
Hydrogen Today



The H2 Scorpion



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Here's the hydrogen car you've been waiting for, built by Ronn Motors in Austin, TX. Press releases say this mid-engine H2 fuel injected 450 HP vehicle will do 200 mph and still get 40 miles per gallon. Fuel is 70% gas or ethanol and 30% hydrogen. Only 200 will be built in 2009. Reserve one of these \$150,000 beauties with a \$1000 deposit. www.ronnmotors.com



This revolving door in a Netherlands train station generates electricity to power a café's ceiling LED lights. The power is stored in super capacitors. The manufacturer, Royal Boon Edam Group, claims the door will provide 4600 kWh a year. There are many critics as well as fans of these human-powered doors.

In our everyday deliberations, we must consider the impact of our decisions on the next seven generations.

The Great Law of the Iroquois Confederacy- circa 1142 AD

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** SAFETY FIRST **

Here's The Deal

**HERE IS THE DEAL
ABOUT OIL AND GAS WARS**

By Roy McAlister

Various "Gas Wars" have provided interesting milestones of the Industrial Revolution. In 1792, William Murdock launched what became known as "town gas" as a clean-coal fuel that was ash and soot free. Towngas was a pipeline-delivered mixture of hydrogen and carbon monoxide in a "gas war" that competed successfully with direct combustion of coal, coal oil, whale oil, and candles of animal-fat.

World War I was largely fueled by gas and oil to manufacture and power the tools of hell that replaced horse-drawn weapons, some of which had 100 horsepower propellers and enabled dogfights. From about 1300 to the end of WW I, the Ottoman Empire controlled much of North Africa, adjoining areas of Asia, and sometimes considerable portions of Europe. Germany was after oil throughout the declining horse-drawn Ottoman Empire and armed the Ottomans and then tribal warlords to oppose colonial efforts of England, France, and others that were competing with German expansion. Following WWI, mandates by the League of Nations dismantled the Ottoman Empire and Winston Churchill managed to successfully lobby for award what became Iraq, Saudi Arabia, and Kuwait to the United Kingdom. The French got Lebanon and Syria. U.S. President Woodrow Wilson was insistently informed by an isolationist congress that the U.S. had plenty of oil and thus declined to join the League of Nations. Adolph Hitler re-armed Germany and launched WWII as another oil-powered and oil-grasping war to secure petroleum in Russia and areas now known as Iraq, Saudi Arabia, Kuwait, and Iran.

Franklin Roosevelt subsidized natural gas in a gas war to deliver price-controlled natural gas, that was being flared in Texas, Oklahoma, and Kansas, to densely populated areas of eastern states. This gas war provided a federal price ceiling and replacement of virtually all of the town gas in U.S. pipelines with natural gas.

Another style of oil and gas war was developed and waged by "service station" competitors in the U.S. in which the local price of gasoline would be lowered as much as required to put upstarts out of business before they could expand sufficiently to transfer profits from "price fixed" areas to survive a gas war. Variations of this type of price war and successful lobbying by fossil fuel purveyors

stymied renewable energy upstarts in the 1960's, 1970's, 1980's 1990's and please notice it again in 2008 in a gas war to undermine support for president-elect Obama's suggestions for renewable energy independence.

And as it became apparent that U.S. oil reserves were being rapidly expended, the U.S. launched "Desert Storm" and subsequently built fortresses to occupy Kuwait and Iraq -- at least until their oil reserves are controllably exported. It is indeed interesting that in 1922 Winston Churchill said, "When Iraq becomes strong enough in our opinion to stand alone, we shall be in a position to state that our task has been fulfilled, and that Iraq is an independent sovereign state. But this cannot be said while we are forced year after year to spend very large sums of money on helping the Iraqi government to defend itself and maintain order."

Will T. Boone Pickens successfully launch another gas war to compete natural gas with oil? It could be a good start at overcoming our present *economy of thieves* that derives over 100 billion dollars per year for subsidizing depletable fuels and refuses to pay the replacement cost of energy. Or will the U.S. decide to lead the world with military expenses, more oil wars, and ultimately pay much more dearly in terms of economic inflation due to finite resource depletion, pollution-induced health costs, global climate changes, protection against terrorism, and moral decay along with loss of civil liberties and self respect?

