the wood.

Note the PV panel on top, which powers a water pump and blower fan.

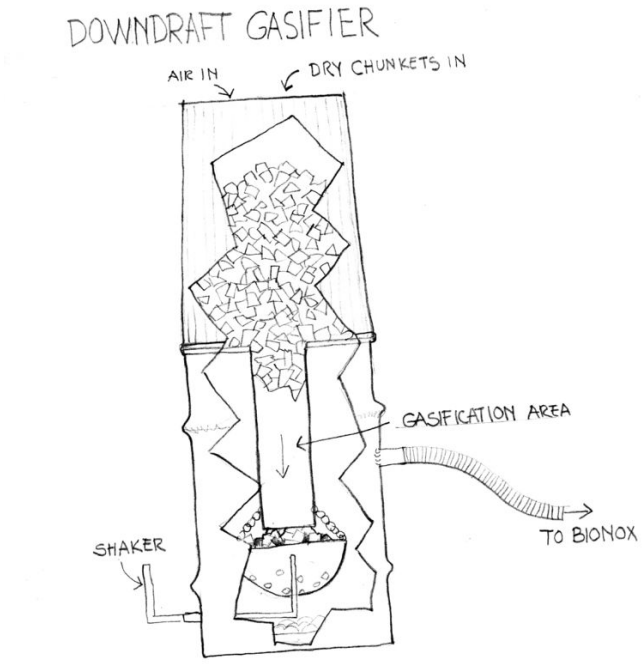
10. The next picture shows two modified garbage containers in which the “wood chunk” are being dried. In the center is the water supply for the solar hot water panels. The line coming down from the top feeds 150-degree hot water into a small car radiator, which is enclosed in the wooden box. A blower sends hot air through the radiator that distributes air to the bottoms of the two wood dryers.

11. The indicated temperature of the wood chip container on this 65-degree day averaged 104 degrees. Solar heated water to the radiator was 156 degrees producing 108 degree hot air at the entry point to the dryer. Moisture content of the wood is reduced to 10-15% most days of the year.

12. Once dried (less than 10% moisture), the 'chunkettes' are placed into this homemade gasifier. The gasifier is composed of two sections, A and B. The upper A section, (an open ended garbage can) simply contains the dried wood 'chunkettes' and funnels them down the burn zone. The lower B section is divided in two. At the very bottom is a propane burner which is used to start the wood burning. There is also an access panel for ash removal. The upper B

section features a recessed container cavity extending down into the burner space. The 'chunkettes' falling into the recessed container cavity are slowly "roasted" consuming all available oxygen in the process. Once oxygen has been consumed, the remaining gasses, are rich in carbon monoxide, methane and hydrogen. The pipe exiting from the left carries the produced gases to the gas cleanup box. Contrary to perception, smoke is not released from the open top as you might imagine. In operation, a vacuum draw is exerted by an engine fueled by the final product, which keeps gasses flowing in one direction.

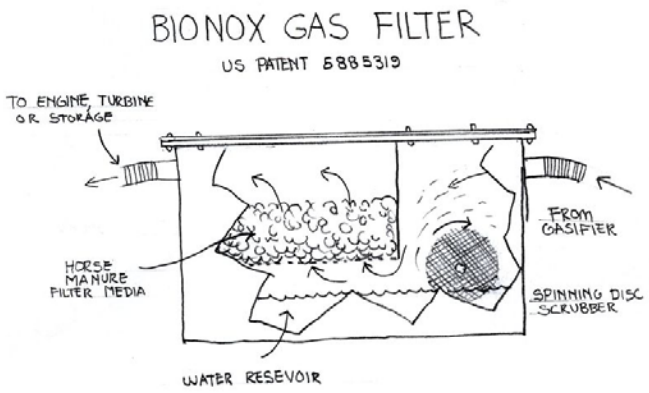
Fig. 1 — Gasifier Schematic.



13. The final process is the "Bionox" gas clean up stage, normally sealed during operation. The gasses travel from the furnace output pipe to the first section at the left. Inside this cavity is a spinning water sprayer, which "washes" the heavier carbons from the incoming smoke and gas. The sprinkler system also moistens the gas and cools the temperature enough to

provide a warm biological environment for bacteria. The second stage of the box is filled with horse manure, a very useful commodity! The bottom of the manure container extends about halfway down the overall box depth. The bottom of the manure section has holes enabling the warm hydrated gas to rise through the manure. As it does so, carbon tars and other impurities are trapped in the manure and consumed by resident bacteria. The manure can be stirred occasionally to extend its usefulness. Eventually the manure is cycled out for use as a nitrate and carbon enriched soil amendment. The result is cleaned up biogas and excellent soil-treatment nutrients.

Fig. 2 — Gas Filter Schematic.



14. The engine is first started on propane. After the furnace is fired and other components come up to operational readiness, the biogas valve is gradually opened. Fully opened, the engine provides the vacuum draw for the entire system. Currently Ed has no instruments for measuring gas percentages. The literature for similar systems built in WWII indicate hydrogen content from 7-22% for gasifiers and up to 45% for Roche's Retorts, which are similar to Ed's design. Hopefully others with the proper equipment will join Ed to produce better data. Ed wants to concentrate on fuel harvesting and drying as well as gas filtering using the Bionox. Because of the hydrogen-enriched gas, residual hydrocarbons are consumed in the engine. Water vapor is an exhaust component, though Ed guesses he has some low emissions of carbon monoxide. The engine turns an electrical generator or otherwise performs mechanical work.

