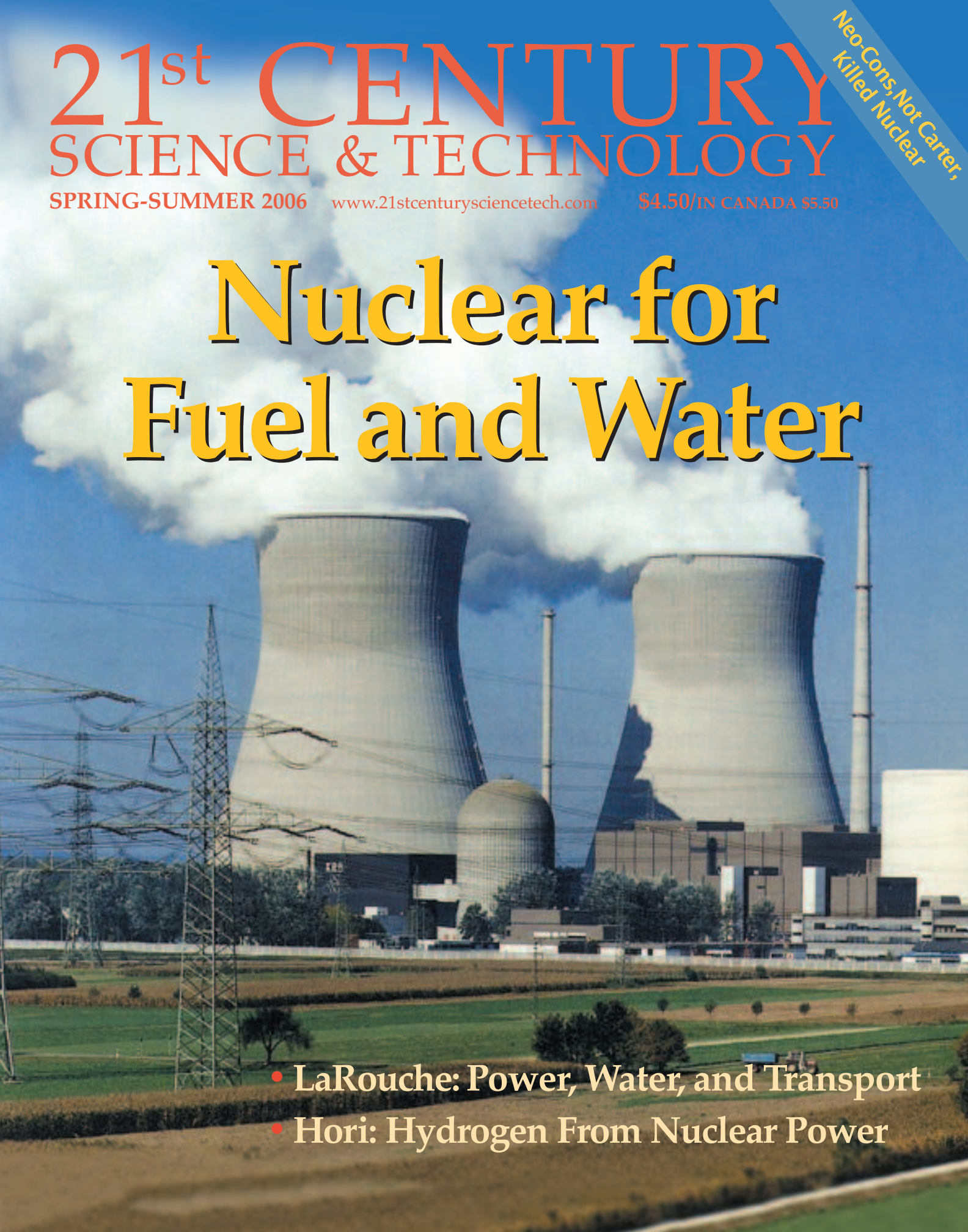
21st CENTURY
SCIENCE & TECHNOLOGY
SPRING-SUMMER 2006 www.21stcenturysciencetech.com $4.50/IN CANADA $5.50

Neo-Cons, Not Carter, Killed Nuclear

Nuclear for Fuel and Water



- LaRouche: Power, Water, and Transport
- Hori: Hydrogen From Nuclear Power

Credit: NASA/GSFC/MITI/ERSCAC/JAROS, and U.S./Japan ASTER Science Team

Los Angeles, as imaged by NASA's Terra satellite. In the 1960s, a nuclear desalination plant was planned on an offshore man-made island to provide freshwater for the entire Metropolitan Water District of Southern California.

Expand your world view with

21st CENTURY SCIENCE & TECHNOLOGY

Subscriptions

U.S.—6 issues for $25
Foreign—6 issues for $50

Books

The Holes in the Ozone Scare: The Scientific Evidence That the Sky Isn't Falling
by Rogelio A. Maduro and Ralf Schauerhammer
$15 each, plus $3 shipping
OR $10 postpaid with a subscription

How We Got to the Moon: The Story of the German Space Pioneers
by Marsha Freeman
$15 each, plus $3 shipping
OR $10 postpaid with a subscription

Global Warming: The Rest of the Story
by Dr. Gerd Weber
$11 each, postpaid
OR $8 postpaid with a subscription

Hermann Oberth: The Father of Space Flight
by Boris V. Rauschenbach
$15 each, plus $3 shipping
OR $12 postpaid with a subscription

Give *21st Century* subscriptions and gifts

ORDER FORM

Enclosed is $_____for:

____ 6 issues/ U.S.— $25 **____6 issues/ foreign airmail—$50**
____12 issues/ U.S.—$48 **____12 issues/ foreign—$98**

_____ $10 for *The Holes in the Ozone Scare* with a subscription
_____$18 postpaid for *The Holes in the Ozone Scare*
_____ $10 for *How We Got to the Moon* with a subscription
_____$18 postpaid for *How We Got to the Moon*
_____$8 for *Global Warming* with a subscription
_____$11 postpaid for *Global Warming*
_____$12 for *Hermann Oberth* with a subscription
_____$18 postpaid for *Hermann Oberth*

Please print or type name and address of gift recipients on a separate paper. Gift cards are available.
Note: Back issues are available at $5 each ($8 foreign)

Name _____

Address _____

City _____ State _____ Zip _____

Daytime telephone (_____) _____ e-mail _____

Send check or money order (U.S. currency only) to:
21st Century, P.O. Box 16285, Washington, D.C. 20041.

www.21stcenturysciencetech.com

21st CENTURY SCIENCE & TECHNOLOGY

Vol. 19, No. 1–2 Spring–Summer 2006

Science & The LaRouche Youth Movement

Features

On the cover: The Gundremmigen Nuclear Plant in Germany; photo courtesy of Nuclear Information Center, Slovenia. Cover design by Alan Yue.

News

Departments

21st Century Science & Technology (ISSN 0895-6820) is published 4 times a year by 21st Century Science Associates, 60 Sycolin Road, Suite 203, Leesburg, Va. 20175. Tel. (703) 777-6943.

Address all correspondence to **21st Century**, P.O. Box 16285, Washington, D.C. 20041.

21st Century is dedicated to the promotion of unending scientific progress, all directed to serve the proper common aims of mankind.

Opinions expressed in articles are not necessarily those of 21st Century Science Associates or the scientific advisory board.

We are not responsible for unsolicited manuscripts.

Subscriptions by mail are $25 for 6 issues or $48 for 12 issues in the USA and Canada. Airmail subscriptions to other countries are $50 for 6 issues. Back issues are $5 each ($8 foreign). Payments must be in U.S. currency.

Printed in the USA ISSN 0895-682

www.21stcenturysciencetech.com

Power, Water, And Transport

by Lyndon H. LaRouche, Jr.

These are excerpts from a speech entitled "Power Water and Transport: The Prospect for Mexico," delivered on March 30, 2006 at the Monterrey Technological Institute in Monterrey, Mexico.

In most parts of the world, much of the world's human population is living by using up what is classed as fossil water. For example, an associate of mine reported on deeply located fossil-water reserves in southern India, water which scientists there have dated to approximately two million years ago. In many parts of the world, the fossil water being used up was buried deep in the Earth during a time as long ago as the recent ice-ages of the past two million years. When those reservoirs are drained, there is no more water for those areas which depend upon these supplies. That example from India is a relatively extreme example, but it nonetheless typifies much of the global problem today.

Look now at the map of the water supplies of Mexico (Figure 1) Look particularly at Mexico City, and compare there, the ratio of the water being supplied to that area, as against the rate of consumption of the water in those areas. So you find in parts of Mexico, fossil water is playing a key part. And therefore, without increasing the water levels in Mexico, it would be impossible to solve most of the economic-development problems which exist today. So, as in other areas, you go to the South: We can move water from the South through the mountainous area, as well as along the coast, where water is rich in the South of Mexico and scarce in the North.

And you see on the map, we're drawing water for production of agricultural products for consumption inside the United States, from this area. The rate of depletion of water by agriculture, is therefore becoming a dangerous limitation. For example, if you had not had large migration out of these areas of Mexico into the United States as cheap agricultural labor, you would not have the opportunities, in terms of water alone, for maintaining a stable income in those areas. This is one of the problems that has to be traced. The very sovereignty of Mexico depends upon solving this water problem for that reason.

In Mexico, this will mean a significant upgrading of agriculture and of social infrastructure, to develop the base among stable family households for a normal continuing development of industrial infrastructure.

Now, thirdly, among the three measures to take, we must have the increase of the organization and maintenance of forests and agricultural crops which lower the temperature of the Earth, of the atmosphere, by converting solar radiation into plant-life, which is one of the most efficient ways of lowering temperature in a climate. Desert climate is very hot, because you have no living growth there. And therefore, if you want to improve environment and improve the water management, what you do, is, you let the solar energy, solar radiation, accumulate as much as 10 percent of the radiation of sunlight upon the land, convert that into trees, or less into shrubs and agricultural crops. These plants, then, give off water. The water given off by these plants, or these systems, now becomes rainfall; so that, by this process, you transform a desert area, over a period of some years of development of growth, you transform it into a cooler area, more habitable, and, through plant-life, becoming more productive, and increasing the wealth of the people.

So, these three measures: First of all,

Stuart Lewis/EIRNS

"There is no real aternative to large-scale reliance on nuclear and then thermonuclear fusion power." Here, LaRouche in Washington, D.C., April 27.

we must generate more water, and I shall come to that.

Secondly, we must manage the water, in such a way as to improve the productivity.

And thirdly, we must think about managing the land-area strictly from an ecological standpoint to improve the area ecologically in terms of water-balance and in lowering temperatures in high-temperature areas. Northern Mexico is a classic example of this, where you have desert-like areas, or semi-arid areas in which this is a problem.

All three of these measures I've indicated require *large-scale increase not only of the quantity of power produced per capita and per square kilometer.* Without adequate increase of the supply of power per capita and per square kilometer, a state of economic health could not be achieved. *This requires, especially for desalination, adequate sources of applied power, as available only from nuclear and comparable sources.* This means relying, chiefly, on the very high-temperature gas-cooled reactor, which are the ultra-safe, Germany-produced model, the pebble-bed reactor, now being developed in China and in South Africa.

For purposes of physical science, we must measure high temperature in terms of what we call energy-flux-density, which means *the density of power, as might be measured in kilowatts, across a square-centimeter cross-section of the generating process.* In other words, you can not measure power efficiently in terms of calories. You might say the *quality of power* is more important now, than the mere quantity. It's the energy-flux density, that is, the power represented in the production of useful heat, which is crucial—not the *quantity* in calories, but the *intensity.*

This is a question of physical chemistry. For example, what is the power required, in terms of energy-flux density, to produce a nuclear reaction, or a molecular reaction? And therefore, your power level in intensity, must correspond to your objectives. As I shall indicate, we're now at a point, where we are, already as a planet, we are approaching, perhaps within two decades, a point at which we will be consuming what we call raw materials more rapidly than we generate them, than the Earth can regenerate them.

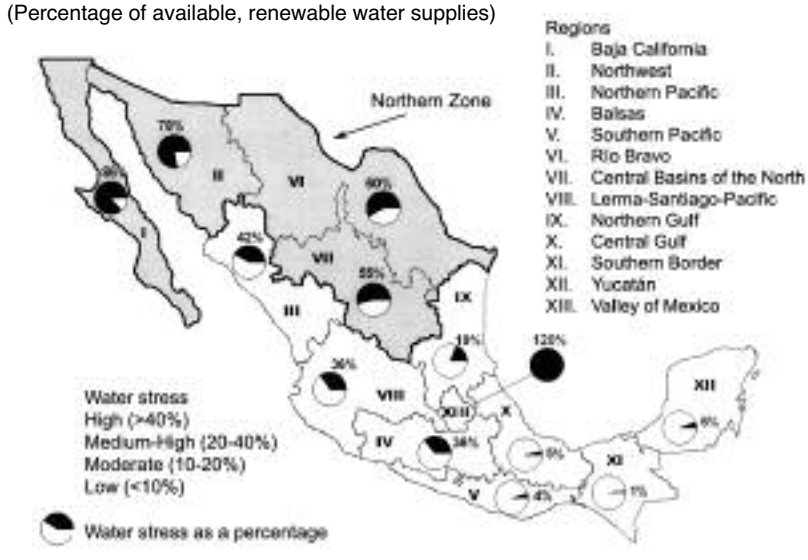
The Biosphere As a Factor

Now, most of the things we live on, called raw materials, exist within what is called the Biosphere. This is the area of

Figure 1
MEXICO WATER STRESS: ANNUAL WATER WITHDRAWALS (2004)

"Water stress" refers to a comparison of the annual water withdrawals for use in an economy, with the total annual available renewable water supplies, both surface and underground, that come from precipitation in that same region. Any area with water stress of 40 percent or more is considered high stress.

Percentages are shown here for the 13 hydrological administrative regions of Mexico in 2004.



the Earth, of the Earth's outer crust, which is the result of the deposit of residue from living processes over millions and billions of years, since at least the time the Earth became a reducing, an oxidation environment of the surface. Most of what we get as minerals, as we mine for minerals, we dig down through the Biosphere, through the crust; we dig down until we find some concentration of something like potassium, or a metal of some kind.

Now, how did it get there? It was put there by dead bodies of plants and animals. And where a particular species of plant would be concentrated, which would have a certain mineral in it, and it would die, it would leave a skeleton behind. And whatever is absorbed in its body would be concentrated, as opposed to some other area where a different species of fossil would have a different concentration of mineral. When we get minerals, which we use for industry or other things, we are largely using up, or reprocessing things that were deposited in the top of the Earth, that is, in the outer Biospheric area, billions of years, or less, ago.

So, we're tending to exhaust the total amount of resources *in that form.* For example, an example of the Biosphere: The water on this planet, with very few exceptions is a result of the action of living processes in an oxidation phase of the planet's existence. The atmosphere that we breathe, on which we depend, is a product of living processes, over a long period of time.

So therefore, we've come to the point that we're now beginning to use up mineral resources at a more rapid rate than an expanding population, a population demanding a higher standard of living and production, will demand. So therefore, we have to now take in, instead of mining for things left by the past, we now have to begin *to produce* what humanity requires as the new form of those raw materials. Therefore, *the cost of producing what we used to get by digging,* is now a cost of production, or will become a cost of production.

And therefore, within about two generations, as the population of China not only grows, that of India grows, other parts of the population grow, not only will there be an increased *rate* of consumption of raw materials, or what we call raw materials today, but, there will be a demand for an improved standard of living. And we're now getting to the point, where *we now must produce, what we used to just take.* We can get enough, but we must produce it. So now, we have a new factor of cost, above the costs which are normally accounted for, in production.

www.icjt.org

Mexico's Laguna Verde nuclear plant. In the 1970s, Mexico planned to build a fleet of 20 nuclear plants, but these plans were aborted by the crisis of 1982.

The Need for Nuclear

And this can only be done by very high-temperature processes, in the order of magnitude of nuclear-fission reactions, in the order of magnitude of thermonuclear-fusion reactions. We're going to have to start to reprocess isotopes. This can be done. But we're going to have to get to that. We're going to have to say, on the horizon, two generations from now, we must reach the point, not only that we use the increase of nuclear power as a way of dealing with water and related problems. We will have to have, within two generations, about 50 years, we'll have to reach the point where we can begin to manipulate other parts of the spectrum for our needs.

It's a great change for mankind, but that's all right. Mankind has made many changes. If we were simply animals like baboons, or gorillas, there would never be more than two or three million of us living on the planet, at any time during the past 2 million years of the ice-ages. We now have six billion people, more than that, now. It will increase. We can no longer live as primitives, going back to nature. We must now begin to create the environment we require to maintain a higher quality of life. And Mexico's a good place to do it. I think Mexicans would appreciate doing that.

There is, therefore, no real alternative to increasingly large-scale reliance on nuclear and, then, thermonuclear fusion power. The economical driving of certain currently indispensable chemical reactions on the needed mass scale, requires large-scale power sources of the relevant high energy-flux density, to produce the needed chemical and other physical reactions cheaply on a mass scale. Contrary to popular beliefs derived from a presently widespread lack of scientific literacy, measuring power merely in calories does not meet this requirement.

For these and similar reasons, during the recent year, there has been a sudden upsurge in the declared intention of governments around much of the world, especially various parts of the Eurasian continent, as also in Brazil, for example, for a rapid development of nuclear power. In part, this very profound shift in policy is a reflection of an increase in the cost of petroleum, and also in shortages. But that is not the real reason. Behind this, is the recognition, that the kind of technology we require for an economy of the future, depends upon the high-density power of a nuclear-fission resource. And the standard reactor, most popular today, for that purpose, is the high-temperature gas-cooled reactor, such as the pebble-bed type. For example, you could produce these types of

reactors in the 120- to 200-megawatt range. That would be good for many purposes, including desalination, and for normal supply of power.

But we also have come to the point that we can not use petroleum power forever. We will use petroleum more and more, as a chemical feedstock, and less and less as a source of heat energy, for driving things. Why should you take something as cheap as petroleum is today, and spend vast amounts of money distributing it around the world by ships and other methods, and processing? Why do that? Can't we produce fuels locally? For automobile vehicles, for aircraft, and so forth?

We can. We can produce—and it is now in process—we can produce hydrogen-based fuels, that is, fuels which are close to hydrogen. We can produce these locally. We can produce them with nuclear plants. This requires a nuclear reactor of about 800 megawatts power. With that, we can produce synthetic fuels, and other kinds of materials.

So, it is not the price of petroleum that's the real driver for this emphasis on nuclear-fission power. It is the reality, the physical reality that we can no longer continue to depend so much as we do, on combustion of petrochemicals. But, we must now synthesize. And, after all, the waste product of synthetic fuels, is largely water—which is not considered polluting. (Except by alcoholics!)

For these and similar reasons, during the recent year, there has been a sudden upsurge in the declared intention of governments around the world, as I said, for the rapid development of nuclear power. Mexico has already buried in its history, a former commitment of about a quarter-century ago to building 20 nuclear plants in Mexico. And of course, one of the places required is largely in the northern part of Mexico, where you have a population which lives under conditions where lack of moisture and so forth is an impediment to agriculture and to forms of life. So, to create the opportunities for life in areas where there's a large population, as opposed to the picture of people fleeing across the U.S.-Mexico border, to find cheap-labor jobs abroad, you can now keep the families together more, by developing the opportunities for normal family life and community life in these areas. Those plans existed 25 years ago, here in Mexico. They were being developed during the 1970s, and they were aborted by the crisis of 1982, and we never got back to it. But those things exist. And the talent exists potentially to do that. And that will give a start. It's a start on providing a basis for new opportunities for life in this area.

Since we must deploy the construction and operation of such nuclear reactors over broad areas, where the relative skill levels are varied, we must have the safest type of reactor model. The high-temperature gas-cooled model is one. There are also experimental reactors being developed, as operating test reactors and for training people, to train people rapidly in various of these types of technologies I've mentioned. And also, there's some more advanced technologies for fission power in the future, for producing all kinds of things.

But, we need a proliferation of this over areas, to transform areas which are now quasi-desert areas or poorly developed areas, into areas with a great inherent infrastructure basis for production.

Only Life Produces Life

As I said before, almost all of the Earth's water and atmosphere are products of life. They're products of action of living processes on a pre-biotic level of existence, to produce things.

This was set forth and proven by a great Russian scientist, who was a follower of Mendeleyev: V.I. Vernadsky. And Vernadsky was a person who gave a rigorous definition of the meaning of the Biosphere, and also went on to describe the Noösphere, that there are three principles we're dealing with as economists, in looking at the world today. First, we're dealing with things which you deal with in ordinary physical chemistry, abiotic systems, systems that are not living systems. On a second level, the fact is, despite some wild-eyed science-fiction people, you can never get a living process out of a non-living process. Only life can produce life. And life is a universal principle.

Vernadsky demonstrated that chemically, by showing the way in which living processes deal with non-living material. Now, going through your own bodies, I don't know if you've inspected this recently, but you'll find a certain chemical throughput. And there's nothing that gets into you, except as a chemical throughput. Normally, these chemical throughputs are considered abiotic. But, in living processes, they behave differently than they do in non-living processes. So, now, what you put out when you die, or animals die and so forth, is the same material, essentially, in terms of normal chemistry, as you took in. A living process selects the materials it wants from its environment, or adapts to them, and does not take in other things. It selects what it wants. It's a strict shopper: Each has its own shopping bag and its own shopping list. And it comes out, and it grabs what it wants. And it takes it in, and it processes it. It builds its body, it maintains its body by this process. Then, it puts the same material out, eventually. When you die, you return this to the soil. It's the same material, but it's different. It comes out in a different form than it would ever occur in a non-living process.

So there we were able to define, as Vernadsky did, that nothing produces life, except life. There is no non-living process that will ever synthesize actual life.

Secondly, we find a second characteristic: The characteristic of the human mind. And in the same sense that only life produces life, only creative mentality produces creative mentality. For example, if we were apes, great apes—or, not so good apes, but great apes—then we would never have exceeded a population of several million individuals on this planet, in the past 2 million years—never. How did we get to *six billion people* and more on this planet today? We did it. It's more or less successful. The standard of living of our people living today around the planet, at the worst, is much better than it was a million years ago, or so.

So therefore, there's something about the human mind and its ability to innovate, by making discoveries of principle, which is called, of course, in Classical Greek *dynamis,* or what we call in English "power," certain principles which we can discover, which are universal, such as gravitation, which is universal. Do you ever see a "gravitation"? Don't defy it. It's there, it's universal. It's a principle, as Kepler showed.

So, we are capable of discovering universal physical principles, which we as mankind apply in various ways, to increase our power to exist, and our development. These principles are embedded as part of the storehouse in

our culture. There are principles which were discovered a long time ago, which are passed down in the form of culture, or passed down in a systematic way with education, as I think some of you may know—that you're supposed to pick up a few principles along the way, in the course of education. Most of what you pick up, if you're good at it, you pick up not only what you're taught, but you develop the ability to make discoveries of the same type yourself. And therefore, you add to the store of principles at the disposal of mankind.

The Power of Discovery

So therefore, we have to be optimistic because of the nature of man, that we have the power of discovery. We have the power of what Vernadsky called the Noösphere. We have the power which no animal has: the power to discover principles of the universal, *to change our behavior as a species,* to increase our power, to develop ourselves, to transmit something to future generations. So therefore, the very nature of mankind should make us optimistic, because we have a power in us, that no animal has. And we are only foolish if we don't develop those powers and don't use them.

Therefore, there are absolutely no limits to the human growth potential immediately before us. However, the physical cost of maintaining supplies on which human life depends, such as clean air and usable water, is going to increase, relative to present-day levels of physical productivity per capita and per square kilometer.

The Case of China and India

For example, let's take the case of China and India. China now has over 1.4 billion people. India over one billion people. The population will continue to increase. And many of these people are very poor; about 70 percent of the population of India is extremely poor—and many of them poor, because of a certain lack of development. In China, you have 1.4 billion people, most of them extremely poor. China is not really producing much for itself. What it's producing, is actually producing a product for the world market, which is largely European- or U.S.-designed. We export our technology to China, to produce with cheaper labor, at lower prices, what we consume ourselves.

Therefore, in these cases, should the European economy, and the U.S. economy collapse, this would be an economic disaster for China, and for India, and for nearly all developing countries. Because the idea of exporting, the idea of outsourcing, in the way it's being practiced today, is a form of insanity. If you ship production from the United States, which has a high standard of living, and high standard of productivity, to Honduras or some other area; or you ship it to Mexico first, in the *maquiladoras,* and then you ship it from there down to Honduras, what's the effect? What's their standard of living? What's their cultural standard? You're not improving them. They're competing savagely for this work, because they think they need it. But the cultural benefit for the population as a whole is not there, because of the competitive standards.

And in the meantime, we, in the United States, who start this exporting process, we export our production, we shut down our factories, we shut down our farms, we stop educating our people, we invent make-work, where they're taking in each other's laundry to live! They don't produce anything, they take in each other's laundry. You don't cook a meal at home any more, you go out to a hamburger stand and get it! All the infrastructure, and the education, and the culture that goes with it, the facilities that go with it, with high-gain production in agriculture and industry, is gone! We've exported it to a cheap-labor market—and we're suffering. The same thing is happening in Europe. Europe is collapsing, and the United States is collapsing internally, *because* of outsourcing, *because* of globalization! *Because* of a breakdown of protectionism.

And therefore, we must consider the cost of maintaining a high-quality person, a high-quality family, a high-quality community. A high quality in use of language—not just learning to speak some common idiom: But a high quality of language used as a medium *of ideas,* of cultural ideas, of conceptions. Language used as a way of conveying the culture of ancestors into the present, and into the future.

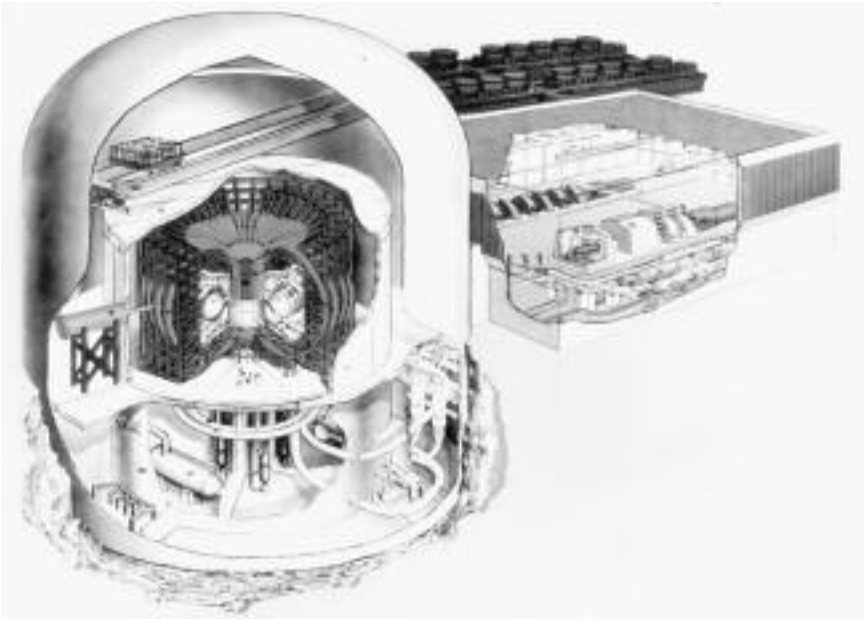
All this means that, that instead of simply extracting materials in the Biosphere, we must help the Biosphere to replenish those supplies at rates consistent with our requirements. It is this challenge which makes nuclear-fission and thermonuclear-fusion technologies indispensable for the future of mankind over the coming two generations. Nuclear and sub-nuclear physical chemistry are the future of the world for today and tomorrow.

Therefore, on both sides of the border, governments must recognize that the policies we require for today are policies based on looking ahead 25 to 50 years. We must think of the improvement of education and skills, of the general population and its labor force, to bring it up to those higher levels of science and technology, which are needed for the generations to come to meet this mission, and to maintain the social standard of living for a growing world population.

In respect to power, policy-shapers of today must think ahead to no less than 30 years ahead, in terms of say, a nuclear power plant. A nuclear power plant has an expected physical economic life of about 30 years now. That could be extended by certain improvements. But you're talking about essentially a generation, 25 years, a generation of investment. It means you must *look ahead* a generation, you must *look ahead* 25 to 30 years, when you talk about what you're doing today, in policy today.

It also means, therefore, an improvement in education. Not for yesterday, or up to today, but education for practice for the coming 50 years of your adult life. You leave university today; the next 50 years is your adult life, essentially, your working adult life. Are you going to be qualified for that adult life, in a growing, advancing technology, a changing society? Are you going to have the foundation, to "keep up with the times," so to speak? And we, who are making policy, or shaping policy, must think in those terms. Governments must think in those terms. We must think 25 and 50 years ahead, in terms of large-scale improvements in infrastructure, and in technology of production, and in changing the land-area.

