

HYDROGEN TODAY

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A Costly Lesson: U.S. AT WAR IN MIDDLE EAST OVER KUWAIT, OIL

By Robert B. Liden

January 16, 1991, marked the first day of open battle in the Middle East between the U.S. and several allied nations (the "Allies") and Iraq. A massive air attack, consisting of over 1,000 sorties by Allied aircraft and 100 Cruise missiles, hammered away at Baghdad and strategic military or industrial sites in Iraq and Kuwait in the first 24-hour period.

At the time of this report (six days later), the war continues with a steady stream of air attacks on Iraqi targets as the first phase of what is forecast to be a lengthy battle. Iraq has countered with some generally-unsuccessful aircraft resistance and with considerable anti-aircraft fire and surface-to-air missiles. In addition, some SCUD missiles have been fired on Tel Aviv and Haifa, Israel (in an attempt to bring Israel into the war and break up an alliance between the U.S. and several

Arab countries), and on Dhahran and Riyadh, Saudi Arabia.

At present, the battle is reported to be very one-sided. The U.S. and allied forces have lost some fifteen planes and reported about twenty airmen missing in action. Iraq has reportedly captured ten prisoners. By contrast, the U.S. forces report having destroyed or seriously damaged billions of dollars in nuclear and chemical factories, the principal Iraqi military communications and headquarter facilities, most or all of the fixed SCUD missiles sites and several of the mobile SCUD launchers, and power and supply lines leading to the capital city of Baghdad. There have been no casualties reported on the ground since fighting began, and the majority of the SCUD missiles have been destroyed in the air by Patriot anti-missile missiles.

**The U.S. Cost of Battle
Already Amounts To Over
\$500 Million Per Day**

Nevertheless, as the war progresses from aerial bombings and missiles (where the allied forces were known to have substantial superiority) to ground battles (where Iraq's proven strengths are greatest), it is predicted that the war will turn far bloodier, with heavy casualties on both sides.

Iraq's Saddam Hussein is known to have dreaded chemical warfare weapons, including both toxic chemicals (mustard gas and other nerve gases) and bacterial weapons. Analysts predict that Hussein will use these (he previously used nerve gas in the eight-year war between Iraq and Iran that ended with a cease-fire just a few months ago). He has also threatened to blow up all 370 Kuwaiti oil wells as a means of frustrating the allied attack and

punishing the allied forces for attacking Iraq (see the accompanying article: *Iraq's Pollution Weapon*).

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IRAQ'S POLLUTION WEAPON ... INSULT OR MAJOR CATASTROPHE?

By Roy E. McAlister, P.E.

Regarding pollution, the war in the Persian Gulf is most unfortunate. SCUDs are in the sky and skud is in the water. Massive amounts of jet fuel, ammunition, rocket propellants, poisons, and explosives are being combusted or released to add to the worldwide insult to the environment. Enormous releases of oil threaten to spoil the ecology of the Gulf. Greenhouse gases from the fires of war will travel throughout the world. Oil slicks will pollute local waters and beaches for a long time unless an exponentially-increasing army of bacteria is unleashed to assault and bioprocess the spill.

Saddam Hussein's threats to blow up the Kuwaiti oil wells, burning whatever comes out to cause catastrophic damage to the world should not be taken lightly. *[As Hydrogen Today is going to press, two or more of Kuwait's oil wells and storage facilities were reported to be burning.]* Hussein's threat is meant to cause terrorizing psychological harm to the world. With the help of compliant news reports, it has had some success. By some accounts, all the Kuwaiti oil wells (some 370) will expel oil and burn violently in oxygen-starved conditions to produce unburned oil particulates that will canopy a large portion of the world, blocking sunlight and causing one or more seasons of
(Please turn to SADDAM ...on next page)

AHA Moves Into New Headquarters

On January 15, the American Hydrogen Association formally opened its new headquarters offices at 219 South Siesta Lane, Suite 101, Tempe, AZ, 85281. The move, from one side of Tempe to the other, required a change in telephone number as well: the new phone number is (602) 921-0433.

The move, which came about one year after the Association was formed, provides more office space dedicated to AHA. These new facilities also include space for manufacturing and test equipment that will be used to develop hydrogen system demonstrations.

The offices are shared with the World Survival Foundation, which is opening an office in the Phoenix area. WSF also will maintain an office in Sedona, AZ.

Members are encouraged to come by and assist in various office and other tasks.

SADDAM HUSSEIN'S POLLUTION WEAPON

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crop failure, increased snow inventories at the poles, and reduced global temperatures.

This scenario is based upon two suppositions: (1) that these oil wells have sufficient bottom-hole pressure to expel the oil; and (2) that the unburned oil particles will be thrust far enough into the upper atmosphere to go around the world rather than fall annoyingly into the surrounding oceans and land masses.

