A New Method for Initiating Nuclear Reactions

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ABSTRACT

Energy from present sources has proven to have serious limitations. Fortunately for the future of mankind, several new but controversial sources of energy have been discovered. This talk will describe a method to initiate nuclear reactions within solid materials, so-called Chemically Assisted Nuclear Reactions (CANR) when the environment is the focus or Low Energy Nuclear Reactions (LENR) if the process is to be emphasized. Proposed is a new field of study which combines the electron environment (chemistry) with the nuclear environment (nuclear physics), two environments which are thought not to interact. The method generates energy without producing serious amounts of radiation or radioactive waste. In addition, the method is suggested as a means to reduce the radioactivity associated with previously generated nuclear waste. A wide range of experience obtained world-wide over the last ten years will be described and the controversial nature of the method will be discussed.

INTRODUCTION

The subject I'm about to describe carries with it a heavy burden of skepticism. Nevertheless, the accumulated experience by worldwide efforts involving hundreds of scientists requires a reexamination. If the process is real and can be understood, we would have a source of clean, unlimited energy and we would be able to eliminate the dangerous radioactivity that has accumulated from present sources of nuclear energy. This might be a very valuable gift that would be worth the painful process of changing our minds.

For a nuclear reaction to be initiated, a method must be used which is able to overcome the coulomb barrier which exists between nuclei. Fission uses the neutral neutron for this purpose and hot fusion uses the brute-force technique involving very high temperatures. Both methods have a long history of understanding and supporting theory.

In contrast, recent studies raise the possibility that the coulomb barrier can be overcome by a new and subtle process operating in certain solids. This process is proposed to initiate a fusion reaction between two deuterons as well as to produce various transmutation reactions involving heavier nuclei. The most common reaction by most scientists to this assertion is BALDERDASH, or less polite words to that effect.

DISCUSSION

I would hope to have your patience while I show you some evidence supporting this novel idea. Please keep in mind that the clear and overwhelming support for an unusual energy source does not require a nuclear reaction as its origin, although evidence is mounting for this explanation.[1]

A total of nine methods are now known to initiate the anomalous effects, as listed in Table I. Over six different chemical environments have resulted in dozens of different nuclear products, or so it is claimed. Each method has a different amount of energy amplification, which ranges between 10% and 1000%, and energy density which ranges from several times that in a nuclear reactor to near the density produced by a gasoline engine. One of the methods is presently being sold as a commercial product while several other methods are in the early stages of commercial development. In general, the devices are very simple, perhaps too simple to be believed.

However, before I describe these methods, I would like to make two points. First, the claims are controversial for good reason. I will not have time to go into sufficient detail to demonstrate

the reality of the claims even if this could be accomplished to your satisfaction. I have time to describe only a few examples taken from hundreds of studies. Unfortunately, much of this work,

TABLE 1
Methods Used to Produce the CANR Effect

Electrolysis of liquids
Plasma discharge between solids in a liquid
Gas Reaction with microcrystals
Electric Discharge in low pressure gas
Phonon conduction through semiconductors
Cavitation involving bubble formation (Ultrasonic)
Mechanical changes involving crack formation
Sudden decomposition of hydride
Biological systems

but not all, cannot fully withstand critical examination. Nevertheless, it is important to understand just how extensive the claims have become. The second point is that much of this work is being done by experienced scientists at laboratories in at least eight countries. These people are as skeptical as you are, yet they keep seeing strange effects. Many aspects of the phenomenon have been seen by more than one researcher and some of the methods are completely reproducible. While I do not expect you to accept everything I will describe, I hope you will entertain the possibility that some part of these novel observations are based on real but previously unknown phenomena. I suggest the claims have been prematurely rejected and have now reached a level of understanding which allows an objective reexamination. If the claims are real, the implications are too serious to be ignored any longer.

