

HYDROGEN

Official Publication of the American Hydrogen Association (AHA)

July, 1990 Volume 1 Number 1 Page 1

A SOLUTION TO GLOBAL WARMING, ACID RAIN, OIL SPILLS AND URBAN AIR POLLUTION. . .

Harry Braun

(*Tempe, AZ*) Of all existing energy alternatives, hydrogen is the only option that is non-toxic, essentially pollution-free when burned, and completely renewable. An industrial transition to solar-hydrogen energy systems would create an unprecedented economic boom, while reducing or eliminating oil spills, greenhouse gases, acid rain, most forms of urban air pollution, sewage sludge, landfill accumulations, and production of additional nuclear reactors.

Hydrogen can be manufactured from water with solar energy processes, or from sewage, paper or other types of garbage with microbial or pyrolytic (i.e., decomposition with heat) methods (see accompanying article on "Toxic Wastes").

A transition from a "fossil fueled economy" to a renewable "hydrogen economy" is being advocated by over 2,000 distinguished scientists and engineers from 82 countries who make up the International Association for Hydrogen Energy (IAHE). This engineering brain-trust holds an international technical conference every two years (the Eighth World Hydrogen Energy Conference will be held July 22-27 in Honolulu, Hawaii), and publishes a technical journal, the *International Journal of Hydrogen Energy*, which is available in most science libraries.

AHA Objectives

The American Hydrogen Association (AHA) is a non-profit organization that was formed in part to help build public support for the IAHE and the hydrogen energy system by reporting on the technical papers that appear in the *IAHE Journal* in a non-technical manner for the general public. In this regard, AHA is seeking to make "hydrogen" a household word to the American public by providing educational briefings and workshops to industrial, environmental and community groups.

(Please Turn To Page 2 - "... Solution")

HYDROGEN FROM TOXIC WASTES

Bob Liden

(*Tempe, AZ*) Preliminary investigations indicate that it is possible to engineer cost-effective and reliable multi-stage hazardous waste treatment facilities that will neutralize toxic chemicals and allow the valuable compounds and metals to be recycled without releasing any toxic emissions in the process.

This is in contrast to conventional incineration systems that emit various levels of toxic compounds and only reduce the volume of toxic material that must be stored in specialized landfill sites for a period of many decades. Biological remediation, neutralization and recycling systems, on the other hand, utilize microbial, pyrolytic, electrolytic and high-temperature combustion processes to reduce toxic compounds essentially to salts, water, carbon, metals and hydrogen (a renewable, non-toxic and virtually pollution-free fuel). Similar methods could also be optimized to neutralize sewage sludge and existing landfill accumulations and produce hydrogen for use throughout the economy.

Although all of these processing steps have not been combined in a single toxic-waste processing facility to date, the technology is well-proven and currently being utilized in various specialized waste processing plants here in the United States and Europe.

There are a number of economic advantages to this type of "bioremedial" processing plant as well. Biological remediation can be significantly less expensive than incineration, and this hydrogen-aided process results in the ultimate reduction of toxic wastes to a number of commercially-sellable products.

(Please Turn To Page 3 - "... Toxic Wastes")

FEATURED INSIDE:

UPCOMING MEETINGS
LETTERS FROM OUR READERS
GOALS OF AHA
PERSONNEL NEEDS
MEMBERSHIP INFORMATION

TRAVELING DEMONSTRATION PLANNED

THE HYDROGEN SOLUTION

(continued from Page 1)

The transition to hydrogen is one of the key variables that makes an industrial transition to renewable solar technologies technically and economically feasible. Although solar technologies and resources have many attractive aspects -- they are renewable, modularized, and generally pollution-free, they also have the disadvantage of not always being present in the right intensity at the right place at the right time.

Hydrogen provides a realistic method of storing, transporting, and using the massive, but intermittent, supply of solar energy. In evaluating the various solar options that have been developed, photovoltaic systems have received the vast majority of research dollars. In spite of this fact, photovoltaic systems are still one of the most expensive and least efficient (10 to 12 percent) solar technology options.