Mexican Oil Well Fire And Mount St. Helens Eruption May Provide Clues

Recent experience in North America in the form of a gigantic oil-well fire in the Gulf of Mexico and in the instance of the eruption of Mount St. Helens suggest that there would not be major global cooling as a result of the burning of Kuwaiti oil wells. In 1979-80, a gigantic Mexican oil well called "Ixtoc I" burned furiously for about nine months before fire fighters could devise a way to get close enough to put out the inferno. Conceivably, if the Kuwaiti oil wells were all to be set aflame and all 370 of them were as high-pressured as Ixtoc-I, there could be a monstrous cloud of black smoke formed.

There is considerable doubt, however, that the Kuwaiti wells have remaining bottom-hole pressure to expel oil at extremely-high rates, rates comparable to fires involving massive above-ground storage depots or even Ixtoc-I. New wells in new areas that have untapped bottom-hole pressure might be expected to spew oil and natural gas in free-flowing geysers, but most of the Kuwaiti wells have been producing for many years.

When Mount St. Helens erupted about ten years ago, it released energy at far greater rates than setting all the Kuwaiti oil wells on fire at one time. It, in fact, released energy into the environment at a rate of several Hiroshima atomic bombs every minute. During the peak rate of discharge, Mount St. Helens hurled particulates of silica and ash fluff into the atmosphere at a greater rate than if all of the oil produced in Kuwait were to enter the atmosphere as unburned particulates. Mount St. Helens did not cause global cooling, and crop production in nearby areas during subsequent months and the years following was still very substantial.

We should take Saddam Hussein's threat, however, in context with what we are doing throughout the world to cause trouble in the atmosphere.

Burning fossil fuels -- coal, oil, and natural gas -- has caused significant alteration of the atmosphere.

One of the most troublesome results of burning fossil fuels is the production of carbon dioxide, a transparent and odorless gas. When burned completely, each gallon of oil, gasoline, or diesel fuel produces, for example, about 20 pounds of carbon dioxide.

Carbon dioxide and other Greenhouse gas accumulations in the atmosphere have caused increased energy collection in the atmosphere. Increased energy collection allows the atmosphere to do more work as a heat engine of global proportions. More water is evaporated from the oceans and lakes. Moisture is moved and precipitated in greater amounts, causing more floods. More and more violent hurricanes and tornados are created. Our desert areas expand as hotter winds dry ground cover and subsequently sandblast the weakened plants or cover them with shifting sand dunes.

Greenhouse gases are travelling throughout the world. Most of the unburned oil particulates from Saddam's threatened fires would fall in nearby oceans and land areas. Efforts to produce complete burning would probably do more harm to Americans by causing increased numbers of tornados, floods, and hurricanes than if the oil is partially burned and allowed to belch out clouds of dense smoke. (Allied military commanders admit that dense smoke will cause some tactical problems by frustrating visual and, possibly, laser-guided missile bombing; it would make bomb damage assessment more difficult; and it would make things less pleasant for the fighting forces. They do not believe, however, that the smoke would be an insurmountable problem from a military standpoint.)

Intentional production of unburned oil particles, though, is analogous to cigarette smoking. In cigarette smoking, the object (though few smokers would admit to it as such) is to produce clouds of nicotine-bearing organic particles and some inadvertent

carcinogens. (If the tobacco and wrapping paper were burned completely, the nicotine would be destroyed as carbon dioxide -- both the smoke and tobacco flavor would be virtually eliminated.)

Saddam's smoky oil-well incineration, similarly, would produce heat, carcinogens, and particulates. Persons in Kuwait and neighboring areas unfortunate enough to breathe this smoke-filled air would be exposed to poisonous particulates and gases.

Saddam Hussein's threat of blowing up Kuwait's oil wells is minor compared to what we do to ourselves each day.

Taken from a global perspective, Saddam Hussein's threat of blowing up all the oil wells in Kuwait is relatively minor compared to what we are doing to ourselves as we (and the rest of the world) voluntarily burn 60 million barrels of oil and twice as much carbon from coal each day. Persons living in Los Angeles, Mexico City, Tokyo, and Taipei are breathing products of combustion to the effect of having health risks analogous to smoking one or two packs of cigarettes each day.

Is Hussein's threat, then, a serious catastrophe or an insult?

It will cause a great deal of smoke and heat -- and the carbon dioxide that is produced simply adds to the already-massive overload of Greenhouse gases we routinely produce. The loss of all that oil would certainly be a tragedy: it took nature millions of years to create this reserve, and the petroleum is a valuable resource for petrochemicals, medicines, and literally millions of products that make our life more pleasant. It would likely lead to an ultimate increase in the cost of a gallon of gasoline. And the smoke would likely make the war effort and life in the region of the world -- already very unpleasant and dangerous -- even more so.