As much as we could do today, which is feasible today, is fine. But by the middle of this century, about 50 years from now, we're going to have entered a new phase, and the next 50 years—which is generally the working lifetime, a professional lifetime of you people, here today—by the time you reach retire-



U.S. DOE

A 1974 design for a thermonuclear fusion plant, based on magnetic confinement. "There are no limits to the human growth potential immediately before us," LaRouche said.

ment, the world will have come to the threshold of the need for qualitative changes in the technology of society, and you have to prepare yourself, and develop yourself along the course of time, shall we say, to keep up with the requirements. But there are going to be qualitative changes in the years ahead, *if* we don't go through a dark age.

Education and Productivity

The emphasis on what has been called the post-industrial society, by others the information society, has tended to blind those who reached the age of employment about 1968, to the actual requirements of an increase of physical productivity, as measured per capita and per square kilometer of the territory. This is the famous problem of the Baby-Boomer generation. There was a cultural change spreading out of Europe and the United States, but also down here, a cultural shift away from the orientation toward a *productive* society, toward the idea of a post-industrial society, without industry, and without agriculture, a so-called information society. And that has been a great failure.

Computers are extremely valuable, but no computer ever made a scientific discovery, or ever will. At least, no digital computer could. Only a human being can make a scientific discovery. Only the human mind can do that. If you transfer to the computer what the human mind must do, you're going to end up in a dead-end. And we have been heading in a dead-end.

What happened is, we had a cultural conditioning which is associated with the time of the great riots of 1968. The cultural conditioning after which we began to go downhill. We said, "Industry is bad. Agriculture is bad. Technology is bad. Information is good." But information didn't include ideas. It included formulations. It included sophistry: Use language to persuade people, not to inform them. Use language to manipulate people, not to inform them.

So, as a result of this process, this idea of this new utopia of 1968ers, we shifted production out of the United States and out of Europe, into poorer parts of the world, where labor was cheaper, and the conditions of life were poorer. The intention was not to improve the conditions of life in these countries where people were poorer, or poorly educated. Rather, the idea was to exploit them to the maximum. To pay them as little as possible is to run away from the responsibility.

For example, the "cost of production," and the "cost of production" are sometimes terms that don't mean the same thing. The cost of production for one person is, is what it costs me to hire somebody to produce something in a given society. From the standpoint of economy, the cost of production is what it costs to produce a society *at a cultural level* consistent with a certain standard of living. And what tends to happen is, you see the cuts in health care, you see cuts in education, you see cuts in sanitation, you see the breakdown of power systems. As over the past 25 years, we're having a breakdown in power systems because we have not *renewed* them in 25 years in the United States. So therefore, the actual costs of maintaining and developing a population, are not taken into account.

You produce by using up the territory which you run. And this has resulted in this condition today, where some people say, China is the nation of the future. China *is* a nation of the future. Or that India is the nation of the future. That the Americas are not important any more. That Europe is not important any more. Europe's economy is being destroyed. The conditions of life in Europe are being destroyed. The conditions of life of the people in the lower 80 percent of income-brackets in the United States have been destroyed *consistently,* since 1977. So, we have been destroying what was in the United States, the greatest economy the world had ever known! *We have largely destroyed it!* Not some enemy destroyed it—*we* destroyed it! We destroyed it by a change in policy, which is typified by the 68er mentality. And therefore, we have to go back to the standards we had before.

In European civilization, of which you're a part, we have one of the greatest successes in all history: that, coming out of the positive side of developments in ancient Greece, we developed a notion of culture which is famous because of the writings of Plato, among others, or the writings of Solon of Athens. The idea of the society which was different than other societies. Because, in most societies, as in the Middle East, society was based on keeping most people almost as cattle, as human cattle, who worked at the pleasure of a ruling caste, which owned them and managed them.

In European civilization, beginning with people like Solon and so forth, we developed the idea which became the

core of European civilization: that the state is not an entity unto itself; that the people are not the property of the state. But rather, the state is an agency which must be dedicated to the care of the general welfare of present and future generations of all of the people. This idea, which was embedded in Christianity, as in Paul's *I Corinthians* 13, is the standard of European civilization, in all its best aspects. It is the standard of the modern nation-state, as established first in 15th-Century Italy, in the form of Renaissance; established with Louis XI's France, where the principle of the general welfare was the ruling principle of society. It was established in England under Henry VII, where the welfare of all of the people was the primary responsibility of society. That was the law. It was called *agapē*. It was called the principle of the general welfare.

Thus, the great advantage of European civilization, which, in every country, as in Mexico, great struggles were fought to bring this standard of government into being. That the government as a republic is responsible for the development of *all* of its people, and their future condition of life. This was the rise out of serfdom and slavery.

And that is in jeopardy today. What we've done today, is, we've said, "economy is all-important." Economy means, the cheapness of production, the cheapness of labor. Cutting this, cutting that: cutting health care, cutting education, cutting the improvement of land-areas—these kinds of things.

And so, we took a step backwards from 1968 on, back from the level of the modern European Renaissance. And that's what you're seeing in this issue about the border of Mexico and the United States. What you have, is you have people in the United States who are drawing forces from Mexico, to produce the agricultural goods and cheap labor for construction inside the United States.

What you see on the streets of the United States—you see everywhere—people who are illegals, working for firms managed by illegals! And these firms are doing the work. They're building the houses, the cheap shacks that are about to come down. So, what we're doing, we're taking the population of Mexico, we're reducing the population that comes across the border to a lower standard of life than they had in Mexico because they see no future. We're using them up! We're not developing them; *we're using them up!* We're tending to criminalize them! Because, we don't realize that the law, is the law of the development of people. And we're losing the productive potential that we had once before.

To give an example of this: Back in the middle of the 1970s, I was one of the founders of an organization which had some 200,000 members, and which represented many of the general generation of scientists. We were working on various scientific questions, largely including nuclear power, fusion power, and so forth.

Most of those people with whom I was associated then, in the 1970s and 1980s are now dead. They have not been replaced. There's a shrinking number of people, a shrinking percentile of people, today, who have the competence they represented. And so therefore, not only have we lost in the condition of life, in the condition of the general welfare, we've also lost a scientific population which was formerly essential to our achievements. And therefore, we are not capable, presently, of the kind of scientific endeavors which we were capable of then. We've lost science. We've lost science and technology. We talk about it a lot, but we've lost it.

We have to rebuild it.

Our Challenge Today

So therefore, our challenge today, is to take the things that we can do, things we're capable of doing in the direction I indicated, largely based on this issue of water, power, transportation; treat that as basic infrastructural development, basic challenge of government, the proper area of government—large-scale mass transit; large-scale power production; improvements in technology in general; and the fostering in the private sector of technological improvements, that's what we used to do. And this is our future. . . .

The full transcript of LaRouche's speech appears in Executive Intelligence Review, *April 7, 2006, and online at:* www.larouchepub.com/lar/2006/3314monterrey_tec.html

Duesberg's AIDS Hoax

To the Editor:

We are all familiar with the attitude of the South African Prime Minister Mbeki, who does not believe that HIV causes AIDS. But after reading James P. Hogan's book, *Kicking the Sacred Cow,* it appears that he may be right.

Hogan says (page 308): "So, you've got all the symptoms of TB" [and presumably hepatitis, dysentery, malaria, pneumonia, Kaposi's sarcoma, one of the VDs, etc.] "and you test positive for HIV, you've got AIDS. But if you have a condition that's clinically indistinguishable and don't test positive for HIV, you've got TB" [Or one of the others].

Page 326: "Peter Duesberg believes that AZT and other 'antivirals' are responsible for over half the AIDS being reported today."

Page 322: "The unifying factor that makes all of 30-odd disparate indicator diseases 'AIDS' in the West is testing positive for antibodies claimed to be specific to HIV. But in Africa no such test is necessary."

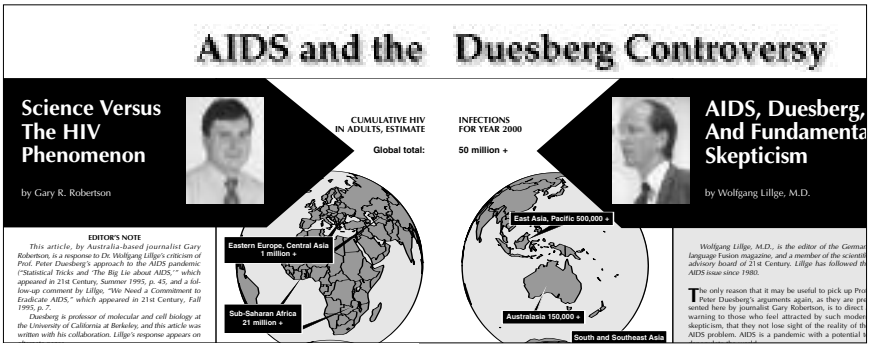
Page 328: "Duesberg has been accused of irresponsibility on the grounds that his views threaten confidence in public health-care programs based on HIV dogma. . . . Publication in the mainstream scientific literature was denied."

If the rampant diseases in Africa (and New Guinea to my near north) are due to poverty, bad water, starvation, ignorance, dysfunctional societies, etc., the cure is to overcome those problems, and not to provide free poisonous antivirals to already weakened people.

The treatment of Duesberg reminds me of Barry Fell's experience.

Maybe Hogan is just milking the subject for his own profit—but what if he's right? A lot of the other subjects he treats are also the same that *21st Century* has featured.

Henry Broadbent
Somers, Victoria, Australia



Colin Lowry Replies

Duesberg's denial of the HIV virus as the disease agent responsible for AIDS rests on his ignoring thousands of experiments and clinical studies, while using pure sophistry to pick out incomplete "facts" to support his conclusion. We dealt with this in great detail in the Spring 1998 issue of *21st Century* ["AIDS and the Duesberg Controversy" by Wolfgang Lillge, M.D.] which I highly recommend that you read.

We now know a great deal about HIV and AIDS, and while the disease has ravaged Africa, it is also killing millions on every continent of the globe. Since HIV destroys the immune system, it is often the case that people infected with HIV die of some other disease that their bodies can no longer defeat in their weakened condition.

Tuberculosis is the number one killer of HIV-infected persons worldwide, but that doesn't mean that TB is the same as AIDS. There are many clinical tests relating to T-cell counts, dendritic cell counts, and cytokine profiles that can be tested for, besides the standard antibody test, when attempting to confirm if someone has AIDS or not.

Certainly, poor nutrition, lack of proper sanitation, and lack of medical care increase the death rate of any disease, including AIDS, and foster the conditions for emergence of new pandemic threats. We agree with you and Prime Minister Mbeki that these questions must be urgently addressed, and not swept under the rug. However, the treatment of HIV with anti-retroviral drugs, including the newer protease inhibitors, does increase survival time in most cases; but the drugs are far from perfect, and do have side effects. The denial of affordable anti-retroviral drugs to the Third World nations is certainly increasing the spread and deadliness of AIDS, and Duesberg's position is helping the very cartels he claims to oppose.

Whatever Prime Minister Mbeki may have said at one time, the South African government is now developing its own program for production of generic retroviral drugs, and is purchasing the drugs from India and other nations.

As for Duesberg himself, he was one of the eminent retroviral researchers in the 1970s, and was very familiar with the research around HIV in that period, so he certainly is not foolish enough to privately believe what he says publicly about HIV now. One has to wonder whether Duesberg is not part of a cover-up operation. His arguments serve the purpose of justifying the benign neglect of the AIDS crisis which has been the *de facto* policy of the United States government since Reagan Administration Surgeon General C. Everett Koop stated that the cost of a crash medical and biophysics research program to deal with this global threat was too high.

Hydrogen in the Sun?

To the Editor:

I know you will get a lot of flak over page 78 [in the Summer 2005 issue, "Nuclear Chemist Oliver Manuel Challenges Theory of Solar Origin"] on "Iron in the Sun." Seems Manuel left out the most abundant element, hydrogen. He apparently ignores what are the parameters for the Sun. For quick rough comparisons, assume iron represents the heavier elements and the balance represents the lighter elements. The Sun's density is 1.41 gm/cm^3. The density of iron is 7.9 grm/cm^3. The ratio is then 1:5.6, or about 17.85 percent. The calculations are simple.

The end result is: All the heavier elements would occupy about 20 percent at the core, the remainder the balance of 80 percent (volume or mass). And since the average density is such, then that 80 percent must be about 95 percent hydrogen. If the exact values were known, the results would be more accurate, but are close enough. It sure as hell is not a thin surface layer of hydrogen as he claims.

Bert Schreiber
Bellaire, Texas

Oliver Manuel Replies

Your note on "Iron in the Sun" illustrates a common misconception: *The Sun's bulk density does* **not** *tell its composition.*

Bulk density also depends on (a) structure, and (b) temperature. An iron ship floating on water illustrates (a). Hot air balloons rising in air illustrate (b).

Leading astrophysicists understand that the Sun's average bulk density does not tell its internal structure and composition. Thus, Fred Hoyle himself suggested that the Sun's core might be rich in *iron-group metals* [*Astrophys. J.,* Vol. 197 (1975) L127-L131] and Clayton, Newman and Talbot suggested that there might be a *black hole* at the center of the Sun [*Astrophys. J.,* Vol. 201 (1975) 489-493].

Thank you, Bert, for giving me the opportunity to address this common misconception.

Oliver K. Manuel
http://www.umr.edu/~om

Cosmic Humbuggery

To the Editor:

In your editorial "The ABC of Cosmic Humbuggery" (Fall 2003), you cite "a lack of epistemological rigor typical of nearly all modern cosmology." I so agree with the content of that phrase.

I'm amazed that so many people appear to be so completely bereft of the idea of using reasonable epistemological tests to evaluate the so-called knowledge that modern pseudo-scientists are generating by their so-called "scientific" activities. There is no other means to provide any sort of a quality index on such generated "pseudo-knowledge" and hence, it has become nearly impossible to differentiate the work product of any modern astrophysicist, or cosmologist or particle physicist from the work product of a clever pathological liar.

Continued on page 11

Ethanol: Less Than Meets the Eye

by Howard Hayden

Biomass is one of exactly two major contributors to renewable energy, the other being hydropower. But producing biomass for energy production is mostly not a very productive use of land. Moreover, there has been an ongoing dispute. On one side are Pimentel (Cornell) and collaborator Patzek (Berkeley) who say that ethanol (EtOH) production is energy-negative, and on the other is Shapouri (USDA) who says that EtOH production is energy-positive by some 24 percent.

Therefore, I was startled to read a quotation from a just-published paper in *Séance* [*Science*] by Farrell *et al.* "Our best point estimate for average performance today is that corn ethanol reduces petroleum use by about 95 percent on an energetic basis and reduces GHG [greenhouse gas] emissions only moderately, by about 13 percent."[1]

To replace gasoline with ethanol would require planting corn over 51 percent of the total U.S. land area.

At first brush, this comment seems to contradict *both* sides of the dispute. Upon further look, it says very little. The problem boils down to this: How is one to allocate all of the energy inputs and energy outputs associated with EtOH production? For example, how about the energy used in producing fertilizer, the energy used in delivering the fertilizer, and the energy used to feed the farmers doing the work? How about the energy that remains in the by-products used for animal feed, and the energy inputs they displace? Farrell *et al.* say of this latter topic:

"The studies that correctly accounted for this displacement effect reported that ethanol and coproducts manufactured from corn yielded a positive net energy of about 4 MJ/l to 9 MJ/l."[1]

The heat content of a liter of EtOH is 25 MJ, so they are saying that the net positive energy is something between 16 percent and 36 percent of the total. The arithmetic is grade-school level, but the decision-making about energy allocation is always dicey and always contestable.

Basically, Farrell *et al.* just wrote a computer program to do the elementary arithmetic. They took no data, made no measurements. All they did was to look at the analyses done by various people, and decide to use Shapouri's data. But what about that 95 percent figure cited above (ethanol reduces petroleum use by about 95 percent on an energetic basis)? Basically, all they are saying is that farmers use energy from coal, natural gas, and other to produce the EtOH, but petroleum supplies only 5 percent of the energy.

Of course, what they did *not* discuss was productivity—how much energy results each year per unit of land area. The same issue of *Séance* has a companion article[2] that, despite reading like a sales pitch, discusses productivity in arcane units: megagrams (Mg) of dry matter per hectare per year, for which they cite numbers ranging from 8 to 22. Using 15 MJ/kg for the heat content of dry matter and 3.16×10^7 seconds per year, we get 4,750 (thermal) watts per hectare (approximately 1,900 thermal watts per acre) for their estimate of 10 dry Mg per hectare per year.

But Shapouri's figure for the EtOH produced per hectare is about 1,980 year-round average thermal watts (approximately 800 thermal watts per acre). Now let's broaden the perspective. In a year, one can expect a year-round average solar thermal power on a hectare to be 2 million watts. Of that, roughly 0.25 percent is converted into biomass energy, and roughly 0.1 percent becomes energy in the ethanol.

Co-products

Mike Brown is a fervent EtOH supporter who mixes one good equation with poor understanding on his website.[3] He provides some useful numbers:

"In the year 2000 there were 9,915,051,000 bushels of corn produced in the United States. Rounding off the production figures, 7 billion went to feed livestock. The remaining 3 billion went for other uses including exports. Assuming we could convert 10 billion bushels of corn to ethanol at the standard rate of 2.5 gallons per bushel, that would be 25 billion gallons of ethanol annually. . . .

"Our livestock wouldn't starve with this program. After you distill the alcohol from the corn, you wind up with distillers dried grains (DDG). *Essentially, it is the starch portion (about 70 percent) of the corn kernel that is converted into ethanol.* All the remaining nutrients in corn, such as the protein, fat, minerals, and vitamins are concentrated and come in the form of distillers grains, which can be fed to livestock wet or dry [emphasis added]."

But just like ourselves, cattle need energy to survive, roughly 7,500 calories

(31 MJ) per day for an average-size cow.[4] If you extract 70 percent of the energy in the corn, that 70 percent isn't available to feed the cattle. Roughly speaking, if three bushels of corn are used to produce EtOH, the DDG that can be fed to cattle has as much energy as one bushel of corn fed directly. There is no free lunch, even for cattle.

Mike Brown reminds us "that ethanol isn't produced by using *other* ethanol. In the big distilleries, it's produced by using natural gas as a heat source. On the farm, it's produced by burning wood, corncobs, corn stover, and the like."

True enough, but farms simply don't have enough corncobs and the like to produce industrial quantities of EtOH. So it boils down to big distilleries that get the energy from natural gas. Oh.

Assuming (very optimistically, with Shapouri) that there is a net gain of 24 percent of energy in producing EtOH, it would require 23×10^{18} joules from natural gas to provide as much energy as we get from petroleum, and that would be added to our current consumption (20.7×10^{18} joules) of natural gas.

It would obviously be better to use nuclear energy, of course, but what about land use? To produce EtOH with as much energy as we use in transportation would require 1.1 billion acres (454 million hectares) devoted to high-yield corn production, complete with all the things environmentalists hate—fertilizer, irrigation, and pesticides. That's about 1.8 million square miles (4.6 million square kilometers), some 51 percent of the land area of the 50 states.

Howard Hayden, publisher and editor of The Energy Advocate*, is Professor Emeritus of Physics at the University of Connecticut. This article is reprinted from* The Energy Advocate *(February 2006), P.O. Box 7595, Pueblo West, Colo. 81007.*

Notes

1. Alexander E. Farrell, Richard J. Plevin, Brian T. Turner, Andrew D. Jones, Michael O'Hare, Daniel M. Kammen, "Ethanol Can Contribute to Energy and Environmental Goals," *Science*, Jan. 27, 2006, Vol. 311, No. 5760, pp. 506-508. Thanks to Alex Weber of Taiwan for this reference.
2. P. Hallett, David J. Leak, Charles L. Liotta, Jonathan R. Mielenz, Richard Murphy, Richard Templer, Timothy Tschaplinski, "The Path Forward for Biofuels and Biomaterials," *Science,* Jan. 27, 2006, Vol. 311, No. 5760, pp. 484-489.
3. www.mikebrownsolutions.com/ethanol.htm
4. Basal metabolism of cattle is given by $70kcal/day(m[kg])^{0.75}$www.asft.ttu.edu/ansc 5001/TTVNCOURSE-Lecture4.doc

Letters

Continued from page 9

Thanks for an interesting article.

I had no idea that the Lyndon LaRouche movement was still viable and only ran across this article doing a google search to determine evidence of intense neutron fluxes that may have left evidence in meteorites.

Charles Cagle
Singularity Technologies, Inc.
Salem, Ore.

Pre-Columbian Journeys Published in English

To the Editor:

In my book review of *La Cola del Dragon* in the Winter 2005-2006 issue of *21st Century,* I neglected to mention that large sections of the book by Paul Gallez had been published in English by Dr. Nito Verdera, who put online (http://www.cristobalcolondeibiza.com/) a treasure trove of materials regarding pre-Columbian contact between the "old" world and the "new."

For example, on the location of the mysterious land of "Punt," in the news again recently with the discovery of some well-preserved ships in caves in Egypt. Academia places it very close to Egypt, since they obsessively repeat the mantra that the Egyptians were not a seafaring nation. Verdera shows Gallez's hypothesis that the Land of Punt was in Peru, is at least as good as the rest of them, and then adds a few facts of his own:

- The first known voyage to this region is that organized by the pharaoh Sahure of the fifth dynasty (circa 2550 B.C.).
- The pharaoh Asa (Isesi) followed Sahure's example. Around 2400 B.C., he also sent out his fleets to the Land of Punt. One of the princesses of the sixth dynasty was placed in her tomb, ready for her journey to the Land of the Dead, wearing a lip coloring with an antimony base. The nearest place where antimony was mined is Madagascar, hardly around the corner.
- The Harris Papyrus, kept in the British Library, says that the pharaoh Ramses III sent an expedition of 10,000 men to Punt in 1180 B.C.
- Queen Hatshepsut (1501-1482 B.C.), whose deeds are engraved in the temple of Deir-el-Bahari, which she ordered to be built in Thebes to honor Amen-Ra, sent out an expedition made up of at least five large ships with 30 oarsmen in each of them. They sailed from somewhere on the Red Sea and were away for three years.

One of the many illustrations from the website of Dr. Nito Verdera: A combination of a sundial and clock. The string is at the angle of your latitude, or co-latitude. If you know your direction, you can then tell the time (on both the vertical and horizontal surface); if you know the time, you can find your direction.

Egyptian scholars do not agree on the location of the Land of Punt. Some of them suggest Eritrea, others Somalia, Zimbabwe, Hadhramaut, or India. However, all these places are much too close to the Red Sea to justify the length of the voyage: three years according to all the relevant Egyptian records.

Gallez locates the Land of Punt in South America, probably, in the Puno region of Peru, on the shores of Lake Titicaca, which yields 70 percent of Peru's annual gold production, together with antimony, mercury, zinc, tin, and cobalt. Old gold and antimony mines can be found in the area, although archaeologists disagree as to their exact age. The boats used to sail on Lake Titicaca, made of cattail (a long-stemmed, reed-like, grassy plant of the Typhaceous family, with a cylindrical ear) are so similar to those used in ancient Egypt, that Thor Heyerdahl went to Puno to recruit workers to build his papyrus boat, *Ra II,* on the banks of the Nile.

Verdera points out, that as matters stand now, Gallez's theory is just as acceptable as any of the other sites suggested for the Land of Punt.

Rick Sanders
Leesburg, Va.

The LaRouche Youth Movement's walking nuclear cooling tower which haunted the Fourth World Water Forum in Mexico City. Inscription reads: "Jose López Portillo Was Right: Mexico Needs 20 Nuclear Plants."

'ONLY ANIMALS SAVE WATER; HUMAN BEINGS GENERATE IT'

So polemicized a giant banner deployed by the Mexican LaRouche Youth Movement outside the March 16-22 Fourth World Water Forum in Mexico City, which brought together several thousand government officials and experts from 140 countries. Amid stultifying discussions on how to conserve, put a value on, and privatize the dwindling fresh water resources of the world, the Mexico City youth intervened like a cool drink on a hot summer's day, calling for nuclear-powered desalination of sea water and large-scale water diversion projects. One of the youth paraded around the conference site dressed as a nuclear cooling tower.

Four of the youth attended the closing ceremony, where they unfurled two giant banners and sang a song composed for the occasion by Laura Flores, to the tune of the American civil rights song "Oh, Freedom":

Let's make water,
Drinking water,
Let's make water from the sea,
And before I'll be a camel
I prefer to be a human
And make water from the sea
To live.

Nuclear power
Nuclear power
Don't be fearful about it,
And instead of saving water
We should start desalinating
And make water from the sea
To live.

CHINESE SPACE OFFICIAL WARNS: 'A CLOSED SOCIETY WILL BE LEFT BEHIND'

From the 1950s through the 1970s, China was a closed society, China's National Space Administration Vice Administrator Luo Ge told a Washington audience April 3. During trips to the United States in the following two decades, Luo said he admired the openness of this country. "Now it's the other way around," he remarked, in reference to the American refusal to cooperate with China in civilian scientific space programs. Luo spoke at the Center for Strategic and International Studies, after a meeting he had held earlier that day with NASA Administrator Mike Griffin.

Luo summarized China's plans for the unmanned exploration of the Moon, a constellation of disaster-monitoring satellites, and the development of a heavy-lift launch vehicle, which he described as "non-polluting," which most likely means it will use more energetic and advanced liquid hydrogen for fuel. There have been strong reactions in the U.S. Congress to China's announcement that it plans a manned lunar landing in around 2017, which is similar to the date planned for the U.S.manned return to the Moon.

This is the first electron micrograph of the Ebola Zaire virus, causative agent for ebola haemorrhagic fever. It was taken in 1976 by Dr. F.A. Murphy.

SCIENTIST CALLS FOR EBOLA VIRUS TO WIPE OUT 90% OF POPULATION

Asserting that human overpopulation was ruining the planet, ecologist Eric Pianka invoked a pestilence, in the form of an aerosol-spread form of Ebola virus, to sweep 90 percent of the population from the face of the Earth. Pianka made the comments in an address to a meeting of the Texas Academy of Sciences held March 3-5 at Lamar University, where he received the 2006 Distinguished Texas Scientist award. The gruesome speech, bolstered by a powerpoint presentation including blood, skulls, and the Four Horsemen of the Apocalypse, was given a rousing ovation by the audience of scientists and students!

Although that portion of the program was not recorded, at Pianka's request, a member of the Texas Academy of Sciences, Forrest M. Mims, took copious notes and snapped a picture of the maniac. Mims's account of the event was printed in one local Texas newspaper, and on his online magazine, *The Citizen Scientist,* and can be viewed at: www.sas.org/tcs/weeklyIssues_2006/2006-04-07/feature1p/index.html.

CHINA BEGINS TESTING SUPERCONDUCTING FUSION TOKAMAK

The Institute of Plasma Physics, under the Chinese Academy of Sciences, recently announced successful initial testing of several crucial components of its newly constructed Experimental Advanced Superconducting Tokamak (EAST). EAST will be the first full superconducting experimental tokamak fusion device in the world. The superconducting magnets will confine the fusion plasma.

The project under way in Hefei, Anhui Province, is an upgrade of China's first such experimental device, the HT-7, which was built in partnership with Russia, in the early 1990s. Discharge tests are planned for July or August of this year, and are expected to produce of 50-100 million°C temperatures sustained over 1,000 consecutive seconds. EAST will prepare China for its participation in the International Thermonuclear Experiment Reactor, or ITER, which includes Russia, the United States, the European Union, South Korea, Japan, and India.

Institute of Plasma Physics

China's newly constructed Experimental Advanced Superconducting Tokamak (EAST) is gearing up for high-temperature discharge tests in July.

PRODUCTION OF NEUTRONS FROM PYROELECTRIC 'DOUBLE CRYSTAL' FUSION

Researchers at Rensselaer Polytechnic Institute announced the development of a tabletop device that produces thermonuclear fusion at room temperature on Feb. 13. Fusion is produced by accelerating deuterium ions in the charge produced between two pyroelectric crystals. This very simple device might have practical applications in laboratory and sensor technology.

Pyroelectricity is the phenomenon known since ancient times, by which certain crystalline minerals, such as tourmaline, produce a difference of charge on opposite faces when heated. Research by Paul-Jean Curie and Pierre Curie in the 1880s showed that 10 of the 32 crystallographic classes exhibit pyroelectricity. In the course of the research, a related new phenomena, piezoelectricity (the generation of current by pressure on the crystal faces) was also discovered.

To produce fusion, the Rensselaer group heats two opposed lithium tantalate crystals of about 1-cm thickness in a small vacuum chamber containing deuterium gas. The crystals are heated to 130°C, and then cooled to room temperature. The resulting electric field pulls electrons off the gas molecules, and accelerates the remaining deuterium ions into the negatively charged crystal face, which contains a deuterium target. Neutrons of 2.45 MeV, characteristic of deuterium fusion, are detected.