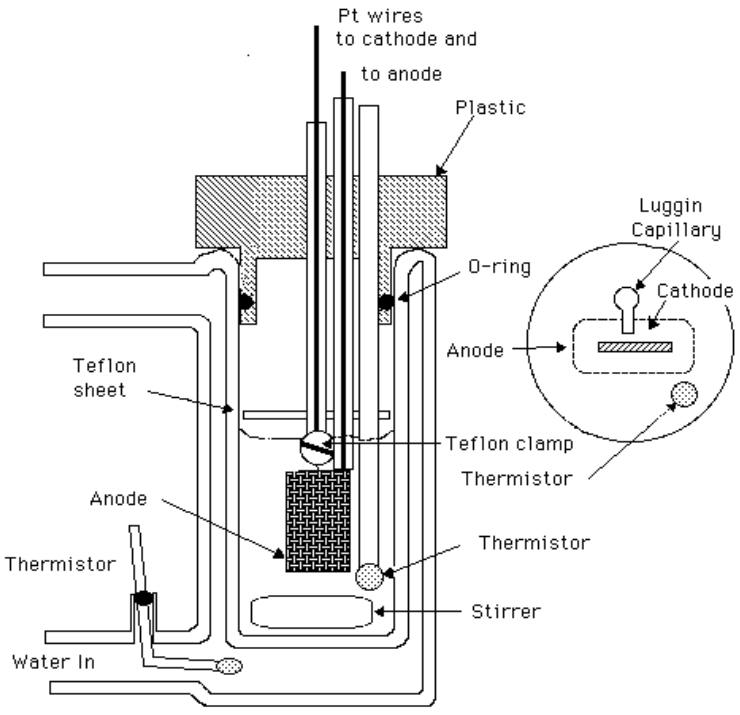

FIGURE 1. Typical electrolytic cell. Not shown is the catalyst used to recombine the evolving gas.

Electrolysis of Liquids

The first method to be explored, and the one about which the greatest knowledge base exists, is the use of electrolysis within a liquid. As some of you will remember, Profs. Pons and Fleischmann used this method ten years ago when they claimed anomalous energy production and called attention to the possibility of initiating a fusion reaction within palladium.

In this case, a current is passed through heavy-water, with palladium being used as the negative electrode. The heavy water decomposes and releases deuterium which reacts with the palladium metal. **Figure 1** shows a drawing of a typical cell. This reaction occasionally produces a previously unknown compound within the surface of the metal which contains a very high con-

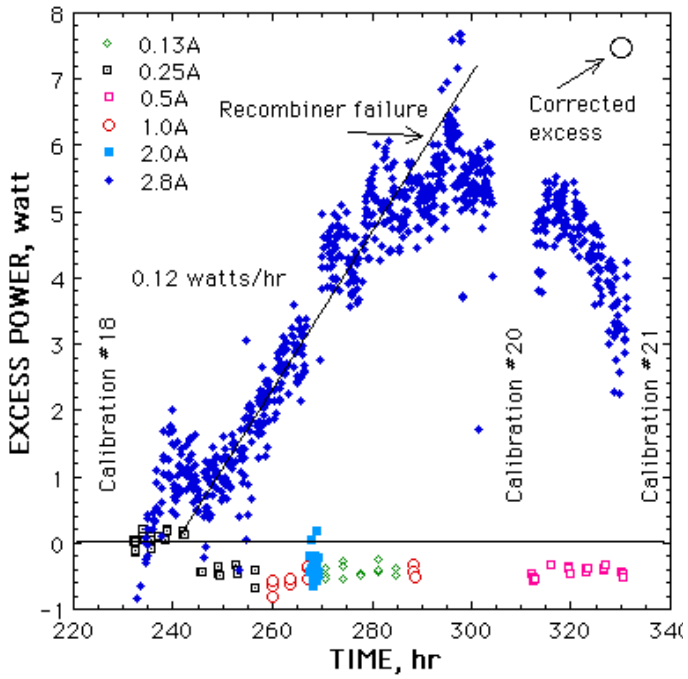

FIGURE 2. Onset of excess heat production after 240 hrs of electrolysis. Calibration before, during and after the effect showed no change in the behavior of the calorimeter.

centration of deuterium. It is in this region that the claimed nuclear reactions apparently occur. One example from over 40 independent studies, each containing many examples, is shown in **Figure 2.** [2] Excess energy is observed only after many hours of electrolysis. It is produced only when the applied current is above a critical value and when the average D/Pd ratio is very high.[3] The nature of the calorimeter in which the excess energy is detected is no longer the issue. The effect has been seen using five entirely different types of calorimeters, each having different sources of error. However, this extra heat is very difficult to obtain because, it turns out, the required palladium is very rare. However, if palladium is used which does not crack upon reacting with deuterium, the effect is very reproducible.