But compared to what we willingly and routinely do to dump poisons and weather-altering gases into our atmosphere, Hussein's threatened actions are serious -- an insult to our world, but not much worse than business as usual.

U. S. AT WAR

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The prospect, then, for the allied forces, which now number over 700,000, including 470,000 from the U.S., is for a tough and expensive struggle. Additional U.S. troops are being sent to the Persian Gulf area at the rate of 5,000 per day. The dollar cost to allied forces of waging this battle already amounts to over \$500 million per day.

Although the vast majority of Americans polled have expressed strong support for the effort, a vocal minority, however, continue to stage peace demonstrations throughout the nation, pleading for an immediate cessation of battle and a withdrawal of U.S. troops. A popular slogan, "No Blood for Oil", reflects a commonly-expressed sentiment of the demonstrators.

As reported in an earlier issue of *Hydrogen Today* (Sept.-Oct., 1990), oil is certainly an underlying factor to the U.S.'s involvement in this costly conflict. But the issue is not simply one of insuring a supply of oil from Kuwait or Saudi Arabia for the U.S.

It's Economics--Not Oil, *Per Se*:

The real issue is a more-complex matter of economics: the abundance of oil in the Middle East has resulted in a massive shift of the world's economic wealth since the OPEC oil embargo of 1973 to a relatively few individuals or families in the oil-rich countries of Saudi Arabia, Kuwait, the Arab Emirates, Iraq, and Iran.

Iraq and Iran both lost much of their wealth in their eight-year war; and Iraq spent billions more to amass a powerful war machine with chemical, biological, and a growing nuclear capability. Kuwait and Saudi Arabia, on the other hand, invested heavily in land and business in the West, particularly in the U.S. In addition, the controlling powers of both countries have provided massive financial backing (primarily loans) to the major banks of the world ... including those in the U. S.

Both Saudi Arabia and Kuwait have been strong supporters of the U.S. economy in yet another way: they have, by using their enormous oil production capability and clout among the OPEC countries, succeeded in keeping an abundant supply of relatively cheap oil flowing to

the U.S. This has had the favorable effect of keeping the cost of oil-based energy low, which has helped hold inflation down and kept the price of gasoline relatively inexpensive.

The actions of Saudi Arabia and Kuwait have had, however, the very unfavorable effect of strongly discouraging the development of alternative energy sources, such as solar or hydrogen energy.

For other oil-producing nations like Iraq, these actions by Saudi Arabia and Kuwait have been extremely costly. Not only have these two countries supplied a disproportionately greater amount of the total oil demand to the U.S. and other Western world nations, but they have kept prices (and therefore income) down for every oil producer.

Iraq, faced with a serious cash deficit and a pile of IOU's following its war with Iran, saw small, essentially-defenseless Kuwait, with its rich oil reserves and bank accounts, as a plum ripe for picking. Saddam Hussein could, with a relatively simple military action, take over control of a major additional source of oil in the region, could pick up a very rich bank account, and could probably drive the price of oil up substantially and quickly pay off his country's debts and get wealthy again.

Saddam did manage to pick up between \$1 billion and \$3 billion in cash and gold out of the Kuwaiti bank. He also managed to pick up the U.S. military as a powerful adversary, something he may not have planned on.

A Collision Course To War:

The U.S. responded to the Iraqi aggression by sending a massive armada to the region for two basic reasons: first, it was repulsed by the ruthless aggression and was gravely concerned that Iraq would continue to use its overwhelming military superiority in the region to take over Saudi Arabia and other nations. In addition, the U.S. felt compelled to support its Arab allies (and banking/business partners) and protect its supply of oil. By sending an awesome military force of ships, sophisticated aircraft, missiles, marines, and highly-trained and -equipped army personnel, supported by other European and Arab allies and the backing

of the United Nations, the U.S. hoped to force Iraq out of Kuwait.

Hussein, however, could not back down without losing face (a terrible fate in the Arab culture) ... and probably the support of his own people. The U.S. also could not back down; nor could it afford to keep its large military force in the Middle East on stand-by status (at an enormous cost per day) for very long.

What has resulted is a horrible and costly war ... one that has been feared and predicted by many strategists and political scientists for some time. The specifics of the war (timing, who's on which side, etc.) have not been as predictable as the fact that, eventually, a violent war in the area would happen. It was almost inevitable. Too much wealth was accumulating in too-concentrated a place, a place where war is almost a constant happening among nations that have fought over too-little land promised to, and occupied by, too many.