The idea of using the high charge density obtainable from pyroelectricity to accelerate deuterium ions was proposed in 2002 by Seth Putterman, a sonoluminescence researcher at the University of California at Los Angeles (see *21st Century,* Winter 1991). Funding for Putterman's proposal was rejected in May 2002 by the University of California Energy Institute. Although peer review found the proposal workable, it was rejected because it was "more of a science proposal than one that has direct relevance to an energy problem."

GREENLAND ICE SHEET GROWING; GLOBAL WARMING PROPAGANDA, TOO

The Greenland ice sheet increased slightly in mass from 1992-2002, according to a study published in the *Journal of Glaciology,* Vol. 51, No. 175, 2005. The East Antarctic ice sheet also increased in mass, but a greater decrease in the West Antarctic ice sheet means a slight net decrease in global ice mass over the 1992-2002 decade. The study by H. Jay Zwally, et al. is based on the most precise satellite altimetry data ever gathered, using the European Remote-sensing Satellites ERS-1 and 2, and other observations.

The net contribution to global sea level of the decrease in ice mass comes to +0.05 millimeters per year, with an error margin of ±0.03 mm. Thus, if current tends were to continue over the next century, the resulting rise in sea level would amount to between 2 and 8 millimeters, or less than one-third of an inch. However, any such extrapolation from a decade-long statistical trend is meaningless. Three astronomical phenomena suggest that the Earth is moving towards an Ice Age: Northern Hemisphere Summer is occurring near aphelion; orbital inclination is high at 23.5 degrees; and ellipticity is moderate. These long-term trends situate the Earth about 11,000 years into an approximately 20,000-year-long interglacial. Climatic optimum was reached nearly 5,000 years ago, and the Earth has been cooling since.

home.earthlink.net

The southern end of the Greenland ice sheet. Global warming hot air has not prevented the Greenland ice sheet from expanding over the last decade.

IN MEMORIAM

Gloria S. Farley (1916-2006) A Lifetime of Discovery

by Julian Fell

Gloria Farley died on March 18, 2006, after a long illness.

She was born and grew up in Heavener, a small town in eastern Oklahoma near the border with Arkansas. It was a recently settled frontier community in what was previously Choctaw lands, and her father was the local physician.

She exhibited a curious, exploring nature right from the start. A local resident knew of an inscribed rock on a nearby mountain and took his daughter and her friend, Gloria, to hunt for this peculiar rock. Young Gloria noted the letterings. A few years later she learned about the Runic alphabet, and realized that the inscription near Heavener contained Runic letters. Her common sense told her that the inscription was ancient, it was not fresh. The rock was too hard to make the inscription a casual piece of graffiti, and only someone familiar with runes could have created the letters.

No such person existed, or had recently existed, in the area. The Smithsonian had (without visiting the site) dismissed the inscription as the recent fabrication by a rune-savvy person. This did not correlate with the attendant circumstances, and young Gloria did not accept it.

Thus, unwittingly, Gloria as a teenager had exhibited the personality traits of a great mind of discovery. Curiosity, an eye for detail, the tendency to connect facts not originally believed to be related, and enough independence and self-confidence in her own rational deductions to reject the simplistic conclusions by professed experts. It has been my observation that innovative thinkers, explorers, and discoverers are born rather than made. Education is useful to these persons, but not nearly as important as their internal drive.

The 'Housewife from Heavener'

Gloria described herself deprecatorily as "the housewife from Heavener," which is about as accurate as describing Einstein as the junior patent clerk from Zurich. Gloria was the most successful locator and recorder of rock inscriptions in the south central United States, and thereby a major contributor to the discovery of prehistoric diffusion.

From Gloria Farley, *In Plain Sight*

Farley (lower left with sons Mark and Scott), at the Heavener Runestone in 1965. Farley first saw this stone as a teenager, and later when she learned about the Runic alphabet, she realized that the inscription on the rock contained some Runic letters. Inset is a drawing of the letters.

Starting in 1950, when she and her husband, Ray, returned to Heavener, and for 50 years thereafter, Gloria tracked down and recorded a huge number of inscriptions. Some she found herself, and others came to her attention by word of mouth. Her patience, innate friendliness, persistence, modesty, and unshakable reputation for trustworthiness enabled contact with the most reserved and private of land owners.

The ultimate measure of the contribution people make to the world is to compare the state of their specialty before they started to that after their departure. Gloria's specialty was history, or more precisely, the process of turning unknown pre-history into history. Regionally, her impact can only be characterized as massive. I personally would describe Gloria as being the right person in the right place at the right time.

Heavener may be considered a backwater locale, but it just happens to sit in the middle of a swathe of several rivers that provide access from the Atlantic and Mississippi to the mid-continental high plains, where mountains do not form a continuous barrier to transcontinental trekking. The ancients that followed these routes left behind an abundance of rock inscriptions that went unrecognized by untrained American experts. This region is one of the most heavily inscribed regions of North America. Fate, providence, provenance, or grand-design (take your pick) placed Gloria in the middle of this abundance with all the drive and interest to record it all.

What makes Gloria great? In few words, the sum of what she achieved over her lifetime. What made Gloria become great? It was a combination of traits: Insatiable intellectual curiosity. Common sense. Deductive and independent

thought. Trust in her instincts. Meticulousness in recording detail and noting attendant circumstances. No ego, acknowledging error and giving credit where due to others. Scrupulous honesty, trustworthiness, humility, and always keeping her word. Patience, long-term drive, workaholic habits. Unfailing cheerfulness in the face of private misfortune. Generosity and kindness to man and beast.

As Gloria's works accumulated, she attracted and joined a select group, of similarly innovative explorers, all with the highest of academic credentials, multi-talented and multi-disciplined. Among this crowd she was considered an equal, and in certain circumstances a leader.

Gloria and Barry Fell

Gloria shared a special relationship with my father, Barry Fell, and family as both a colleague and a personal friend. Barry had studied and deciphered ancient Mediterranean scripts, and was later astonished to discover that these same scripts were to be found in North America, and in locations all over the world. Gloria had been accumulating a massive record of inscriptions from Oklahoma and adjacent states, and among these were some very important ones. The pairing of discoverer and recorder with a translator was a natural result, and each greatly aided the other. There was a

Gloria Farley, Barry Fell, and the Role of The Amateur in Intellectual Advancement

Barry Fell always had an historical view on life and his works, not seeing it as something of the moment but more as a moment in a long sequence of time. His books and papers are full of references to historic persons in advancing the subject under discussion. It added color to his writings. The persons he mentioned were innovators, independent, creative thinkers, and experimenters; and invariably their results were controversial. They were often in conflict with the inertia of orthodox beliefs, mostly held by the clergy and vested or entrenched interests.

In the past, there were few institutional career choices for those who made a living with their minds. There was the church, the military, or the administrative/political bureaucracy. These were bastions of conservative thinking. Holding ideas contrary to the conventions of the day was regarded as disloyalty, and risked a career stall or outright dismissal or expulsion. In turn, promotion and advancement meant complying with the opinions of those senior to oneself. For the last 150 years, the role of the church has been reduced and largely supplanted by academia, a mass of colleges and universities where the security of orthodoxy still rules, and inertial resistance to discoveries that contradict the dogma of the day is as firm as ever.

Major advancements, breakthroughs, and innovations come from persons who were curious, observant, creative, and possessing enough self-confidence to defend and promote their views in contradiction to the fads and prejudices of the day. Today we call these persons mavericks or outsiders. Historically, these innovators were mostly amateurs. By amateur, I mean the word in its original and proper meaning—literally, a person who loves their work and does it for this love.

The schools of orthodoxy have changed this meaning by using it as a term of disparagement implying incompetence, lack of skill or knowledge. They promote themselves by demeaning the competition. By using the term amateur, they label the works and the innovator as insignificant and inconsequential. In reality, the distinction of amateur and professional relates to sources of employment income, not to competence. The terms are used correctly in sports.

The whole process is perpetually dialectic. Conformance allows incremental change only. Radical advancement generates conflict until acceptance. Thus all creative innovators will face unpleasant controversy and remain outsiders, shunned by the minions and colleagues who remain silent so as to not endanger their career security. Being an intellectual leader is economically risky and requires courage. No person who is not independently wealthy chooses to be an outsider. The shunning—the slings and arrows and isolation—is not pleasant.

As an innovator, Barry found himself frequently in the role of outsider. Being under such attack generates a tough hide, and can cause outsider-amateurs to develop suspicious or cranky personas. Establishment archaeologists had no interest in Gloria's discoveries, and in her role of outsider she endured constant attacks, yet she remained constantly cheerful. She had a rebellious heart but it was couched in a sweet disposition.

As a biologist, Barry was very appreciative of the assistance, observations, and collecting by amateurs (lovers). They provided the distributional and behavioral information, particularly in regard to migrations. In no field are the observations of amateurs more important than ornithology. Amateurs collected much of the fossils and new species that Barry studied, and their role was always acknowledged in his papers.

In linguistics and epigraphy, amateurs have always been the leaders. No major decipherment has been the work of a mainstream historian or archaeologist: Champollion, Rawlinson, Ventris, Fell, Knorosov—amateurs all. *—Julian Fell*

huge mutual respect, and their correspondence was so huge that each had to keep their mutual files separate from their other correspondence, as the rate of expansion was disproportionate.

Gloria's book *In Plain Sight* (1994) stands as a monument to herself and a milestone in epigraphic discovery. It is my favorite book, not because of any outstanding event or discovery therein, but because it provides such a broad and thorough treatment of its area of specialty. It provides a unique picture of the process of epigraphic discovery.

The generous financial support of a sponsor enabled the inclusion of personal details and photographs, names and accounts of helpers, and biographies of principle participants of this era and process. It is not just a revelation of history. It is a history of the history, and in my view the most accurate and thorough account thereof. I am very pleased that it appeared in print in a preliminary form only days before my father's sudden death. I know from his notes, and comments to colleagues subsequently related back to me, that he was immensely pleased with the book.

Gloria is now internationally recognized and admired for her achievements. She is acknowledged in her hometown Heavener (and Oklahoma) as the person most responsible for identifying the runes of Oklahoma. She has been named as Oklahoma's "Woman of the Year," and is a member of the Oklahoma Women's Hall of Fame. Her Book *In Plain Sight*[1] is an epigraphic classic, and another is in preparation. She has published more than 95 papers in scientific and news journals, and she has herself been the subject of over 20 articles. She has held membership and officer position in numerous historical, epigraphic, exploration, and museum organizations.

Gloria's monument will be her books, her place in the discovery process, but I believe perhaps most of all it will be in the high opinion of her held by all of those that knew her.

Diffusionism Not a Fad

Diffusionism is not a fad. No one became a diffusionist because it is trendy. Diffusionists are currently outsiders, and pay a price for it. All the diffusionists that I have known came to the belief as a result of discoveries that were in conflict with the "Columbus was First" idea that we were all taught (or indoctrinated in) in school.

There is a plus side to being a diffusionist. Barry found himself in the company of like-minded individuals who had all made discoveries that contradicted the Columbus dogma. These were all brilliant minds in many fields, and when they gathered, a most intellectually stimulating session was created. These persons were mostly academicians, engineers, or professionals in some specialty (or several).

Gloria Farley was a natural (and most welcome) addition to this group. Gloria noted in her writings what great company she found herself in, and she acquired many lifelong friendships. It is also obvious from the profusion of remarks from these people, that Gloria was in turn held in the highest regard by them. The extent of her discoveries evoked awe and admiration, and she was most pleasant company.

Julian Fell, a marine biologist, has written two parts of a biography of his father, Barry Fell, which appeared in 21st Century, *Winter 1999-2000 and Summer 2001. A third part is forthcoming.*

Notes

1. Gloria Farley, *In Plain Sight: Old World Records in Ancient America*, (Columbus, Ga.: ISAC Press, 1994), hardcover, 483 pp., $37.00. A review of *In Plain Sight* appeared in the Summer 1999 issue of *21st Century.*

We Can Solve the Water Problem!

by Creighton Cody Jones

In the Fall of 2005, the LaRouche Youth Movement began a project to break through the popular misconception that economics is primarily driven by monetary processes, by developing animated representations of the physical economy. The challenge was to get across the higher conception of the way in which breakthroughs in the human creative process act upon living and non-living nature to transform the Noösphere and Biosphere. This is an essential step in organizing the population to understand why they must fight for a science-driven economic development program, as the only path to survival.

Since that time, alternating four-person teams from our youth movement have been working in concentrated two-week periods on a mapping/animation project. We began by gathering statistics on some basics of the U.S. physical economy over long historical periods, including the spread of population from the East Coast inland and the development of the national railroad grid, and developing these into computer animations.

Recently, the animation project turned its focus to the world water crisis, which Lyndon LaRouche identified as one of the key problems of human survival that must be addressed. The main perspective we started with came from some of the more recent writings by LaRouche. One of the first things we did was to read through some of the relevant sections in his paper "Economy Despite Alan Greenspan: What Connects the Dots,"[1] where he defines the problem of economic animations.

Robert Detloff/EIRNS

Cody Jones: "We've got the solutions."

The greatest challenge comes in portraying those upshifts and downshifts of a transcendental nature, which are the actual driver of economic advance or decline. We also were looking at LaRouche's "Vernadsky and Dirichlet's Principle"[2] and his "Science: The Power to Prosper"[3] paper.

Of special relevance there, is the question of what occurs when you take a productive process, say, some kind of manufacturing, and move it to a location with lower wage levels and less development of productive infrastructure, as has become the pattern under globalization. Effectively, you have moved into a lower economic potential field. So, even though you may have the exact same technology operating at the point of production, by virtue of it existing in a lower potential field in respect to the economic infrastructure—including skill levels and general infrastructure development—you've actually lowered the productive potential of the economy, overall, worldwide.

SCIENCE and the LaRouche Youth Movement

You see that in Mexico, in the water crisis which is part of the general economic crisis facing Mexico. But, what we've found is that the same thing is going on within the United States itself (Figure 1). One of our team has an animation in the works which is particularly looking at the High Plains aquifer. We also have the data for county-by-county across the country, of groundwater level readings.

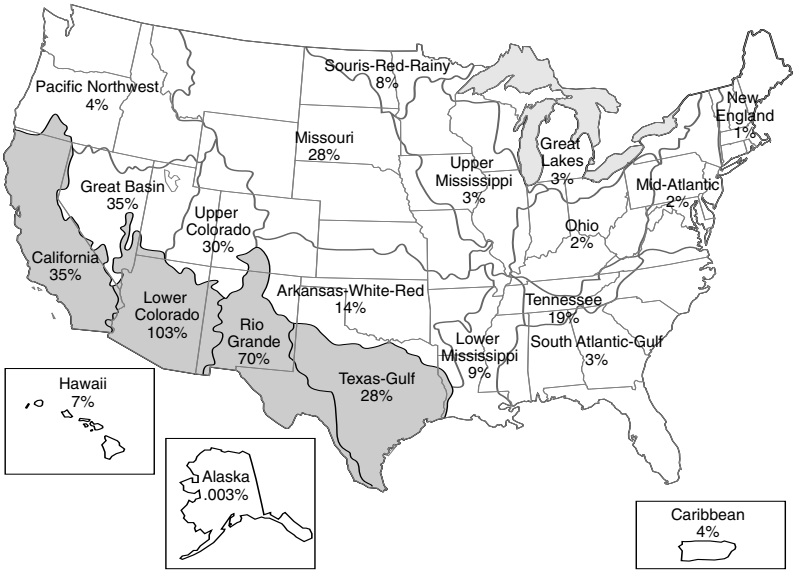


Figure 1
UNITED STATES WATER STRESS (1995)
Average U.S. water stress is 6 percent; excluding Alaska, it is 9 percent.
Source: United States Geological Survey

Water and Economic Health

In some areas, there were really drastic drops in acceptable groundwater levels, particularly in the High Plains aquifer. In West Texas, farmers have had to shift to what they call "dry farming," because the cost of accessing the water is beyond any kind of profit level for the crop produced. This means a shift in crops to such things as cotton—not exactly something that's going to feed hungry people in Detroit.

As the water level drops, you have to go deeper to get it, which means using a

lot more power, electricity, to run the pumps to bring the water up. You also have a situation where the deeper you have to go, the longer it takes to bring the same amount of water to bear on your irrigation. And so, as these aquifer levels drop, you're reaching a situation where you're actually operating in a much lower potential field. If you combine the fact that you have to use more energy to get the water, and it takes longer to bring that same amount of water to bear on your irrigation process, plus the fact that energy costs are going up—we're reaching a point where it's just not economically viable for these farmers any more, to continue the same kind of irrigation and crop growing that they once had.

We've got the data collected on irrigation density for farming. And what you'll find is that the most productive farming takes place under conditions of irrigation as opposed to just reliance on rainfall. We're talking about the breadbasket of the country, and at one point, much of the world: where you just don't have the farming going on, and the density of farming that you once had, to be able to really support a hungry world population.

SCIENCE and the LaRouche Youth Movement

So, one of the things we're working on is a 3-D animation of the United States, where 1949 will be base levels: You'll have a flat United States. And over time, you'll start to see the country depressing—morphing down—as a function of the lowering of the depth to which you have to go to access groundwater.

One of the problems we've run into, is that the statistics and data, really haven't been collected in the way that is needed, up to this point. For example, some of us went to the U.S. Geological Survey (in Reston, Va.) for help with maps and data. One person found that when he explained the project we're engaged in, of tracking collapsing water levels and aquifers, the response was something to the effect of, "Oh yeah, this is something we've been wanting to do for 100 years." That gives you an idea of some of the problems that are out there.

All Aquifers Are Not Recharged

Another problem we found was in the oversimplified assumptions made about the question of recharge. Looking at some of the studies, you see they're very open about it: "Well, we assume that if so much water comes down in rain, you're going to have this much evaporation; some of it's going to make it into streamflows; and then this much is eventually going to make it in to recharge the aquifers." They use this kind of linear statistical modelling, which may be 100 percent off.

As Lance Endersbee wrote in his book *A Voyage of Discovery* (see article, p. 20), in many places the concept of recharge from rainfall and from river runoff is totally bogus; it doesn't exist. As Endersbee showed in a location he studied in Australia, the water comes from deep in the Earth, and was formed a long time ago. He actually talked about this kind of bubbling up from the core of the Earth, in the form of plasmas, where you actually then start to see the forming of water as it makes its way up to accessible layers in the aquifers.

So, in some places the water may be absolutely non-rechargeable by rainfall, but solely as a geothermal process. And this really does intercept our efforts to look at physical economy from the standpoint of Vernadsky, of the interaction of human noetic processes with the biosphere.

We saw the same thing in the studies of recharge by the Mexican water authority, where they're looking at the percentage of water being taken for irrigation and other purposes, away from the recharge levels. Well, they're assuming that this recharge is taking place. Now, it very well may be the case, that it's not taking place.

In California, there is the Central Valley aquifer. Now the most recent data they have on water levels for this aquifer, are from 1985! This is on the website. And they talk about studies done in 1985, which say, "Well, we probably have enough water in the aquifer to continue irrigation through the year 2010"! Right? Four years from now! And, as far as I know, nothing's really been done to address that.

There's the other problem down around the Imperial Valley, where bills were passed, including by our Congressman in southern California—we call him "Drunken" Hunter—to take water away from the irrigation there, from the Salton Sea, and pump it into San Diego, just to meet the demands of the growing population for simple drinking water.

We've Got the Solutions

So, we're really careening towards a cataclysmic crisis in food production and accessibility of water, and it intersects the energy crisis, because, if you don't have the energy, you can't continue to do the pumping.

But we've got the solutions. Most of them have been on the books for a long time. If you get nuclear desalination, you can overcome both these problems: You'll have the abundance of energy, and you'll have the ability to get fresh water by desalination. And we can bring in the North American Water and Power Alliance (NAWAPA) project (Figure 2) to bring melt water down through the Rocky Mountain Trench from Alaska and Canada. This plan has been around since the 1960s.

The Metropolitan Water District of Southern California commissioned a report back in 1993, calling for the development of desalination projects. General Atomics, based in San Diego, then came up with their study—they'd actually done the study several years prior to that—which concluded that the best form of desalination was nuclear. They looked at the different alternatives, such as using diesel power, and the various methods used in Saudi Arabia and elsewhere, and they concluded that the safest, most environmentally friendly, and cost-effective method was nuclear desalination.

But, none of this was ever implemented.

So, you've got all the solutions on the books, like the NAWAPA, which has been around for half a century. Getting it done now really comes down to a political question. And that's where we come in. In California, four LaRouche Youth Movement members who are on the Central Committee of the Los Angeles Democratic Party have formed a grouping of young Democrats, with support from the party, called the FDR Legacy Club. Our aim is to educate party members and voters on the economic program we need for the 21st Century, and especially to get them to learn how to think about it. We have to turn around 40 years of brainwashing and demoralization of the Baby Boomer generation, which turned against science and industrial technology. Nuclear power, a modern national rail system with electrification and maglev, and large-scale water projects are all part of this.

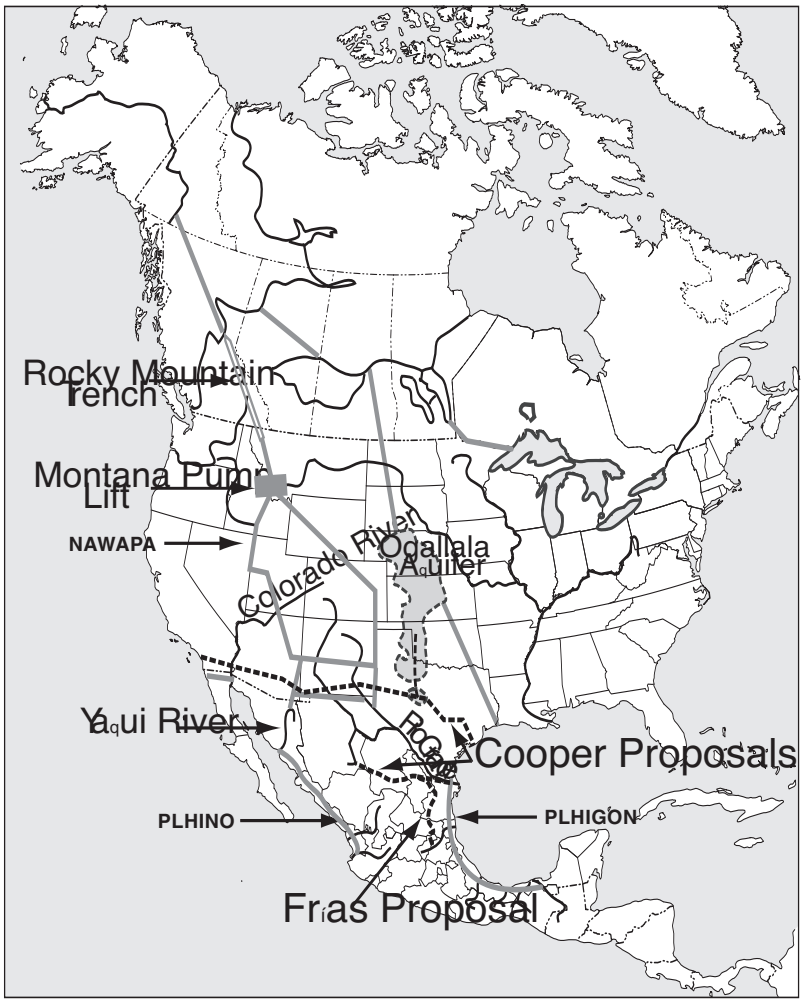


Figure 2
NORTH AMERICAN GREAT WATER PROJECTS

The map combines the proposals of the North American Water and Power Alliance (NAWAPA) study to bring abundant runoff and melt water from Alaska and the Canadian Rockies to the U.S. Southwest and high plains, with several Mexican proposals. These include the PLHINO (Plan Hidraulico del Norte) which delivers water from the southern states of Sinaloa and Nayarit to the agricultural state of Sonora, and the PLHIGON (Plan Hidraulico del Golfo Norte) which carries water from the water-rich jungle region of the Tehuantepec isthmus to Mexico's Gulf coast. From there the Frías and Cooper proposals deliver it to dry interior areas.

Sources: Parsons Company, "North American Water and Power Alliance Conceptual Study," Dec. 7, 1964; Hal Cooper, Manuel Frıas Alcaraz; EIR

Allying Scientists and Labor

We'll be bringing in scientists and labor leaders, whom we already have contact with, to help us. I've talked with one auto union leader who's really excited about coming out to California, and helping us jump-start the work with the unions. We've created the political infrastructure where we can revive the same kind of thing that, I understand, existed with the Fusion Energy Foundation in the 1980s. We start bringing together these scientists, with the unions, with the laborers, with the political forces, with the elected officials. And then, through the Youth Movement, we are going to have this ability to start to bring all this back together.

So, when I get back to California, we're going to contact the people we know in science and industry, to see what they have, and to start to set up forums, where we bring in our political contacts, people from the Democratic Party. Particularly as we get these animations moving, we can present the crisis; present the proper epistemological focus through LaRouche and his ideas; and then bring in these scientists, bring in these laborers, to discuss the solution, to discuss the viability of the solution and to discuss the viability of the technology, and what's out there. And then, the ball's really in the court of the political institutions as to whether or not they're going to make the moral decision to do what's right.

We've got similar potential in Texas, where our Youth Movement is active. In west Texas, the University of Texas of the Permian Basin and General Atomics have just signed the contract to build the first research facility for a high-temperature gas-cooled reactor. [See p. 53.] We've got a potential for a broad political alliance around the development of nuclear power and water desalination. Typical is a farmer we know out there. He's a Republican, but he's all jazzed up about working with LaRouche around the farming situation and water crisis there.

So, you start to bring these networks together: You've got these farmers, and these political networks. You bring them together with what's going on in the scientific and research and development facilities in developing the technology for nuclear desalination. Then you can really start to build a real base and a real political force to start moving things. So, that's definitely going to be the direction we're going to move things in the coming days, weeks, and months ahead.

Creighton Cody Jones is a leader of the LaRouche Youth Movement in California and a member of the Central Committee of the Los Angeles County Democratic Party. The article is adapted from a presentation he made in Leesburg, Va., March 25, 2006.

Notes

1. Lyndon H. LaRouche, Jr. *Executive Intelligence Review,* Feb. 17, 2006. (www.larouchepub.com/lar/2006/3307connect_dots.html).
2. Lyndon H. LaRouche, Jr., *21st Century,* Winter 2005-2006. (www.larouchepub.com/lar/2005/3222vernad_dirichlet.html).
3. Lyndon H. LaRouche, Jr. *Executive Intelligence Review,* Apr. 16, 2005. (www.larouchepub.com/lar/2005/3217science_prosper.html).

The World's Water Wells Are Drying Up!

by Lance Endersbee

An Australian civil engineer and tunneling expert reviews the disastrous state of world groundwater, and shows why it is often not replenished by rainfall, contrary to the textbook models.

Jack Dykinga/USDA

G. Bizzarri/FAO photo 17187

Around the world, groundwater from deep wells is the main source of drinking water for more than three billion people. In addition, a large proportion of the food supply in many poor countries is based on irrigation from wells. However, almost all of the world's wells have falling water levels, and declining yield, and already, many have run dry.

These deep water wells cannot be replenished from rainfall. The source of the groundwater that supports these three billion people lies in the interior of the Earth. There is a continuing release of water from the interior towards the surface of the Earth, and we see that in the steam of volcanoes, and the

Professor Lance Endersbee is a former Dean of Engineering, former Pro-Vice Chancellor of Melbourne's Monash University, and a world authority on rock behavior and tunnelling.

This article is adapted from the first chapter of his new book, *A Voyage of Discovery: A History of Ideas About the Earth, With a New Understanding of the Global Resources of Water and Petroleum, and the Problems of Climate Change,* which is available from the Monash University Bookstore website, http://bookshop.monash.edu.au. It is used here with the kind permission of the author.

water gushing from deep ocean vents. Over geological time, some of the rising water was trapped in the path towards the surface of the Earth, and accumulated as underground reservoirs of water.

There are resources of groundwater underlying most of the flat lands of the world. From early times, men dug wells by hand, and lifted water in buckets for their needs. Many civilizations were established where groundwater was available at oases or in shallow wells. The ancient Romans built aqueducts to bring springs of groundwater to their many cities around the shores of the Mediterranean. Vitruvius, a Roman engineer and architect, describes in his book, written in the First Century B.C., the methods the Romans used to find and test underground sources of water. He tells of the adverse properties of some spring waters. There are cautionary tales about a little well at Susa, the capital of Persia, where those who drink of the water lose their teeth, and a well in the Alps where those who drink the water immediately fall lifeless. There are also wells with healing properties, such as the acid springs in Campania that have the power to break up stones in the bladder. Vitruvius advises on the tests for good water: The first test is to look at the physique of the people who dwell in the vicinity!