Summary

Ed has an end-to-end solution for fire management, with several products produced along the way. Cut wood and wood 'chunkettes' can be sold for use in a fireplace. The enriched manure can be used or sold and the biogas could even be compressed and stored in containers for future use.

CONTINUING WORK

Update: Ed has acquired the services of another scientist who is going to measure his gas product. Call Ed for test results.

Ed Burton can be reached at 707-459-6219.

"..and I did it all with my pocket computer.—Ed"

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A Modular Building System for Shaping Your Environment
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Suntools ™
P.O. Box 1029
Willits, California 95490
(707) 450-2624

Biomass Hydrogen

Byron Anderson

In 1973, at the time of the first Oil Embargo, the U.S. imported about 35% of the oil required by this economy. Today? Over 60% of oil consumed in this country is imported. Now we spend about one billion every two days for imported energy.

There is an urgent need to produce and deliver economically competitive hydrogen. By 2010 biomass hydrogen could be $1.00 to $2.00 GGE—Gasoline Gallon Equivalent. Today hydrogen is priced at about $6.00 GGE from natural gas and liquid fuels.

Price of gasoline is predicted by NREL to be over $6.00 a gallon by 2010.

If we used renewable energy to extract hydrogen from sewage, garbage, and agricultural wastes, the U.S. would have enough hydrogen to provide more than 50% or our transportation needs.

Carbon Facts

Decay and combustion of biomass releases carbon dioxide and methane, which puts more carbon in the air than the entire amount of coal that is mined and burned in the U.S. in a year.

This does not mean that being dependent upon annually mining and burning coal that took a million years to accumulate is a good idea. It means that we should have a high national priority for collecting and converting biomass wastes into carbon, hydrogen and soil nutrients.

Two billion tons of manure are produced by domesticated animals each year. Each pound of dry manure can be converted into about one cubic foot of biogas, which will contain methane and hydrogen in a relation that depends upon the composition of the dung, and the temperature, acidity, carbon to nitrogen ratio and types of bacteria that are present in the wet digester slurry.

One cubic foot of biogas will produce about 500 to 1,000 BTUs of heat, which is enough to cook a meal for 4 people. Depending on composition, about 150-225 cubic feet of biogas will run a car about the same distance as one gallon of gasoline.

National Renewable Energy Laboratory (NREL) has made hydrogen from biomass (peanut shells) experimentally for $2.90/kg—approximately equivalent to 1 gallon of gas. (See links at the end of this story.)

Methane

Using natural gas is a mixed blessing. It's cleaner than other fossil fuels, but it still contributes CO2 to the atmosphere.

Tax authorities have generally encouraged the natural gas industry by giving tax benefits but recent months have witnessed a significant increase in natural gas prices. Again all fossil fuels are subject to world events and the whims and business plans of oil companies. The price of natural gas is expected to follow the escalation price of gasoline.

A car converted to run on natural gas is ready to use hydrogen with only minor modifications. Conversion prices for hardware range between $1500 and $2000. Labor is extra.

Hydrogen ICE benefits - Hydrogen produces no acids or carbon to corrode or wear engine parts. Lubricating oils last a lot longer.

Build Your Own Biogas Digester

The object of this "plant" is to emulate the production of bacteria that thrive in the intestines of most animals, which is at 90 F to 105 F and in a slightly basic condition of pH 7.0 to 8.0.

Take one 50 gallon drum. Configure it with a stir paddle to slowly mix the contents periodically. Wrap

with insulation. Add 3% to 9% solids to chlorine-free water. (You don't want to kill the friendly bacteria within.) A spare garbage disposal unit will work very well in reducing kitchen waste to the slurry preferred by the bacteria. Plastic piping from the disposal to the drum must be designed to minimize air entry to the anaerobic system. All additions to the slurry must be anaerobic - without addition of air. Build a solar hot water heater system to provide necessary heat using coils of plastic or copper tubing to wrap around or underneath the drum. (See Ed Burton Story)

Keep the slurry well mixed and adjust the insulation around the barrel to provide a constant temperature of about 100 F. A temperature probe is needed for serious operation of the system. Check the pH with litmus strips or a pH meter periodically and adjust to a slightly basic condition by reducing the feed rate of vegetable matter. If the slurry is too basic add vegetable matter at a greater rate.

The most methane will be produced when the carbon to nitrogen ratio is about 30:1. (See TESI Handout.) Urine will greatly enrich the nitrogen content and vegetable matter will enrich carbon content.

Harvest Time:

From the top, or near the top of the provide an outlet pipe to conduct the bio-gas to storage or use. Ed Burton has an ingenious method of filtering the bio-gas through dried manure to clean up the gas and trap carbon. By determining the rate of gas production, on optimal days a small compressor might be added to the system and run periodically to “harvest” gas into used propane or natural gas storage tanks. The cleaned gas can now be used for cooking, powering a vehicle or to provide heating.