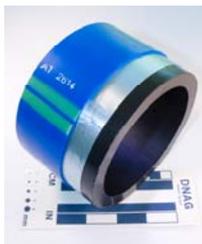
The decisive U.S. gas war could use plentiful natural gas, biomethane, and methane hydrates as energy spring boards and carbon sources for reinforcing equipment to harness solar, wind, moving water, geothermal, and biomass resources in the *Sustainable Prosperity Revolution* to enable virtually full employment with out inflation as it provides a unifying purpose for every family and community on Earth.

Where Has All the Hydrogen Gone?

Hydrogen has some curious properties. Because it is the smallest known molecule in the universe, it has a propensity to leak through the minutest of holes. This can be desirable if you're in a business that handles extreme toxics, such as plutonium, and can afford zero leaks. Pipes and tanks are pressurized with hydrogen and a portable hydrogen-specific mass spectrometer is used outside to "sniff" out any leaks.

Another characteristic of hydrogen is that it's odorless. Odorants are added to propane and natural gas so that your nose can detect a leak. If a leak is smaller than an odorant molecule added to H₂, it will be trapped inside and you will not be able to smell the escaping hydrogen.

Hydrogen can also penetrate into the surface of certain steel alloys. Very high pressures are created inside the metal either by the recombination of monatomic hydrogen or the H₂ combining with carbon to form methane gas. This causes cracking known as hydrogen embrittlement. Hydrogen Discoveries in Oak Ridge, TN is producing a polymer and aluminum pipeline which eliminates many of the problems in transporting hydrogen. (www.hydrogendiscoveries.com) They also have an excellent hydrogen FAQ.



Hydrogen Today Editorial

If you think you can do a thing or think you can't do a thing, you're right.

Henry Ford (1863-1947)

When I was a youngster, my heroes were medical doctors like Tom Dooley and particularly Robert V. Pearson, the General Practitioner who delivered me and who would drive through a snowstorm in the middle of the night to ease anyone's pain. In high school, when I said I wanted to become a doctor, my adviser said it was too hard and my relatives said it was too expensive, so I never even tried. The dream finally ended when I realized my hands and eyes weren't good enough anymore.

What about you? Do they tell you that calculus or learning to read Japanese or pole vaulting is too hard? Haven't they proven that the Hydrogen Economy is too expensive to work? Are you reminded every day that something can't, shouldn't or has never been done? Has school already crushed your creativity to death? Go over the mountain just to see what's on the other side. Enter the Steppenwolf's Magic Theater. This country needs more heroes.

Some of you may have trouble using the Internet links here. The trick is to hold down the control key (Ctrl) and click on the link with your mouse. Occasionally the link page will be hidden on a window behind this one. The name of the page should appear at the bottom of your screen.

Hydrogen Events – 2009

Mar. 6-7 (Fri.-Sat.) Sustainability and Energy EXP09, Tucson, Arizona. Meet the experts and learn about alternate fuel vehicles, solar heating, PV, biodiesel and ethanol, water conservation, the local food movement and sustainable construction. www.tucsonaltenergyexpo.com

Mar. 30-Apr. 3 (Mon.-Fri.) 20th NHA Conference and Hydrogen Expo, Columbia, SC. Lectures, Expo and tours. See the latest technology and meet the people from manufacturing, universities, government, research and the energy utilities who know all about it. \$998 for non-members, \$200 for students and \$75 for the Expo only. www.hydrogenconference.org

May 3-6 (Sun.-Wed.) International Conference on Hydrogen Production, Oshawa (Toronto), Canada. Covers every method of the production, transport and storage of large quantity, reasonable cost hydrogen needed for the Hydrogen Economy. T. Nejat Veziroglu is chair of the conference. \$C375, \$C200 for students. www.ich2p.org

May 31-Jun 3 (Sun.-Wed.) Hydrogen + Fuel Cells 2009, Vancouver, BC, Canada. Features the latest in hydrogen and fuel cell products, including micro fuel cells, back-up power, materials handling, stationary power generation, hydrogen fueling and hydrogen powered vehicles. www.hfc2009.com

Third Saturday of every month. AHA Silicon Valley Chapter meeting. 10am to noon. Peninsula Conservation Center, 3921 E. Bayshore Rd. Palo Alto, CA. 408-245-6056. www.ahascv.org

Cont.....

One August morning, if you were in the parking lot of Gateway Community College in Phoenix, Arizona, you could have driven a hydrogen fuel cell powered Toyota Highlander. Or a Honda, or a Mercedes, GM Equinox, Nissan, BMW, Kia or VW. It was one stop of the 13 day, 31 city, cross-country Hydrogen Road Tour '08 from Portland, Maine to Los Angeles. One engineer said that their fuel cell development was much further ahead than expected. It's clear these people love and believe in their work. For those of you who think fuel cell vehicles are still a long way down the road, you better look in your rear-view mirror.