Conti/FAO photo 17886

Around the world, ground water sources are drying up. Here, clockwise: A woman draws well water in Zambia; a village water well in India; a Pakistani farmer pumps underground water for irrigation; and Mexican farmers walk in a dried up irrigation ditch near Rio Bravo, during the 1996 drought year.

Courtesy of Lance Endersbee

Today, in the United States, groundwater provides drinking water for over one half of the population. The same applies in much of Europe, India, China, and many other countries.

The pattern of dependence on groundwater that had continued for centuries began to change from about 1950. The population of the world was continuing to increase, there was growth of cities and expansion of city water supplies based on the use of groundwater, and in rural areas there was the introduction of mechanical pumps and commercial agriculture based on groundwater. As a consequence, there was a simultaneous and rapid growth in the use of groundwater all around the world. In countries like India and China, in North Africa and the Middle East, the use of shallow hand-dug wells, and hand lifting of water, was replaced by drilled bores and mechanical pumps. The use of fertilizers enabled a very great increase in yield, but that required much more water. There was a vast increase in the areas under irrigation from groundwater.

There was a rush to exploit the limited groundwater resources. The groundwater was freely available at the cost of a bore and a pump. There was competition to use more and more groundwater. Water tables dropped, and farmers drilled deeper bores, and installed more powerful pumps. Almost simultaneously, all around the world, the wells began to run dry, and governments were quite unable to control the extraction of groundwater, or protect the resources.

Most governments did not know where the wells were, or the depth of the wells. Governments did not record water levels, but were certainly informed when farmers complained when their wells ran dry. Farmers, governments, and their professional advisors, had all believed that the wells would flow forever.

The groundwater rush was like a gold rush; it was a great uncontrolled bonanza. The International Water Management Institute has estimated that the total global withdrawal of groundwater is now about 1,000 cubic kilometers each year, but it is quite unsustainable. This great global rush to exploit available groundwater resources in our time is a one-off extraction of a limited natural resource.

Groundwater has been, and in many areas still continues to be, the best and only readily available source of clean drinking water. This is because the groundwater may be just directly below the place of use, for agriculture, cities, factories, and mines. In most cases the groundwater is available at no cost, except for the cost of the well, and the pump.

The groundwater in these underground reservoirs has accumulated in geological time. The resource can be considered as a great reservoir of water that has been captured in open joints and fissures in the rock, and in pores in porous rocks. In the natural state, prior to intervention to exploit the resource, the underground reservoir was filled to the brim, and overflowed naturally at springs, and into lakes and streams.

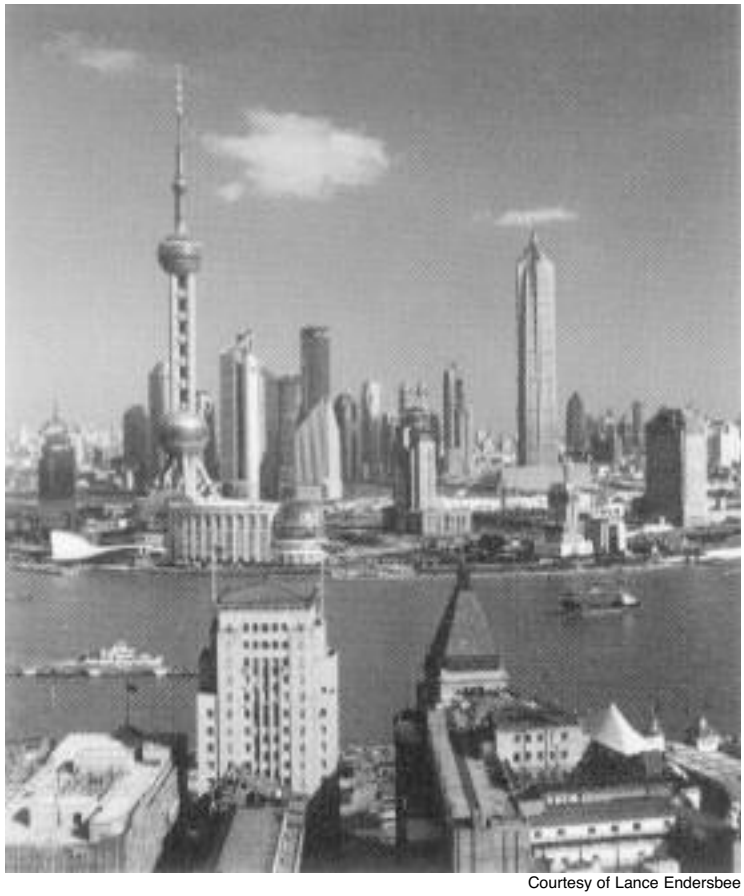
Prior to 1950, most of the world's groundwater basins were

in a condition close to a state where the rate of use of the groundwater was compatible with the sustainability of the resource. After over half a century of massive exploitation, far greater than any possible rate of recovery, most of the groundwater basins of the world are now close to the limits of the resource.

The consequences are now evident in many countries. In essence, the world has been exploiting the reserve bank of groundwater at a rate far greater than the rate of natural replacement, and the water bank is becoming insolvent. This excess use of water is a deficit that can never be repaid in our time.

The deficit in the groundwater bank is also being matched by a deficit in the food it provided. Thus the present prosperity in much of the world is based on *borrowing from the bank of water,* which is also, in essence, *the borrowing of food from the food bank,* neither of which can be repaid. As a consequence there has been an artificial stimulus of food production in many countries where groundwater enabled food production to be raised well above sustainable levels.

The U.N. Food and Agriculture Organization even suggested that the rapid exploitation of groundwater has *saved* the world from a food crisis. But if countries have been *borrowing water on credit,* and effectively, *borrowing food on credit,* it means that the world is facing the prospect of *an even more serious food crisis.* This prospect is already highly evident in some countries as they try to rapidly expand food production from resources of surface waters, especially in China, and India.



Courtesy of Lance Endersbee

View of Shanghai's Pudong New Area, from across the river. The load of the new buildings on the saturated sediments, together with groundwater pumping, is leading to a subsidence of the area by about 3 cm per year. It has been reported that 46 cities in China are sinking, because of settlement under load and excessive pumping of groundwater.

China's Water Crisis

China is heavily dependent on groundwater. Most of the flat areas of China overlay groundwater basins, and the groundwater is being extracted for water supply for cities, industries, and agriculture. The northern agricultural areas of China are virtually drying out: The major rivers have ceased to flow in the dry season. The water table under the North China Plain, which produces half of China's wheat, and a third of the corn, is falling at an alarming rate. Under Hebei Province, in the heart of the North China Plain, the water level in the deep aquifer is falling at a rate of 3 meters each year.

The decline of the water table has led to wells drying up, and to deeper wells being drilled. The consequent increase in pumping costs has forced some farmers off their land, while the demand for groundwater for cities and industries has continued to grow. In Beijing, the new wells for the city water supply now have to reach 1,000 meters to tap fresh water.

The pumping of groundwater in the North China Plain has resulted in the entire area subsiding, with many funnels and sinks appearing on the ground surface. Cities are reporting substantial subsidence, complicated by the consolidation of the ground under the new high-rise buildings.

Shanghai started pumping groundwater for the city water supply in 1860. The old city of Shanghai sank almost 2 meters in the period 1921-1965. Subsidence is continuing, and the authorities are now trying to correct it by injecting water into the aquifers.

Such ground subsidence in densely populated cities has caused great economic losses, as well as presenting a hazard to buildings and people. It is reported that Shanghai has suffered economic losses estimated at $35 billion in the past 40 years due to destructive flooding and tidal effects caused by subsidence, probably mostly caused by groundwater extraction.

In the Pudong New Area of Shanghai there are a large number of new skyscrapers. Settlement of the new urban area is being recorded at about 3 centimeters a year. The foundation of the tallest building, at 420 meters high, sank by 6.3 centimeters in 2002. Most of that settlement is probably due to the great weight of the building, but extraction of groundwater would have contributed. It may be unfair of me to mention that during construction of a tower in Pisa in Italy, from the year 1173, it began to tilt in 1178, due to extraction of groundwater nearby. Construction continued intermittently in the tilted position until 1350. It became famous as the Leaning Tower

of Pisa. I am pleased to note that the buildings in Shanghai appear to be subsiding without tilting.

The urgency of the need to control the use of groundwater, and to provide other sources of water and food, has been recognized by the Chinese government. They are planning to build several new water projects, including two very large projects, one in China, and one in South East Asia to provide a food bowl for China.

In November 2002, the Chinese Government authorized the construction of a hugely ambitious water diversion plan to take waters from the Yangtze River system to the Yellow River.

The aim of the project is to divert water from the south of the country, where the rivers flow from the Tibetan plateau, to the areas of water shortage in the North China Plain, and to Beijing and other industrial cities in the north. There are three separate diversion systems. Construction of the first diversion system began in 2002, and is estimated to cost $19 billion, and will divert 13.4 billion cubic meters per year to north China. There are two more similar diversions in the total project.

The population of China is about 1.3 billion, and still growing at about 0.8 percent each year. That means an increasing demand for food. Even with the proposed water projects in China, there will still be a need to import food.

One prospective source of food for export to China is the Mekong Basin in South East Asia. The Basin begins where the Mekong River leaves the mountains at the Thailand-Myanmar border, and comprises the flood plain of the Mekong River in parts of Thailand, Laos, Cambodia, and Vietnam.

In 1956, a Mekong Committee, comprising representatives of the four riparian countries, was established with a secretariat provided by the U.N. Economic Commission for Asia and the Far East (ECAFE), in Bangkok. They studied conceptual plans that had been developed by the riparian countries with significant input from expert engineers from U.S. Government agencies (Corps of Engineers, Bureau of Reclamation, and Tennessee Valley Authority).

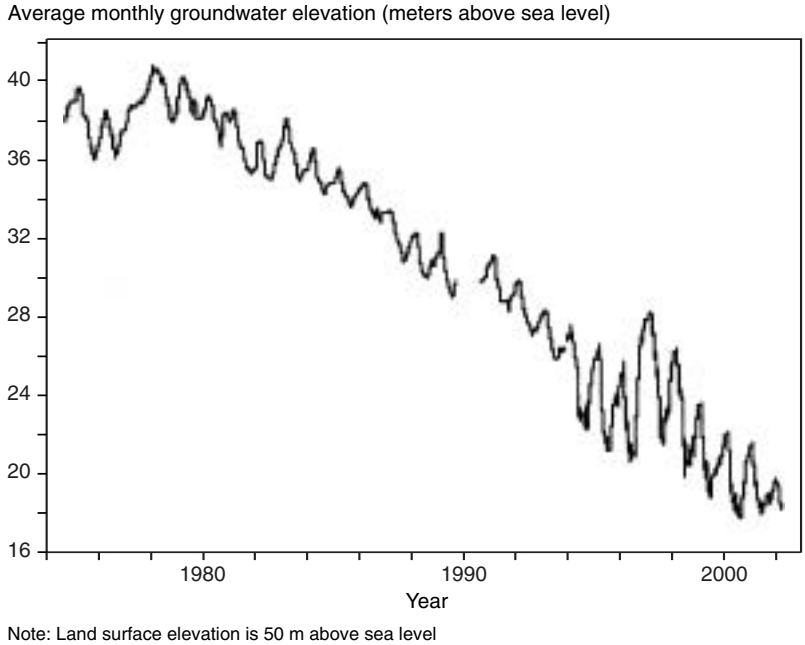
The conceptual plan was a vast scheme involving a cascade of seven dams on the Mekong River, associated hydropower, river navigation for 1,000 kilometers inland from the sea, the diversion of waters for extensive irrigation development throughout the Basin, the construction of many dams on tributary rivers, and water supply to cities and towns, and flood control.

In 1964, I became interested and involved in the Mekong Project when I went to Thailand as a U.N. advisor on dam design and hydropower. At the time, there was great enthusiasm to get on with the Mekong project, and wonderful international co-operation. Some excellent and extensive investigatory studies had been made on many aspects of the project by experts from friendly nations, all under the umbrella of the United Nations—for example: U.S.A, Japan, Israel, Australia, France, and other countries were active in programs of assistance in planning and evaluation. In addition, there were offers of support from many countries for participation in the construction of the project. Overall, it was a wonderful example of international co-operation in action. For my part, I was delighted to share in the work with my Thai colleagues, and to collaborate with experts from so many countries.

At the beginning of 1965, it all seemed to stop. The war in Vietnam halted any prospect of the project continuing, even on-site investigations on the main river dam sites. Shots were sometimes fired at the operators of drill rigs in the middle of the river, lessening enthusiasm for international cooperation. The World Bank was quite firm in refusing to fund any part of the project while hostilities continued.

Later, the terrible civil hostilities in Cambodia, especially the genocide, and the laying of a vast number of land mines, did not encourage any construction activity in that country for the foreseeable future. The effect was to stop all work on the key parts of the project—for 40 years.

Recently, the Chinese government announced an interest in funding and building the entire project, and sought the coop-



DECLINE OF WATER TABLE IN THE HEBEI PROVINCE, CHINA

The decline of the water table level at the Luancheng Agro-Ecological Research Station, Hebei Province, in the North China Plain. As the water table falls, springs have dried up, streams have ceased to flow, and lakes have disappeared. Out of 1,052 lakes, now only 83 remain.

Note that the level of the water table in 2002 was less than 20 meters above mean sea level. Seawater is now intruding into the lower aquifers.

EIRNS

The Mekong River rises in Tibet, and flows south through the four countries of the Indo-China peninsula, Thailand, Laos, Cambodia, and Vietnam. China has shown interest in reviving the Mekong Project, designed in the 1950s, which would build dams and hydropower plants to create a new food bowl for the world.

eration of the riparian countries. The Chinese were quite clear that they wanted to create a new food bowl for the world, and especially for China.

The Chinese government indicated that there would be no need for funding from international sources such as the World Bank, or the Asian Development Bank. The Chinese were prepared to fund the project and to undertake the design and supervision of construction of all the major dams and hydropower plants. The total cost of all those parts of the Mekong Project in the four riparian countries will probably be much more than $100 billion dollars. The offer of such large funds is a strong incentive to the riparian countries to accept the Chinese proposals. Of course the World Bank and the Asian Development Bank would also welcome the Chinese proposal, as it frees bank funds for other purposes.

Far upstream on the Mekong River, in China, near Tibet, the Chinese government is now constructing a 290 meter-high concrete arch dam project, which includes a large hydro-electric power plant. It will be the highest dam in the world. The project is likely to be followed by a cascade of hydropower dams down the river towards the Mekong Basin.

These two great projects to be funded by the Chinese government, the south-north river diversions in China, and the Mekong Project, illustrate the urgent concern about future food supplies for China, and the magnitude of the extraordinary problems that have been created by the exploitation of the Chinese groundwater resources towards extinction.

India— 'Where Has All the Water Gone?'

In India, there has been an enormous increase in irrigation from deep groundwater over the past 50 years. India is mining aquifer waters in virtually all states, and water tables are steadily falling, in some cases by 1 meter each year.

The population of India is well over one billion people, and increasing. There were 1 million wells with pumps in 1960. Now there are 21 to 26 million groundwater wells, with 55 to 60 percent of the population dependent on groundwater. The total use of groundwater is 200 cubic kilometers each year.

The Indian agricultural economy prospered from the benefits of this abundant, free, and clean groundwater. Groundwater irrigation expanded to create more agricultural wealth than any other irrigation source.

Irrigation from groundwater had many advantages. The farmers could use the groundwater when and where they needed it. The improved prosperity enabled them to use higher yielding crops, fertilizers, and pest control, making the use of groundwater far more productive, and thereby causing increasing dependence on groundwater. As a consequence, a great groundwater economy was created in India over the past 50 years. It has now reached its maximum level of development, and is starting to decline, rapidly in many cases.

The over-exploitation of groundwater has led to declining water levels, drying of shallow aquifers, and saline water intrusion. The deeper groundwater wells are highly mineralized, and in some parts of India, the population is now suffering fluoride poisoning and arsenic poisoning.

It is evident that India faces a terrible calamity as the groundwater economy limps to a standstill. Half of the country's traditional hand-dug wells have already run dry, as have millions of bored wells. Many farmers have borrowed money to spend on new wells, only to find that they did not flow. Because of the risks involved, the money had to be borrowed at high interest rates. The consequent inability to repay borrowings has led to suicides of farmers.

Urgent action is now planned by the Indian Government. They have approved a plan to use waters from the rivers flowing from the Himalayas for diversion south to replenish 17 southern rivers, and to be distributed over much of the Indian Peninsula. The project is based on using the waters of 14 tributaries of the Ganges and Brahmaputra Rivers.

The scheme involves some 300 reservoirs, 12,000 kilometers of canals, and will divert a total flow of 1,500 cubic meters/second. The estimated cost is from $70 to $200 billion. The proposed project has already caused tensions with Bangladesh, because it involves diverting rivers which flow through Bangladesh.

The Indian Government has formed a Task Force to imple-

ment the project, with a completion date of 2016. It will be an enormous task to complete the project in that time. On the other hand, the provision of a secure supply of water to the people of India is now a matter of crucial human and economic importance to the nation, and to the world.

Bangladesh—Arsenic Poisoning from Groundwater

Bangladesh has a population of 141 million, as of July 2004, and has the highest population density in the world, other than the city-states such as Hong Kong and Singapore. Yet Bangladesh is a rural economy with most of the people working in the agricultural sector. It is a low-lying country on the delta of the Ganges and Brahmaputra Rivers. About one-third of the country floods annually during the monsoon season.

Bangladesh came into existence originally as Bengali East Pakistan after the partition of India in 1950. It became a separate country in 1971, when it seceded from its union with West Pakistan. As an ethnic group the people are almost entirely Bengali, and 83 percent of the population is Moslem. Almost the entire land border is with India, and relations between the two countries are tense.

It is an extremely poor country. Until the 1970s, the people in the countryside were largely dependent for their water supply on surface water ponds and rivers. With increasing population, the surface ponds became highly polluted. Sewage bacteria unleashed water-borne diseases, which killed a quarter of a million children each year. The United Nations became concerned about this dreadful calamity, and the Children's Emergency Fund (UNICEF) sought to solve the problem by installing a great number of water wells in order to replace dangerous surface waters with clean groundwater.

The economic impact of the mass introduction of groundwater wells was quite dramatic. The contribution of groundwater to the total irrigated area increased from 4 percent in 1971 to 70 percent in 1999. Some 12 million wells were installed. Employment and output in agriculture increased, and poverty was reduced. The United Nations had saved the children.

The health problem seemed to be solved, but by 1985 the people were beginning to be diagnosed with arsenic poisoning. Arsenic is a slow killer, and the signs of poisoning are blisters on the palms of the hands and soles of the feet, which eventually become gangrenous and cancerous. Almost all the wells had traces of arsenic. In Bangladesh, almost all the rural water supplies, and most of the urban water supplies are groundwater based. This means that virtually the entire population is now exposed to some degree to arsenic poisoning; almost every one of the 68,000 villages in Bangladesh is at risk.

Corrective action is slow. The population has now been alerted to the problem, and the authorities are trying to identify the most contaminated wells. But there are about 12 million wells, and testing all of these may take decades.

But the situation is actually much worse. Further testing has shown that arsenic is not the only toxic metal in the groundwater—it is just that arsenic poisoning was the first to be revealed in patients. There are also unsafe levels of manganese, lead, nickel, and chromium. And now it has been discovered that a proportion of wells also exceed World Health Organization limits for uranium. . . . An entire population of over 140 million is slowly being poisoned in Bangladesh, and it is time for effective action.

In June, 2004, the Board of the World Bank provided a grant of US $40 million to the Government of Bangladesh to expand

J. Holmes/FAO photo 17283

A child in Bangladesh drinks from a water pump. A system of wells was built starting in the 1970s, to avoid the dependence on surface water ponds and rivers, which were polluted and spreading disease. But by 1985, people were beginning to be diagnosed with arsenic poisoning. Much of the well water throughout the country was found to contain unsafe levels of arsenic as well as other toxic metals. Effective action is now necessary to provide the countryside with safe drinking water.

Bangladesh is a low-lying country on the delta of the Ganges and Brahmaputra rivers. Extensive flooding occurs during the monsoon season, and pollution spreads throughout the surface waters.

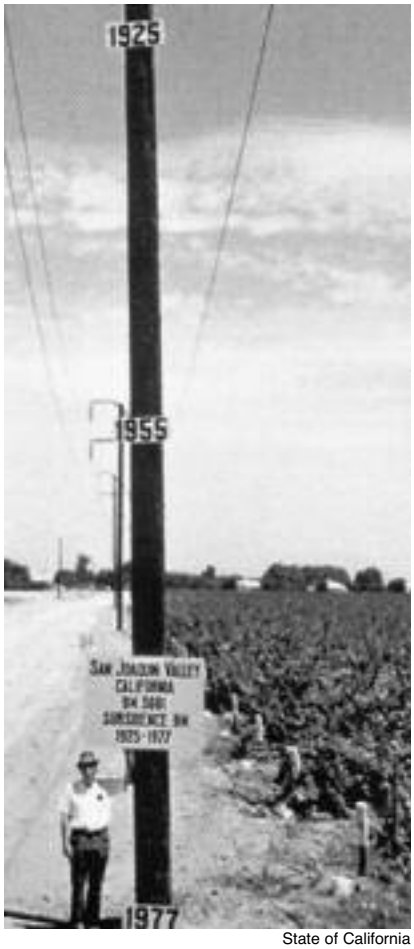
the provision of safe drinking water to some rural areas by promotion of piped water supply, but that is a small amount for the task when there are about 100 million rural people at risk.

I recall that in the early days of the United Nations, there was a wonderful spirit of goodwill between nations, and nations were prepared to give generously to support worthy projects. The gifts were often support in kind, such as construction, plant, and equipment, or sending a team of experts, or making donations of food to regions stricken with famine.

Bangladesh is in desperate need of international assistance if the problem of arsenic poisoning is to be corrected quickly. At present there is a tendency for the international community to stand back, and to fund *studies* of the problems, rather than intervening directly and solving the problems. An entire population of over 140 million is slowly being poisoned in Bangladesh, and it is time for effective action.

U.S.A.: Groundwater and Market Forces

In the United States, the state governments retain residual responsibilities for such matters as land and water. All states maintain their own legislation on water. In the case of groundwater, the property owner has an absolute right of *capture* of the groundwater under his property. This means that the land owner may pump as much water as he wishes, without incurring any responsibility, if his actions are found to be detrimental to his neighbors or the community as a whole.



State of California

This telephone pole in the San Joaquin Valley in California shows the level of the land in 1925, 1955, and 1977. Such subsidence is caused by extraction of groundwater, and arises from the closure of fracture openings and pore spaces in the rock. It is essentially irreversible.

Under state environmental laws, a state may establish controls to maintain groundwater quality, and that may influence well spacing and disposal of waste into the groundwater. But overall, throughout the United States, the state legislatures treat groundwater as a basic property right, and there is no control over groundwater withdrawal. Because of problems of depletion of groundwater in some basins, many states have established local district conservancy boards, which are self-governing bodies of users of groundwater. The boards are charged with responsibility to deal with all property owners in the management of the water resources. It is hoped that the problems will be solved by mutual agreement. Nevertheless, in any dispute, the legislatures and the courts continue to treat groundwater as a basic property right.

Even with the conservancy boards, the consequence has been a disastrous emptying of the nation's groundwater basins. In cases of dispute, the right of unlimited private use of groundwater is defended by the law!

Groundwater is the source of drinking water for about one-half of the U.S. population, including nearly all of the rural population. The pumps deliver in total about 50 billion U.S. gallons per day, or about 70 cubic kilometers per year. The problem is made worse by a continued quaint view in the groundwater profession that the aquifers are being recharged from surface rainfall. They use dubious mathematical models of groundwater flow to show farmers and cities where to drill more and deeper wells, but inevitably the new wells cause the water table to drop, while the wells decline in flow.

The reality is that the United States is coming to the end of the cowboy era of groundwater exploitation, and it is to be expected that the flow in all basins will gradually decline towards extinction. The evidence is clear.

There are reduced flows of water to springs, lakes, and streams. In the natural state, the small residual flow of groundwater came to the surface as springs, and as flow to streams, lakes, and wetlands. With the lowering of groundwater levels, the associated springs and streams cease to flow.

There is serious subsidence of land in many parts of the United States due to pumping of groundwater. In the area of Houston, Texas, groundwater pumping has led to subsidence at the surface of about 3 meters, together with a lowering of the groundwater level by about 120 meters.

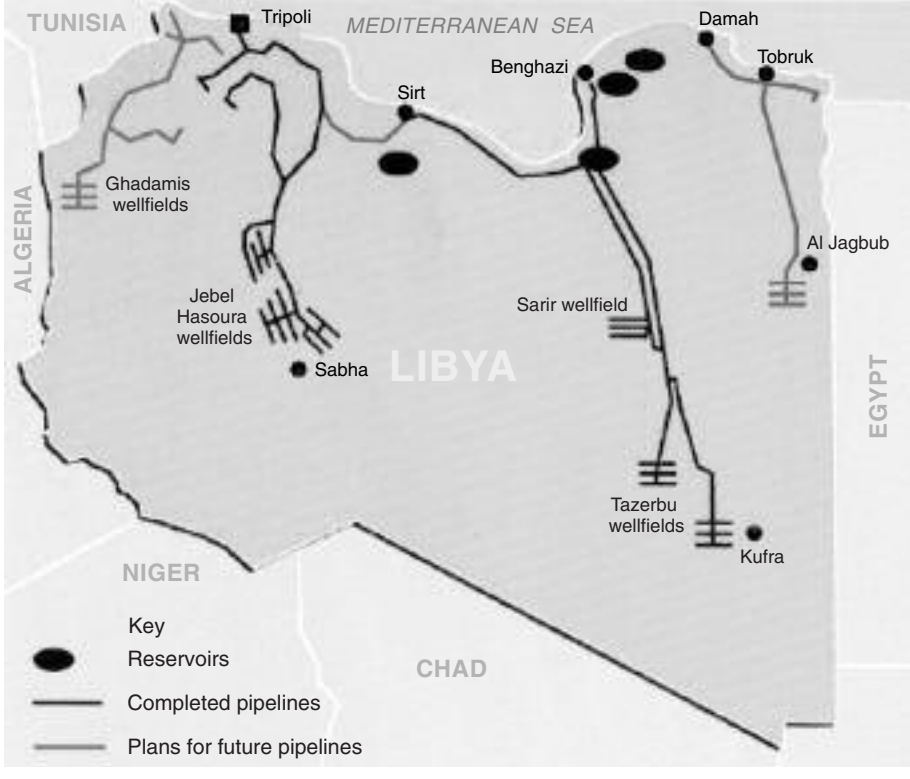
In the desert state of Arizona, there have been water level declines of between 100 and 200 meters over much of the area, and associated subsidence of the ground of 5 meters and more. Unequal subsidence and deep land fissures are a serious problem. (The following internet reference is informative, http://ag.arizona.edu/AZWATER/arroyo/062land.html.)

In 1952, I became familiar with problems being caused by land subsidence in the San Joaquin valley in California. I was with the Bureau of Reclamation in Denver, and the engineers in the Bureau were designing a canal system for the area to distribute surface water for irrigation. They had a problem with land subsidence that was being caused by extraction of groundwater. The land was subsiding at the rate of about 1 meter in three years, presenting major difficulties in the design of irrigation canals, which follow very flat grades. The subsidence continued for decades after, as the accompanying photo shows.

Government of Libya

Libya's great man-made river draws on non-replaceable reserves of fossil water, with the objective of reducing dependence on food imports and employing people in modern agriculture and industry. These pipe sections are 4 meters in diameter, made of pre-stressed concrete, weighing up to 80 tons.

The map shows the location of the major pipelines, taking groundwater from the Sahara to cities and farms along the Mediterranean coast.



In Kansas, groundwater accounts for 90 percent of the total water supply. It is the principal source for 600 public water supply systems, and most rural-domestic supply. Most of the groundwater is used for irrigation. Groundwater levels have dropped substantially, in some areas by over 200 feet. There are many similar examples in other states.

Virtually all of the drinking water in Florida is supplied from groundwater. The Florida aquifer system extends across the entire state of Florida, southern Georgia, and adjoining parts of Alabama and South Carolina. A major concern is the increasing contamination of the aquifer system as the water levels decline. There is intrusion of seawater into the aquifers along the east coast, and on the south coast along the Gulf of Mexico.

In Texas and Arizona, there are proposals to privatize the groundwater aquifers. This would absolve governments from the responsibilities for management of groundwater, and leave the matter to the private sector and the people to sort out. This seems a dangerous proposal in a country where citizens may own guns.