(Portions of this story excerpted from Roy McAlister’s “Philosopher Mechanic”)

See the following stories:

Hydrogen from peanut shells:
http://www.spacedaily.com/news/energy-tech-02o.html

http://www.eere.energy.gov/hydrogenandfuelcells/hydrogen/pdfs/33_cau_yaw_yeboah.pdf

Total Energy System From Biomass Wastes

Roy McAlister and Chuck Terry

The purpose of the Total Energy System Innovation (TESI) project is to increase the utilization of any available fuel energy. A large portion of our global energy problem is the result of poor utilization of energy. TESI shows how to greatly improve energy security and how to utilize much more of the energy that is released by combustion.

An example of the waste of energy by present practices is the way electricity is produced in large central power plants. The laws of physics, as applied to conventional power plants, limit the energy utilization to about 30 percent. The rest of the energy is dumped into the environment as unusable heat.

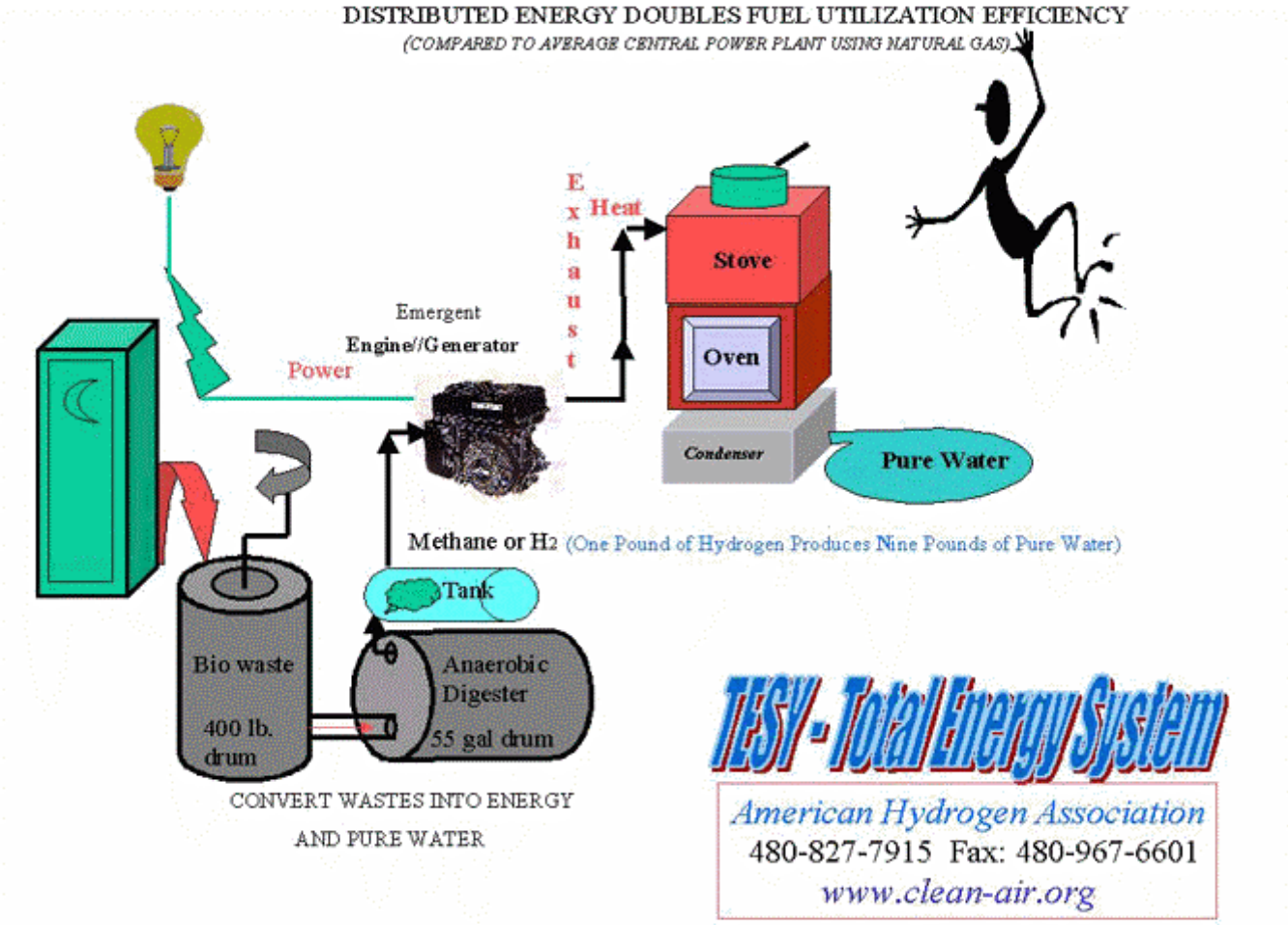
In the TESI concept, an internal combustion engine is fueled with hydrogen to drive an electricity generator. The hot exhaust (steam) is passed through a heat exchanger that can provide the heat needed in a cooking stove or space heating unit. As the steam is cooled it is condensed into distilled quality water.

Renewable hydrogen can be produced in many ways. An anaerobic digester that produces hydrogen rather than methane is the preferred method for many locations. The digester is fed with garbage and sewage. This disposes of objectionable materials that smell bad and could spread diseases. Carbon and trace minerals from the anaerobic digestion can be placed back on farms where it improves the quality the topsoil for growing crops.

