BREAKING THROUGH EDITORIAL

The Alternative to Nuclear Energy

Peter Graneau

The most significant new energy development of the past hundred years has been electricity generation with nuclear reactors. This complex technology was stamped out of the ground in a couple of decades because of a guilty conscience of scientists and the U.S. government for having created nuclear weapons. Under the banner of "atoms for peace" Eisenhower promised that the nuclear sword would be beaten into a nuclear plowshare.

The "atoms for peace" campaign soon ran into trouble. A chief concern became the proliferation of nuclear arms. Where there are nuclear power plants, there exists the possibility of producing plutonium for weapons of mass destruction. This alone is sufficient reason to halt the construction of further nuclear power plants. But it was for additional problems of the nuclear industry that new plant construction in the United States virtually ceased in the late 1970s.

At the present rate of consuming uranium, which is the primary nuclear energy source, the estimated reserves of this rare metal will last for only about fifty more years. It may be too pessimistic an outlook, but it casts serious doubts on any nuclear based long-term solution of averting global warming, thought to be brought on by the burning of fossil fuels.

Nuclear energy is not economically competitive with coal, oil, and gas fired electricity generators. A major burden of the nuclear industry is the cost of radioactive waste disposal and the decommissioning of nuclear reactors. Half a century has gone by and we are still waiting for a disposal site for the most hazardous nuclear waste. A number of proposals have not proved acceptable to a public which would like to ensure a safe environment for the next 100,000 years.

Every nuclear power station leaks radioactivity into the environment. Accidents have occurred with the loss of life, as in the Chernobyl disaster of 1986. Radioactive particles suspended in the air can circle the earth. They respect no political boundaries and endanger mankind whether it benefits from nuclear energy or not.

Scientists and engineers all over the globe have every incentive to find a new source of energy which can be converted to electricity and is as plentiful as nuclear energy, but has none of the latter's troubling disadvantages. I suggest such an energy source has been found in the hydrogen bond energy of ordinary water.[1] It can be set free as kinetic energy of small water droplets which have the power to drive hydro-electricity generators. In the course of time the atmosphere will restore the severed liquid bonds and their extracted chemical bond energy. In this cycle from bond rupture in the water turbine to the condensation of water in the clouds, the extracted hydrogen bond energy is replaced in rain drops falling back to earth. It makes hydrogen bond energy a self-renewing energy source, so long as the sun shines on earth.

The cohesion of liquid water is due to the inter-molecular chemical bonding (H_2O-H_2O) between oxygen and hydrogen atoms in neighboring molecules. This phenomenon was first discussed by the American Nobel Chemist Gilbert Lewis in 1923. He coined the term "hydrogen bond," which must not be confused with the O-H bond inside the water molecule. Lewis' hydrogen bonds are chemical bonds. Like the chemical bonds in fossil fuels, they store chemical energy. But unlike fossil fuel compounds, water does not contain carbon atoms. Hence the liberation of hydrogen bond energy from water is not a process like the combustion of carbon, which pollutes the atmosphere with carbon dioxide.

That hydrogen bonds of water do contain a significant amount of chemical energy was first discovered in 1994.[1] Not until that time had water arc explosions been captured on high-speed film. The filming of the explosions in the United States, in Canada, and in Great Britain all revealed the ultrasonic pulse ejection of small fog droplets from water-filled arc cavities. The ultrasonic fog traveled first through water and then through air. The fragmentation of liquid water into droplets confirmed the rupture of hydrogen bonds.[1] The droplet velocity proved the liberation of previously stored bond energy. This discovery has still to be integrated into chemistry textbooks and the teaching of chemistry and physics. Lewis' oversight of the energy in hydrogen bonds continues to delude scientists engaged in new energy research and their battle against global warming.

It is this hydrogen bond energy stored in the liquid form of water which has the potential of becoming an alternative to nuclear energy. This fact did not strike home until it was realized that hydrogen bond energy is so plentiful that it does drive hurricanes.[2] Two aspects of hurricanes have not been satisfactorily explained without hydrogen bond explosions. One concerns what is happening in the cyclonic storm at the junction between the eyewall and the sea. This is the location where the highest wind speeds have been

measured and the storm rages at full fury. The second mystery is the self-intensification which causes hurricanes to become so powerful.

A rare photograph of the inside edge of a hurricane eyewall touching the sea has been published by Emanuel in his fascinating book on the history and science of hurricanes.[3] The photograph is reproduced in Reference 2. It depicts the calm water level inside the eyewall of fog up to a vertical wall of water, perhaps 10 or 20 ft high, which presumably is held back from the eye by centrifugal forces on rotating fog and water. It is inconceivable that the normal phenomena of evaporation and condensation, which must take place inside the eye, can raise so much water up in the eyewall. Other forces and another mechanism, unrelated to phase changes, must be at work.

The storm sweeping over the water inevitably rips droplets off the ocean surface and thereby ruptures hydrogen bonds. Because of the intensity of the wind, water will be dragged along to a depth of inches, if not feet. Therefore hydrogen bonds will be ruptured by liquid drag forces not only on the surface but also at some depth below the surface of the ocean. The result seems to resemble some continuous explosion of water which shoots great quantities of droplets into the air and simply lifts liquid water above the ocean surface. This mechanism should be operative all over the hurricane area and it should be strongest at the eyewall.

Emanuel writes that a mature Atlantic hurricane can extract power of the order of 3×10^{12} watt from the ocean. It is roughly equal to all the electric power being generated instantly on earth. The extent of this phenomenon substantiates the claim that hydrogen bond energy is an alternative to nuclear energy. Energy densities in nuclear reactors are much higher than those prevailing in the vast volumes of hurricane clouds. Against this we have to weigh the dangerous consumption of uranium in nuclear reactors instead of the limitless availability of renewable solar energy from the ocean.