War, always bad, usually provides a lesson for those who care to heed it. This war is no exception. The lesson is obvious: *the world must give up its dependence on oil.*

It Could Have Been Different:

Hindsight is always 20-20. Had the U.S. adopted a different long-range energy strategy back in the Seventies; or had it at least maintained support for an aggressive alternate-energy research and development program that was initiated then, we could be in a position by now to turn away from oil as our energy lifeblood.

Instead of giving away billions of dollars to Middle East oil barons, we could be taking in billions of dollars from the sale of clean-burning solar hydrogen. Instead of staring at a huge and rapidly-mounting debt, our nation could be looking at a fat bank account. Instead of sending a half million men and women to fight a war, we could be creating a similar number of new jobs in a Hydrogen Economy.

And we would not be choking in a smog-laden environment and suffering the effects of dumping massive amounts of "Greenhouse Gases" (primarily carbon dioxide and methane) into our atmosphere.

All this could have been ours by now -- at a total outlay that is far less than we

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Editorial

Oil Wars: Defending the Snowman

By Harry Braun

Given the initial news reports on the war in the Middle East, it seems clear that it is only a matter of time before the U.S. and its Allies prevail. What is unfortunate is that thousands of people will have been killed or maimed in order for the Emir of Kuwait to be returned to his throne.

Kuwait is not a democratic country -- at least by Western standards. Although the Emir has 80 wives, they have had little influence in bring women's rights to the country: Kuwaiti women are not even allowed to drive, much less vote.

Nor has Kuwait been an American ally by treaty. On the contrary, for years the government of Kuwait has been one of the harshest critics of the U.S. human rights initiatives in the United Nations.

Iraq, it could be argued, invaded Kuwait primarily because Kuwait had consistently violated oil production quotas set by the OPEC countries. For years, Kuwait stated that it was deliberately glutting the oil markets to keep oil prices down. This would insure that the U.S. (in particular) would have little incentive to develop renewable energy sources that could make America energy-independent.

Unless Saddam Hussein carries out his threat to blow up and burn all of Kuwait's oil wells as a response to the attack by the U.S. and its allies on Iraq, it is likely that the Emir of Kuwait, once reinstated on his throne, will resume his practice of glutting the market to keep oil prices -- and

competition -- down. And many people will assume that the energy problem will have been solved.

Oil will continue to be used as the primary energy source for much of the world, and the resulting problems related to global climate change, air pollution, oil spills, and the loss of the remaining wilderness areas will all continue to worsen exponentially.

If all of these environmental costs, along with the billions of dollars in health care costs that result from using fossil fuels as energy are factored into the cost of gasoline at the pump or the cost of heating our homes, hydrogen would always have been less expensive to use than fossil fuels.

Thus, the real problem is not the current price of a barrel of oil; rather it is our country's and world's continued reliance on it as an energy medium.

One thing is certain: as the remaining oil reserves are depleted, the cost of oil will continue to increase. In contrast, as more and more scientists and engineers focus on improving solar hydrogen energy systems, the cost of hydrogen will continue to decrease.

The U.S. could become a Saudi Arabia-class energy exporter if renewable resource solar-hydrogen energy systems were mass-produced in our country's automotive, shipbuilding, and aerospace industries. Instead of spending a billion dollars a week to import foreign oil, the U.S. could be earning a billion dollars each week by exporting hydrogen to other nations.

Such a reindustrialization effort would revitalize the rapidly-deteriorating American economy. It is sad to note that the United States is now the largest debtor country in the world; there are few U.S. cities that are not desperately short of money; we have a rapidly-growing and substantial population of homeless people sleeping in our streets; our educational system is sadly non-competitive with that of many other nations of the world (including so-called "Third-World Countries"); and our savings and loan and banking institutions are all on or over the brink of financial collapse.

These observations underscore the need to shift our national priorities so that the U.S. can make a transition from oil to hydrogen.

Fighting over the remaining oil reserves in the Middle East is somewhat like defending a snowman that is melting.

Instead, the U.S. should be making an industrial transition from oil and fossil fuels to a hydrogen energy system that is both pollution-free and inexhaustible. This transition is now being advocated by thousands of distinguished scientists and engineers from over 80 countries.

Such an energy transition would create an unprecedented economic boom for America, while essentially eliminating many of the most serious environmental problems related to urban air pollution, global greenhouse warming, acid rain, sewage and landfill accumulations, or the production of additional nuclear reactors and their associated radioactive wastes.