After providing your electricity, cooking your food, and heating your home, TESI’s final product after condensation of the steam exhaust is pure water, free of chemical and biological contamination. The other exhaust gases, oxygen and nitrogen are also free of harmful bacterial and chemical agents. One kilogram of hydrogen will produce nine kilograms or nine liters of pure water.

TESI systems can be mass produced in factories and shipped to locations where they are needed. It is much faster and far less expensive to bring the benefits of electricity, renewable cooking/heating/sterilization, and pure water to remote areas via a modular TESI than to build a large power plant and grid distribution system.

TESI systems produced by assembly lines that



rival automotive production efficiencies can quickly bring the benefits of the industrial revolution to remote areas of the world. It offers a fast and sure way for communities to raise their quality of life and standard of living in an environmentally sound way.

TESI technology also produces local jobs. Good jobs are developed to produce and install sanitary piping systems to collect wastes that would ordinarily be allowed to rot or burn, build and operate anaerobic digestion plants, distribute electricity, and provide potable water. These jobs facilitate many other jobs that come to communities with low cost energy, good water, productive soils, and optimistic workers.

TESI technology enables communities to achieve superior living standards and greatly reduce the disappointments that are often suffered by people that migrate to big cities in unfulfilled hopes of finding better living conditions.

TESI is another example of what is accomplished by your contributions to AHA. ***Please renew your membership and sponsor several new members.***

$87 BILLION! What could AHA do with $87 billion? We would provide transfers of essential technologies to the best and most determined from 6,500 Self-Help areas that have approximately one million persons and help launch new ventures:

* that produce, store, and distribute renewable hydrogen;
* to manufacture products that utilize substantial amounts of carbon in various designs that harness solar, wind, wave, and hydro resources.

This will facilitate production of countless other carbon-enhanced products that are stronger than the strongest steel and lighter than aluminum; products that conduct more heat than copper; products that are diamond plated for extreme wear and corrosion resistance; and semiconductors that operate faster throughout a much greater temperature range than the best silicon-based semiconductors.

The result will be development of two billion new jobs and achievement of sustainable prosperity in virtually every community that wishes to participate.

Webmasters' Hydrogen Safari

Byron Anderson

Introduction

In early August I embarked to Southern California for a week long 'hydrogen expedition' that has marked my summers for a couple of years now.

I made two stops on this last trip. The first was to the White Mountain Research Center to visit the webmaster of the California Hydrogen Business Council. White Mountain is a peak in the Eastern mountain ranges of California and at 14,246' is the second highest mountain in the continental U.S. The second stop was in Diamond Bar, in the Los Angeles area where I attended the California Hydrogen Business Council meeting.

White Mountain

Richard Masters is a busy guy. He is the webmaster for California Hydrogen Business Council, the webmaster for the New Mexico Hydrogen Business Council and is working with David Haberman (former DCH CEO) in the formation of a new enterprise with Israel. Rick, as he is known, had recently returned from a visit to northern Italy where he won high praise for his CHBC website and met the top hydrogen people in the country.

My purpose in visiting Rick was to become acquainted and learn the latest on a proposed high altitude fuel cell and hydrogen production proposal for the White Mountain Research Center. Rick does "odd jobs" for University of California which runs the center. He is quite knowledgeable in natural sciences related to the White Mountain region. As far as the hydrogen project, it turns out that UC politics and budget considerations have muddied the project timeline is currently in limbo.

When I got to Big Pine I called Rick's cell phone and left a message. Later in the evening he came by my motel and we got to talk. The next day we went up to White Mountain (14,246 feet) in a honking, snorting 4X4 diesel suburban. Grinding up through Silver Canyon's steep switchbacks, it really felt like an expedition to the 'Lost World'. We passed through an area populated by Big Horn Sheep (didn't see any) and higher up skirted ancient Bristle cone forests. 4,000 year old trees! Around noon we got to the Barcroft lab at 12,470 feet. http://www.wmrs.edu/

At the lab facility I talked with graduate students about their work as we waited out a raging lighting and thunderstorm which commenced as soon as we arrived. The facility serves a number of experimental research project having to do with the physiological affects of high altitude on sheep, mice and men. I was told astronauts had trained there, which was not surprising considering the 'moonscape' look of the land.

The mountain was once a prime candidate for the Keck observatory site, but lost out to Hawaii. As it now turns out, White Mountain is being reconsidered for another big observatory project because Mauna Kea in Hawaii, where the Keck is located, is out of level building space and there happens to be a real nice spot above Barcroft near an existing small observatory.

After the storm passed Rick and I threw in more gear including a Honda generator and a load of gas tanks and headed for the summit. On the way I learned that one of the things that keeps him busy is operating a couple of bulldozers to keep the road clear. More on that later. Once above Barcroft we encountered a vast "moonscape" of barren meadows populated by some of the biggest, fattest marmots I've ever seen! These ‘critters’ were not like the gopher sized beasts you

might imagine, some of these guys were the size of small dogs, the biggest in the world he told me. I also saw a big fat badger scuttle under a rock shelf in reaction to the growl of the diesel engine.