Subsidence of lands due to groundwater extraction is a serious problem in several states of the United States. Differential settlement, sometimes with cracking of the ground surface, and sinkholes, can cause serious damage in built-up areas.

Throughout the United States, the common law right of capture of groundwater is firmly entrenched in the minds of the people, and in legislation. Landowners protect their claim to capture by pumping the water. Consequently, there has been a race to the pumphouse. The race is now ending. From now

on, water supply will become a far more important issue for farms, cities, and states. Water supply for cities will become more expensive, and there will be pressures for transfer of water across state boundaries.

The rapid decline of groundwater resources in China and India has led to the governments of those countries moving to construct huge projects for the transfer of water to their cities and farms. Similar actions may be needed in the United States.

Libya—The Man-Made River

In the 1960s, during the exploration for oil in the desert in Libya, vast deep reservoirs of groundwater were discovered. Four major underground basins have subsequently been identified, and estimated to contain over 35,000 cubic kilometers of water, a truly huge volume of groundwater, if the estimates turn out to be close. The groundwater is recognized to be fossil groundwater, and there will be no effective recharge as the resource is exploited.

In 1983, the Libyan Government created an Authority to plan and build a great project to take waters from the aquifers in the desert in the south to the coastal plain, along the Mediterranean Sea, for irrigation and public water supply. The project involves 270 deep wells, and 4,000 kilometers of large diameter pipe, over 4 meters in diameter, all buried under the desert sand.

The entire project will cost about $27 billion, funded entirely by the Libyan Government from its oil revenues. The project is described as the Great Man-Made River Project. By 1996, a key stage of the project was reached when water was delivered to Tripoli, the capital of Libya.

Libya covers a large area, but the population is little more than 5 million. The construction of this project, funded entirely without overseas borrowing, is a most remarkable achievement. It is one of the largest construction projects ever undertaken. It was intended that the project would make Libya self-sufficient in food. Libya imports about 75 percent of its food. Irrigated farmlands are now being developed along the coast towards this purpose of self-sufficiency. But self-sufficiency in most foods may not be the most efficient and economical way for Libya to use these abundant new resources of groundwater. For example, it may be a great waste of water for Libya to grow cereals such as wheat, barley, and rice. These crops have high water demands, and are best grown in areas of sufficient natural rainfall.

There may be far higher financial returns, and far more employment, if Libya uses its lands, sunshine, and high-value water to grow higher-value foods for export to world markets, such as fruit and vegetables, and to support new industries based on these new crops.

A Brief Review of Some Other Nations

Yemen is a rocky barren country, with very little arable land, and a population of 20 million people. Groundwater was developed in the last few decades to provide water for urban areas, and for limited agriculture. The water table is now falling at 2 meters each year in the agricultural areas. The capital is Sanaa, and its groundwater level has been falling at 6 meters each year. This presents a very serious problem as there are no other supplies of groundwater, and virtually no supplies of fresh surface water.

Iran is a rocky country with limited areas of soils suitable for agriculture, and a population of 69 million. Iran is facing an acute shortage of water. In eastern Iran, villagers are leaving the region as wells run dry. It has been reported that in the fertile plain in the northeast, the water table has been falling by 2 to 3 meters a year.

Mexico. There are serious problems of water supply in some states and several cities, as aquifers are pumped dry. Mexico has a population of 105 million people, growing by about 2 million each year. The agricultural lands are deteriorating, and there is a drift of people to the cities, but the cities also have serious water and pollution problems. The government considers that lack of clean water is a national security issue. There have been serious problems of land subsidence in Mexico City for a long time, simply due to the weight of monumental buildings on the underlying clays. The subsidence is aggravated by groundwater extraction.

The World Groundwater Deficit: How Did It Happen?

The great magnitude of the problems caused by the depletion of the world's groundwater resources is abundantly clear. Yet except for China and India, there has been very little action by governments. In Australia, the government has recently issued a report recommending the use of groundwater to supplement surface irrigation in the Murray-Darling Basin, a vast flat area that is the food-bowl of the nation. The decision seems to have been made with no consideration whatever of the prospect of very serious damage of irrigation areas, due to land subsidence caused by groundwater extraction, or increased salinity in low areas, or earth fissures as in Arizona, and a firm conviction that recharge from surface rainfall would maintain water levels.

I believe that one reason for this inability of most governments to comprehend the situation lies in the nature of the professional advice they receive. I note that in the scientific and professional journals of the world, there is never any mention of world groundwater problems. The professional groups most concerned with water resources and groundwater are all strangely silent about the worldwide decline of groundwater resources. The textbooks on groundwater hydrology appear to be part of the problem: They all show mathematical models of groundwater flow based on the key assumption that the groundwater is recharged from surface rainfall. As a consequence, the related computer models of groundwater flow are very seriously misleading.

These days it is so easy for professionals to share ideas with colleagues all around the world, and one would expect that the serious matter of the worldwide decline of groundwater resources would command attention. But it does not. It is apparent that the main cause of the silence is that the present understanding of the origin of groundwater by the professions involved, is not all consistent with what is actually happening. The theory is not working out in practice. There is a global disaster, and the key experts are silent.

There is clearly a need for a new understanding of the origin of deep groundwater. It is hoped that this book may be a step in that direction.

Freshwater from Nuclear Desalination

by Christine Craig

A proven technology whose time has come.

IAEA

Japan began nuclear desalination in 1978 at the Ohi nuclear plant, and now 10 Japanese nuclear plants desalinate water on a small scale, mostly for in-plant use.

Early in the 1960s, foreseeing a time when freshwater needs would outstrip available supplies, the U.S. Department of Interior's Office of Saline Water (OSW) authorized funding for five research facilities to study and develop desalination technologies for the country. These facilities were strategically placed in Freeport, Tex.; Roswell, N.M.; Webster, S.D.; Wrightsville Beach, N.C.; and San Diego, Calif.

The Wrightsville Beach facility on Harbor Island, set up in the early 1960s, was dubbed the "world center for experimental development in saline water conversion," by the director of the OSW at that time, C.F. McGowan. Its mission was to study and assess the feasibility of a variety of possible desalination technologies—freezing, reverse osmosis (RO), electrodialysis, and distillation—of which the most promising were RO and distillation. While the lab was still in operation during the 1960s and 1970s, a huge sign covered the three freshwater storage tanks for the research station, proclaiming mysteriously: "Fresh Water from the Sea."

Desalination is by no means a modern concept. The importance of fresh water would be inescapable to any long-distance seafaring people. As Samuel Coleridge's ancient mariner lamented: "Water, water, everywhere, nor any drop to drink." Japanese (and undoubtedly many other) early mariners used heat evaporation and cooling condensation to provide emergency fresh water on voyages. Thomas Jefferson even wrote a technical paper in 1791 on an improved form of distillation process for desalination aboard ships. And with the advent of sea-going steam ships, desalination became absolutely necessary to provide the relatively pure water necessary for the steam process. Nowadays, regardless of what powers an ocean-going vessel, desalination of potable water is the norm, and eminently more sensible than trying to carry a hold full of drinking water across the wide ocean.

Nuclear: Perfect to Power Desalination

Modern desalination techniques require large amounts of electricity or process heat for large-scale production of fresh water, and nuclear power is the perfect candidate to supply it.

Nuclear desalination seemed a natural outgrowth of the potential envisioned for nuclear power by the Atoms for Peace Project initiated by President Dwight D. Eisenhower after World War II. In fact, in 1967, just days after the Six Day War, former President Eisenhower and Adm. Lewis L. Strauss, former chairman of the Atomic Energy Commission, proposed an ambitious program for development in the Middle East, which was an extension of Eisenhower's 1953 Atoms for Peace program. This program, called "A Proposal for Our Time," aimed at promoting peace and stability in a war-torn region by priming the pump with a massive infrastructure project to bring cheap fresh water to the region—a nuclear water-desalination project.

This proposal envisioned the construction of three huge, multi-purpose nuclear plants, two on the Mediterranean and one on the Gulf of Aqaba, which would be capable of generating more than a billion gallons of fresh water per day, using the well-studied distillation technique. At the same time, the plants could be used for electricity production in the region. Based on studies done by the Oak Ridge National Labs, Eisenhower was confident that the price of water generated at these facilities could be made cheap enough for agricultural use, making possible an agro-industrial oasis in the desert.

Early Nuclear Desalination Projects for America

As early as 1964, an announcement was made of a partnership among the Department of the Interior, the Atomic Energy Commission (AEC), and the Metropolitan Water District of California to study the construction of a 150-million-gallon per day (MGD) desalination distillation plant near the OSW test facility in San Diego. According to then-Secretary of the Interior Stewart Udall, "Preliminary reports indicate that a well-designed plant using nuclear energy can produce fresh water at seaside for 22 cents a thousand gallons and generate electric power for as little as 3 mills per kilowatt hour."

The Bolsa Island Dual-Purpose Nuclear Power and Desalination Project, as it came to be called, grew out of an early desire of the Metropolitan Water District of Southern California to explore desalination as a way to augment water supplies for the fast-growing region. It began preliminary studies in 1959, and in 1964 signed a contract with the AEC and Department of the Interior for joint feasibility studies, to be carried out by Bechtel Corporation, for a 50-150 MGD desalination plant coupled with a 750-megawatt-electric (MWe) nuclear plant.

During the study period, in 1965, two Southern California utility companies, San Diego Gas and Electric and Southern California Edison, plus the Department of Water and Power of the City of Los Angeles proposed to join the project, if the generating capacity of the plant were increased to 1,800 megawatts-electric. They would bear the financial responsibility for the generating plant, leaving the desalination plant costs to the Metropolitan Water District and Federal agencies. Bechtel Corporation was to be the project coordinator.

The group chose a unique site for the nuplex: Bolsa Island, a man-made island to be created for the sole purpose of housing the plants. The island would be built off Bolsa Chica State Beach, south of Los Angeles. The 1,800-MWe nuclear plant would be coupled to a multi-stage flash distillation (MSF) desalination plant, supplying up to 750,000 people with fresh water and electricity in the arid southern California desert.

By the 89th Congress, in September 1966, the Metropolitan Water District project was well along, and was touted as "the first dual-purpose desalting application of its kind and size in the world" in the Joint Committee on Atomic Energy hearings on the project.

The project was never completed.

U.S.-Mexico Desalination Plan

In 1965, the United States, Mexico, and the International Atomic Energy Agency signed an agreement to assess the technical and economic feasibility of a nuclear co-generating plant in northern Mexico producing electricity and desalinated water from the Gulf of California. The plans called for plants capable of producing 1 billion gallons per day of fresh water and 2,000 megawatts of electricity. In the near-term, two 5,000-MW-thermal light water reactors would be built by the mid-1990s. The desalination plant would consist of multi-stage flash distillation units. It was projected that a second phase of the project might utilize the newer liquid-metal fast-breeder reactors, which would reduce water costs. Capital costs were estimated at from $850 million to $1.2 billion.

One of likely sites proposed was El Golfo de Santa Clara on the Sonora side of the northernmost extent of the Gulf of California. Product water would be piped to reservoirs for storage, one in Mexico, and one on the U.S. side. The big worry in 1965 was: Who would use all that electricity? You can't store electricity as you can water. They considered replacing

How Desalination Systems Work

There are two main types of desalination technologies: thermal and membrane.

The thermal processes are elaborations of the basic evaporation/condensation cycles of water. Under partial vacuum, boiling will occur at lower temperatures, as at high altitude. Simple distillation, such as that used by higher-class liquor bootleggers, is energetically expensive relative to the amount of product. Coupling many evaporation/condensation stages in series, though more complex to construct and run, gives much more product for the amount of heat added. Even more efficiency can be added by carefully controlling the pressure in each stage to be lower than the last one. When properly designed, the process only requires heat at the first stage, and cascades through the other stages on that impetus, with product water and brine collected at each stage.

- **Multi-stage flash (MSF) distillation.** In MSF, saline water is sent through tubing from the last stage through the first, and into the brine heater, where heat is applied, usually from steam. The

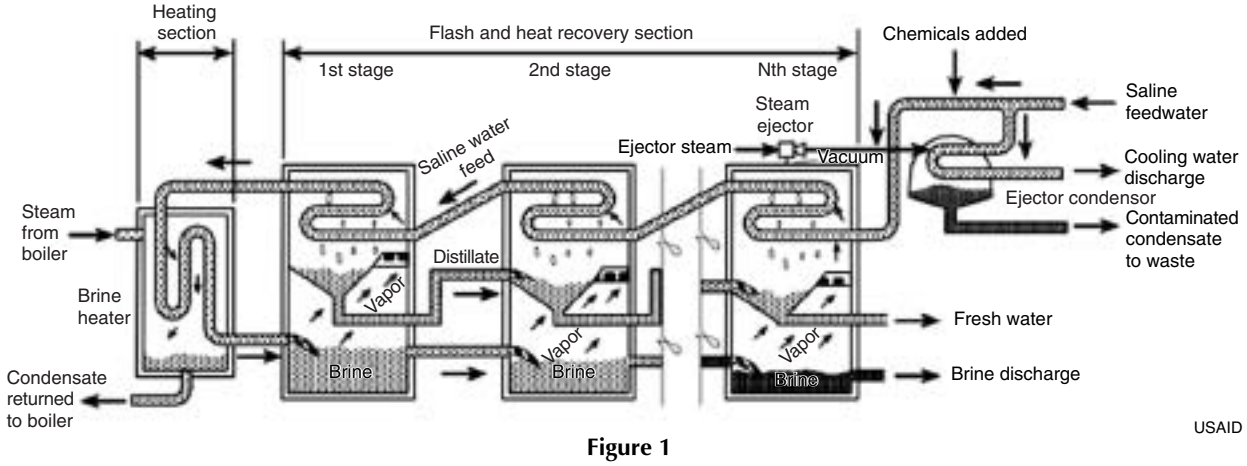


Figure 1
MULTI-STAGE FLASH PLANT

some of the electricity generators with vapor compressors coupled to a multiple-effect evaporator, with this coupled to the MSF system. Their study never considered coupling industrial applications like fertilizer plants to the nuplex, even though much of the water was destined for agricultural uses.

The project never got off the ground.

Unfortunately, Eisenhower's "Proposal for Our Time" was never implemented, as the nation's optimism for nuclear power was manipulated and transformed into fear and pessimism by nuclear non-proliferation fanatics and their puppets in the environmental movement.

Other Nations Move Ahead

As nuclear desalination languished in the United States, other nations have amassed decades of experience coupling the two technologies. The first large-scale nuclear production of fresh water was at a Soviet-era 150-MWe liquid-sodium-cooled fast breeder reactor in Aktau, Kazakstan—the BN-350. From 1973 until its decommissioning in 1999, the BN-350 reliably and safely produced 80,000 cubic meters per day of fresh water by multi-stage flash distillation and multiple-effect distillation (MED). The water was used in plant operations and for municipal water consumption in the arid Mangyshlak Peninsula, on the east coast of the Caspian Sea.

Japan first harnessed nuclear power for desalination back in 1978, with its Ohi Nuclear Power Station's 1,175-MWe Pressurized Water Reactors. Since then, 10 of Japan's 53 electricity-producing nuclear plants have used waste heat or electricity to desalinate water on a small scale—100 to 3,900 cubic meters per day—mostly for in-plant use for steam generators and potable water. The desalination technologies used by these plants have included all of the major types.

More recently, Pakistan hooked up its KANUPP 137-MWe Pressurized Water Reactor to an RO desalination system, producing 454 cubic meters per day of water as an emergency source of feed water to the steam generator. In the last few months, the reactor staff has also installed a larger demonstration MED unit capable of producing 4,500 cubic meters per day.

India has done the same with its Kalpakkam PHWR in the southern state of Tamil Nadu.

Even in the United States, which long ago turned its back on nuclear desalination, the Diablo Canyon Nuclear Power Station, owned by Pacific Gas & Electric, quietly has operated a desalination unit powered by its two 1,100-MWe Pressurized Water Reactors, which produces 4,500 cubic meters per day by RO for in-plant use. The desalination plant was originally conceived as a joint project of the California State Department of Resources and the OSW.

So, nuclear desalination is not a radical untested idea. It is a mature technology which has been waiting in the wings, perfecting itself for the call to action by a world (including the United States) waking up to the nuclear power imperative.

heated brine is emptied into the first stage, where the lower pressure leads to flash evaporation. The vapor condenses on the tubing of the cooler saline water moving toward the brine heater, and is collected and emptied into the next stage, and so on. As it condenses, it heats the saline water stream in the tubing, setting up a heat gradient in the tubes, which works in concert with the pressure gradient in the stages.

Separate from this stream of product water, the brine moves through the stages, collecting at the bottom of each. In each stage, some of it flashes at the lower pressures, moving up into the vapor phase, condensing, and joining the product stream. After the last stage, the product fresh water is collected and stored, and the brine is discharged to waste.

• **Multiple-effect distillation (MED).** MED has a similar series of chambers, called effects, and a similar temperature/pressure gradient through them. It differs in the plumbing connections of the water components to the effects. In this system, a steam loop in the first effect introduces heat through tubing. Saline water is sprayed onto the hot tubing, leading to vaporization. The vapor is collected and moves through tubing to the second effect, where saline water is sprayed onto it, vaporizes, and is collected and fed into the next. This vaporization on the tubing from the previous effect causes cooling and condensation within the tube of fresh water, which is then directed out to a product stream from each effect. The unvaporized brine in each effect is collected into a brine stream.

• **Reverse osmosis (RO).** RO is the predominant modern membrane process, especially in the United States. It requires the high-pressure pumping of pre-treated saline water through layers of semi-permeable membranes which selectively block the movement of the salts. Units of these membrane cartridges are hooked in series, and water moves through in a product stream, with brine collected into a waste stream. Pre-treatment is necessary because the membranes can be fouled by certain chemicals naturally in the introduced saline water.

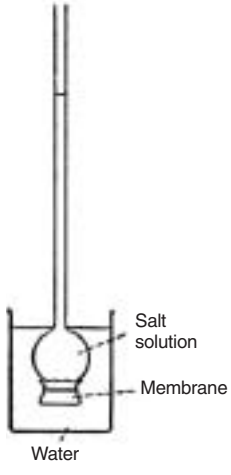


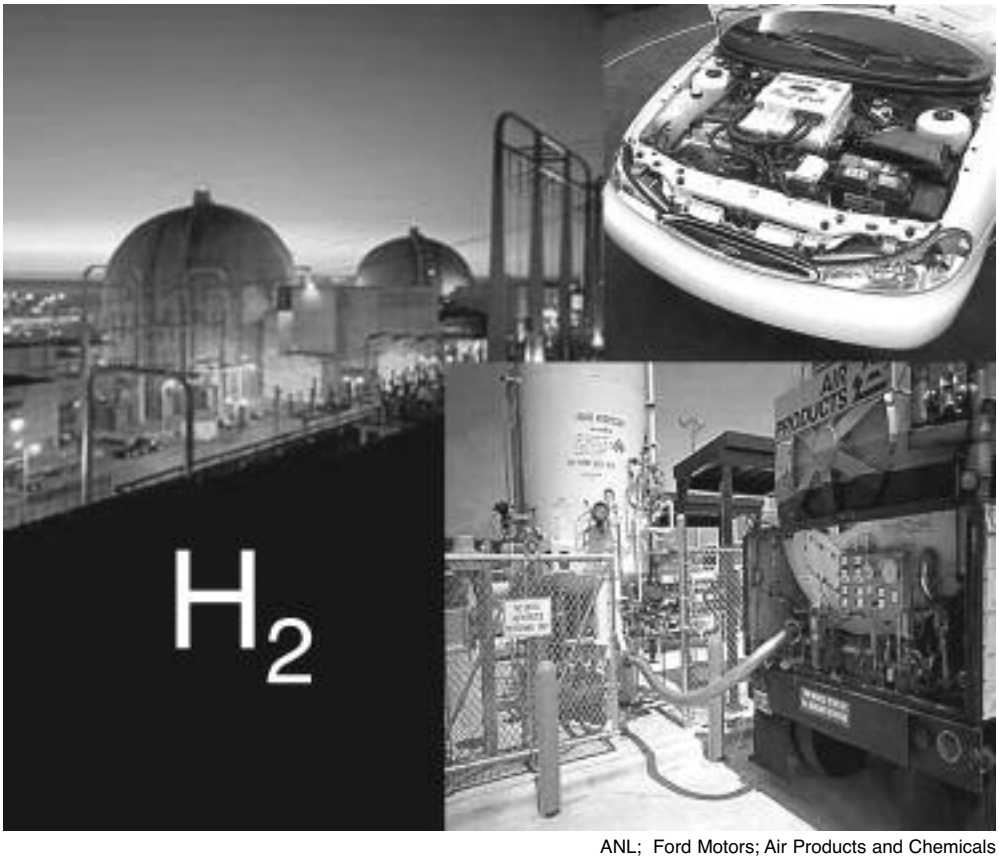
Figure 2
HOW OSMOSIS WORKS

The principle of osmosis was discovered in 1824 by Henri Dutrochet and elaborated by a series of investigators in the 19th Century. Imagine the thistle tube in the diagram filled with a solution of salty water and covered with a semi-permeable membrane, such as an animal bladder, which allows passage of the water molecules but not the salt. By immersing the inverted tube in pure water, a pressure (called osmotic pressure) is created across the membrane, causing the pure water to enter the tube and dilute the saline solution.

If a reverse pressure is applied, for example by blowing into the tube, the pure water will be driven out, and the salinity of the solution in the tube will be increased. This is the principle applied in reverse osmosis to purify salty water.

Hydrogen From Nuclear Power

by Masao Hori



ANL; Ford Motors; Air Products and Chemicals

Nuclear energy will produce the hydrogen needed for the fuel of the future. Here, a hybrid car and a hydrogen tank filling up.

The Age of Coal and Oil is giving way to the Age of Hydrogen. An international expert in nuclear technology examines the necessary role of nuclear power in ushering in this new era.

The energy sources we use for industrial and consumer purposes are called *energy carriers.* These are sources of energy which are derived from primary energy sources. Gasoline and electricity are familiar examples of energy carriers (Figure 1). After electricity, hydrogen is one of the most promising energy carriers for the future, because hydrogen is not only clean and efficient, but also storable. Essentially, water is the only emission when hydrogen is used.

The chemical energy of hydrogen can be converted to power most efficiently by a device known as a fuel cell. Combustion of hydrogen, as in an engine, could also be used for obtaining power. Hydrogen is easier to store than electricity, but hydrocarbons, especially liquid fuels, are much easier to store than hydrogen.

Hydrogen is the most abundant element in the universe. However it does not normally exist on Earth as a gas (H_2), but is rather found in the form of chemical compounds. It is most often found combined with oxygen in water (H_2O). It is also found combined with carbon in the various hydrocarbons. Examples include the gas methane (CH_4), which is the principal component of natural gas; the heavier liquid hydrocarbons which make up petroleum; and coal. To produce H_2 from compounds, it is necessary to use energy to break the chemical bonds which hold the hydrogen.

Hydrogen gas can be obtained from fossil fuels (hydrocarbons) by the steam reforming process. There

are drawbacks to production processes using fossil fuels, however. Not only are resource reserves of fossil fuels limited, but as environmental regulations intensify in the future, it will be necessary to take measures, such as carbon capture and storage, or sequestration, to reduce CO_2 emissions. As for renewable energies like wind and solar, they are inherently dilute, so their hydrogen production capacity is naturally limited.

The merits of using nuclear energy for hydrogen production are that there is no CO_2 emission, a sustainable bulk supply capability, and a high energy density, facilitating energy security. These advantages also apply to using nuclear energy for electricity generation.

About one-third of the world's primary energy is converted to electricity at present. The remaining two-thirds are consumed in such non-electric applications as process-heat for industry, space heating, and transportation. Although the ratio of electricity will likely increase to about one-half at the end of the 21st Century, that still leaves one-half of the world's primary energy being used for non-electric purposes. As it is essential to reduce the global use of fossil fuels, it is important to explore the feasibility of nuclear energy replacing fossil fuels as the power source for non-electric applications. The most promising and realistic way to fulfill this need is to use nuclear energy to produce hydrogen, an excellent energy carrier.

Nuclear Hydrogen As a Future Energy Source

In the future, nuclear energy will be needed for more than just electricity production. According to the World Energy Council, the world primary energy demand in 2100 will be about four times that of 1990, in its middle course scenario (Table 1). In this scenario, nuclear energy is expected to supply 24 percent of the total primary energy for electricity production, which corresponds to the output of about 5,200 plants of 1,000 megawatts-electric (MWe) capacity.[1] The supply of fissile fuel for all of these plants is feasible, assuming natural uranium resources of 16.3 Mton, as estimated in the "Red Book" (*Uranium Resources, Production, and Demand,* jointly prepared by Organization for Economic Cooperation and Development/Nuclear Energy Agency and the International Atomic Energy Agency), and the recycling use of plutonium by fast breeder reactors with a breeding ratio of 1.2 to 1.3. These fast reactors would be introduced from 2030 to 2050.

Optimizing the recycling of plutonium in fast breeder reactors could increase the quantity of nuclear supply by 1.5 times in 2050 and by 2.0 times in 2100, the World Energy Council scenario estimates. By effectively utilizing nuclear energy, this excess supply capacity of nuclear energy could replace the fossil fuel share in the World Energy Council scenario, thus developing a "proactive nuclear scenario," as shown in Table 1. The extra nuclear capacity could, and should, be used for hydrogen production, not just electricity generation.

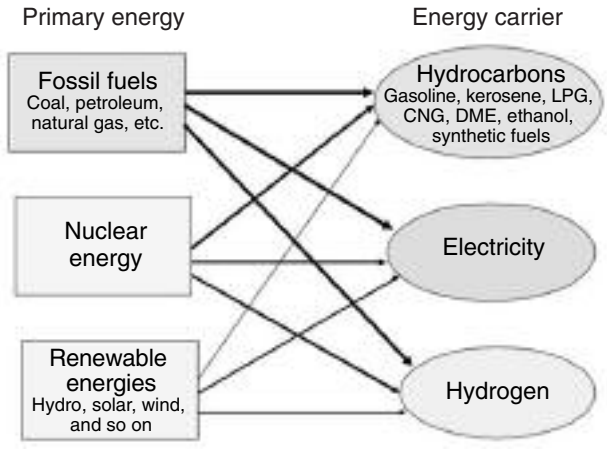


Figure 1
ENERGY CARRIER PRODUCTION FROM PRIMARY ENERGY

In such a scheme, the global use of fossil fuels in 2100 would become smaller than it was in 1990, thus stabilizing atmospheric carbon dioxide concentration, even in the face of global growth of energy use by a factor of four.

Actually, all of the primary energies (fossil fuels, nuclear energy, and renewable energies) must be used concurrently and in parallel to fill global demand in the 21st Century. Hence, it is essential to utilize these energies as efficiently as possible, from production of energy carriers to applications at the demand end, for the security of global resources, the environment, and the economy.

Prospects for the Hydrogen Economy

By the term Hydrogen Economy, I mean a society which uses predominantly electricity and hydrogen for its energy carriers, replacing the now-dominant hydrocarbons (such as

	1990	2050	2100
Fossil	**6.9**	**12.7- >11.4**	**15.0- >5.0**
Nuclear	**.45**	**2.7- >4.0**	**8.3- >18.3**
Renewables	**1.6**	**4.4**	**11.4**
Total	**9.0**	**19.8**	**34.7**

Table 1
ESTIMATION OF PRIMARY ENERGY SUPPLY IN GIGATONS OF OIL EQUIVALENT (1990-2100)
The arrows denote the change from the World Energy Council's middle course (WEC-B) to the proactive nuclear scenario.[1]

gasoline, kerosene, and natural gas) with hydrogen.

Utilization of hydrogen in automobiles, through fuel cell technology, is one of the primary goals of the Hydrogen Economy. A fuel cell is a device which combines hydrogen gas with the oxygen in the air to produce electricity. By putting an electric current through water, the hydrogen and oxygen components of the water can be split as gases, in a process called electrolysis. A fuel cell can be thought of, in first approximation, as electrolysis in reverse. The hydrogen and oxygen gas go back together, with help of a catalyst, producing water vapor and an electric current which can power motors attached to the wheels of the vehicle.

There are still major problems to be solved before commercialization of hydrogen fuel cell vehicles (FCV) can be realized. The biggest challenge we face is the cost of the fuel cell. Other challenges are the method of storing hydrogen on board to ensure an adequate cruising range, the creation of hydrogen distribution infrastructure, and so on. Still, because hydrogen is the most promising energy carrier, it is expected that the Hydrogen Economy will evolve steadily by breakthroughs in solving these problems we encounter now, although it might take three decades or more.