Such cells also produce nuclear products including helium, occasional tritium, slight neutron emission, and weak X-rays. Indeed, two independent studies have demonstrated a quantitative relationship between the amount of extra energy and the amount of helium detected.[4] As attention is paid to the possibility of other nuclear reactions, various transmutation products are also seen.

On the other hand, when the method is used with light water, heat is also produced but from different nuclear reactions. In this case, the nuclear products involve nuclear reactions between hydrogen and elements in the electrolyte. For example, if the electrolyte contains potassium, the nuclear product is calcium. In this case, the cathode is nickel rather than palladium. Because various transmutation products are also detected, this environment has been proposed as a method to reduce the radioactivity of nuclear waste. Clean Energy Technology (CETI)[5] is attempting commercial development of the method for this purpose as well as an energy source.

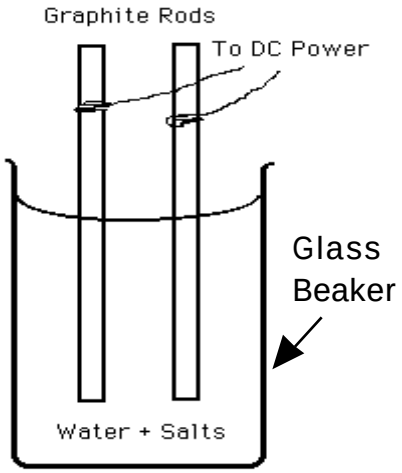

FIGURE 3. Simplified device for producing plasma discharge in fluids.

You might well expect that if these results were caused by error or self-delusion, palladium would produce the same results as nickel, but it does not. Nickel is required in light-water, but it does not work when heavy-water is used instead. In contrast, palladium appears to be inert in light water. Therefore, it is important to realize that the results are very dependent on the materials being studied and not on the people doing the work.

Plasma Discharge Between Solids in a Liquid

When the DC voltage between two electrodes immersed in water is increased to a critical level, a plasma

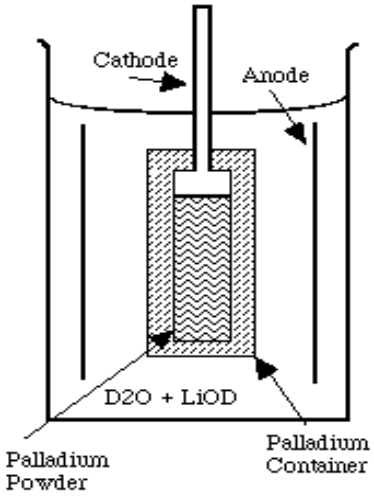

FIGURE 4. Electrolytic cell used to load palladium powder with deuterium. Energy production is measured by placing the cell in a calorimeter.

is formed within the liquid. Rapid, localized discharges produce local boiling and emission of broad spectrum light. It is a dramatic show. A simplified arrangement is shown in **Figure 3**. When the electrodes are pure carbon, evidence for unusual nuclear reactions is seen. The most obvious product is magnetic iron plus some chromium which can be collected using a magnet and is easily analyzed. In addition, neutron emission and excess energy have also been detected. The applied voltage is far too low to allow a conventional nuclear reaction to take place. This effect has been demonstrated in at least five different laboratories using ultra pure carbon.

A similar reaction can be produced between zirconium electrodes using AC voltage. In this case, a layer of zirconium oxide is formed on the surface of the electrodes through which many plasma discharges occur. This arrangement, called the LENT-1 cell by the Cincinnati Group[6], is claimed to reduce the radioactivity of thorium or uranium dissolved in the solution. In this case, no neutrons are produced. These cells are being sold with a money back guarantee and are being studied as a means to reduce the radioactivity of nuclear waste.

Gas Reaction with Microcrystals

Very finely divided palladium will react readily with deuterium gas. Under special conditions, excess energy, helium-4 and helium-3 are seen by Prof. Arata (Osaka University)[7]. In other words, just by applying deuterium gas at modest pressures to palladium microcrystals, nuclear reactions are initiated. In this case, the pure deuterium gas is made by an electrolytic reaction in surrounding heavy water, as shown in **Figure 4**. The method is reproducible in the hands of the inventor and is now being replicated successfully in the US.

A variation on this method, proposed by Dr. Case[8], uses finely divided palladium particles on charcoal - a commercial hydrogen catalyst. Excess energy and helium-4 are found to result when deuterium gas is applied at temperatures near 200° C in an apparatus shown in **Figure 5**. The claimed results have been duplicated several times and the method is being actively studied at several laboratories in the US.