As we approached the basalt summit, it got rather in-

teresting, let me say. The last quarter mile is a steep grind up a road cut from 'scree' (loose rock). It was "white knuckle" time trying to get that 4X4 around the hairpin switchbacks all the while contemplating just how many times the rig would roll over before launching into the 'big air' of a couple thousand feet drop.

Surprisingly, the weather at the summit was pretty nice. No harsh wind or frigid temperatures, in fact it was balmy. The views were of course spectacular. The storm clouds were still around, but between were vistas of desert and distant valleys. We dropped off the generator and gas and had lunch in the hut. Doing anything made my living at sea level quite noticeable. I was huffing for air after even the minor work we did.

Lunch at 14,246’

The mushroom soup took a long time to boil, but nothing tasted better with our mugs of hot chocolate. It has been said that White Mountain is actually higher than Whitney but they don't publish that fact so as to deflect hordes of ’glory seekers’ from trashing the site.

We spent an hour or so at the summit and then closed up. As mentioned earlier, Rick maintains the road, so one of his tasks was to finish up some work with a D4 CAT parked about 3/4 of a mile down the mountain. As we stopped at the CAT, he told me it would take him an hour or so to clean up a section of road we had just traversed so I wandered around overlooking the cliffs and took pictures. But after awhile, I was bored and my attention was drawn back to where he was working the D4. I grabbed a rake from the truck and

started cleaning up the berms and rolling big rocks out of the road, which the blade of the D4 couldn't get at. Boy that was a workout! In honor of the stretch of road we cleared, I erected a small monolith off to the

side to mark a good day's work.
It was now late in the afternoon and the sun was setting as I drove the 4X4 back to Barcroft with Rick trailing behind with the D4. After leaving Barcroft, we didn't talk much, but he did mention that there were infrequent sightings of UFOs seemingly heading to or coming from the Nevada side. (While waiting for Rick at Barcroft I thought I saw something shoot between the clouds which prompted his comment.) Then we just listened to country western music the rest of the way down. We were both pretty tired, but it was good. He dropped me off at my motel and we looked forward to Friday when we would meet again at the California Hydrogen Business Council meeting in Diamond Bar.

On to Diamond Bar

The next morning I set out on Hwy. 395 for L.A. It was a hauntingly beautiful drive through the Owens Valley, but once in the desert it was back to business keeping myself hydrated in shimmering roadway heat. I knew I should have fixed that AC before I left.

I got to Diamond Bar and was late for the first event, a bidders conference at the South Coast Air Quality Management District. In early July the SCAQMD announced a Request for Proposal for a hydrogen refueling station and hydrogen internal combustion engine (ICE) vehicles grant. This very exciting effort is a consortium of five cities around the L.A. area that collaborated on the project. The project is to fund the building of five hydrogen refueling stations, one in each city. Part two is to convert 30 ICE hydrogen vehicle to be used by city municipal departments. The objective is to start a hydrogen infrastructure and demonstrate that ICE hydrogen vehicles can be a viable option TODAY while we wait for the future fuel cell vehicles. The L.A. basin, as everyone who has been there knows, has ongoing problems with air quality. In a meeting the next day it was mentioned that after many years of progressive improvements, L.A. has slipped backwards in air quality. The speculation was that part of the problem was the rise in popularity of SUVs.

The next day the California Hydrogen Business Council meeting took place at the same SCAQMD facility. As a general point, I think it is very important that readers monitor what the CHBC is doing. It's one of the most seriously well organized groups forwarding the goals of a hydrogen economy and is the polestar of hydrogen stakeholders in the hydrogen friendly state of California.

The meeting was attended by approximately 50-60 people representing a broad range of interests. Some Government participants that come to mind were the state California Energy Commission (CEC), local AQMD, DOE, Sandia, Lawrence Livermore, and the California Power Authority. Vendors included ISE research of San Diego, Praxair, Air Products, Stuart Energy and many more. There were also venture capital startups, attorneys, and publishers of various related journals and magazines.

Recurring themes throughout the meeting centered around using H2-ICE vehicles as the bridge to launch refueling stations, the need for education and education programs, the angst of the stalled economy, government involvement, and comments about economic forces working for or against the H2 movement.

In no particular order, here are a few notes on the speakers:

Paul Scott - ISE Research - pscott@isecorp.com - http://www.isecorp.com/ - see Company Info: Personnel:Paul Scott on their page.

ISE has done a lot of hydrogen conversion project for heavy duty applications. Right now they have one of the Ford model U prototypes and are doing testing. I heard they are having some trouble with NOX emissions. (injector problems?) Anyway, Paul made a good presentation arguing for a ramp up of wind turbine/electrolyzer technology. ISE is apparently working on a project in Cochella Valley using a Stuart Energy CFA 1350 electolyzer and 3-65kW Turbines. There was some sticky points in getting the utility company (Edison) to hook up, but they seem to be past those problems. Plans include sending the onsite hydrogen produced through a pipeline to several destinations in Cochella Valley including Sunline Transit. Some in the audience said 'why don't you just move electrons (from the wind turbines) instead of hydrogen.' The response was they want to demonstrate a local distribution system scenario, but that if they couldn't manage it, sending the electricity was an option. Paul underscored the need for education and political will to get momentum built up.