In October, Phoenix hosted the four-day Fuel Cell Seminar and Exposition. The Expo was free and open to the public. Companies from Taiwan, Japan, Germany and Canada were offering fuel cell components- pumps, valves, instruments, ceramic and nano materials. One manufacturer had a fuel cell the size of a candy bar. When asked what it was used for, he replied that we'll get it working first and figure out the applications later. Fuel cells are now going into back-up power supplies, forklifts and military equipment. There was a sweet, not-for-sale Suzuki fuel cell motorcycle. College students were hungrily looking for information. The air in the hall hummed with excitement, as if these people thought they're making history.

Hydrogen on the Internet

Build It Solar- Renewable Energy Site for Do-It-Yourselfers

www.builditsolar.com

This isn't primarily a hydrogen site, but browsing the 500 do-it-yourself R.E. and conservation projects collected by this retired aircraft products engineer will keep you up all night. Excellent list of resources.

Clean Air Now

www.cleanairnow.us

Dr. Robert Zweig was appalled by the damage to children's lungs caused by air pollution in California. He founded CAN in 1969 to do something about it. He sponsored an early hydrogen powered pick-up truck. They focus on clean air advocacy and education and also encourage the building of hydrogen fueling stations.

Alternative Energy News

www.alternative-energy-news.info

Coverage of everything from batteries to hydrogen to pedal power to wind farms. Also has a green collar job board.

Solarbuzz- World of Solar Energy News

www.solarbuzz.com

Solar industrial news. For example, Akeena, a large California solar installer reports that revenue growth for 2008 will be *only* 25-30%.

McMaster-Carr

www.mcmaster.com

McMasters carries half a million industrial products- tools, lubes, electrical devices, fasteners and raw materials from aluminum to zinc. Their index is 84 pages. They don't seem to mind small orders.

Books & Publications

Build a Solar Hydrogen Fuel Cell System, Phillip Hurley, 2004

Wheelock Mountain Publications. Downloadable ebook only. \$16.95. 249 pages.

www.goodideacreative.com/wheelockmtn.html

This book shows you how to build a complete solar hydrogen system from the custom low-voltage, high-current solar panels to the P41 alkaline electrolyzer made from 3" PVC drain pipe to a fuel cell stack with 12 proton exchange membranes. There is background information, plenty of pictures and the author stresses safety throughout. There are complete tool and material lists. Some parts even have the McMaster-Carr part numbers. You'll find most items at the local hardware store. He includes a source list for the more specialized parts. One electrolyzer costs about \$25 to build; half the cost is a square foot of stainless steel mesh for the electrodes. This is not a book for the unskilled or careless. You need to use a drill press, solder iron, multimeter and handle very caustic potassium hydroxide (KOH). You'll still have a lot to figure out on your own. Believe me, it's a heart-breaker to crack a \$12 solar cell in half while learning to solder the leads on. Reading this book will give you some serious knowledge about producing hydrogen. Building the system will be worth a semester class in college. The text is landscape oriented.

Fuel Cell Projects for the Evil Genius, Gavin D.J. Harper, 2008

McGraw Hill. \$24.95. 196 pages.

If you just sit down and read this book, you'll learn a goodly amount about alkaline and PEM (Proton Exchange Membrane) fuel cells, high temperature cells and even microbial cells. There are plans for building a radio-controlled fuel cell model car and a power supply for small radios or iPods. He includes chapters on history, the Hydrogen Economy and H₂ safety. There are many references to Internet sites for further information. Some of the fun mentioned on the cover vanishes if you actually try to do the 44 projects. Chemicals and quantities are omitted from "you will need" lists. In project 5, he confuses baking *powder* and baking *soda* and don't ruin a good alkaline 'D' cell battery looking for a carbon rod inside because they don't have them. Use the cheaper, old-style 'heavy duty' ones. Gavin had access to a fuel cell lab and equipment that is too expensive for most of us. Although the book is new, some of the parts mentioned are no longer available from the Fuel Cell Store. Do look at their site though for an amazing array of fuel cell supplies. (www.fuelcellstore.com) If the author and publisher had spent just a little more time on it, this would have been a great book.