Point-Focus "Dish" Gensets

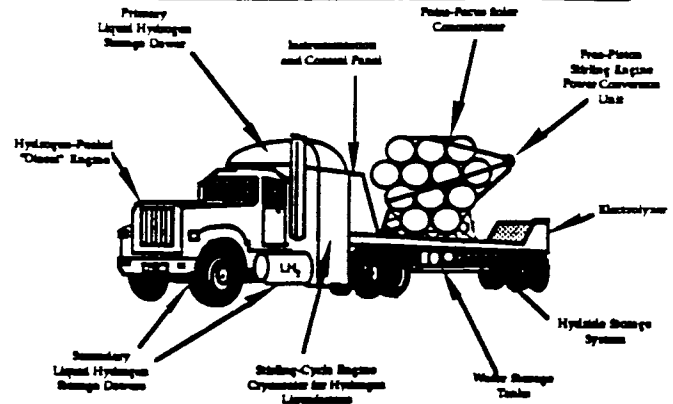
In contrast, point-focus concentrator "dish" generator sets (gensets) have been one of the least funded options. Yet, field experience obtained by investigators at the National Aeronautics and Space Administration (NASA), the Jet Propulsion Laboratory, and the Electric Power Research Institute (EPRI), has demonstrated that Stirling dish gensets are one of the most efficient (25 to 30 percent) and cost-effective solar technology options developed thus far.

A point-focus "dish" genset is a 5 to 12-meter diameter solar collector that concentrates the Sun's energy, like a magnifying glass, onto a mechanical heat engine and electrical generator. Dish gensets, which look similar to a satellite or radar dish, are one of the most cost-effective solar technology options because they are able to utilize highly efficient Stirling engines that can be mass-produced with existing automotive and aerospace technology. Its individual sections could be made of non-strategic materials, such as glass and steel, and they would be about the same size as the hoods and fenders for automobiles.

Solar gensets are like "technological trees" because they will be watered and then use sunlight to break the water down into hydrogen and oxygen. Individual dish gensets can be connected together for large-scale electricity or hydrogen production, and unlike nuclear or fossil fuel systems, they would be able to produce electricity without producing any toxic wastes or consuming any water in the process.

Mass-produced Stirling dish gensets should be able to generate electricity much less expensively than can be produced from conventional fossil fuel or nuclear facilities. This is important because the cost of

electricity directly impacts the cost of hydrogen; with current electrolysis technology, gaseous hydrogen will cost about \$3.65/million Btu for each cent/kilowatt hour of electricity costs.



An artist's rendering of a specially-equipped hydrogen-fueled truck that is integrated with a Stirling engine/point-focus solar concentrator system. This unique vehicle is to be deployed as a part of the Mobile Hydrogen Demonstration Fleet under development by the AHA.

Calculations indicate that if 20 twenty-kilowatt solar Stirling gensets are installed per acre, roughly 10 percent of the desert areas in the American Southwest could make the U.S. energy independent of the Earth's remaining fossil fuel and uranium reserves. Assuming the solar gensets cost about \$4,000 each, the overall cost of building the roughly 400 million units eventually needed to meet current U.S. energy requirements would total about \$1.6 trillion. Such investments will likely come primarily from private-sector energy companies, and not deficit-financed tax dollars.

It is significant that utility-oriented engineers and planners are generally only interested in electricity production. Such individuals are not normally involved in hydrogen energy or engineering research. In fact, with few exceptions, the engineering teams that have been involved in developing Stirling dish genset systems were not even aware that the *International Association for Hydrogen Energy* even existed.

It is equally significant that the hydrogen engineering community is generally unaware of the solar Stirling dish genset technology and its potential for large-scale hydrogen production. This is a classic case of a significant information-gap between highly-trained specialists who, by necessity, focus their efforts in relatively narrow fields. Compounding this problem is the shortage of energy research and development specialists who take a look at the "big picture" with a relatively long-term view.