Bob Glass - DOE

H2 Infrastructure discussion - Possibly early next year, EERE will make announcements on second round of funding for H2 infrastructure with a submission deadline of August 2004. He showed a pie chart of different allocations, I noticed $30 Million for Storage, an area of very promising research. In his presentation it became apparent how ponderous the government machine thinks and moves. He was showing slides about phases of infrastructure all the way out to 2040. The 1st phase, no surprise, was the goal of getting hydrogen down to $1.50 a Kg (at the production site) using natural gas reformation or other fossil fuel. Costs went up from there. The cost of biomass hydrogen was stated as $2.60/Kg and electrolysis much higher. He didn't show any reasonable estimates for renewable generated hydrogen until 2020 or beyond. He came under some audience criticism, but was buffered by personal friends who said he was just doing his job (implied he was not the policy maker).

DOE projections portend widespread use of 5,000 psi storage by 2015. A project manager was mentioned for the future funding of semi-commercial projects: Chris Bordeaux 202-586-3070.

The government is wagging the dog of CO2 sequestration as a solution for fossil fuel production of hydrogen. (In a recent news item, it was concluded that CO2 sequestration in the oceans could lead to acidification.) The Florida Solar Center seems to be involved, (http://www.fsec.ucf.edu/), which I thought was kind of odd. It seems some in Florida are contemplating sequestering CO2 underground (www.epp.cmu.edu/csir/giardina.htm) (www.treepower.org/globalwarmingresearch.html)

Jay Keller - Sandia - Discussion on H2 ICE and related subjects.

His points included attacking the easy target of converting utility turbines to hydrogen ASAP in order to reduce overall emissions. The vehicle market will take longer to have an impact, but using hydrogen in turbines will give very quick results owing to the reliance on existing turbines for electricity production and plans to build more. Turbines running 24-7 put out 'gobs' (scientific term) of CO2. There are many fast track Turbine projects in California as a result of the "energy crisis."

Andy Birmingham - Hydrogenica Partners

Represented a hydrogen portfolio fund (http://www.hydrogenica.com/) and pitched the idea of a traveling hydrogen education show with industry stakeholders showing their wares. The first effort to test this as a commercial venture will occur in Denver, CO sometime in December of this year.

Mentioned in this article:
www.wmrs.edu/

Readers can look forward to a number of products arising out of current R & D programs. Most renewable technology can be combined as integrated systems, contributing to lower hydrogen production costs. We may have sustainable supplies of hydrogen sooner rather than later simply from the advance of technology now being tested by the American Hydrogen Association. Of course, world conflicts, national and state politics, all have huge implications for our energy future.

At this writing, the 'nation-state' of California is anticipating governor elect Schwarzenegger and changes that may significantly influence the rate at which hydrogen is introduced. California, has been very pro-hydrogen under Davis in the shadow of the California 'Energy Crisis.'

Campaign speeches by Arnold Schwarzenegger were very supportive of hydrogen. A colleague of the author is in fact converting Arnold's Hummer to hydrogen. No doubt a big press splash will be made when he drives it around Sacramento.

Some of the most recent announcements concerning hydrogen stations have come out of California. In the story 'Webmasters' Hydrogen Safari', the South Coast Air Quality Management District announced a five city project to develop hydrogen refueling stations and to develop a fleet of vehicles that use internal combustion engines. In the north of the state San Francisco and Honda are in talks regarding a demonstration project with two fuel cell cars and a refueling station provided by Air Products. The meetings the author has attended on this project reflect the interest of the program managers to move to a renewable hydrogen production station at the first opportunity.

The advent of hydrogen powered internal combustion engines will inject additional vigor into the development of fueling stations. Clearly Ford, BMW, Mazda and several other manufacturers will be following the SCAQMD project. This would influence other states to do the same given that hydrogen ICE cars could be ready for market in a very short time. This is a very exciting time for hydrogen supporters and anyone that breathes.

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Summary of the book called

"THE SOLAR HYDROGEN CIVILIZATION"

A new book called *"The Solar Hydrogen Civilization"* discusses how Civilization flourished when a Grand Plan was established and faltered in the absence of serving a purpose that could continue beyond the lifetime of individual participants.

The Egyptians had *pyramids*, the Greeks had *democracy*, the Romans had *conquest*, and the Industrial Revolution is based on *conspicuous consumption*. *The Solar Hydrogen Civilization* presents the option of a "Grand Plan" for *Sustainable Prosperity* to overcome present dependence upon burning over one million years' of fossil accumulations each year.

As bonus for overcoming this burn rate of a "million-in-one" the Grand Plan is to overcome the 150-year failure of the fossil-fuel economy to meet the needs of most of the world's population. The Grand Plan is to unite all segments of Civilization in an honorable mission to achieve sustainable prosperity without pollution and to overcome four looming threats to life on Earth.

Sustainable prosperity can be achieved by virtually endless addition of energy from outer space to make energy-intensive goods and services. "Solar Hydrogen" provides for production, storage, and distribution of energy derived from solar, wind, wave, and biomass resources. More than two million new jobs at $80,000 per year to provide renewable hydrogen to replace present U.S. dependence upon imported oil are advocated with similar new job development around the world.