Water driven bond energy explosions in hurricanes bring the hydroelectric turbine to mind. In this turbine the water drags metal blades around the turbine axis. The dragging process subjects hydrogen bonds to tension. Some of the bonds almost certainly must rupture. As in water arc explosions,[1] the nuclear repulsion of the previously bonded molecules then accelerates molecules along the drag force line of action. This effect should help to drive the turbine. The exceptionally high efficiency obtained with the best hydroelectric turbines may, in fact, be caused by the liberation of hydrogen bond energy.

The efficiency of hydroelectric water turbines has recently been discussed in *Infinite Energy*.[4] First we note that fossil fuel burning electric power plants are at best 35% efficient. The poor performance of fossil fuel plants is partly imposed by the laws of thermodynamics, as they apply to the steam cycle. The hydroelectric system does not involve a heat engine. Therefore it can run at a considerably higher efficiency than the fossil fuel plant. The efficiency of large modern hydroelectric systems has been quoted as 85 to 95%. These figures are said to allow for all energy losses originating from liquid flow, pressure shock, bearings, and electrical and mechanical losses in the electricity generator. Since the generator alone may be responsible for wasting 5 to 10% of its throughput energy, the exceptionally high efficiency of hydroelectric schemes is not credible, unless hydrogen bond energy liberation makes a contribution.

An important consideration in the upgrading of hydroelectric water turbines[4] is the very small amount of gravitational energy stored in the water, which is supposed to be responsible for the generation of all hydro-electricity. To appreciate this fact the gravitational energy, per unit mass of water, must be compared with the hydrogen bond energy stored in the same amount of liquid water. For a head of water of 1000 m, the ratio of gravitational to bond energy is 1 : 200. At lower heads the ratio is even smaller. At 100 m it comes down to 1 : 2000. Therefore to double the turbine output, less than 1% of the available bond energy has to be added to the gravitational energy of the water. In low-head hydroelectric schemes, such as tidal and wave power, less than one part in a thousand of the bond energy has to be added to the gravitational energy to double the turbine output.

Ample evidence for the liberation of hydrogen bond energy by stirring water in a rotating machine is being provided by mechanical water heaters.[4] These commercially available machines consist of a metallic rotor revolving inside a stationary metallic housing filled with water. The internal surfaces of rotor and stator, which face each other across a layer of water, are shaped so as to violently stir the liquid. The action heats the water and the temperature of it can rise to above the boiling point. Rotor and stator have been found to remain cooler than the water, thereby proving the liberation of internal water energy by mechanical bond rupture.

In a recent book by Inslee and Hendricks[5] on America's clean energy future, two young American politicians exam-

ine the prospect of building more nuclear power plants. The authors knew nothing about the availability of internal water energy. They claim that the reduction of greenhouse gases to acceptable levels ". . .would require tripling total global capacity (of nuclear plants) from the current 17% of electricity." This growth would add several thousand tons of plutonium to the world's current stock of approximately 1000 tons. Inslee and Hendricks see it as too high a price to pay when other more promising options are waiting in the wings.

If we take the Inslee and Hendricks figure and assume, hypothetically, that the addition of nuclear plants could be made in 2008, it would mean that for 100% of all electricity generated, 34% would then have to be generated by new nuclear reactors to stabilize global temperatures. Approximately 10% of the world's electricity is generated by hydroelectric plants. If this contribution could be doubled with hydrogen bond energy in improved water turbines, as suggested here, the new nuclear electricity fraction could be reduced from 34 to 24%. This is a very worthwhile objective, particularly since hydroelectric electricity is far cheaper than nuclear electric energy.

In the long run it may become possible to expand hydroelectric electricity generation with combined gravitational and hydrogen bond energy to such an extent that no nuclear reactors are required to stabilize global warming. It should be made the goal of a Manhattan-type project[6] supported by the U.S. Department of Energy. So we come to the question of how much research and development effort has to be mustered to meet the Inslee and Hendricks challenge.

It would be convenient to start the project in the laboratory with small water turbines in the 1 - 10 kW range. The experimental turbine can be driven with an electric motor while water from a laboratory reservoir is piped into the turbine. The power delivered by this motor will simulate the gravitational power consumed in an hydroelectric system. Experience with mechanical water heaters[4] has demonstrated that the bond energy transactions of the 1 - 10 kW range can be handled by a machine resembling a water turbine. The essence of the research is to find turbine configurations operating at optimum speed to double the electricity output compared to the gravitational input at a given height of water head. When the goal of energy doubling has been achieved with a small turbine, progressively larger turbines should be developed. This R&D process does not appear to be excessively expensive and may not require more than five to ten years.

References

1. Graneau, P. 2006. *Unlimited Renewable Solar Energy from Water*, New Energy Foundation, Concord, NH.
2. Graneau, P. 2007. "Hydrogen Bond Energy Drives Hurricanes," *Infinite Energy*, 13, 74, July/August.
3. Emanuel, K. 2005. *Divine Wind: The History and Science of Hurricanes*, Oxford University Press, Oxford.
4. Graneau, P. 2008. "Upgraded Hydroelectric Water Turbines," *Infinite Energy*, 13, 78, March/April.
5. Inslee, J. and Hendricks, B. 2008. *Apollo's Fire: Igniting America's Clean-Energy Economy*, Island Press, Washington.
6. Graneau, P. 2008. "Manhattan or Kyoto," *Infinite Energy*, 13, 77, January/February.