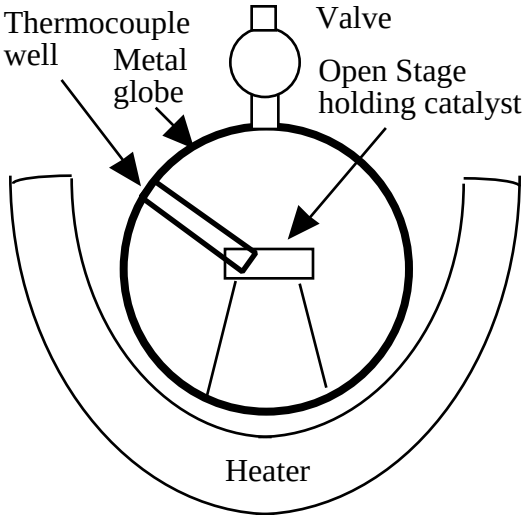

FIGURE 5. Cross section of Case cell. Catalyst is suspended within heated sphere.

Another variation using palladium powder, but in a different environment, is being studied by ENECO, Inc.[9] as a potential commercial product.

Electric Discharge in Low Pressure Gas

Workers in Russia, at LUTCH, have developed a method of bombarding various metals with low energy deuterium ions. A range of transmutation products are detected as well as excess energy and gamma emission. The ion energy is too small to allow conventional nuclear reactions. Attempts to replicate this method in the US at the Naval Research Laboratory were only partially successful.

Dr. Claytor, at Los Alamos National Laboratory[10], has developed and studied a discharge

method to produce tritium. A fine wire of palladium or its alloy is used as the cathode during pulsed, high voltage discharge in deuterium gas.. Again, the voltage is too low to allow conventional nuclear reactions. Occasional tritium is produced in the gas which can only result from a local nuclear reaction. A typical result is shown in **Figure 6.** Neutrons, if produced, are below the detection limit Success depends very strongly on the nature of the palladium electrode.

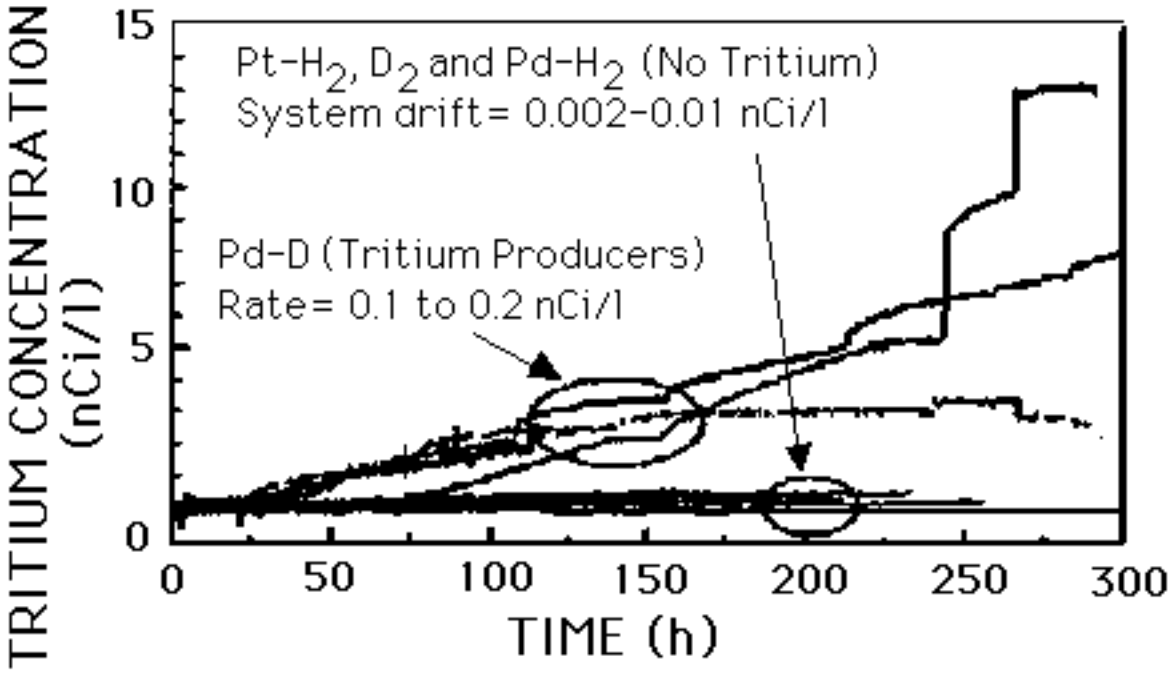

FIGURE 6. Example of tritium produced at Los Alamos National Laboratory. Tritium detected using an ionization chamber to measure ions produced by beta emission from the isotope.