The Grand Plan will provide virtually full employment without inflation by creating durable goods and energy that cleans the air, water, and soils to provide better living conditions for all forms of life on Earth. The Grand Plan is to overcome hardship, starvation, waterborne diseases, and child abuse by enabling each family in 6,500 Self-Help areas that each have about one million persons to earn a honorable living in the

Solar Hydrogen Economy.

Selling this book which was donated to AHA by Roy McAlister will help raise funds needed to support advancement of renewable resources. Funds will support AHA's International Renewable Resources Institute (IRRI) and provide a campus of renewable resources demonstrations. The IRRI will solicit the best, brightest, and most determined persons from each Self-Help area to receive technology transfers to support new venture launches.

A high priority is creation of essential businesses that facilitate sustainable economic development in each Self-Help District. An example of a high priority business is conversion of biomass wastes (anything that will rot or burn) into hydrogen, soil nutrients, and sequestered carbon. Sequestered carbon in forms that can be stronger than steel, lighter than aluminum and provide greater heat conduction than copper will be used to make wind and wave driven generators along with solar dish gensets.

Carbon will be utilized to produce much more compact (and far safer than gasoline) hydrogen storage systems and to reinforce pipelines to provide hydrogen distribution. Carbon will be used to make much lighter, stronger, and safer transportation components. Carbon will be used to make marine structures that are much more corrosion resistant than steel, aluminum, stainless steel, or titanium structures.

CLEAN AIR CORRIDORS OF PROSPERITY:

Renewable hydrogen and/or methane will be transported from farms and other generation sites to market by "HyWays" that in many instances are national highways and/or roadways with the addition of renewable energy pipelines below them. Industrial parks along these HyWays will process renewable methane into carbon products and hydrogen for energy conversion and transportation applications that clean the air. Service stations will efficiently fill vehicles along HyWays from modular distribution units that offer hydrogen and various blends of hydrogen and methane called *Hy-Boost* fuels.

The U.S. federal Highway trust fund is designed to advance transportation and can do so by financing the improvement of highways to HyWays for distribution of hydrogen to vehicles that clean the air. This will create market pull for development of jobs to produce sufficient Solar Hydrogen to replace present U.S. dependence upon paying more than a billion dollars every two days for imported oil.

It is of particular interest to provide modular service stations to municipalities that have difficult air pollution problems. This will enable 800 million existing vehicles to provide much higher fuel efficiency, longer engine life, and greater power when needed and still remain capable of instantly returning to petrol if desired or required because of travel out of the HyWay corridors. The Grand Plan also provides water conservation, purification and new water production capabilities in which renewable hydrogen will be used in existing engines and fuel cells to produce new water (but with less humidity than now caused by burning fossil fuels).

GRAND PLAN ACTIONS AGAINST TERRORISM:

The Grand Plan provides principles for overcoming terrorism including:

1. **ENERGY INDEPENDENCE**: In order to end oil-wars, every Self-Help area that chooses to participate will be provided with technology transfers through new ventures that facilitate achievement of sustainable energy independence. Energy security is essential for

economic development.

2. **HOMELAND SECURITY**: A related technology transfer provides for the utilization of hydrogen engines that clean the air including conversion of bioterrorism germs, tire particles, diesel soot, peroxyacetylnitrate, and pollen into water vapor and carbon dioxide. Existing engines can be used to clean the air, particularly with retrofit kits for stratified charge combustion of hydrogen in contaminated air. Converted engines can produce 9 kilograms of purified water per kilogram of hydrogen utilized as fuel.

ELIMINATION OF CHILD ABUSE: Children are being forced into wars to control diminishing resources. In many impoverished areas of Africa, Asia, and South America children suffer from malnutrition to the extent that causes dwarfism and mental retardation. Some 8,000 children per day are saved from dreaded diseases by humanitarian efforts to provide immunization inoculations but in order to lead meaningful and satisfying lives these children must have good nutrition and education. Upon reaching maturation these children will need good jobs and the responsible awareness that these jobs are part of the peaceful, healthful, and sustainable economic development that Solar Hydrogen provides. The Grand Plan provides opportunities for full employment of virtually all persons on Earth in the achievement of sustainable prosperity.

ANALYSIS OF MYTHS: Numerous myths are analyzed. Illustratively, a popular myth is based on the observation that hydrogen (H_2) is smaller than methane (CH_4) and would escape faster from the same leakage paths that now allow methane to leak into the atmosphere. This myth is supported by observations that there are vast numbers of natural gas wells, countless miles of pipelines, and numerous cryogenic tankers required to deliver the enormous amounts of natural gas being marketed. And this commercial activity correlates to substantial annual leakage of methane and with the build up of methane in Earth's atmosphere.

Analysis shows that the Solar Hydrogen Economy will greatly reduce destruction of protective ozone in the stratosphere. It will do so by prioritizing conversion of fugitive methane into sequestered carbon for producing durable goods and hydrogen for energy conversion purposes. Halogens that are the primary cause of ozone destruction in the stratosphere can be safely removed from the stratosphere and precipitated as salts into the oceans following reactions with atomized sodium and/or sodium hydroxide. Hydrogen balloons, guns, and rockets will be used to deliver these reagents to the stratosphere to allow restitution of stratospheric ozone.