(Continued on page 5 - "... Fleet Planned")

HYDROGEN

Official Publication of the American
Hydrogen Association (AHA)

2026 West Campus Drive • Tempe, Arizona 85282
(602) 438-8005 • FAX (602) 431-9626

Editor-in-Chief: Robert B. Liden

Contributing Writers:

Harry Braun Roy E. McAlister
Herbert Hayden Sherwin Berger

Published Bi-Monthly

HYDROGEN FROM TOXIC WASTES

(continued from Page 1)

In addition, the hydrogen generated by the biodegradation of hydrocarbon waste products can be utilized to convert toxic metal oxides to water and reusable metals and for converting toxic chlorine gases released from PCBs, TCE, and similar chloro-hydrocarbons into hydrogen chloride, which can be further reacted with metals to form valuable salts and/or sold for chemical plant and certain purification uses. Hydrogen can also be used in fuel cells to provide electricity for the plant's uses. Finally, some of the hydrogen can be burned to generate a 6,000° F flame that will sterilize any gases or other plant effluents.

Many members of the American Hydrogen Association support an initiative that is being circulated in Arizona currently seeking to place on the November 1990 ballot a mandate that any state-owned or supported toxic waste plant in Arizona must utilize bioremediation and other processes that can insure that virtually no toxic wastes will be able to escape from the plant. This initiative, 24-I-90, also bans the importation of toxic wastes to Arizona state-owned or operated facilities.

At an open forum/workshop held at Arizona State University (ASU) Saturday, June 23, 1990, Roy McAlister, President of AHA, provided a technical discussion on a specially-designed bioprocessing plant for the handling of toxic wastes. McAlister's presentation was received enthusiastically by the estimated 75 people in the audience, many of whom were attending their first AHA meeting. Copies of the slides presented by McAlister are available from the AHA office.

Letters From Our Readers:

Toxic Waste Plant Comments In June Newsletter Employ "Scare Tactics"

Sir,

I am a member of AHA and an Environmental Scientist by profession. I strongly support our efforts to promote hydrogen as an alternative fuel source; however, I was shocked when I read the Association's newsletter of Mid-June, 1990. I agree that better alternatives to incineration at the Mobile [AZ] facility exist and should be pursued, but we must not support our agenda with half-truths, fallacies, and omissions regarding the technologies we are promoting.

Specifically, [you state that "we will be breathing and drinking PCB's, dioxins and other toxins, as well as poisonous metals like mercury, lead, and arsenic"]; Federal land disposal restrictions ban the disposal of all solvent wastes and require all other hazardous waste to be treated prior to landfilling so that the potential for pollutant leaching is minimized. Furthermore, these treated wastes are then placed in a double-lined landfill with leak detection between the liners and groundwater monitoring around the landfill.

Given the normal precipitation in the Mobile area, it is unlikely that enough water will get in the landfill before they cap it with another impermeable layer to produce any leachate.

Federal law also requires intermittent sampling of all drinking water sources for pollutants, and if a source is contaminated, it cannot be used unless [properly] treated. We will certainly not be drinking PCBs (which can never even be landfilled!). As for breathing, it is my guess that most pollutants would be non-detectable from background levels a few miles downwind. And this is from instrumentation that can detect the day a person goes to a gas station by analyzing his breath for benzene! We probably face as much exposure to "toxic" and harmful substances in a day from the automobiles we use and houses we live in, than we would from a properly-run hazardous waste facility.

[With regard to your statement that "There will be increased acid rain, ozone depletion, and huge quantities of greenhouse gas emissions"], given the amount of CO₂ and NO_x emissions from automobiles in Maricopa County, I fail to see how the Mobile facility will have any additional impact to the greenhouse effect or acid rain. Emissions wise, it is a drop in the bucket. As for ozone depletion, could you please explain to me which ozone-depleting chemicals the Mobile facility will be emitting?

[You note that there is an "impressive arsenal of microbes to eat PCB, TCE, dioxin, engine oils, ..."] Bioremediation has been shown to successfully degrade petroleum hydrocarbons and some of the solvents such

(Continued on next page)

LETTERS ... (continued from previous page)

as TCE. So it is indeed an appropriate technology for such wastes. However, bioremediation of persistent and highly toxic chemicals such as PCBs is still in the research and development stage. ... It should also be noted that in most cases bioremediation will produce greater air emissions of "toxic" (organic) substances than incineration. This is because bioremediation takes much longer than incineration so there are emissions due to volatilization. Another drawback researchers are trying to overcome is that wastes are degraded to a threshold level at which degradation then occurs very slowly because there is little organic material for the micro-organisms to utilize. The main advantage of bioremediation over incineration (which you failed to note) is that it is less costly.