Producing Hydrogen from Nuclear Power

Hydrogen, as well as electricity, can be produced from any of the primary energy sources (fossil fuels, nuclear energy, and renewable energies). But nuclear hydrogen, because of its characteristics, will be expected to supply the base load.

Many processes have been proposed for production of hydrogen using nuclear energy (Figure 2). The leading processes presently under research and development are:

- electrolysis of water by nuclear electricity,
- high temperature electrolysis of steam by nuclear electricity and heat,
- thermo-chemical splitting of water by nuclear heat, and
- nuclear-heated steam reforming of natural gas, or other hydrocarbons.

Although it is not certain what course the commercialization of nuclear hydrogen production will take, a typical prospect based on the current state of knowledge could be as follows:

(1) In the near term, electricity generated by light water reactors (LWR) can be used to produce hydrogen gas from water by electrolysis. This process can be commercialized, in

The Sulfur-Iodine Cycle for Hydrogen Production

For centuries the world has been moving toward primary chemical energy sources with higher energy densities, from wood to coal, to oil, to natural gas (Table 1). At the same time, these chemical energy sources are characterized by a rising ratio of hydrogen to carbon: 1 to 5 for wood, 1 to 2 for coal, 2 to 1 for oil, 4 to 1 for methane. Now, the world is poised to develop the capacity to produce hydrogen directly, without combustion of a carbon intermediary at all, and to do this cheaply and efficiently enough for commercial purposes. The key to this development is to utilize the process heat of the most efficient primary energy source yet commercialized—nuclear power.

Using the process heat from a nuclear power plant, hydrogen can be produced directly by several processes, including electrolysis and thermochemical water splitting. There are hundreds of thermochemical cycles which can be used for splitting water to generate O_2 and H_2, but of these, only two are being actively developed for eventual commercial use: the UT-3 cycle, developed by the University of Tokyo, which uses a cycle of reactions involving calcium, bromine, and iron, and the Sulfur-Iodine (S-I) cycle of General Atomics Corp. The UT-3 cycle will generate hydrogen at lower temperatures, but the efficiency of the reaction is limited to around 40 percent.

The Sulfur-Iodine cycle, using process heat from a high temperature nuclear reactor (HTR), is the most promising thermochemical method of splitting hydrogen from water. At a temperature of 950°C, hydrogen production by this method could exceed 50 percent efficiency.

Table 1
COMPARISON OF HEATS OF COMBUSTION FOR SEVERAL FUELS

Energy source		kcal/kg
Hydrogen	(H_2)	34,200
Methane	(CH_4) (Natural gas)	13,200
***n*-Heptane**	(C_7H_{16}) (Gasoline)	11,499
Ethanol	(C_2H_5OH)	7,140

Source: Data are from James B. Conant, *The Chemistry of Organic Compounds* (New York: Macmillan, 1934).

The Sulfur-Iodine cycle basically involves three carefully coupled chemical reactions (Figure 1). Temperatures of at least 850°C are required to drive the decomposition of sulfuric acid into sulfur dioxide, water, and oxygen. The reformation of sulfuric acid from iodine, sulfur dioxide, and water at the end of the cycle is exothermic, and can be accomplished at 120°C. The cleavage of the hydrogen iodide to iodine and hydrogen requires about 450°C. The water is not regenerated in this cycle, as it is cleaved into oxygen and hydrogen gases. The brute-force splitting of water into oxygen and hydrogen gases by heat alone, would require temperatures in excess of 2,500°C; however, using

some cases by using off-peak power, because the relevant technologies are already proven.

(2) In the intermediate term, nuclear-heated steam reforming[2] of natural gas, using medium-temperature reactors could be utilized, in spite of some carbon dioxide emissions, because of its advantages in economic competitiveness and in technical feasibility. Also, high-temperature reactors could be used to carry out high-temperature steam electrolysis, with higher conversion efficiency and fewer materials problems.

(3) In the long term, high-temperature reactors would be coupled to thermochemical water splitting. These bulk chemical processes benefit from economy of scale, and may turn out to be the best for very-large-scale nuclear production of hydrogen for a mature global hydrogen energy economy. (See box.)

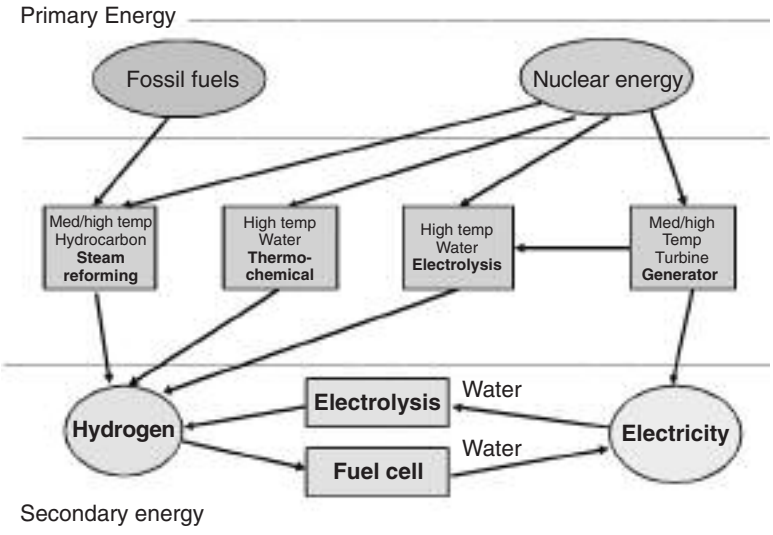


Figure 2
METHODS OF HYDROGEN PRODUCTION BY NUCLEAR ENERGY

coupled reactions under advantageous conditions, one can accomplish the same end result at high efficiency, at a temperature achievable by nuclear technologies already developed in several countries.

Some of the advantages of combining nuclear power with the S-I thermochemical cycle for hydrogen production are: No pollutants are generated; the hydrogen gas comes off at high pressure, allowing it to be easily transported from the reactor through pipes; and the efficiency is high. The disadvantages include: high temperature is required; highly corrosive chemical reactants and products require the development of special glasses, ceramics, and metals for containment; and very complex separation and concentration steps are necessary to achieve the high efficiency potential.

The S-I cycle was initially studied by General Atomics in the 1970s, spurred by the gasoline crisis of that period. As gas prices dropped, interest in producing hydrogen from the S-I cycle dropped, with only the Japanese continuing investigations until recently.

With the upsurge of interest in the Hydrogen Economy, General Atomics and others are again pursuing the S-I cycle for hydrogen production. General Atomics envisions using modular 600-MW helium-cooled HTRs to produce temperatures up 950 degrees, plenty high enough to push hydrogen-production efficiency above 50 percent.

India is considering a similar course, and engineers at Bhabha Atomic Research Center have developed a proposal for a 600-MW HTR which would produce hydrogen at 850°C, and then use the waste heat to produce electricity and to desalinate water. They estimate that 80,000 cubic meters per hour of hydrogen could be produced, while still producing 18 megawatts of electricity and 9,000 cubic meters of fresh water per day. *—Christine Craig*

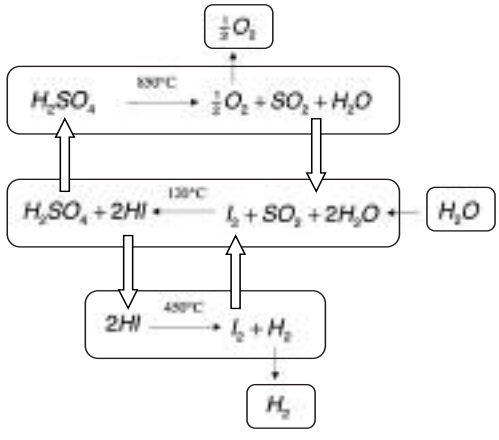


Figure 1
THE SULFUR-IODINE CYCLE

Sulfuric acid (H_2SO_4) is collected, concentrated, and decomposed at 850°C to oxygen gas (O_2), sulfur dioxide (SO_2) and water (H_2O). The O_2 gas is removed. The addition of iodine (I_2) and more water to the other products of the first reaction readily leads to reformation of the sulfuric acid at 120°C. The hydrogen iodide product of that reaction is then heated to 450°C, whereupon iodine is regenerated and hydrogen gas (H_2) comes off as the required final product. The overall reaction is simply water breaking down into oxygen gas and hydrogen gas.

Air Products and Chemicals

This Carson, California plant produces hydrogen by the steam-reforming of methane.

Industrial Applications for Nuclear Hydrogen

Hydrogen will be increasingly consumed in the petroleum industry for refining or upgrading heavier (lower hydrogen-to-carbon ratio) oils and oil sands. Usually, hydrogen is produced by reforming of natural gas or other fossil fuels, releasing CO_2 in the process. If nuclear-produced hydrogen is used in these industrial processes, overall CO_2 emissions per vehicle-mile can be decreased. In the future, hydrogen may be used for aircraft propulsion to reduce the impacts of aircraft exhaust on stratospheric chemistry and climate. Nuclear hydrogen could respond to such large, industrial-scale demands.

The reforming process presently used requires a considerable amount of heat. In the conventional process, the heat is supplied by burning some of the fossil fuel feed. Switching to the use of nuclear heat for the production of hydrogen by steam reforming of fossil fuels would effectively reduce the fossil fuel consumption and CO_2 emission by about 30 percent.

This synergistic process can efficiently convert nuclear heat to chemical energy, thus facilitating efficient conversion of primary energies into energy carriers. It will become more attractive as the cost of nuclear power drops. It could be applied extensively not only to produce hydrogen, but also for upgrading hydrocarbons and generating electricity, thus both conserving energy resources and enabling the "noble use" of fossil fuels.

Alternatives to Fuel Cells for Transportation

Figure 3 shows the energy flow to different types of alternative fuel vehicles. These include battery electric

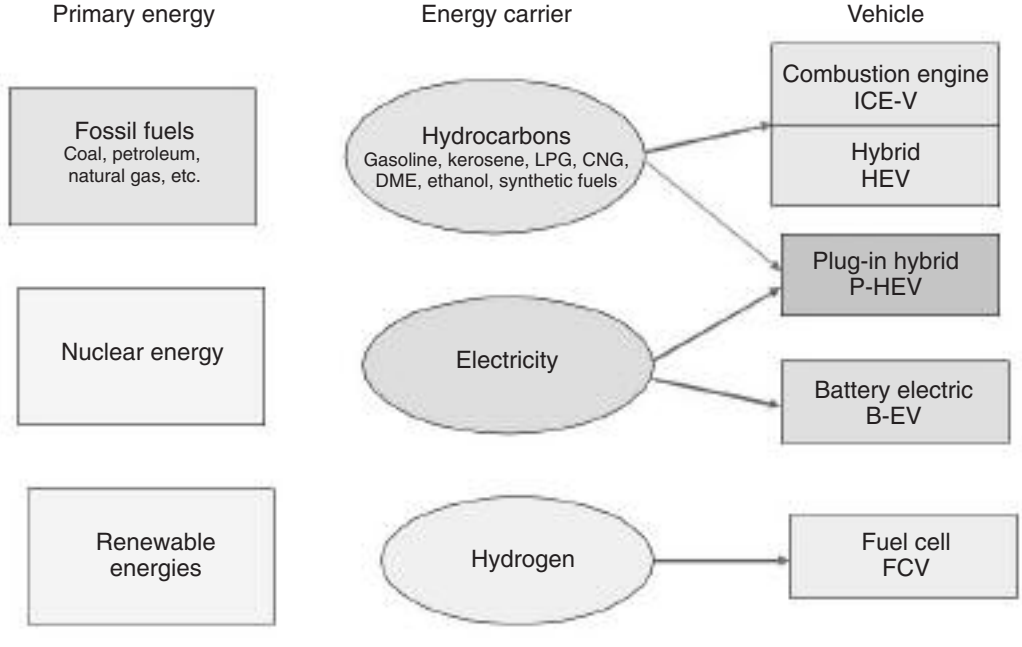


Figure 3
ENERGY FLOWS TO VEHICLES WITH VARIOUS DRIVE TRAINS

vehicles (B-EV) and plug-in hybrid electric vehicles (P-HEV) which are as efficient as fuel cell vehicles (FCV), and could be powered by nuclear electricity.

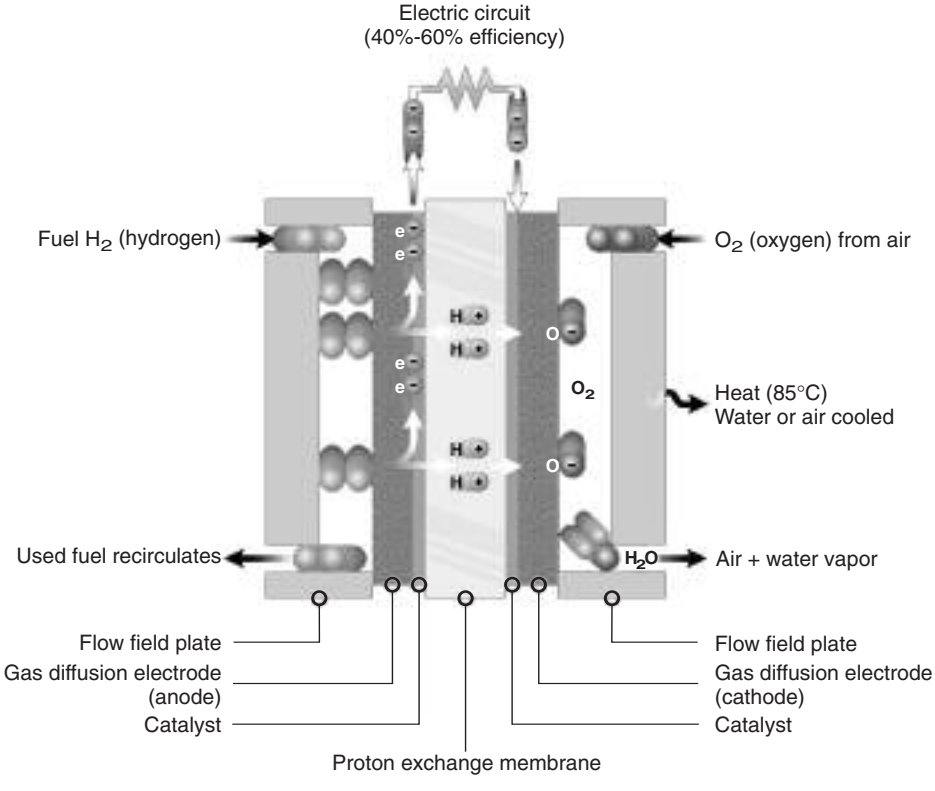
A plug-in hybrid electric vehicle is a hybrid electric vehicle (HEV) which has been provided with increased battery capacity, capable of being recharged from an external electrical plug. Up to a certain distance, which depends upon the battery capacity, the plug-in hybrid electric vehicle is powered solely by the battery, like a battery electric vehicle. Only after that distance, does the plug-in hybrid electric vehicle have to rely on an internal combustion engine like an hybrid electric vehicle. By this means, the plug-in hybrid electric vehicle can save on fuel consumption as compared to an ordinary hybrid. All of the energy powering an hybrid electric vehicle comes from petroleum (gasoline or diesel), while the energy powering a plug-in hybrid electric vehicle comes from both petroleum and the primary energy which has generated the electricity used to charge the battery when plugged in.

It is estimated that on any given day, on average, 50 percent of U.S. vehicles are driven less than 20 miles. Thus, a battery capable of powering a plug-in hybrid electric vehicle for a certain distance, say 30-60 miles—which is far less than the capacity required for an ordinary battery electric vehicle—could power the plug-in hybrid electric vehicle by electricity alone, and thus save a substantial amount of gasoline.

With the recent rapid evolution in battery technology, especially in lithium ion batteries, there is a possibility that plug-in

NASA/NREL

Lightweight hydrogen powers the Shuttle's main engines.



Source: Ballard Power Systems

Figure 4
HOW THE FUEL CELL WORKS

The core of the Ballard fuel cell consists of a membrane electrode assembly (MEA) which is placed between two flow-field plates. The MEA consists of an anode and a cathode separated by a proton exchange membrane (PEM). The flow-field plates direct hydrogen to the anode and oxygen to the cathode. When hydrogen reaches the catalyst layer of the anode, it separates into protons (hydrogen ions) and electrons.

The free electrons, produced at the anode, are conducted in the form of a usable electric current through the external circuit. At the cathode, oxygen from the air, electrons from the external circuit, and protons combine to form water and heat.

Daimler Chrysler

The Mercedes plug-in hybrid Sprinter is hitting the streets in New York.

hybrid electric vehicles (more so than battery electric vehicles) can be commercialized within a decade. Now the U.S. government is pushing the development of advanced battery technology to be applied to plug-in hybrid electric vehicles. In Japan, also, the plug-in hybrid electric vehicle is drawing attention. At a recent plug-in hybrid electric vehicle workshop held in Tokyo, participants came from a wide range of sectors, including research institutes, auto and electric-appliance producers, utility companies, and government.

Nuclear can supply energy to the transportation sector by generating the charging electricity for plug-in hybrid electric vehicles. As half of U.S. electricity is produced by coal-fired power plants at present, increasing the share of nuclear power for the future will be beneficial for the environment as well as for energy security.

Hybrid Vehicle Impact in the U.S. and Japan

According to Robert E. Uhrig, Professor Emeritus of the University of Tennessee, who analyzed the effect of introducing plug-in hybrid electric vehicles into the United States, transportation petroleum use could be reduced by about 74 percent by powering the plug-in hybrid electric vehicle with electricity from a battery of 35-mile cruising capability.[3] Assuming that all of the 225 million light transportation vehicles (automobiles, SUVs, pickups, vans, etc.) are plug-in hybrid electric vehicles, then 422 GWe would be required to charge the batteries during eight hours at night. He concluded that, considering spare generating capacity at night, perhaps 200 new 1,000-MWe nuclear power plants are needed.

I analyzed plug-in hybrid electric vehicle introduction into Japan using the same methodology. Assuming that plug-in hybrid electric vehicles are introduced in the category of private passenger vehicles, about a 70 percent savings in gasoline would be realized by using batteries with a range of 20 to 40 miles, depending on the size of the vehicles. For powering all of the 54 million private passenger vehicles in Japan, the electric power needed for charging the batteries in 8 hours at night would be 35 GWe. Since there is about a 50-GWe difference between the peak hours and the night time usage currently in Japan, the power for plug-in hybrid electric vehicles could be supplied by the existing spare generating capacity. Because nuclear power is presently used as the base load in Japan, additional power requirements would have to be supplied by increasing the operation of fossil-fuel-powered plants. For energy security and the global environment, it were better to shift the power supply structure to more nuclear electricity, replacing fossil fuel electricity and converting vehicles to plug-in hybrid electric.

So, for our energy security and the environment, we would look forward to evolving from hybrid electric vehicles to plug-in hybrid electric vehicles, and further to the battery electric vehicle/fuel cell vehicle in a few decades. Also, there are possibilities for vehicles powered by synthetic fuels (hydrocarbons) or bio-fuels (ethanol), which may well be upgraded or produced using nuclear energy synergistically.

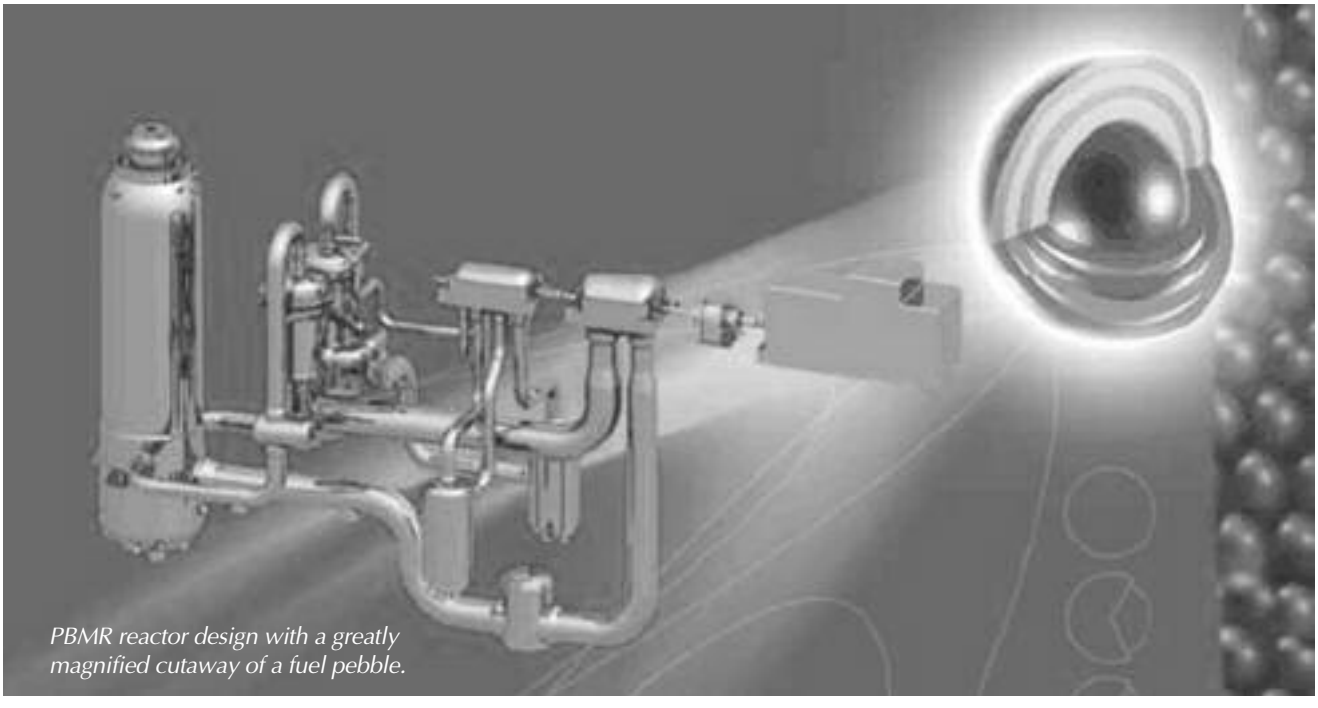
Whether essential energy carriers for the transportation sector, or more broadly, for our society in general, become electricity, hydrogen, synthetic fuels, and/or bio-fuels, nuclear energy will become an increasingly important primary energy source to produce these energy carriers.

Masao Hori, based in Tokyo, has served in the nuclear industry for many years and has worked to promote nuclear development internationally. He was chairman of the committee on Vision for the Second Fifty Years of Nuclear Energy, *which published its report in 1996. More recently, he chaired the International Nuclear Society's Task Group on Nuclear Energy's Role in the Future, which in 2004 published the groundbreaking work,* Nuclear Production of Hydrogen—Technologies and Perspectives for Global Deployment. He can be reached at mhori@mxb.mesh.ne.jp.

Notes

1. M. Hori, "Role of Nuclear Energy in the Long-Term Global Energy Perspective," OECD/NEA First Information Exchange Meeting on Nuclear Production of Hydrogen (Paris, October 2000). See also James Muckerheide, "How to Build 6,000 Nuclear Plants by 2050," *21st Century,* Summer 2005.
2. Steam reforming of natural gas produces hydrogen by combining the oxygen in steam with the carbon in natural gas, thus releasing hydrogen from steam, as the natural gas (which consists of carbon and hydrogen) is decomposed.
3. Dr. Robert E. Uhrig, "Using Plug-in Hybrid Vehicles to Drastically Reduce Petroleum-Based Fuel Consumption and Emissions," *The Bent of Tau Beta Pi,* Spring 2005.

South Africa's PBMR:



PBMR reactor design with a greatly magnified cutaway of a fuel pebble.

World's Most Versatile Nuclear System

Jonathan Tennenbaum

A report on an international conference in London to discuss the fantastic economic potential worldwide of South Africa's Pebble Bed Nuclear Reactor.

Next year the Republic of South Africa will begin on-site construction of the first Pebble Bed Modular Reactor (PBMR)—a revolutionary nuclear power source which South Africa's Minister of Public Enterprises calls "the perfect nuclear technology for Africa and the developing countries."

With the PBMR, South Africa has taken the leading edge in fourth-generation nuclear technology, combining extraordinary simplicity, robustness, and "inherent safety" with the capability to produce high-temperature heat for the production of hydrogen-based fuels and other industrial processes, as well as cheap electricity.

The PBMR is a leading exemplar of the High Temperature Reactor (HTR) technology, which Lyndon LaRouche and his collaborators have long identified, in the context of development programs (for example, the Eurasian Land Bridge and the recent campaign for re-industrialization of the United States), as the key "workhorse" power system for global economic reconstruction and growth in the coming period.

The PBMR project builds upon a long historical development, which began in the 1950s, when the German nuclear physicist Prof. Rudolf Schulten began to think about creating a 100 percent "inherently safe" nuclear power source, which could be deployed all over the world, including in developing countries, as an efficient industrial heat source and for the generation of electricity. A key to Schulten's ingenious solution was to encapsulate small particles of fuel within ceramic materials that could withstand high temperatures, in such a way that the radioactive fission products remained permanently trapped in situ, where they are created.

At the same time, Schulten tailored the choice of fuel, helium coolant, and reactor construction, to ensure a uniquely favorable nuclear reaction behavior, which excludes the danger of a runaway chain reaction, and permits routine operation at temperatures up to 1,000°C. Schulten's concept was tried and proven in over 20 years' operation of the AVR 30-megawatt test reactor at the nuclear research center in Jülich, Germany.

Geraldine Bennett/PBMR

A somewhat different reactor type, based on the same basic ceramic-coated particle principle, was pursued by General Atomics in the United States. The General Atomics GT-MHR uses tiny fuel particles, but places them in small rods that are stacked into columns, not as loose pebbles.

Unfortunately, after brief operation of a larger, 300-MW HTR version, all work on Schulten's concept was dropped in Germany, as part of the politically motivated, virtual shutdown of that nation's once-proud nuclear sector. The U.S. HTR work did not fare much better, and it is only thanks to three countries, South Africa, China, and Japan, that this technology has been kept alive.

Today, HTR test reactors are operating in China and Japan—the first based on Schulten's essential design, the second closer to the U.S. design. China has recently announced that it will move to large-scale production of commercial HTR units as part of its nuclear energy program. General Atomics has a joint project with Russia to build a GT-MHR that will burn weapons plutonium. However, by far the most advanced project, one which promises to deliver a crucial, long-delayed breakthrough for Schulten's original concept of a universally applicable nuclear energy, is South Africa's PBMR.

The International PBMR Conference

On Jan. 30, 2005, Britain's Nuclear Industry Association sponsored an international conference devoted entirely to the PBMR, and attended by some 200 industrialists, nuclear experts, and political representatives from South Africa, the United Kingdom, the United States, Japan, France, Germany, Spain, and Switzerland. The conference, addressed by leaders of the South African program, as well as that nation's Minister of Public Enterprises, served both as a first full-fledged public presentation of the entire PBMR program in Europe, and as a follow-up meeting of international suppliers and investors, to an August meeting in South Africa.

The account of the conference presented here speaks for itself, and should enable the reader to become familiar with leading features of the technology and its potential importance. I shall not comment on the geostrategic implications of this technology not being produced in Germany (its country of origin) nor in the United States, but in a nation of the British Commonwealth. This should be a wake-up call to all, that the era of suppression and stagnation of nuclear energy development has drawn to an end.

I was also impressed by the display of national pride and optimism on the part of the representatives from South Africa, and also of a certain basic competence in industrial and economic policy, which is a highly refreshing contrast to the sheer insanity that still dominates policy-making in the United States and Europe. If there was a certain, understandable amount of "hype" in the PBMR presentations, it was a pleasant one.

Greeting the conference, Robert Hawley, former Chief Executive of British Energy, emphasized two points. First, the major technological advances embodied in the PBMR; its sim-

Geraldine Bennett/PBMR

John Ritch, head of the World Energy Association (left) and Thulane Gcabashe, CEO of Eskom, at the PBMR conference.

plicity, speed of design, and rapid construction. The 165-megawatt-electric modules are very appropriate for developing countries, which lack extensive electricity grids. Hawley noted also the massive support given to the project by the South African government and the state-owned electricity company, Eskom, as well as the wise decision by both to draw in world-renowned industries, such as Mitsubishi Heavy Machinery, in supplying certain key components of the reactor, alongside the major role of South Africa's own domestic industry.

"Tears of frustration come to my eyes when I compare the attitude of the UK government to that of South Africa," Hawley said.

Dr. Alistair Ruiters, the chairman of the PBMR project, emphasized the fruits of "14 years of hard work," starting with the 1990 decision by Eskom to devote a small budget to examining the potential of the original German technology. A crucial turning-point came in 1994-1995, when South Africa voluntarily abandoned its originally military nuclear program and redeployed its manpower and resources into the PBMR project. Now the project is engaging suppliers spanning the globe, guaranteeing the commercial viability of a new path for nuclear energy. At the same time, the PBMR will constitute a major contribution by South Africa to improving the lives of people in Africa.