The natural gas industry leaks fossil methane but even greater amounts of methane enters the atmosphere from anaerobic digestion, rot, and decay of organic materials. Comparative impacts of human activities that release methane include landfills (34.6%), livestock farming (26%), natural gas production and distribution (19.7%) and coal mining (10%).

Chlorine and bromine continue to cause ozone destruction by catalytic reactions. Each atom of chlorine (or bromine) that reaches the stratosphere is estimated to cause destruction of 100,000 ozone molecules before these serial killers are somehow randomly removed to the lower atmosphere. The net result of the catalytic destruction of stratospheric ozone by halogens is:

$$Cl + O_3 \rightarrow Cl + O_2 + O$$
$$O + O_3 \rightarrow 2O_2$$

Atmospheric methane as evidenced by analysis of polar snow cores is now more than 100% greater than at any time in the 160,000 years that preceded the Industrial Revolution. Methane (CH_4) is composed of one carbon atom and four hydrogen atoms. Each molecule of ozone reacts with methane as summarized below.

$$CH_4 + 4O_3 \rightarrow CO_2 + 2H_2O + 4O_2$$

Catalytic destruction of ozone is also caused by hydrogen (H_2) that reaches the stratosphere to destroy ozone by producing a water molecule. High-energy ultraviolet radiation dissociates the water molecule to release a

hydrogen atom that continues the ozone destruction. However, compared to methane a water molecule requires considerably more energy (shorter wavelength radiation) for dissociation. Therefore the probable initiation rate for ozone destruction in the stratosphere by methane is greater for equal molecular concentrations of hydrogen and methane. Each molecule of methane delivers four hydrogen atoms for the potential catalytic process compared to two hydrogen atoms that are delivered by a water molecule or by diatomic hydrogen.

Through the eons of Earth history, icy meteors have continuously added water to the atmosphere and water vapor has been constantly supplied by the oceans to interact with stratospheric ozone. Hydrogen has been constantly supplied by the solar wind. Addition of chemicals including halocarbons and methane changed this equilibrium. In comparison with four molecules of ozone destruction by a molecule of methane only one molecule of ozone is consumed by a molecule of hydrogen that reaches the stratosphere.

$$H_2 + O_3 \rightarrow + H_2O + O_2$$

Therefore, hydrogen is a much better choice for energy storage and conversion purposes than hydrocarbons in comparisons of greenhouse gas and ozone destruction hazards. Regarding leakage of hydrogen from containment such as a tank, valve or pipeline, it is important to note that for an equivalent high-pressure drop through the same size crack or orifice, about 2.8 times as many hydrogen molecules would leak compared to methane. However the amount of stratospheric ozone destruction would be less with hydrogen than methane. This is because each molecule of methane can destroy four molecules of ozone but each molecule of hydrogen will probably destroy one molecule of ozone.

GRAND PLAN TO PREVENT CATASTROPHIC MASS DESTRUCTION:

Four formidable threats face human dominion on Earth. Three of these threats, namely collision with a high momentum mass from space, nuclear war, and catastrophic greenhouse gas accumulation could cause mass destruction by severe climate changes. The fourth threat is economic demise and illness due to malnutrition and pollution-compromised immune responses that fail the assault of naturally evolved and/or man-made developments of communicable diseases.

In addition to offering far better alternatives than terrorism for improving local living standards, sustainable wealth creation provided by the Solar Hydrogen Economy will enable Civilization to afford adequate preparations to avoid catastrophic events. Catastrophic climate changes including loss of protective stratospheric ozone, greenhouse warming, and oceanic changes will be remedied by advancement of the Solar Hydrogen Economy.

Localized disasters such as heat waves and typhoons can be very severe and cause loss of life and devastating property damages. (See related story on page 1.) The Solar Hydrogen Economy is envisioned as 6,500 Self Help Districts and will be far more effective in supporting communities in recovery efforts from heat waves, tornadoes, floods, fires, and earthquakes. Total Energy System Innovation (TESI) units consist of modular engine-generators that utilize hydrogen and/or Hy-Boost fuels that can be produced from disaster debris, sewage, garbage, and other wastes to quickly provide electricity, refrigeration of medicine and food, cooking centers, and potable water. Modular TESI units can be quickly delivered to restore power and lights and serve as a learning center for transition from disaster conditions to sustainable economic development.

Catastrophic climate changes due to nuclear war must be avoided by logical people in every country who support global disarmament by choosing to embrace the sustainable prosperity revolution. Avoidance of doomsday germs and diseases will be affordable by the Solar Hydrogen Civilization that is advocated. This wealth expansion economy will provide for avoidance of a disastrous collision with a high momentum asteroid and overcome this threat which looms as a greater risk to every living person than being killed in an automobile or airplane crash.

Expediting creation of the Solar Hydrogen Civilization can avoid economic demise due to continued dependence upon annually burning over one million years' of fossil accumulations. This is fundamental to sustainable progress and will enable Civilization to overcome four looming threats of mass destruction.

IT IS TIME TO RENEW and HELP OTHERS CONSIDER BETTER OPTIONS

Help advance the *Renewable Prosperity Revolution*. Renew your membership or become a new member of the American Hydrogen Association or sponsor a new member and receive a free copy of *The Solar Hydrogen Civilization*. (See summary on page 20) Check your local bookstore or order directly from the American Hydrogen Association. www.GoH2.org

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