[You recommend Initiative 24-I-90, which requires that all incineration result in no toxic or harmful emissions.] From a chemical standpoint, this proposal is impossible. Even our bodies, marvelous as they are, produce minute "toxic" emissions. ... No chemical reactions are ever 100% complete. If the objective is to ban all incineration, then say so; don't try to achieve it by subterfuge.

[Finally, you recommend banning the importation of toxic wastes to State facilities.] Philosophically, this is a good proposal. However, [carrying this to its logical conclusion], I suggest we ban the importation of all goods produced out-of-state. [Practically,] we must not limit ourselves to local issues when protecting the environment. Environmental issues know no borders. If Arizona can dispose of hazardous wastes better than other facilities out of state, then so be it.

I have a vision of a low-impact, self-sustaining, conservationist society, which is why I support the Association. I feel though that an explanation to all members is in order, for it is apparent that homework has not been done, and we cannot be a credible organization if we rely on nonsense and alarmism to promote our agenda. There are certainly enough technical and financial justifications to promote bioremediation and hydrogen technologies without resorting to scare tactics.

Sincerely yours,

Michael Milczarek

Dear Mr. Milczarek,

Thank you for your thoughtful letter. You are quite correct concerning the purpose of AHA. It is our goal to promote the merits of renewable resources through the dissemination of scientific knowledge and promotion of scientific research.

While we are aware of the Federal regulations regarding landfill management and testing, we are also sadly aware of the fact that the EPA has become extremely casual regarding testing (rationalizing that their budget is not sufficient to cover the inspections and monitoring specified by law.) Furthermore, the current specifications for the ENSCO plant do not require sufficient monitoring by the state and only voluntary controls by ENSCO. This, coupled with ENSCO's history of pollution violations in other plants, forces us to the conclusion that it is possible -- in fact, likely -- that at one time or another (at least), some of the toxic gases and/or toxic materials produced or handled by that plant are going to escape into the atmosphere or into the ground and groundwater. (The site study is also, according to experts at ASU, insufficient and fails to note that the plant site is near a geological fault area that may lead to a breach in the planned landfill lining.)

Your point is well taken, however, concerning the automobile and home as sources for more toxic substances and CO₂ than a properly-run hazardous waste facility. As you have probably come to know as a member of AHA, we advocate the minimization and/or elimination of many of the sources of those toxic emissions from our automobiles, power plants, etc., as well. We believe we should do everything we can as readily as we feasibly can to get rid of those things that poison our world. And while it may take a while to convert from fossil fuels to a hydrogen economy, we can try to eliminate unnecessary sources of potential or real pollution from wherever we find them. The added CO₂ and other emissions from a large incinerating plant is, in this instance, unnecessary. We can use bioprocessing, combined with further chemical processing and final sterilization with hydrogen produced from the hydrocarbon waste materials at the plant as a practical, less-expensive, and far cleaner way of disposing of toxic wastes than simply burning them. And we end up with some valuable metals and salts to recycle as well. (Incidentally, there is a PCB bioprocessing facility currently in operation in Louisiana.)

Regarding your comments concerning the fact that incineration seems to be faster than catalytic derivation of hydrogen from toxic hydrocarbons, we should note that the process we propose to use is a special subclass of bioremediation that we call (for want of a better term) "bioprocessing". The distinction is that bioprocessing starts with concentrated forms of toxic wastes and utilizes equipment that will maximize the rate of dehydrogenation by catalytic action of soluble hydrogenase. The process equipment allows for continuous flows of material through the plant and the concentration of toxic waste to maintain "waste-rich" conditions. This arrangement brings the optimum temperature and concentration of toxic waste feedstock in contact with catalytic dehydrogenation enzymes.

(Continued on next page)

LETTERS ... (continued from previous page)

This process design overcomes the problems you cite of long processing times and avoids the "threshold level" you refer to wherein the micro-organisms literally are starved.

We also propose a design that is totally closed to the atmosphere -- one that superimposes several safety systems -- including using a 6000° F hydrogen flame to sterilize whatever is finally left over at the end of the plant's multi-stage processing.