Natural Capitalism: Creating the Next Industrial Revolution, Paul Hawken, Amory Lovins and L. Hunter Lovins. 1999

Little, Brown and Co. \$17.95. 396 pages.

Every lunchroom, classroom, barroom and waiting room has an expert willing to tell you what's wrong with the world. What if somebody comes along and tells you that we can all live twice as well on half as much? Absurd, you say? The authors of Natural Capitalism describe how to do it and why it's going to happen.

Natural capital is water, minerals, oil, trees, soil and air. It means the grasslands, oceans and forests that are alive with the plants and fauna essential to our life. Conventional capitalism has provided very well, but it has also left behind the wreckage of Superfund sites, refugees, collapsing bridges, drug abuse, road kill, school drop-outs, landmines and depleted aquifers. This time, building more fishing boats is not

going to produce more fish. What is the price of water when there isn't any? A billion underemployed people can't support their families with any dignity. How many trillion dollars are wasted on crime, traffic jams, preventable diseases, high-tech warfare and archaic subsidies?

Sustainability has always existed in nature. One hundred percent of everything is recycled. Business people are discovering that good business is compatible with good environment. They're using new materials, new designs, new software, recycling and old fashioned common sense. Some examples are:

- Steel used in an office building was reduced from 100,000 tons to 35,000 tons.
- A windshield wiper was reengineered from 49 parts to one carbon fiber part at lower cost.
- Daylighting at a Lockheed building cut their lighting bill by 75%. Reduced absenteeism and increased productivity paid for the daylighting in one year.
- The quarter million pages with every phone number in the US could be put on one CD.
- Redesigned factory piping with smaller pumps and bigger, low-friction pipes reduced the pumping power required from 95 HP to 7 HP.

These kinds of changes are going to give businesses a real competitive advantage. Maybe it is time for a revolution. Start voting with your dollars. Build a 100 mile per gallon car. The bottom line- every human being on this planet is a shareholder.

Careers in Renewable Energy, Gregory McNamme, 2008
PixyJack Press. \$20.00. 190 pages.

Careers is not another old list of companies looking for engineers or back-hoe operators. It's much better. This book tells you how to get prepared for R.E. jobs. There are chapters on every renewable energy field- solar, wind, geothermal, hydro, bioenergy, hydrogen and fuel cells, green buildings, green transportation and teaching. There's even a chapter on nuclear, an alternative if not renewable fuel, in case it makes a comeback. There are examples of actual job listings. Each chapter has a list of relevant professional organizations and publications. They cover the places where you can get training. The majority of R.E. jobs require more than the 3 R's of reading, writing and 'rithmetic. Try to get a couple years experience as a welder, electrician, accountant, mechanic, carpenter or HVAC (Heating, Ventilation & Air Conditioning) installer. Study hydrology or computers. Some jobs will be a travel adventure and others offer outdoor work. There's going to be millions of new jobs and new millionaires. Get in on the ground floor.

Merriam-Webster's Collegiate Dictionary, 11th edition, 2005
Merriam-Webster, Inc. \$21.95.

One of these indispensable tools should always be within easy reach. You'll probably wear out two or three in a lifetime.

On Wednesday July 30th, 2003, a major pipeline supplying gasoline to Phoenix, Arizona ruptured near Tucson. By the weekend, many stations were out of gas, fistfights were breaking out in the quarter mile long lines and prices jumped from a dollar and a half to over three dollars. This soon-forgotten event gave us a Katrina-like taste of what it's like to be unprepared. There's a Joni Mitchell song that goes, "You don't know what you got 'til it's gone." Some of you experienced the oil shortages of 1973 and 1979. There were long lines at the pump then, too and some residents, like me, were unable to buy propane for

heating and cooking. However, not everyone back then forget when the gas started flowing again. Out of that era came a host of brilliant innovations in energy independence. Much of it still applies today. All these books are available used from Amazon.com. for a few dollars, but try your library first.

“Let us set our national goal, in the spirit of Apollo, with the determination of the Manhattan Project, that by the end of this decade we will have developed the potential to meet our own energy needs without depending on any foreign energy source.”

-Richard Nixon, President of the United States on November 7, **1973**

Mother’s Energy Efficiency Book- Heat, Light, Power, 1983
Mother Earth News. \$14.95. 260 pages.

Over 60 different articles give plans for solar collectors, ovens and water heaters. Convert your motorcycle to homebrew ethanol, build your own hydroelectric plant, analyze your wind potential with an anemometer, or construct a wind-powered washing machine with scrap, used and recycled material. They cover woodstove safety, methane generator designs, bicycle generators and how to fuel your pick-up with wood-gas. There are lists of materials, and many diagrams and color photos.