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WAR CASTS DOUBT ON PLANS FOR H₂ EXHIBIT IN NATION'S CAPITOL

The comprehensive "Solar Hydrogen: Energy Carrier of the Future" display created by Germany's DLR and sponsored in the U.S. by the American Hydrogen Association has been scheduled to be displayed in Washington, DC, the last week in January. Arrangements for its presentation, in cooperation with the National Hydrogen Association (NHA) and the Global Tomorrow Coalition (GTC), call for the elaborate display to be shown in the rotunda or lobby area of the Russell Senate Office Building. As a result of added security precautions resulting from terrorist threats vowed by Iraq, there is, at the time of this printing, however, doubt that the display can be shown.

The Washington display is to be sponsored by The Humane Society as well as AHA, NHA, and GTC.

Previously, this display has been shown extensively in Arizona, and it has also been shown in Northern California.

Too Many Zeros

In the last issue of *Hydrogen Today*, in the article on "Hydrology Aspects of Hydrogen Production" (page 7), we mistakenly said that Arizonans used 1.7 trillion gallons of gasoline per year. This obviously should have been "billions". (We drive a lot in the open deserts of our state ... but not *that* much.) The rest of the article and figures stand as printed. Sorry for any confusion this error may have caused. - Ed.

A Lesson From War

(Continued from Page 3)

have spent and have committed to spend on a war with Iraq. (What money we would have spent on a conversion to a Hydrogen Economy would be rapidly returned to us in energy export sales. No one really believes our rich allies -- including Japan, Germany, and the Middle East countries whose borders we are fighting to protect -- will reimburse the U.S. for our costs of war. So far they have only agreed to pay around \$5-6 billion -- enough to pay for about a week of fighting at current rates.)

At this moment, our options are not many. The 470,000 brave men and women from the U.S. -- and their many brave partners from our fighting allies -- deserve our full support and prayers. *They* did not start this war; they are, however, our only hope for ending it.

For their safety and success, then, we pray. But we also pray that our nation's policy-makers will take this war -- with all its costs in lives, dollars, and enormous hardship and sacrifice -- as a lesson not to be repeated.

If the U.S. is to regain and retain its economic, political, and world leadership strength, it must make itself energy-independent. It will not be able to do that (at least for a sustained future) with oil, or coal, or natural gas, or fuel alcohols, or even nuclear-fueled energy. Not only are our resources of these commodities insufficient to last for many generations to come, but they all carry enormous and intolerable long-term environmental penalties.

The only option that will work -- not just for this generation but for all generations to come -- is solar hydrogen. *And the time to start making the shift to hydrogen is now.*

DEFENDING THE SNOWMAN

(Continued from previous page)

Arizona and other states in the American Southwest would particularly benefit from such a transition because of their vast areas of land that could be used for large-scale solar-hydrogen production. If, for example, twenty solar gensets (20 kW each) were planted per acre like trees in a vast dish forest in a triangular area bounded

by Phoenix, Tucson, and Yuma (AZ), enough hydrogen could be produced to make the U.S. energy-independent.

It is important, however, to understand that the longer such a capital-intensive transition to renewable resources is delayed, the more expensive it is going to be.

All of this suggests that the U.S. should be moving with wartime speed to implement solar-hydrogen energy systems -- rather than going to war to defend the oil kingdoms in the Middle East.

Hydrogen From Glen Canyon Dam Power

By Roy E. McAlister, P.E.

Hydroelectric power is made by using falling water to turn an electric generator. Solar energy evaporates the water from the ocean, winds deliver the moisture over continental areas where cooling precipitates the moisture as rain or snow, and water falling back towards the ocean is available as a clean renewable resource for inexpensive electricity. Because there is no fuel cost, electricity is generally available at about one cent per kilowatt hour in the U.S. from hydroelectric sources.

Such a power plant was constructed at Glen Canyon Dam on the Colorado River in northwestern Arizona. This plant was created to provide supplemental or "peaking" power for electric air conditioning and other high summer power loads in the cities of the Southwest.

Environmentalists object to the cyclical operating characteristics of this plant, because it causes cyclic flood erosion, followed by low-water conditions, in the Colorado River downstream from the dam. They cite irreversible erosion of scenic wilderness areas of the Grand Canyon, interference with fisheries and wildlife, and other problems created by the cyclic flooding during peak power operation.

Environmentalists want to alter the operation of Glen Canyon Dam, suggesting that the plant should be run at more or less steady flow. Utilities object to this policy because it would mean either that water would be allowed to flow out of the dam without making electricity or that cheap Glen Canyon hydroelectricity would displace baseloads now produced by the Palo Verde Nuclear Power Plant and other plants.

Recent hearings and invitations for public comment concerning the controversy have stimulated large public response from both sides.