'Join Us on an Exciting Journey'

Jaco Kriek, CEO of PBMR, showed an upbeat video on the South African project, entitled "Expand your mind." The basic message was well presented: In the context of the need to upgrade an infrastructure that is already strained by South Africa's rapid economic growth, and at the same time to recapitalize the country's heavy industry and scientific-technological capability, South Africa has decided to make itself into a "global center for nuclear excellence," placing export of standardized nuclear reactor modules at the forefront of a strategy to cement the country's role as a major exporter of capital equipment. At least 12 countries are currently interested in purchasing PBMRs.

Kriek noted that "energy is a hot topic," and that the PBMR is "South Africa's unique contribution to the global challenge" of meeting mankind's power needs, not only for electricity, but also for transport and industry. He pointed to the decisive importance of this technology for Africa in particular—the giant continent that shows up nearly totally dark, from lack of electric power, in the satellite image of the world at night. Power is the key to kick-starting the African economies.

The first pilot PBMR will be completed in 2011, to be followed by commercial mass production of at least 30 commercial modules for domestic use and export. Eventually, hundreds could be produced. At present, the approximate timetable looks something like this: First commercial units produced by 2014; production rising to 6 modules a year by 2015; at least 24 modules eventually to be delivered to the electric utility, Eskom. It could go even faster.

Key components of the technical infrastructure already being set up for the PBMR effort include a pilot fuel-element plant at Palindaba, the HTR helium test facility, and the HTTF, Heat Transfer Test Facility. These, Kriek emphasized, are world-class test facilities that will offer their services worldwide, in addition to supporting the PBMR program itself.

Kriek emphasized also PBMR's commitment to leverage the project toward creating new jobs in South Africa. Besides beefing up the country's high-value capital goods export potential, PBMR is encouraging international suppliers to the project to localize parts of the production in South Africa itself. Production of PBMR modules will have a local content of about 60 percent, while international partners will provide the remaining 40 percent.

The electricity-producing version of the PBMR already has a large customer in the South African power company, Eskom, which is committed to purchasing a total of at least 4,000 megawatts-electric of PBMR capacity, as the spearhead of its modernizing and expansion program for power production. However, in the future, the process-heat application may be even more interesting, not least of all for hydrogen production. PBMR is already planning to construct a second demonstration plant that will demonstrate the process-heat capability.

PBMR is classified as a "National Strategic Project," but at the same time it involves a remarkable international coopera-

tion. The list of PBMR's international suppliers includes Mitsubishi Heavy Industries (MHI), which will provide the crucial helium turbine systems for the PBMR direct-cycle electricity production, as well as British Nuclear Fuels/ Westinghouse, Germany's Nukem and Uhde, SGL Carbon, Spain's steel supplier ENSA, Canada's SNC-Lavalin, Murray Roberts, and many more.

Africa's lack of electricity is striking in this satellite view of the continent at night, where electric lighting shows up as white dots. Although the continent has 12 percent of the world's population, it accounts for only 2 percent of the world's energy consumption.

Africa Needs Power!

Most interesting was the presentation by the CEO of South Africa's state-owned national electricity company Eskom, Thulane Gcabashe. Eskom is currently the ninth largest electrical utility in the world, he noted, producing 95 percent of South Africa's electricity and 50 percent of the entire electricity consumed on the continent of Africa.

Gcabashe showed once again the impressive satellite mosaic of the Earth at night, pointing to the fact that Africa—very literally the dark continent in the picture—accounts for 12 percent of the world's population, but only 2 percent of the world's energy consumption. On the other hand, Africa has extremely plentiful natural resources for energy generation, in terms of hydro, coal, and uranium, which could be used. Gcabashe made clear that Eskom's strategy takes into consideration not merely South Africa's needs, but the requirements of the entire African continent, home now to 700 million people.

For the last 10 years, despite a massive electrification campaign in South Africa, Eskom has maintained an excess of power-generation capacity. That excess is rapidly shrinking, however, and the country is now only one year away from the point at which a rapidly growing demand for electricity will overtake presently installed capacity. As an immediate measure, Eskom added an additional 3,600 megawatts-electric of capacity in 2005, by bringing several power plants back on line that had been mothballed since the 1980s. Further capacity of 5,304 megawatts-electric is being added, by upgrading the performance of existing units. But in the medium term, it is only by mounting a massive program of new plant construction, that South Africa will be able to keep up with the skyrocketing demand.

After taking into account all available options, Eskom decided to choose nuclear energy, in the form of the PBMR, as the key vehicle to meet this challenge. The crucial areas of application are the rapidly growing coastal regions in the Cape and Kwa-Zulu regions of South Africa, which are located far from the country's coal-producing area.

After a detailed feasibility study in 2002, Eskom made its initial commitment to install a minimum of 1,100 megawatts-electric of nuclear PBMR capacity, beginning with the "Strategic National Demonstration Project" that goes into construction next year. Beyond this, Eskom is looking at a total of at least 4,000 megawatts-electric of PBMRs. Gcabashe's projections suggest that in the longer term, some 10,000 megawatts-electric of additional capacity will be needed, corresponding to about 60 of the standardized PBMR modular units.

How to Build a Stable Energy System

South Africa's Minister of Public Enterprises, Alec Erwin, elaborated on the thinking process behind the strategic decision by the South African government to go for its ambitious PBMR-based nuclear energy program. Why would a country like South Africa opt for such a policy course? For a long time, energy was not at the forefront of the government's agenda. But after 10 years of rapid economic growth, Erwin said, we had to really start thinking about the problem: How do you get a stable energy system?

Because there are no powerful energy suppliers among the neighboring countries, the emphasis would have to be on South Africa's own production. The nature of South Africa's economy dictated the need to diversify, and at the same time provide for long-term stability of energy production and energy costs.

The South African government decided to keep the electricity company Eskom in state hands, giving it the ability to raise capital and to carry out sophisticated projects. South Africa is one of the world's largest uranium producers. In addition, South Africa possesses an entire complex of facilities previously connected to the military nuclear program. Going with the PBMR project was not an easy decision, but

the technology seemed to fit so well, particularly in view of its potential impact on the industrial development of South Africa's economy.

Further, the favorable fiscal situation gave the government the possibility to support big projects. The worldwide community of scientists and nuclear technology suppliers provided enthusiastic support, giving us the sense that we were not alone, Erwin said. Thus, the PBMR has the character of a global project.

Erwin emphasized the unique advantages of the PBMR for the developing countries in Africa and around the world (see accompanying interview). He noted the major interest from many countries with whom South Africa is in discussion, including Brazil, India, and China. China, which is already operating a small test reactor based on the same basic pebble-bed technology, has signed a memorandum of understanding for cooperation with South Africa.

There is a certain amount of opposition to nuclear energy in the country, Erwin noted, but most of it is coming through the global non-governmental organizations, NGOs. The debate in South Africa is more reasonable than it has been in the so-called developed world, and in reality, the so-called renewables like wind provide no serious alternative to nuclear technology, he said.

All in all, Erwin concluded, "this is an important time for nuclear energy as a whole" and a "wonderful confluence of events" that placed South Africa in a position to play the leading role in realizing the revolutionary PBMR technology.

Nuclear Modules in Six-Packs

A particularly enthusiastic note was added from the United States by Regis Matzie, Chief Technical Officer of Westinghouse Electric Corporation. Matzie called the PBMR project a "model of international cooperation," noting that in addition to the international suppliers already mentioned, Russia was also playing an important supporting role by providing testing facilities for the PBMR fuel elements.

Matzie had high praise for the South African effort and the full-hearted support given to it by the government. Already 4.3 million man-hours have gone into the design, and world-class test facilities. South Africa's Northwest University has carried out extensive work on the Brayton-cycle helium cooling system, and the helium test facility with its 40-meter tower is nearly completed.

"There are no serious technical issues left," Matzie said, noting that the PBMR construction will incorporate the proven fuel element design and operating experience of the AVR and THTR systems in Germany, as well as standardized materials from the conventional light water reactor industry.

What about the future market? When we speak of the PBMR being able to supply a "niche" for plants with total power of 700 megawatts-electric or lower, "that niche is pretty big." It includes much of the developing sector of the world economy. Moreover, the possibility of combining many standardized PMBR modules in "four-packs," "six-packs," and "eight-packs" (so-called "multi-modular design") could make them building-blocks for commercial plants worldwide.

But the process heat applications, Matzie said, are potentially even larger. Of the U.S. energy consumption, for example, about one-third is electricity, but two-thirds is transportation and heat applications. The PBMR will be key to a future hydrogen economy.

Europe's Energy Challenge

Dr. Sue Ion, technical director of the company British Nuclear Fuels (BNFL), which has been a major partner of the South African project, spoke about "A European perspective on nuclear energy and the PBMR."

"Could there be a renaissance of nuclear energy in the UK and Europe?" Dr. Ion asked. The European Union is the largest energy importer in the world, and the import quota could increase from 50 percent to as much as 70 percent in the coming decades.

The stability and security of energy supplies is in serious question. She said the United Kingdom is facing a gradual depletion of the North Sea oil and gas reserves. The reserve storage of natural gas in the U.K. is a mere 14 days. Europe currently has 685 gigawatts-electric of electric-generating capaci-

Courtesy of General Atomics

The predecessor of the PBMR, the AVR experimental pebble bed reactor in Jülich, Germany, came on line in 1967 and operated successfully for 22 years. It demonstrated many safety effects of the high-temperature reactor. One test showed that in a sudden total shutdown, the plant cools down and the fuel remains intact.

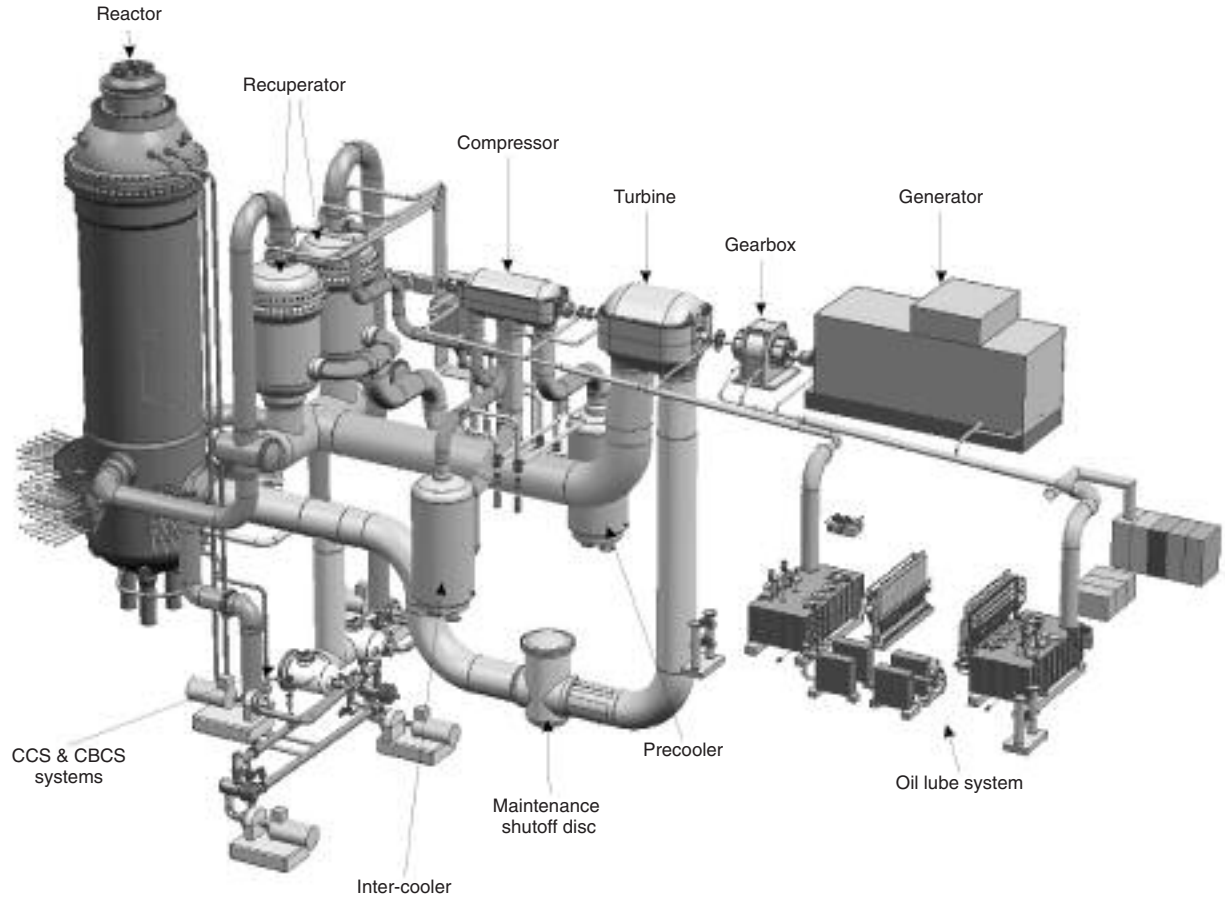


Figure 1
PBMR REACTOR DESIGN
This schematic drawing shows the main power and support systems for the Pebble Bed Modular Reactor.

ty, which must be expanded to more than 900 gigawatts-electric by the year 2020. At the same time, much of the existing fleet of power plants is aging and must be replaced, many already in the coming 10- to 15-year period. The present state of the electricity distribution system in Europe, including the limited capacity for interconnections, leaves no alternative to a major push for new plant construction.

In this context, European countries are having to look very seriously at the role of nuclear energy. France is set to begin major replacements of its nuclear reactor fleet. In the U.K., influential "environmentalists" such as Gaia proponent James Lovelock and Hugh Montefiore have come out in favor of nuclear energy, and recent studies of the British Institute of Civil Engineers have underlined the weakness of wind power and other so-called alternative technologies. Finland is building a new nuclear power plant, and in Switzerland the population voted in a referendum to keep the nuclear option open, Ion said.

In addition to the electricity-generation problem, we must do something about the energy requirements of the transport sector, which accounts for nearly 56 percent of energy use in the European Union, she said. Here the pebble-bed technology, as a heat source for hydrogen and other synthetic fuels, gives us "the first real breakthrough."

"The PBMR is a fantastic technology," Ion said, and would be ideal for a number of locations in Great Britain itself, where smaller units are most suitable. In addition, the U.K. could exploit its extensive experience with gas-cooled reactor technology. "I hope I live to see the first PBMR switched on here," she concluded.

Building on a Long History

Dieter Matzner, the general manager of the Power Plant Division of PBMR, described the historical process leading to South Africa's taking up the High Temperature Reactor technology originally developed in Germany. A key turning-point, ironically, was the German government's own decision in 1990 to discontinue all work on its HTR. This crazy decision came just months after the basic HTR modular reactor design, which provided the take-off point for the later PBMR development, had been officially licensed by Germany's Nuclear Safety Commission.

The inventor of the HTR, Prof. Rudolf Schulten, died suddenly in April 1995, just two weeks after having signed a cru-

cial agreement with South Africa for the transfer of the HTR technology. South Africa's early interest in the HTR was heightened by realization of the implications of large-scale desalination for a largely arid country, as well as the large distances separating the country's huge coal fields from most of its population centers.

Matzner emphasized the uniqueness of the safety features of the PBMR, underscoring the difference between so-called "passive" safety incorporated into the latest-generation light water reactor designs of the European EPR (European Pressurized Reactor) and the Westinghouse AP-1000 on the one side, and the "inherent safety" of the PBMR on the other. A crucial difference is that in the PBMR a meltdown of the reactor core is not only extremely improbable—as in the EPR and AP-1000—but literally impossible.

In addition, Matzner said, the same design for the spherical fuel elements, based on encapsuling tiny particles of fissile fuel in high-temperature ceramic coatings, which is key to the inherent safety features of the PBMR, also provides an unrivaled packaging system for nuclear waste. The ceramic materials employed, remain stable and corrosion-proof for millions of years. In the context of the reactor fuel, the ceramic encapsulation prevents significant release of radioactive substances up to temperatures of 1,800°C or more, far above the maximum temperatures attained in the reactor, even in the "worst-case" accident scenarios.

Among other additional advantages of the PBMR design (see accompanying interview), Matzner mentioned the uniquely favorable dynamic behavior of the reactor, which is linked to its strongly negative-temperature coefficient. This means, that when the reactor temperature increases beyond a certain point, the efficiency of the fission reactions decreases rapidly, leading to the chain reaction "shutting off" by itself. This not only excludes the possibility of a dangerous runaway chain reaction, with overheating and other negative effects, but also means that the reactor's power output can be regulated essentially by the rate of cooling that the cooling system provides. The faster we cool it, the more power the reactor supplies. And the less we cool it, the less heat the reactor produces, as the fission reactions slow down automatically.

Japanese Know-how

A very important feature of the South African PBMR system, is the decision to use a "direct-cycle" helium turbine to power the generator for electricity production. Virtually all existing nuclear power stations and conventional electricity plants employ steam turbines for their power generation. The very high (900°C) operating temperature of the PBMR, the extremely low level of release of radioactivity from the fuel, and the characteristics of the coolant itself—inert helium gas—provide the possibility of operating a gas turbine at very high efficiencies, while at the same time avoiding the bulky and complex heat exchangers of conventional light water nuclear power plants.

It also affords great ease of repairs and maintenance in a low-radioactivity environment.

The helium turbine of the PBMR has some similarity to a jet engine; it is simpler, relatively much smaller, and has a higher power density than the steam turbines of conventional power plants.

For this high-technology item, the South Africans decided to bring in the experience and expertise of Japan's famous Mitsubishi Heavy Industries (MHI), one of the world's major producers of power turbines, including gas turbines for natural gas-based power plants. Mitsubishi was represented on the conference panel by Yoshiaki Tsukuda, general manager of MHI's Takasago Machinery Works.

On the Way to a Hydrogen-Based World Economy

Willem Kriel, manager of U.S. Programs for the PBMR company, gave an exciting overview of the potential of the HTR-PBMR system as a source of high-temperature heat for industrial processes—applications that promise to generate an even greater economic impact, than that of electricity generation. These include large-scale hydrogen production; synthetic natural gas and other liquid and gaseous fuels from coal, oil, or other carbon sources; process heat for refineries and other chemical plants; heat and steam for recovery of heavy oil and other resources; large-scale desalination, and so on.

Kriel spoke of a "new frontier" opening up, symptomized by the suddenly emerging interest on the part of fossil-based fuel companies, to explore the possibility of applying nuclear energy to "leverage" existing hydrocarbon reserves. The PBMR is presently the only existing technology, apart from combustion of fossil fuels, which can economically provide large amounts of heat in the range of 900°C. It is also the only carbon-dioxide-free source. Applying this heat to endothermic steps in the conversion of coal and oil to synthetic fuels, and to the thermochemical production of hydrogen, which is an important intermediate for synthetic fuels, will make it possible, in effect, to "stretch" existing fossil fuel reserves by a very considerable factor.

The PBMR could leverage gas by 30 percent, and coal by 100 percent, while at the same time providing the basis for economically exploiting vast amounts of oil sands existing in various locations. The recoverable hydrocarbons from the oil sands in Canada and Venezuela alone, would exceed in equivalent the entire oil reserves of Saudi Arabia, Kriel said.

In this context, "he who hesitates will be last," Kriel declared, pointing to five conditions defining a unique "window of opportunity" for the introduction of nuclear process heat into the world's energy market. To succeed, any proposed technology: (1) must come soon; (2) must be safe, in order to be located close to process heat-consuming plants; (3) must be economical; (4) must have the right size, ideally in the range of 400-500 megawatts-thermal; and (5) must produce the right temperatures, in the range of 800-1,000°C. The PBMR modules fit exactly these requirements, with no serious competition on the scene.

Kriel praised the "revolutionary" pioneering work of Prof. Rudolf Schulten and his collaborators in Germany during the 1960s, on applications of HTR process heat. It was a pity, he said, that political circumstances prevented that work from coming to full fruition. But with the PBMR, "nuclear energy has finally broken the shackles of only being able to make electricity."

Parallel with the effort to complete the demonstration PBMR for electricity production, work is now going on to prepare for a

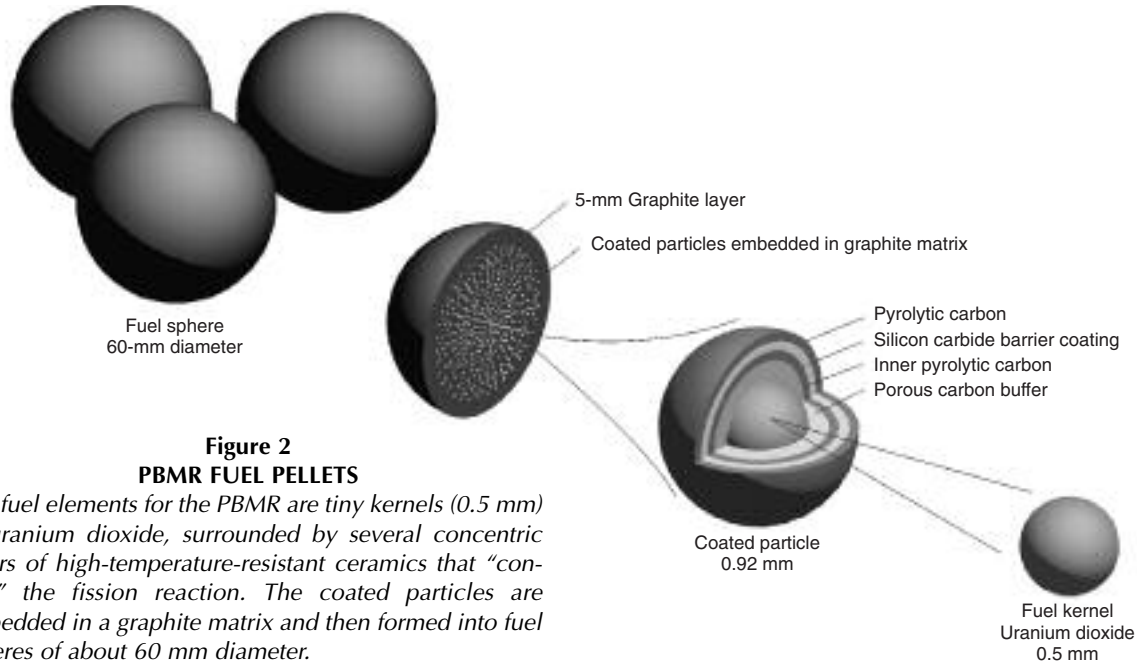


Figure 2
PBMR FUEL PELLETS
The fuel elements for the PBMR are tiny kernels (0.5 mm) of uranium dioxide, surrounded by several concentric layers of high-temperature-resistant ceramics that "contain" the fission reaction. The coated particles are embedded in a graphite matrix and then formed into fuel spheres of about 60 mm diameter.

pilot plant for process-heat application, in discussion with a variety of potential industrial users, including the petrochemical industry. Kriel spoke of "three to four near-term applications" which could potentially involve "large numbers" of PBMR modules. The modules in question would be "dedicated" to heat production, and would not need the elaborate heat-to-electricity conversion system of the electricity-producing PBMR.

At the same time, work is proceeding on addressing the details of matching the output heat production of the reactor, to the different characteristics of the consuming processing plants. The first demonstration facility will involve a consortium of industrial clients. The required heat-exchanger and chemical reactor technology can be developed and tested in parallel, separately from the nuclear reactor, using other heat sources, Kriel said.

There are "three to four possible projects" in the near-term, Kriel stated, and the priority now is to push ahead with planning, complete technical development in 2007-2012, and have pilot plants running by 2015, which would be the date of "commercial roll-out" of process-heat PBMRs.

Educating a Young African Labor Force

Thabang Makubire, general manager of the Fuel Plant Division of PBMR, took his audience through the fascinating process of production of the spherical fuel elements—the "pebbles"—which constitute the heart of the PBMR technology. First, microspheres of enriched uranium-containing solution are formed in special nozzles, and then jelled and calcinated at high temperatures, producing tiny "kernels" of uranium dioxide of 0.5 millimeter diameter. These are then run through a Chemical Vapor Disposition furnace at temperatures of 1,000°C, where they are coated with successive layers of silicon carbide ceramic and pyrolytic carbon.

The result is a hermetically sealed, coated particle of a little less than 1 millimeter diameter, which is extremely hard and high-temperature resistant. This multiple coating constitutes a practically fail-safe barrier to the release of the radioactive fission products generated in the uranium kernel as a result of the nuclear reactions. Approximately 15,000 of these coated particles are then mixed with graphite powder and resin, and pressed into a sphere of about 60 millimeters diameter, covered with an additional layer of

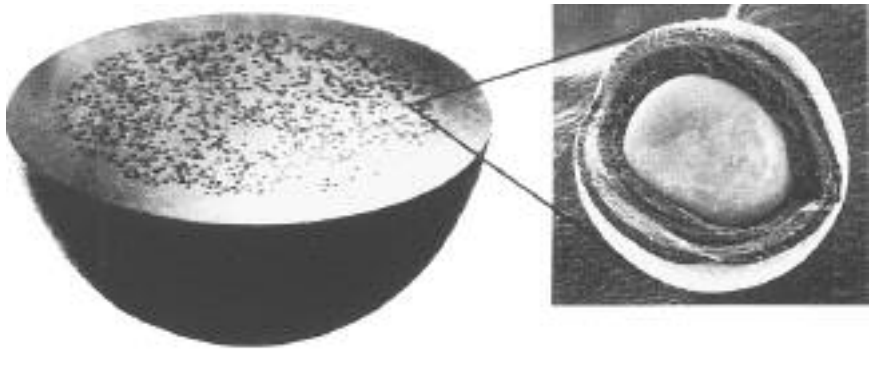


Figure 3
CROSS SECTION VIEW OF FUEL PEBBLE
A cross section of a PBMR fuel pebble, with a cutaway view of a coated fuel particle.

pure carbon (graphite) as a "buffer," and finally sintered, annealed, and machined to extreme hardness.

The core of the PBMR module—the pebble bed—consists of 450,000 to 500,000 of these tennis-ball-size fuel elements. In the course of operation, the pile of fuel elements is constantly renewed and recycled, as fuel balls are gradually introduced into the annular-shaped core from the top, and withdrawn from the bottom. Each fuel ball makes about six passes through the core, with the degree of "burn-up" measured in between.

Because this is a continuous fueling process, it is no longer necessary to shut down the reactor at frequent (18-20 month) intervals for refueling, as is necessary for conventional nuclear power stations. A pilot fuel-element production plant is already in operation, and has produced a small lot of 81 fuel balls, which are now being tested in Russia under reactor conditions.

A full-scale fuel-element plant is scheduled to be commissioned in 2008-2009. Meanwhile, the South Africans are using the pilot plant to train technical staff for the commercial plant. This, as Makubire emphasized, is part of a broader policy of PBMR and the South African government, to use the nuclear energy program as a driver for labor-force development, focussing on so-called "localization" of production, and drawing into the process young Africans, who are the key to the country's future.

Crucial Role of Government Institutions

The conference drew to a close with a presentation by Mukesh Bhavan, executive vice president of South Africa's state-owned, but self-financed Industrial Development Corporation (IDC), and with final remarks by PBMR CEO Jaco Kriek.

Bhavan noted that the IDC's present role in the financing of the PBMR project continues a very long tradition of support for government-identified strategic projects directed toward developing South Africa's industry. A key success story was the creation of SASOL, the chemical giant which leads the world in the production of gasoline and other hydrocarbon products based on coal. At present, SASOL's coal liquification plants produce about a third of South Africa's gasoline and diesel consumption. The technology developed in the context of SASOL has had "phenomenal spin-offs" for the country's industry and economy generally, Bhavan said, "and we have the same vision for the PBMR." The IDC is increasingly engaged, also, in financing industrial projects in other African countries.

As a National Strategic Project of the South African government, the PBMR seems indeed to be on the road to success—reminding us of the kinds of things the United States and some other countries used to do so well, before the insane, radical "free market" ideology took over. Time for rethinking?

Meanwhile, South Africa is on the countdown, with officially 2,096 days to go, for its first pebble bed modular reactor to go online.

Dr. Jonathan Tennenbaum, based in Berlin, heads the Fusion Energy Foundation in Europe and is a scientific advisor to Lyndon LaRouche. His report also appeared in the Feb. 10, 2006 issue of EIR. *He can be reached at tennenbaum@debitel.net.*

INTERVIEW: ALEC ERWIN

PBMR Is 'Perfect' for Africa's Development

Erwin is Minister of Public Enterprises of the Republic of South Africa. He was interviewed by Jonathan Tennenbaum on Jan. 30 at the London conference on the PBMR.

Geraldine Bennett/PBMR

Question: Somebody might exclaim, "my goodness, Africa is starting at such a low level and now you are bringing in such an advanced technology like nuclear. Isn't this a complete mismatch?" What would you say to that?