Technician’s and Experimenter’s Guide to Using Sun, Wind, and Water Power, Richard E. Pierson, 1978
Parker Publishing Co. 270 pages.

This book is about private and affordable electricity generation. The author, an engineer, encouragingly says, “Just about all the mistakes that you could possibly encounter have already been solved for you.” There are projects for two wind generators, a water wheel, a bicycle generator and a solar boiler. The plans are probably outdated, however most of the book deals with system design, which still applies today. It covers system sizing, economics calculations, reducing loads, battery storage and 12 volt appliances and wind and water power charts and formulas. Excellent photos and drawings.

Producing Your Own Power- How to Make Nature’s Energy Sources Work for You, ed. Carol Huppington Stoner, 1974
Rodale Press, Inc. 322 pages.

A collection of articles, mostly theory, with some general designs for wind generators, small hydro sites, wood burning, methane digesters and solar space and water heaters. Concludes with a chapter on home energy conservation.

Handbook of Homemade Power, Staff of Mother Earth News, 1974
Bantam Books. \$2.25. 374 pages.

This is more of an idea book than a detailed how-to book. There are about 40 articles on wood, water, wind, solar and methane. You’ll find axemanship and the art of cooking on a woodstove. Need a water-wheel powered 8-ton capacity rock tumbler or a \$10 solar shower? How about converting the waste from a 1000 hogs into methane? There are also interesting interviews with several of the early renewable energy pioneers.

The Hydrogen University

Superbright LEDs (Light Emitting Diodes)

When you walk down the street at night, homes are lit up, conveying a feeling of warmth and friendliness. Many of us have already replaced those heat-producing incandescent bulbs with the far more efficient compact fluorescent lamps. Now there is something a magnitude better. LEDs have been around for decades. The new superbright or high output LEDs started showing up in expensive flashlights a couple years ago.

A year ago I bought a CC Vivid + 36 LED light bulb which fits into an ordinary 110V socket. I got a 12V version for my son's Bluebird school bus conversion. It cost \$44.95. It's available now for \$29.95 from the C. Crane Company. (www.ccrane.com) They also sell an 18 LED bulb for \$19.95. We screwed the light into a desk lamp connected to a 12 volt power supply. What you don't get is a roomful of warm light. This is task lighting. LEDs are directional, meaning they have a very narrow viewing angle. From 18" away, there is enough light for reading or writing. They are appropriately named superbright because the light is bright and harsher than what we're used to. Warmer LEDs are now available. There is no noticeable heat. Keep in mind you're only using 2.5 watts. The company's web site says that if each household in America used one LED lamp, Palo Verde, the world's largest nuclear power plant located 70 miles west of here, wouldn't be needed.



If you want to experiment, check out (www.superbrightleds.com). An under \$10 multimeter that measures voltage, ohms of resistance and amps of current would be very helpful. The short lead and flat side of the LED is negative. Use a resistor to get a 3.6~4.2 DC voltage drop across the LED. LEDs will last for years at 20 milliamperes (0.020 amps). At 100 milliamps, their lifetime is only 100 hours.

Thanks

Brian Beaulieu- for LED demonstration many years ago at the E.V.I.T. open house.

Claude Culbertson- for Univega bicycle and refreshments.

Cross Roads United Methodist Church- for AHA meeting room.

Roy McAlister- for checking the math and words of encouragement.

Kill A Watt Watt-Hour Meter

Whether your electrical power comes from a nuclear reactor, solar panels on the roof or a hydrogen fuel cell, it's prudent to not waste the electricity. The easy-to-use Kill A Watt watt meter is a tool that can enlighten you about where your money is going.

The hand-sized unit plugs into a 110V outlet and the device to be measured plugs into the Kill A Watt. The meter displays voltage, amps, watts, frequency, kilowatt hours, volt-amps, power factor and elapsed time. After obtaining your kWh rate from your electric bill, you can calculate the operating cost for appliances in your house. If you have an old refrigerator, you may find you'd put a lot of cash in your pocket over the long run by buying a new energy efficient model.