Hydrogen provides an answer that should please both environmentalists and utilities. The concept would be to operate Glen Canyon at steady release rates, using the cheap hydropower to produce hydrogen. Hydrogen from one cent/kWhr electricity produced at that plant could equate to gasoline at about 30 to 35 cents per gallon. Hydrogen entering the transportation market (being sold, for example, to fleets operating in the Southwestern states) would not deprive utilities from earning revenues from conventional electricity sales and should, in fact, be a welcome source of new revenues.

Everyone would benefit by having cleaner air, because hydrogen greatly reduces pollutive effects compared to use of fossil fuels in the transportation system. This should please environmentalists and utility company stockholders.

Production of hydrogen at steady rates could also allow electric utilities to have peak power production. Hydrogen could be stored in depleted natural gas fields and then used as fuel in fuel cells or a conventional power-generating plant to produce peak power. Hydrogen could also be used in on-site engines to provide peak power and heating loads. On-site "total energy systems" consist of an engine, a generator, and heat exchangers that cascade any energy not used as electricity into water or air for space heating, clothes drying, domestic hot water, industrial heating applications, and even air conditioning.

In many instances, on-site production of electricity would double energy-use efficiency compared to a conventional power plant that dumps two units of heat at distant power plants in order to deliver one unit of electricity through the electric grid.

Utilities could market on-site total energy systems and gain additional revenue either through the sales of equipment and/or the sale of hydrogen fuel to operate the on-site systems. These systems would not produce any smog and would, in fact, reduce carbon dioxide and particulates to less than 1% of the levels generated in conventional fossil-fuel plants.

(Ed. Note: This subject will be further explored in the next issue.)

An Open Letter To The U.S. Department

(Following is a letter written by an AHA member, Charles Terrey, to Secretary James Watkins of the U.S. Department of Energy. It is based on a presentation Mr. Terrey gave to the ASU Chapter of AHA at its January 16, 1991, meeting.)

Dear Secretary Watkins:

Our country needs a clear energy policy to guide us into the future. The past policy of letting the market determine the energy policy of the government and, therefore, the country does not work. Government actions, in effect, subsidize oil by protecting the Middle East sources and by not taxing fuel to compensate for the damage done to the environment.

I have read the DOE report (DOE/PR/0095P) "Assessment of Cost and Benefits of Flexible and Alternative Fuel in the U.S. Transportation Sector." It covers CNG, methanol, and electricity. It appears from this report that these fuels are the only ones being seriously considered by DOE. The decision to use these fuels for the transportation sector will prove to be a costly mistake that would need to be corrected in the future because it will bring on environmental disaster.

The future well-being of our country is dependent upon having a fuel that can both make us energy independent *and* protect our environment.

There are seven factors to be considered in selecting the primary fuel for the future:

- **RENEWABLE.** A fuel for the future must be renewable, meaning it can be manufactured from readily available resources that can be considered either recyclable or inexhaustible.
- **NON-TOXIC.** The fuel should be non-toxic before or after it is used. This means that it is not a poison or a carcinogen. If it is spilled, it should not damage the environment; and the by-products from its use should not damage us or the environment.
- **COST-COMPETITIVE.** The fuel must be cost-competitive with our present fuels. This means that if we produce this fuel in the quantities necessary to run our economy, it will be available to the consumer at

prices which are competitive with other fuels for equal energy content.

- **PORTABLE.** It must be portable, meaning that the fuel can be moved, stored, and used when and where it is needed, and that we can use it in our transportation system. The future fuel and its container, therefore, must be practical in weight and in energy content to carry aboard the vehicle.
- **SAFE.** It must be safe. All fuels are dangerous under certain circumstances. Safe means that, all things considered, the fuel is, at least, no more dangerous than existing hydrocarbon or nuclear fuels.
- **PRODUCIBLE IN VOLUME.** Can we produce the fuel in the quantities required to support the economy? Do we have sufficient resources to produce the fuel -- now and for the foreseeable future?
- **NO UNDESIRABLE BY-PRODUCTS.** Its production and manufacture must not produce by-products that will create additional pollution problems.

These are the most important factors in selecting the primary fuel for the future. Industry will require an energy policy that is clear about the future primary fuel. For example, automobile companies will require about six years and an investment of billions of dollars to bring products to market with new fuel requirements. The "energy industry" will also require a number of years to develop the infrastructure to manufacture and distribute the new fuel, requiring investment of several more billions of dollars. Industry cannot be expected to make such investments if there is no fuel to run the vehicle or no vehicles to use the new fuel.

Keeping in mind the importance of making the right selection of alternative fuel the first time, let us examine these seven factors a bit more closely:

A RENEWABLE ENERGY BASE:

A renewable fuel is necessary to make the United States energy-independent. Our standard of living is tied directly to having energy (fuel) when and where it is needed. The Middle East has 65% of the world's

known oil reserves, and most of the world's new reserves are being added in the Middle East. The United States has only about 6% of the world's known oil reserves, and new reserves are more and more difficult for us to find.