J. Dufour[11], in France, also produces excess energy and nuclear products using low energy discharge in deuterium or hydrogen gas. In this case, part or all of the effect may be similar to the process being developed by Blacklight Power.[12]

Proton Conduction Through Semiconductors

Certain complex oxides can dissolve a small amount of hydrogen. When these materials are heated to several hundred degrees centigrade and a small voltage is applied, a current flows because the dissolved hydrogen ions can move. When this happens, more energy is released from the material than is applied by the electric current. This energy is far above that produced by any known chemical process but is yet too small to be of commercial interest. This work has been duplicated at three laboratories located in Japan, France and the US.

Cavitation Involving Bubble Formation (Ultrasonic)

When intense ultrasonic waves are caused to pass through a liquid, bubbles are formed for a brief time in the trough of the waves. If these bubbles collapse on a metal surface, they will inject into the metal a plasma composed of the liquid components. **Figure 7** shows a bubble on a metal surface just before collapse. This is the origin of cavitation damage to ship propellers. If the metal is palladium and the liquid is heavy water, deuterium and oxygen will be injected into the metal surface. As a result, very high local concentrations of deuterium will result. This condition is found to initiate various nuclear reactions. Roger Stringham and Russ George[13] have detected excess energy, helium and transmutation products. Evidence for heat production is shown in **Figure 8**. Replication of the work in Japan is claimed to give positive results. Indepen-

dent studies are ongoing in the US.

A device is presently being sold by James Griggs[14] as a means to convert electrical energy to heat, essentially an efficient way to make hot water. Surprisingly, this device has been shown to provide more energy to the hot water or steam than is take from the electrical mains. The apparatus consists of a motor which turns a rotor containing holes within normal water. These holes set up sonic vibrations which initiate a novel heat producing reaction. In addition, several variations on this method, one developed in Russia, have also been claimed to produce anomalous energy. The expected nuclear products have yet to be identified.

FIGURE 7. Cross-section of a bubble just before collapse on a surface.

Mechanical Changes Involving Crack Formation

Various metals crack when they react with hydrogen. Formation of these cracks cause a very brief separation of charge which may be sufficient to accelerate deuterium ions to energies needed to produce conventional fusion. This process has been studied in some detail in the US and in Italy and may account for the occasional bursts of neutrons. However, it can not account for the excess energy.

Sudden Decomposition of Hydride

Workers in Japan and Russia have studied palladium to which a diffusion barrier is applied to one side. When this material is reacted with deuterium gas and then heated rapidly to expel the deuterium, neutron and charged particle emissions are detected. While interesting as a method to understand the process, the effect is too small to have a practical application.

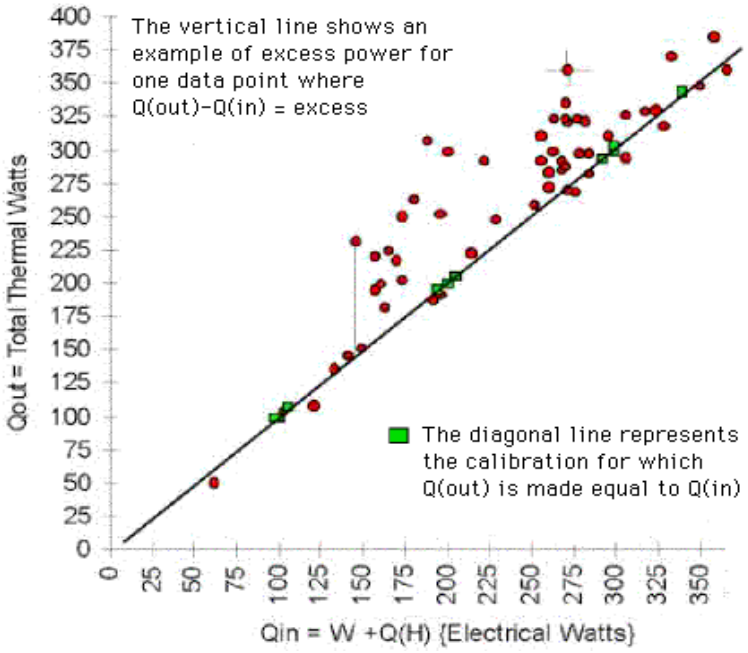

FIGURE 8. Power applied to sonic device is compared to power being produced. Points above the line imply excess power.