I went around the house looking for phantom loads- the equipment that uses electricity even when the switch is turned off. Here are the results based on 13 cents per kWh:

Old stereo, transistor radio and shortwave radio- 0.0

Computer, video, printer and speakers- 72 kWh/year, \$9.36

Fax machine, unused for a year- 54 kWh/year, \$7.02

TV, DVD, digital converter and cordless headphone charger- 59 kWh/year, \$7.67

Cordless electric drill charger, battery left in charger- 33 kWh/year, \$4.29

That's \$28.34 wasted a year, more than enough to pay for a Kill A Watt. For the TV and computer I use two inexpensive outlet strips each. The first plugs into a wall outlet and remains on all the time for lights, electric clocks and telephones. The second plugs into the first and one switch shuts everything else off when you are finished. I think it's a good idea to keep one non-electronic phone in your home. It will still work when the power goes off because it's powered by the phone line.

The Kill A Watt can handle a maximum of 15 amps and comes with a single page operation manual. (www.p3international.com) There are fancier, more expensive products available, but they don't provide much additional useful information. You don't really need a Kill A Watt to start saving electricity. Imagine if all 100 million households in America pulled the plug on a few unused gadgets around the house. The Kill A Watt is available for \$24.95 with free shipping from Energy Federation, Inc. (www.efi.org) Now if only my wife can get me to stop standing in front of the refrigerator with the door open.



Show Me the Hydrogen

Got hydrogen? The United States produces 9 million tons of hydrogen a year, mostly by reformatting natural gas. That's enough to fuel 34 million cars. Unlike oxygen which is commonly used by hospitals and welders, hydrogen is not quite so readily available in small quantities. Your neighbors will certainly object to a 40' hydrogen tube truck parked in your driveway. A simpler source of hydrogen for your Briggs & Stratton lawnmower experiments is to buy or rent a cylinder from a local welding supplier.

My last refill, which was actually a tank exchange, cost \$49.47. A 'K' cylinder is 9 inches in diameter and 56 inches high. It holds 196 cubic feet of hydrogen at about 2600 psi. That's roughly one pound of hydrogen gas. Now if a cubic foot of hydrogen is equal to 0.00246 equivalent gallons of gasoline, then a full cylinder holds 0.48 gallons worth of gas. In other words, my \$49 would take my Toyota Corolla only about 15 miles.

Certainly we don't need 99.9999% (four nines) purity hydrogen when 70-90% fuel grade hydrogen will work. Where are we going to get enough cheap hydrogen to run the Hydrogen Economy? One of the best things about hydrogen is that it is a good alternative to batteries for storing energy when the sun isn't shining or when the wind isn't blowing. The electrical utilities have a large excess capacity at night when demand is minimal. They're willing to sell power cheap to recharge your electric car or to operate an electrolyzer.

The king of France once used spoons of aluminum because the metal was then rarer than gold. Today there are new discoveries weekly that are bringing down the cost of producing hydrogen. Recently Daniel Nocera, an MIT chemistry professor, and his crew developed a new method to split water by replacing the costly platinum on the oxygen electrode with a much cheaper catalytic film made from cobalt and potassium phosphate. They are looking for a catalyst that can produce hydrogen directly from sunshine without any external electrical source. QuantumSphere, Inc in Santa Ana, California is now selling a stainless steel water electrolysis electrode with a new type of nano coating. Sintered nickel and iron particles increase the electrodes surface area 1000 times. They say it increases gas production by 2-3 times. Get a 2" x 2" sample pair for \$99. (www.qsinano.com)

Researchers are making breakthroughs and they are also rediscovering ancient, forgotten ideas. It looks like we're going to need a lot of fresh ideas. Maybe you have some.



AHA Membership Form

Name(s) _____

Address _____

City _____ State _____ Zip _____

Country _____

Telephone _____ email _____

- Regular Membership- \$39.00/year
 - New members receive a free copy of Roy McAlister's "Solar Hydrogen Civilization".
- Family Membership- \$49.00/year
- Student & Senior (60 and over) Membership- \$25.00/year
- Sustaining Membership- \$100.00/year
- Corporation/Institutional Membership- \$2500/year

Print this form and mail with your check or money order to:

American Hydrogen Association
2350 W. Shangri La
Phoenix, Arizona 85028
USA

AHA publishes *Hydrogen Today* to help educate the public about new developments in renewable energy and the science and people behind them. Join us in making a better world. You can help too by writing for *Hydrogen Today*. Tell others about your grassroots alternative energy projects, either scientific or social. Review a book, product, service or event. A picture is still worth a thousand words. The range should be approximately 300-1000 words. Send to the above address or to the *Hydrogen Today* editor at bikesintl@netzero.com.