The fossil hydrocarbon resources that we do have are far too valuable to be used as fuel. These resources should be conserved for use by the petrochemical industry for making many of the materials that are required to maintain and increase the standard of living.

Hydrogen can be considered to be a renewable fuel because it can be manufactured from water with electricity produced from solar energy. (Some other fuels, such as methane, ethanol, and methanol, can also be considered renewable only when they are manufactured from renewable resources.) Hydrogen can also be produced from sewage, toxic waste, and much of the material that now goes into landfills. The processes used to extract hydrogen also encourage the recovery of other valuable raw materials that can be recycled back into the economy. Any renewable materials used to produce methane, ethanol, and methanol can also produce hydrogen and recover other valuable materials.

NON-TOXIC FUEL:

Most hydrocarbon fuels are toxic before they are used. Gasoline, diesel, methanol, and ethanol are all considered to be toxic. Methanol is considered to be very dangerous because its vapors will cause illness, and ingestion will cause permanent nerve damage and death. Methane is not considered to be toxic. All hydrocarbon fuels, however, produce poisons to varying degrees when they are burned. Alcohols (methanol and ethanol) when burned are a particular problem because they produce aldehydes, which are known carcinogens.

Nuclear fuel (uranium), of course, is a poisonous heavy metal that is radioactive. It requires special handling from the time it is mined, and we cannot agree on a safe way to store the spent material after it is used. Plutonium is produced from uranium in breeder reactors and is one of the most potent and dangerous poisons known. Even small amounts of plutonium in the environment can have a disastrous effect.

Hydrogen, by contrast, is not toxic either before or after it is used.

Of Energy On The Virtues of Hydrogen

COST-COMPETITIVE:

The government's stated policy in the past ten years has been to let the market determine which fuel would be dominant. The government's actions, however, have artificially kept the price of oil low. These actions range from continuing the oil depletion allowance, to providing protection to oil tankers in the Persian Gulf, to sending troops to Saudi Arabia, and more. If we were to account fully for the cost of a gallon of gasoline, it would cost at least three times its present price at the pump. And, as time goes on, oil and natural gas will be more difficult to find and more expensive to extract.

Solar gensets (machines that convert solar energy to electrical energy) are projected to cost about \$200 per kilowatt (100 kilowatts is equal to about 135 horsepower), if they were mass-produced like automobiles. Note that this is about 1/10 the kilowatt cost of an atomic power plant -- and the fuel (the sun) is free. Engineering calculations indicate that gensets will be capable of producing 1 cent per kilowatt-hour electric power, a price comparable to hydroelectric power.

If this cheap power is used to electrolyze water, we could produce enough hydrogen to satisfy all of our primary fuel requirements for as long into the future as the sun will shine. OTEC (Ocean Thermal Energy Conversion) also shows promise of producing low-cost electricity. In general, the technology exists today to develop machines that can produce low-cost electricity from solar, geothermal, tidal, wind, etc.

Converting low-cost, intermittent electricity into hydrogen provides a fuel that can be stored and shipped for use when and where it is needed. All told, then, Hydrogen shows considerable promise of being less expensive than other fuels, fossil or renewable fuels.

A PORTABLE FUEL:

Hydrogen is similar to natural gas, which means that much of the technology that we presently use for transporting natural gas -- a proven-portable fuel -- would also apply to hydrogen.

Lockeed Aircraft studies indicate that liquid hydrogen would be the preferred fuel for future commercial aircraft because of its

high energy-to-weight ratio and its safety. The range of the aircraft would approximately double for the equal weight of kerosene.

In the past, the storage volume required for hydrogen in vehicles has been one of the greatest drawbacks to its use. New developments with certain carbon-based alloys and composites, however, suggest several promising ways to store hydrogen in volumes equal to that of gasoline for equal energy content.

A SAFE FUEL:

Despite impressions given by the Hindenburg disaster and news about hydrogen leaks in our space program, hydrogen is one of the safest fuels. It is not toxic. Being sixteen times lighter than air, hydrogen, if it is spilled, will rapidly rise up and away from the spill -- leaving no residue to clean up, to pollute waterways, or to ignite. While hydrogen will burn rapidly, it is very difficult to create an explosion unless it is held in a confined space mixed with the right amount of air. When hydrogen burns, it creates water and radiates very little heat compared to fuels that contain carbon. All things considered, then, hydrogen is a very safe fuel.