Finally, we do not believe it is necessary or desirable to turn Arizona into a toxic-waste dumping ground for the rest of the world. It is safer and environmentally more responsible to take care of toxic wastes as close to the point of origin as possible. And there is nothing that we are proposing to do here in Arizona that cannot as easily be done elsewhere as well without the expense of transportation to Arizona. By dealing with toxic wastes at or nearer to the sites of generation, the atmosphere will be spared the added burden of unnecessary CO₂ generated from the trucks and trains that haul the waste.

We have done our homework on this matter and agree with your conclusion that there are certainly sufficient "technical and financial justifications to promote bioremediation and hydrogen technologies". We apologize, however, if our attempts at presenting these ideas in simple, non-technical language failed to reflect our scientific knowledge and came across instead as "scare tactics", etc.

Sincerely,

Roy E. McAlister, P.E.
President, AHA

NOTE: The editors invite comments from readers and will select letters to print in *HYDROGEN* based on availability of space. Also please write and tell us what your special interests are with regard to hydrogen and renewable resources. Suggestions for future articles (and contributions) are welcomed.

***** UPCOMING MEETINGS *****

July - 1990

July 4: "The Last Clean Picnic" 5 PM to Midnight, South Mountain Park, Phoenix: Sponsored by Friends of Hydrogen and Concerned Citizens of Arizona.

July 10: St. Vincent Church, 7:30 - 9:30 PM, 3140 N. 51st Ave., Phoenix: Features Harry Braun of AHA as guest speaker.

July 18: Joint ASU-AHA Meeting 7 - 9 PM, Student Svcs. Bldg., ASU Campus: Features Video "Fire In the Water". Agenda also includes Sam Steiger, Rep. Gubernatorial Candidate as guest.

July 22 - 27: Eighth World Hydrogen Energy Conference - Honolulu, Hawaii.

Mobile Hydrogen Fleet Planned

(continued from Page 2)

For this reason, AHA researchers are also in the process of developing a proposal for a Mobile Hydrogen Fleet of vehicles (consisting of several trucks, automobiles, recreational vehicles and a helicopter) that will demonstrate state-of-the-art solar-hydrogen technologies to members of the media, industry, and local, state and national governments. A primary objective of the Hydrogen Mobile Fleet will be to demonstrate a number of different hydrogen-fueled vehicles with both hydrogen production, storage and end-use applications.

The American Hydrogen Association Needs:

- Researchers and Engineers** to provide technical development in the electrical, chemical, mechanical, and thermodynamic fields.
- Managers and Business People** to initiate progressive changes in commerce and industry.
- Molecular Biologists and Microbiologists** to develop energy and material renewal processes.
- Communicators** to facilitate the transition.
- Architects and Artists** to visualize the future.
- Educators** to teach and inspire.
- Builders of Ideas** -- winning workers that make things happen.

That is to say ... AHA Needs You.

AHA ANNOUNCES AMBITIOUS GOALS

The American Hydrogen Association has adopted several ambitious time-phased goals for itself for the 1990's. Specifically, AHA wants:

- "Hydrogen" to be a household word by the end of 1990.
- The clean hydrogen energy system and the concept of renewable and recyclable resources to be incorporated into school curricula (at least at high school and college levels) and under active research at the university level by the end of 1991.
- Municipal and industrial pilot programs in place by the end of 1992.
- Hydrogen production and use by the consumer to begin by the end of 1993.
- The automotive and energy industries to adopt clean hydrogen fuel into their product and business planning by the end of 1995.
- And the use of fossil fuels in new cars and trucks halted by the end of the decade.

An Open Letter To The Arizona Governor And State Legislators

The Honorable Rose Mofford,
Governor of the State of Arizona
Members of the Arizona Legislature

Dear Governor and Legislators:

The environmental issue is here to stay. The public realizes it. If we don't meet the challenge, it will only get worse and Arizona will suffer.

Arizona's economic future and quality of life depend upon our making wise and responsible environmental decisions. Today's degradation of life, both human and natural, and pollution cleanup costs are caused by our own practices of the past; today's practices will become costly in our immediate future. These costs are partially due to a lack of awareness, but are largely a result of business practices that provide short-term economic benefit to a few. In all cases the penalties far outweigh the gains, and the public as well as nature pay an unreasonable price.