Biological Systems

We come now to the most outrageous claims of them all. Various people, but especially Prof. Kervran[15] in France, have claimed for many years that organisms can produce elements which are needed for life but are missing in their food supply. Recently, workers in Japan[16] studied several single-cell organisms and tested this idea using modern analytical techniques. Surprisingly, they found that the needed but missing elements were, indeed, manufactured by the organisms using elements that were present in the environment.

Workers in Russia[17] went one step further. They placed various single-cell organisms in heavy-water containing manganese sulphate. Iron-57 would result if a nuclear reaction were to cause a deuteron to enter the nucleus of the manganese. Production of iron-57 was detected

using the Mössbauer effect, a method which can easily determine the presence of this isotope at very low levels and with no chance for mistaken identity. They found that iron-57 was made at a constant rate when heavy-water and manganese were both present in the growing cultures. No effect was seen when normal water was used or when the manganese was absent.

If these claims are correct, a process in the living cell is able to initiate nuclear reactions without producing radiation or radioactivity. In other words, the nuclear landscape perhaps can be modified by the presence of life. While this claim is hard to believe, evidence supporting the idea is growing.

SUMMARY

I would like to summarize where we have been and ask where do we go from here? We are presented with a variety of methods, all of which show a consistent pattern of unexpected nuclear activity. The studies have become increasingly sophisticated and more carefully done. The results have become more reproducible rather than less so. Yet this improved understanding has had little effect on the attitudes of conventional science. The Patent Office, with a few noteworthy exceptions, still refuses to issue any of the many hundreds of submitted applications, the DOE still refuses to support studies in the field, and many journals will not accept papers describing positive results. The popular press especially likes to take cheap shots.

On the other hand a few bright spots exist, this conference being one of them. The American Physical Society had several papers on the subject at their March meeting in Atlanta, the Society for Scientific Exploration will host an afternoon of papers at its meeting in Albuquerque in June, the Seventh Russian Conference on Cold Nuclear Transmutation (RCCNT-7) is scheduled for May 23-30, the biannual meeting of active workers in the field will held in Asti, Italy in October. The Japanese Cold Fusion Society has held their first meeting at Osaka University in March with 20 papers about the subject. The Media has also been active recently. Wired magazine published a supportive article in its November issue, a documentary for TV(Cold Fusion: Fire From Water) has been released, and another movie (Breaking Symmetry) featuring the effect is expected to be released soon. Two books supporting the claims have been recently published in Japan and another will be published in the US some time this year. Infinite Energy, a magazine devoted to the subject is expanding its circulation. An excellent website is available at www.alt-energy.org. Slowly, the word is getting out. However, skeptics continue to believe that the growing body of people who support the work are suffering delusion even though this attitude is becoming increasingly harder to justify.

In spite of these islands of interest, the field is slowing dying from inattention, especially in the US. Many of the experts are old, retired, and running out of money. Because of the general negative attitude in this country, very few young people are going into the field. Consequently, if a commercial product were identified, a major educational effort would have to be undertaken before the required technical staff could be assembled. As anyone who has successfully replicated the claims will testify, special knowledge is required. Therefore, teachers are necessary but only a few are available.

What might we expect if this field were given the necessary and justified support? Three benefits are suggested. These are cheap, clean power; elimination of nuclear waste; and a new understanding of nuclear interaction. None of these benefits are certain but they are too important to ignore. Power production is especially attractive. The absence of radiation and radioactivity means that the power generators could be located in each home or business. As a result, the entire power generation system could be more reliable and more efficient. The generators would have a wide market, especially in the Third World. It takes little imagination to see the benefits to the world in general or, in contrast, the disadvantages to certain individuals and nations this change would produce. We can continue down the path we are currently following, with the obvious consequences, or we can have the courage to shift to a new path, hopefully having a better outcome. The question only remains as to when this shift will be made, how much pain we will all have to endure before better methods are adopted, and which country will make

the switch first and reap the benefits.

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