PRODUCIBLE IN VOLUME:

Growing plants convert less than one percent of the solar energy striking them into biomass. The growing of biomass to provide ethanol and methanol in sufficient volume to supply the entire transportation system is not practical. Supplying fuel for one automobile will require as much land as food for fifty people; this will put the land used to produce fuel in serious competition with that used to produce food.

Hydrogen fuel can be produced in a variety of ways. Any source that can be used to produce electricity is a potential source of hydrogen. These include direct solar with gensets or photovoltaics, OTEC (Ocean Thermal Energy Conversion), geothermal, tidal, wind, and hydroelectric sources. Hydrogen can also be extracted from sewage, toxic waste, biomass, and many of the materials we now put into land fills through processes of pyrolysis or bioremediation. These processes not only produce hydrogen, but also recover other valuable materials so they can be recycled into the economy,

creating new products, new industries, and new employment.

A hydrogen fuel economy, in fact, will let us utilize energy resources that would not be practical to tap in any other way. For example, deserts that cannot be used for growing crops may be ideal for setting up solar gensets or photovoltaics to produce hydrogen.

NO UNDESIRABLE BY-PRODUCTS:

Carbon dioxide (CO₂) is an undesirable by-product of the use of all fossil fuels, because, when burned, these fuels release CO₂ into the air. CO₂ is an undesirable by-product of the use of all fossil fuels because it is the key perpetrator of the so-called "Greenhouse Effect," which increases the temperature of the earth. Hydrocarbons and carbon monoxide are already considered to be undesirable by-products of combustion.

A good case could be made for the fact that any fuel containing carbon produces undesirable by-products, and is, therefore, less than desirable for use as the primary fuel of the future.

Hydrogen, when burned, puts pure water back into the atmosphere. It is naturally occurring, it is renewable, it is non-polluting and non-toxic, it can be produced and manufactured in volume in a competitive way in a cost-effective manner, it can be made from readily-available materials, it is safe and can readily be packaged to be portable, and has the capability to create new industries and many new jobs. Additionally, producing hydrogen from sewage, land fills and toxic waste aids in the clean-up of already polluted areas.

Overwhelming scientific facts and simple logic point to the fact that hydrogen fuel can be the foundation of a secure economy for the future, making the United States energy-independent while preserving our country's role as a world leader.

The implementation of a new energy policy is very complex. It will be necessary to coordinate the move away from the fossil fuel economy. A coordination effort similar to the War Production Board during the Second World War may be valuable in coordinating the energy policy.

Sincerely,

Charles H. Terrey

COMING EVENTS

January 15: AHA Moves Into New Headquarters in East Tempe, AZ

January 15: Roy McAlister Speaks at Western States Environmental Conference, 10 AM, The Pointe Resort, Phoenix, AZ

January 15-18: Open House at New AHA Headquarters, 10 AM to 7 PM. Features AHA/DLR Display

January 16: ASU - AHA Chapter meeting -- Amphitheatre, Student Services Bldg., ASU Campus (Tempe) 7 PM

January 28 - February 1: (Tentative) AHA/DLR Display In Russell Senate Office Bldg., Washington, DC

February 14: Workshop I Sponsored By CCAN Innovation Group: "Transporting Into the 21st Century", Pyle Recreation Center, Tempe, AZ, 8 AM to 3 PM. Speaking on "Solar Hydrogen Economy": AHA Member Harry Braun at 9:30AM

February 15: Workshop II Sponsored By CCAN Innovation Group: "Transporting Into the 21st Century", City of Long Beach Gas Dept., Long Beach, CA, 8 AM to 3 PM. Speaking on "Solar Hydrogen Economy": Harry Braun at 1:30 PM

February 20: ASU - AHA Chapter Meeting -- Amphitheatre, Student Services Bldg., ASU Campus (Tempe) 7 PM

URGENT PLEA TO ALL AHA MEMBERS & FRIENDS OF HYDROGEN:

Please write your Congressmen today in support of House bill H.R. 1078 ("Global Warming Prevention Act"). It is scheduled for Congressional review early in this current session.

(See the last issue of Hydrogen Today for details about this bill or call your Congressman's office.)

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.

Take part in the most important transformation in history. Become a member of the American Hydrogen Association and help 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: _____

☐ Student Membership (\$15/year)

☐ Seniors (60 +) Membership (\$15/year)

☐ Family Membership (\$40)

☐ Regular Membership (\$30/year)

☐ Sustaining Membership (\$100/year)

☐ Life Membership (\$1,000)

☐ Corporate Sponsor (\$1,000/year)

☐ Foreign Government (\$1,000/year)

☐ Other Gift (specify amount)

Signature: _____ Date: _____

Enclose check or money order and mail to: American Hydrogen Association, 219 S. Siesta Dr., Ste. 101, Tempe, AZ 85281

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