Starting now, let us adopt an unwavering state-wide direction toward complete environmental neutrality. Let's take the easy, less-expensive road and clean up our act up front.

Arizona must move toward total resource recovery from our wastes - eliminating disposal to the environment and the depleting of our natural reserves. We must begin the recycling of all commercial and residential toxics and landfill materials. These wastes contain the same raw materials as the new resources we desire.

Arizona must also move toward clean and renewable energy. We can reduce our use of fossil fuels and nuclear power and begin using our abundant renewable energy sources, primarily the energy of the sun.

The Arizona Legislature should establish an economic and regulatory environment promoting renewable and non-polluting practices at every turn, and deter depletion and disposal. The Legislature must require our Department of Environmental Quality and the Arizona Energy Office to work wholeheartedly toward accomplishing these objectives; and it must see that only those individuals who will commit them-

selves and their offices wholeheartedly to these goals are put in charge.

Arizona's economic and regulatory climate must encourage businesses and individuals, from state government on down, to adopt renewable resource practices. Tax and regulatory policy must discourage virgin resource depletion and the use of products that promote such depletion. Regulation must halt pollution and disposal. Our state and municipal agencies must establish total recycling services, convenient to the public, to reclaim raw materials from all commercial and residential waste outputs; and the public must learn to use recycled resources.

These goals can be realized using today's technologies. Proven bioprocessing methods exist that will efficiently decompose waste mass and liberate fuels and useful materials. The remnants of these processes contain quantities of metals that can be recovered with further refining, ultimately more economically than by mining. The task will be challenging and unending, but we can draw from leading companies and pioneering researchers and use our local universities and industry to put these new technologies to work.

Arizona must also encourage the use of cleaner-burning transportation fuels. This state alone consumes billions of gallons of gasoline and diesel fuels each year in our cars, trucks, and buses, making transportation the largest source of pollution in our cities.

Natural gas is a much cleaner fuel, proven locally and to a much greater extent in other countries. It is non-toxic, widely available, and it costs less than petroleum fuels. Vehicles running on natural gas produce much lower toxic emissions and greatly reduced carbon dioxide emissions, due to its relatively low carbon and high hydrogen content. In the long term, as a transition fuel it can enable the gradual adoption of pure hydrogen as the completely non-polluting fuel made from renewable energy sources.

The Arizona Legislature has a unique opportunity and responsibility facing it today. The pressure to change is all around us: California, for example, is at the verge of dramatic environmental action in response of shocking realities. Arizona should act simultaneously, so that the public and industry can meet the challenge in an economic, coordinated manner.

(Continued on page 7 - "Open Letter")

OPEN LETTER

continued from previous page)

We must lead the way to our own future quality of life. In the process, we will create a truly stable economy for our future. Let's create the jobs, save the world, and save ourselves money in the long run. It's in our own best interest to start now.

Sincerely,

Herbert T. Hayden, P.E.

Editor's Note: Mr. Hayden is an active member of AHA and serves on its administrative board.

CURRENT OPPORTUNITIES IN THE HYDROGEN ENERGY MARKETPLACE

While our ultimate goal is to eliminate fossil fuels and other non-renewable energy sources, we recognize that this is a massive transition that must be "phased in". It is neither possible nor sensible to target for an instantaneous switching from one energy regime to another.

A logical first step in this "phasing-in" of cleaner-burning fuels (at least here in North America) is to more fully integrate into the transportation industry a much-cleaner-burning fuel, *natural gas*, that is also less expensive and more abundant than oil and oil-based products like gasoline and Diesel fuel. This first step will begin to address the immediate needs of cleaning up the environment; and it can also lead to a large first commercial market for mass-produced solar hydrogen.

To do this, we need to convert cars, trucks, buses, etc. to multi-fuel capability, permitting the use of compressed (or liquid) natural gas in addition to gasoline or Diesel fuel.

As solar hydrogen production begins (and even before the entire infrastructure of delivery systems, liquefaction systems, in-vehicle storage tanks, pumping stations, etc. are all well established in the marketplace), it is possible to blend the hydrogen into natural gas supplies, upgrading the BTU content of the natural gas and extending these valuable reserves.

Other relatively-immediate opportunities in the "hydrogen energy marketplace" include making practical electric cars and electric generators using highly-efficient hydrogen fuel cells. We also need electrolyzers to make hydrogen from existing power sources to use in some specialized applications where hydrogen produced by photovoltaic electricity, etc. can be used today.

Finally, we need to pursue aggressively the development of cost-effective solar, wind, and biomass hydrogen fuel generators for the future.

LESS TECHNICAL BUT IMPORTANT THINGS YOU CAN DO TO HELP

Write your Congressmen. Write the governor. [Ed.: Refer to Herb Hayden's "Open Letter" for example.] Write the heads of the U.S. Department of Energy and your state Energy Office. Even write the President.

Write to other environmental groups. Write the media (local newspapers, radio/TV news anchors, etc.).

Tell them you want The Total Environmental Solution of Renewable Solar-Hydrogen Energy ... not any partial or half-baked solution. Tell them about the long-term economic benefits (both macro- and micro-) of this new, non-destructive domestic energy industry. Ask them to join you in campaigning for a real and permanent solution to smog and the greenhouse effect. Ask for environmental legislation that will truly save the environment, not just make it a little less-dirty in spots. Ask for government financial support (including tax credits and other incentives to encourage private industry to pursue hydrogen energy investments). Ask for congressional support of House Bill 639 and an end to support for the fossil-fuel industry.

Help create a consumer demand for hydrogen energy for our cars and homes and industry. Point out that while no one can meet that demand now (on a large scale), there is a market -- and a desperate need -- for clean-burning hydrogen today ... and tomorrow. With a strong market demand, there will come enterprising companies (large, small, old, and new) to fill that demand.

Become informed about the clean hydrogen energy alternative; then tell others. And join the American Hydrogen Association (AHA).

Why Join AHA?

The American Hydrogen Association is the only public awareness group offering permanent solutions to the world's energy and pollution problems. We *can* have prosperity without pollution. We *can* eliminate the dumping of poisonous and life-threatening exhaust chemicals into our air; we *can* find economic uses for our sewage and trash waste products; and we *can* have clean air and clean water everywhere ... not just in plastic bottles.

AHA is promoting crucial public awareness and the building of a hydrogen constituency. A change to hydrogen will only come when the public demands it.

Membership in AHA is inexpensive and important. All your dues and other monetary contributions are spent to spread the word about the merits of hydrogen energy, and your help in this important work is critical. Membership in AHA shows others that you care about our World and you care about our future.

Join the American Hydrogen Association And Help To Make a Transition To Renewable Resources.

A transition from fossil and nuclear energy sources to solar-hydrogen technologies could fundamentally resolve many of the most serious environmental problems including global greenhouse warming, acid-rain, oil spills, sewage and trash recycling, stratospheric ozone depletion, urban air pollution or the production of additional radioactive wastes.

The reason the hydrogen economy is not a reality today is not technological; rather, it is the enormous information-gap that exists within the scientific and educational community, the political establishment, the media, and most importantly, the general public. In that regard, we have our work cut out for us. But our objectives are clearly defined -- and they are achievable.

Take part in the most important transformation in history. Become a member of the American Hydrogen Association and help to make a transition from the fossil depletion economy to a renewable solar-hydrogen economy that will last forever. Do it for the children; do it to preserve the remaining wild animals that are struggling to survive in the vanishing wilderness areas; do it for yourself; *but do it soon. The time to stand and be counted is rapidly slipping away. . .*

(Tear Or Cut At Dotted Line)

* * * MEMBERSHIP APPLICATION * * *

Yes, I want to join and help make a transition to clean, renewable solar hydrogen energy.

New Member Name: _____

Address: _____

City: _____ State: _____ Zip: _____

Telephone: Home: () _____ Office: () _____

Occupation and/or areas of special interest: _____

Regular Membership (\$20/year) Sustaining Membership (\$100/year) Life Membership (\$1,000)

Corporate Sponsor (\$1,000/year) Other Gift (specify amount) _____

Signature: _____ Date: _____

Enclose check or money order and mail to: American Hydrogen Association, 2026 West Campus Drive, Tempe, AZ, 85282