Well, I think that would be a naive view. If you look at the South African economy itself, it ranks as 25th largest in the world. It is an increasingly sophisticated manufacturing exporter. More than 60% of our exports are manufactured products. We are now a significant exporter of automotives and motor cars, and we make significant amount of avionic and aerospace equipment.

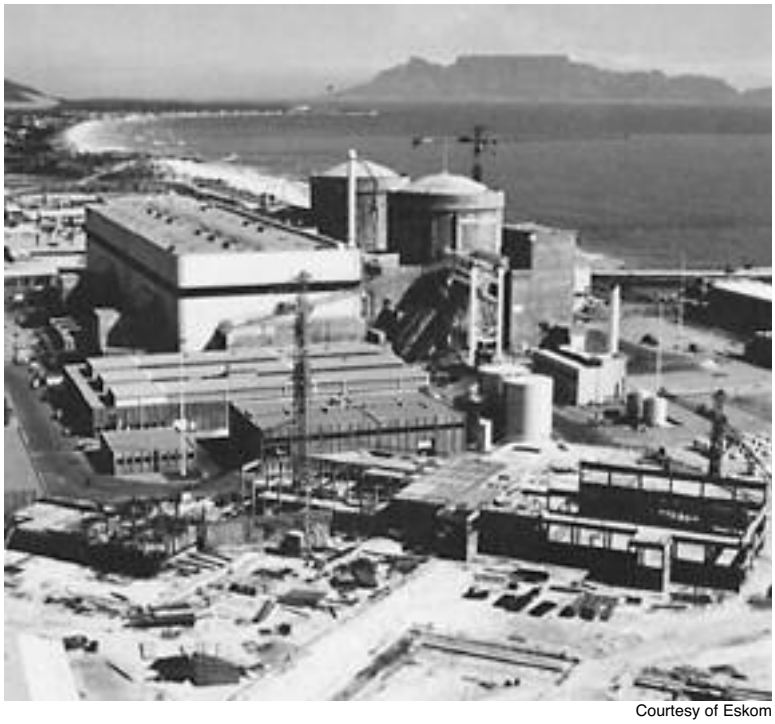
In South Africa you already have an industrial base that is strong, and if you look at Africa's needs, which are the exploitation of its mineral resources, increasing its agricultural potential, and so on, it needs energy to do that. So, in fact, the contrary is true; this is the perfect technology for Africa—and not just for Africa, but for many developing countries. This is wonderful: You can take a plant, you can put it close to your energy needs, you can put it close to the surrounding town, and you don't have to put in gigantic grids, because the management of grids across an extensive terrain is a difficult process. In Africa only South Africa has that capacity.

So I think this is actually one of the reasons we backed it so strongly: It is the most appropriate technology for the developing countries. It will allow Africa to exploit its massive potential.

Question: Many think of nuclear as mainly a black box, only concerned with obtaining electricity as cheaply as possible. But what about the effect of having a nuclear energy program on the economy, on the labor force, and so on. How do you look at that?

I am glad you raised that. There are three components which went into our strategic decision-making. Some relate to South Africa specifically; some are relevant for the rest of Africa.

First, we do have an industrial base. And this helps us to rebuild many of the heavier industrial componentry of our base, which were linked with the mining industry. Second, it allows



Courtesy of Eskom

South Africa's Koeberg Nuclear Power Plant has two conventional 922-MW reactors that have been in commercial operation since 1984 and 1985. Nuclear now supplies about 4.5 percent of South Africa's electricity.

us to enhance our scientific and technological capacity; it's a very useful component of that.

But third, the heat uses we can devise here are very very important. A very basic one for us is the prospect of desalination of water, which is very exciting for us. And we will be working with our own very big company, SASOL, which is a very advanced chemical company, pioneering gas-to-liquid technologies and coal-to-liquid technologies. We are going to do pilot plants with them.

So you have the spin-off effects from the point of view of your industrial base, your science and technology base, but also the heat-transfer uses that will have an important industrial effect on the economies.

Question: In the United States, one of the big projects of Roosevelt was the rural electrification program, which had an enormous impact, especially in developing some of the poorest and most backward areas. What is the situation in your country, and how might the PBMR be brought into play beyond South Africa per se?

South Africa is in a fortunate position. It has probably mounted one of the largest electrification programs in history. In the last ten years, we have connected 3.8 million households. Electricity connectivity now rises above 70% of the economy. We are now starting the second big round of doing that, reaching even farther into our rural areas. So it shows we can do it.

Now, we have the advantage of a big grid, that allows us to do that. What is wonderful about this PBMR technology, is that it would allow three things to happen for a developing country. You could start your mining activity, but now at the mine (with the PBMR as a heat and power source), you could put your processing activities directly at the mining point, so you get value addition. And you can at the same time supply surrounding electrification for agricultural activities and for residential and household uses. So I think the flexibility is tremendous.

We are now working on a massive project from the Inga hydroelectric project in the Congo, which will have very big transmission lines traversing southern Africa. Now to be able to complement that distribution network with the pebble-bed reactors along the way, would allow for a genuine electrification program for agricultural, industrial, mining, and residential use. So this is an exciting set of possibilities that will allow the African economies to develop.

African economies are short of energy. They are short of infrastructure. And both of these can, to an extent, be solved by the PBMR over time. So we are looking at the next ten years or more, but it is very exciting.

Question: I and my colleagues were involved in 1978 in writing a book, *The Industrialization of Africa,* which among other things included a proposal for an African railroad grid. Africa still does not have a modern transport grid. More recently, we have emphasized the importance of "infrastructure development corridors," in which transport, energy, communications, and water systems are "bundled" together as the most efficient means to develop a large territory. Are you looking in that direction for Africa?

Yes, it's very interesting. Through the new partnership for Africa's development, NEPAD (New Partnership for Africa's Development), which is now an African Union project, there are a range of projects. We took up that idea of the corridors; in fact, we financed it. If you look at the Maputo development corridor, we did just that. We built a new highway, we are upgrading the rail line, we upgraded the telecommunications; and the Mozambican government is bringing in new operators for their port.

So you've got a whole logistical and telecommunications passage going down through to Moputo. Obviously it's easier there because you can use the strength of the South African economy. But you can do this in many African countries. So we are looking at that. And another point I should make, of course, is that with telecommunications you also need energy. The telecommunications industry in Africa is growing very fast, led in the main by the big South African telecommunications companies, and this is mainly wireless and mobile telephone, but that needs energy to get coverage. So again, you see the complementarity between the energy and the other infrastructure.

And quite clearly also with the rail system. There are a number of projects put forward in NEPAD that we are looking at developing. I would say that the main obstacle we are having on those projects at the moment is raising finances. In South Africa we can use more sophisticated public-private partnerships; our

big state companies, rail companies can enter the capital markets successfully. Elsewhere in Africa, we are probably still dependent on a higher element of grant assistance, and that is a restraining factor in Africa at the moment which we need to change.

Question: Neo-liberal dogma says that governments should stay out of the economy. But in South Africa, the government plays a crucial role in infrastructure and economic development. How do you see this issue?

Our view is that you must examine your economic position at any point in time. The state will always play a role, also in the United States. But what role it plays and how it does that successfully is always a question of the moment. There are no religious dogmas on these things either way.

We have a very specific set of roles that we see the state playing. For example, the state will retain ownership of the electricity company, Eskom, because that gives us a much clearer strategic shareholding. But we then designed the total electricity system in a way that brings in private capital, through independent power producers (IPPs) and other areas. So you get a genuine structural partnership between the private and the public sectors. And you can adjust the proportionality of that partnership as the economic circumstances change.

For us in South Africa now, we need a strong state involvement; but the instruments we use are not necessarily the old-style ones. Our state-owned enterprises, as we call them, Eskom, our transport companies, and so on, have to be capable of entering the capital market, raising private capital at rates that are equal to the sovereign rate. So that puts a lot of pressure on the management and the boards to manage their companies efficiently. But we do give them an economic mandate. They are not profit-maximizers. We say that you have to meet these targets with social delivery.

For South Africa, we have an exceptionally important program. Because of poverty, we have a situation where we provide a basic free allowance of water, sewage treatment, and electricity to the poorest of poor households. So you get the basic allowance which is free, in terms of electricity, that is enough to keep your lights and cooking going for the year, and it allows kids to study, with a reasonable standard of living. We can do that because we use the instruments not just to maximize profit, but to achieve certain economic objectives.

But the mix with the private sector is very strong. We work closely with the private sector; we bring them into the investment plan. So this should not be some matter of religion, it should be a matter of concrete economics.

INTERVIEW: DIETER MATZNER

A Safe, Foolproof Nuclear Reactor

Dieter Matzner is General Manager of the Power Plant Division of PBMR. He was interviewed by Jonathan Tennenbaum on Jan. 30 at the London conference on the PBMR.

Question: I think that building a fundamentally new type of reactor has not happened for 40 years.

Yes, it's probably 40 years.

Question: What do you think are the most interesting and challenging features that people should keep in mind about the PBMR?

I think the most important feature by far is that the PBMR reactor design utilizes ceramic fuel, and the whole core design is made of ceramics—that is graphite materials which can withstand very high temperatures. The basic advantage of this is that the fuel is meltdown-proof. A core melt is made impossible essentially by the choice of materials, and therefore there is no need even for discussion about a probability of a core melt. That is the unique advantage of this high-temperature gas-cooled reactor.

Of course, there are many other advantages which this reactor has, starting with the whole idea that it has an on-line fueling system. There is only one other reactor in the world like that, Canada's CANDU reactor, a heavy water reactor [which uses natural uranium fuel].

This on-line fueling system has some very unique advantages. First and foremost, you can design the reactor with a very low excess reactivity, which means that in case of an

Geraldine Bennett/PBMR

Dieter Matzner (left) and Regis Matzie.

accident, you are essentially safeguarded by the design from a reactivity event [runaway chain reaction].

On-line fueling of course enables you to have much longer operational cycles between maintenance outages—planned shutdowns. In our case, the aim is to achieve an outage cycle of 30 days every six years, instead of the conventional 18-24 months' fueling and refueling cycles of light water reactors. In theory, this should give you an availability capability of about 97.5 percent, if, of course, all the mechanical equipment performs satisfactorily. But in principle, it's possible to achieve this very high availability. That, for the nuclear power generation industry, is very important.

The other thing is that because outage cycles are not determined by the fueling cycles, you have much greater flexibility to schedule maintenance outages. So, when there are, say, outages of other power-generating equipment, you are in a much better position to plan when the reactor must come offline for maintenance.

The other very important advantage of this pebble-bed reactor is that the pebble itself, the fuel form, lends itself perfectly for heat transfer, because the heat transfer around the sphere is optimal. It has a high surface area and stress distributions in the fuel are optimal because of its symmetrical fuel arrangement. That in itself is very unique. You are not restricted in any sense in the design. The other interesting fact about this reactor is that it is very proliferation-resistant. It is very efficient in burning plutonium, and in fact you would never deploy this technology for the purpose of breeding weapons-grade material.

Question: Do you mean that any plutonium that is generated in the reactor is burned up right away?

Yes, it is burned up right away, and there is very little plutonium left. To get enough plutonium from this reactor for a bomb would require something like 100,000 fuel elements to be diverted, which is unthinkable in a process inspected by an international authority like the International Atomic Energy Agency. Therefore, we see this as a very strong feature of this technology.

Furthermore, the technology lends itself very well to handling multiple fuel cycles. In South Africa we utilize UO_2, uranium dioxide, but it is very thinkable that different fuel cycles could be introduced into the same reactor without changing its design. First and foremost, in Germany the thorium-uranium fuel cycle was demonstrated very successfully. If you wish to do so, you could burn plutonium in this reactor, and even mixed oxide (MOX) fuels would be possible. All these different fuel cycles could be introduced into this reactor without actually needing to make any reactor design changes.

Question: Are there any other unusual features of the PBMR?

Another unique feature of this reactor technology is that it is unrivaled in terms of its high-temperature process heat application. In other words, this is the only carbon-dioxide-free high-temperature heat source available to mankind at this point in time. There is just no other way around this.

This reactor also has a very high burn-up rate of the fuel. The achievable burn-up at the present enrichment of 9.6 percent, is about 92,000 megawatt-days a ton of heavy metal. This leads to a significant reduction in high-level waste, and of course promotes the economics of the reactor from a fuel-efficiency point of view.

We have opted to couple this reactor technology with a gas-turbine cycle, which is unique, and that enables us to utilize the high-temperature capability of the reactor with a subsequent increase in efficiency. Normal reactor technologies coupled to the steam cycles give you on the order of 25-36 percent thermal cycle efficiencies, but we are on the order of 42 percent, which is a significant increase.

So in principle therefore, the specific safety features of a meltdown-proof core, the on-line fueling capability, the high efficiency capability, the process-heat applicability, the proliferation-resistance of this reactor technology, make it a very unique system design, and therefore it can be truly labelled as a so-called Generation IV reactor.

Question: How does the design complexity of the PBMR compare to that of the traditional light water reactor? Conventional light water reactors have extremely complex safety systems.

We have done a comparison to an AP1000 [Westinghouse] reactor, which is regarded as the Generation III-plus reactor and which relies much more on passive safety features than the traditional Generation II reactors. The PBMR essentially has about half the systems which the AP1000 reactor has, in order to support the whole power-generation process. I haven't got the exact figures to tell you now, but this study has been done and it is amazing how few systems the PBMR really utilizes.

Of course it is true that because of the very low energy-densities in the reactor, there are very large reactor structures, for a relatively small power output. That in itself means that there are few components, but these components are very large, and are essentially of the same size as a large light-water reactor.

Question: So, you save on the safety systems, but pay more for the components. And do you have confidence that in the overall cost, the PBMR will be competitive with the conventional light water reactor or even with coal generation?

You have to compare like with like. We cannot compete with a large coal-fired station located directly at the coal field. We have very cheap coal. So we must compare ourselves with power-generation options on the coastline, which is far away from our coal fields. There we can say that we are definitely competitive with combined-cycle baseload gas. There is no question about it—in fact, we are cheaper than that.

But I would expect that our technology is more expensive than the large light-water reactors. That is because the new generation of light water reactors, going up to 1,600 megawatts, are very large machines, and they have achieved economy-of-scale benefits by their larger size.

We have a definite disadvantage because of the small size, but it is for that reason that we picture ourselves not in the areas where large-scale power requirements are, but rather in the areas where you have 600 megawatts and less for power requirements. There are many countries, specifically in the developing world and most notably in Africa, which need only 200 or 400 or 600 megawatts of power for the country's grid. They would never be able to afford to buy a large 1,600-MW light water reactor.

Even South Africa, with its distribution grid, it would not be considered viable to have one large machine put onto the coast line, for the simple reason that if that machine goes offline for maintenance, or whatever, then you have no power.

So you still have to install the spinning reserves in the transmission grid in order to be able to compensate for the loss of such a machine. And benefits of size, in terms of power-generation, also bring financing risks. Because the financing risks of such a large power station are substantial, the utilization risk that it would not be utilized from day one, and the disruption factor of not being able to feed an area where a large machine goes off-line—these extract a premium in the price.

Question: How big a market do you envision developing countries to be for the PBMR, and where would the staffing come from?

The most important challenge with respect to the deployment of this technology in Third World countries, at the moment, is that most of these countries do not have the nuclear regulatory frameworks and regimes. And, therefore, we would have to find a way to be able to deploy these systems in these countries. I believe it is quite likely that in Africa, specifically sub-Saharan Africa, one could probably find a way where the South African licensing regimes, also with Eskom which is a major regional utility, would provide the operational support, within the regulatory framework from South Africa, under which these reactors could be licensed in these countries.

We see it as one of the operational benefits that the costs of power generation are less from a staffing point of view. We expect to have less staff on a station like this, because it is a simple station. Also because it is such a forgiving technology. In other words, this is probably one of the big advantages: If anything goes wrong, you have days, not minutes, before something happens. Even in the worst case, with this technology you will not have a catastrophic accident. You might lose your investment, but you will certainly not have a core melt. This is, of course, totally different from the other reactor technologies.

So from that perspective, I don't want to say that you can get away with unskilled and untrained personnel, but the severity of an accident, is much less, even if the plant doesn't have the most highly trained persons there. So this is exactly the technology of the future that can be deployed in the developing countries, where there is a shortage of skills and where the large power requirements are just not there.

Question: In terms of the plant construction, what are the requirements for the nuclear-quality components?

About 40 percent of the cost of the plant is in good-quality industrial equipment, like that you would find in any country, on the electrical side and chemical auxiliaries, civil structures, and so on. Of course, the reactor itself and the turbo machinery are high-quality components, and those always have to be imported or manufactured in factories which can make them according very stringent quality control. That's already a requirement in order to have not only safe operation but reliable operation. And that is the intent of any utility.

INTERVIEW: DR. REGIS MATZIE

How the U.S. Plans to Use the PBMR

Dr. Regis Matzie is Senior Vice President and Chief Technical Officer, Westinghouse Electric Company. He was interviewed by Jonathan Tennenbaum on Jan. 30 at the London conference on the PBMR.

Geraldine Bennett/PBMR

Question: How do you see the situation with PBMR applications in the U.S.A.?

We have started the early phases of licensing in the Nuclear Regulatory Commission (NRC) of the pebble-bed reactor, the so-called pre-application review. Pre-application means before the official design certification application, which is our process in the United States.

We're going to take about two years to complete pre-application review, and what we do in those two years is, first of all, educate the regulator about the design and the safety case. Second, we address a handful—six, seven, eight issues—that you need to get agreement on how to resolve them, before you submit a licensing report, a safety analysis report. We are picking issues that are very fundamental: What are the classifications of the systems and components, the safety classification? What are the codes and standards that you would use? What is the requirement for fuel qualification, and so on? So there's about six or seven of those that we are addressing, and we're resolving those while we're licensing this plant in South Africa.

So the current intention is, that once the South Africans are finished licensing the plant, so that they can start construction there, then we'll be ready to submit a similar application in the United States.

Question: Would you be building essentially the same design in the United States as the South African PBMR?

That is the current intention. The question is, I don't think we will be building what you would call a single unit, one module. Probably they'll come in four-packs, which is about 660-700 megawatts-electric. Another question, however, at this time, is, do we go ahead, and make the application for the electric plant, which would be a multi-module (probably four), or do we go ahead and license the process heat plant?

Now the process-heat plant is behind the electric plant in terms of the engineering, but we're working on that right now.

The other aspect is, that we haven't quite figured out how to approach the subject with the U.S. Nuclear Regulatory Commission. Can we license the basic safety case for one module, and then have just certain types of interface requirements, so that we can have a two-pack, four-pack, and eight-pack [of modules]?

You don't want to have to license each individual configuration on a modular reactor. You want to get a basic safety case. They have never done that before, so we are going to work through that issue with them.

Question: There has been discussion in the United States—including, for example, from Bill Ford, the head of the Ford Motor Company—of launching major government-supported programs to bring in hydrogen and other synthetic fuels, and new types of automobiles using hydrogen-based fuels. How are you thinking about these issues?

When I say the process-heat plant, there are specific types of applications. One of them is to generate syngas, another is to convert coal to liquid. Now South Africa SASOL is a major company that produces about one-third of all the petroleum products in South Africa; gasoline, diesel are converted from coal; these are all coal-based. SASOL does a coal-based conversion to liquid, that puts it into the transportation sector.

Question: And they also burn some of the coal to get energy for those processes?

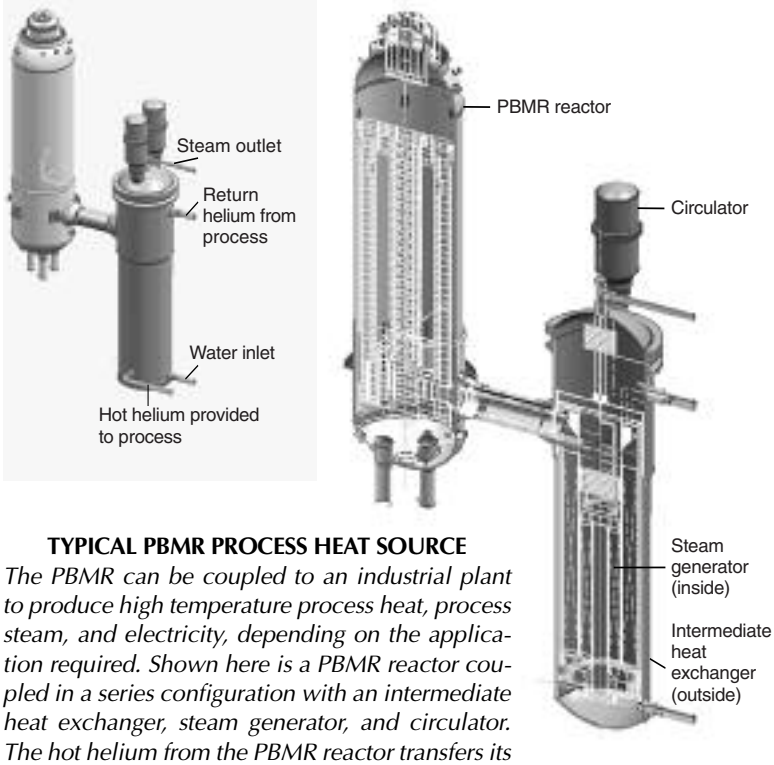
Exactly right. There are a lot of emissions, as they are burning fossil fuels to do that conversion. What we want to do is develop the processes with the process-heat plant as a heat source, and also to generate hydrogen. Then hydrogen goes into the conversion process, and you can convert all the carbon to liquid petroleum. Right now, a significant percentage of the carbon goes up the stack when you're doing the current conversion process.

Question: What do you mean by liquid petroleum?

Diesel, gasoline, the whole set. And so we are looking at that with people like SASOL, British Petroleum, and so on. We have had preliminary discussions with many of them, and the question is, can we bring them along? It is a big step for people in the fossil industry to get involved in nuclear; it's kind of a psychological hurdle. So you have to bring them along. And of course today we do not have a product, where you can sort of show them the entire product.

We're designing the electric plant, and we're going to build that. So we'll prove the nuclear technology. We need to finish the design work on the process-heat plant plus the process side: How do you integrate the heat into, say, a coal-to-liquid or a syngas process, with the reformers and all the things that are on that side. Because there are different designs of those components, too.

We are going down that road. For the early stages, we're working with a process-heat company that does this for these types of companies, and we're getting there slowly.



TYPICAL PBMR PROCESS HEAT SOURCE

The PBMR can be coupled to an industrial plant to produce high temperature process heat, process steam, and electricity, depending on the application required. Shown here is a PBMR reactor coupled in a series configuration with an intermediate heat exchanger, steam generator, and circulator. The hot helium from the PBMR reactor transfers its energy to the intermediate heat exchanger. There it passes through the steam generator before the circulator returns the helium to the reactor inlet.

Question: Will this also include hydrogen production?

Thermochemical water-splitting is what we think is the most economical way to generate the hydrogen.

Question: I think that the inherent safety of the PBMR will be helpful in incorporating the industrial companies into the project.

It should be helpful in convincing them that this is not a technology they have to worry about. It should be helpful in allowing siting of the nuclear plant close to these chemical plants; what is the stand-off distance you need from the reactor—all this has to play together.

Question: What about the cost of the process-heat plants?

Right now, if you look at electricity, it's probably competitive with natural gas at around $6 per million BTU. Hydrogen production is in the same range, because most hydrogen today is done by steam methane reforming, where they're now using natural gas. So electricity and hydrogen are in the same general range, and of course natural gas prices are above that today, and they will probably stay above that.

INTERVIEW: JAMES WRIGHT

Texas University to Build First HTR Research Reactor!

Dr. James Wright, manager of the HT³R project at the University of Texas.

James Wright, Ph.D., is the manager of the HT³R project (pronounced "heater") at the University of Texas of the Permian Basin. He was interviewed Feb. 23, 2006 by Marjorie Mazel Hecht.

Question: First, congratulations! It's good news to know that there is a new nuclear project starting up, especially a high-temperature reactor. It's long overdue. How did this project get started?

In June 2005, the president of this campus, the University of Texas of the Permian Basin, was looking for ways to jumpstart research here. This campus is the smallest in the University of Texas system. The president, Dr. David Watts, is a sociologist, very bright, and he's done more for science, and has more vision for science, than many university presidents that are physicists, engineers, or chemists.

Dr. Watts asked a faculty member, an attorney, Jack Ladd, who runs the John Ben Sheppherd Public Leadership Institute, about this, and Jack suggested that he get in touch with me. Jack and I had worked on some technical projects together, when he was practicing law. So we started having discussions about implementing a scientific research program, which was basically using the national laboratory model—what Los Alamos used when I was there. That is, you start with a facility that is constructed with sound science, and then that facility also must have a myriad of activities that can be associated technologies.

So, being in the middle of the oil industry, we were aware that the oil and gas industry in the United States had already started decreasing around 2 percent per year, and that world production is soon to be decreasing. I don't know exactly when that's going to be happen. For this reason, Andrews, a small community north of us, several years ago went out and became involved in a low-level nuclear waste facility. They educated their population about nuclear energy. And, Andrews County has historically been one of the country's leaders in oil and gas production. The oil and gas business is a dangerous one. We lose people every year to accidents, so folks are aware of industrial

The first U.S. fourth-generation nuclear reactor will be built at the University of Texas of the Permian Basin as a teaching and test facility, according to an agreement signed on Feb. 22 between General Atomics and the University. The GT-MHR is a modular high-temperature gas-cooled reactor, which uses a direct-conversion cycle that is 50 percent more efficient than the conventional nuclear steam cycles in producing electricity. (The initials stand for Gas-Turbine Modular Helium Reactor.)

In the GT-MHR, the high-temperature heat created by nuclear fission is conveyed by the helium gas to directly turn a turbine that produces electricity. The GT-MHR is similar to the South African Pebble Bed Modular Reactor. The difference is that the GT-MHR has its fuel particles stacked in rods arranged in a prismatic core, instead of the tennis-ball-size fuel pebbles of the PBMR. The GT-MHR and the PBMR both have the same passive safety systems that automatically shut down the reactors, without human intervention, if there are any problems.

The project is named HT³R, and pronounced "heater," which stands for high-temperature teaching and test reactor. As the accompanying interview spells out, if all goes according to plan, the HT³R should be operating in six years—2012. It will be a 10- to 25-megawatt-thermal reactor, depending on the determination of the preconceptual design study.

The enthusiasm for the West Texas project should spur other U.S. universities to look ahead to a nuclear renaissance and reopen the research reactors that were shut down under anti-nuclear pressure in the past two decades, or even better, to build new fourth-generation reactors to train the engineers and scientists the country will need!

—Marjorie Mazel Hecht

Rafael Aguilera/UTPB

Participants at the signing ceremony for the HT³R agreement give the new project a standing ovation. Standing at far left is Dr. David Watts, president of the University of Texas of the Permian Basin. General Atomics CEO Neal Blue is third from left. Among the others present are local mayors and county officials.

accidents and dangers; they live with hydrogen sulfide in their communities. In fact, here on our campus we have wells that, if they weren't controlled, would emit hydrogen sulfide and kill people.

So in West Texas, we understand risk. We understand big equipment. Drilling an oil well is like mining, in a way. You hang a piece of pipe on an oil rig that goes 5,000, 10,000, even 20,000 feet down into the Earth. That's a lot of weight. You have to turn it in order to drill the well. So, the communities out here are really unique in that sense, of understanding risk.

And through the education process that this low-level nuclear waste plant went through, and the city and county of Andrews went through, it just seemed like a good opportunity for us. Dr. Watts had already recognized that.

Of course, there is also an enrichment facility that will soon be licensed—it's almost complete. They actually expect to break ground by August. That facility is just within a few feet of the waste control specialist facility, even though it's in New Mexico—on the border.

So, I looked at this, and said, really what we have is a Permian Basin Nuclear Industry Park! It's unique, and we should be able to exploit this. It's been a while since I've been around reactor technology. My Ph.D. is actually in nuclear chemistry, and so I decided I would call a friend, with whom I used to work at Los Alamos National Laboratory, Harold Agnew. Harold was the director of Los Alamos, and I worked in the director's office. I worked for him and enjoyed it—he's a tremendous guy. And I knew that he had gone to General Atomics, and was a CEO, and was still a director of the company.

I called him and told him I needed to find out about the status of nuclear energy in this country, and he said he was going to have someone call me. Literally, within minutes, Mike Campbell, the Senior Vice President for Lasers, Inertial Fusion, and GT-MHR from General Atomics called me, and invited me out there to talk about it. Two days later, I was in San Diego, and we talked and kicked around ideas for two days; and I was brought up to speed—at some level—on gas reactors, on what they had done, and what General Atomics had been doing while the rest of the country was sort of asleep at the wheel.

And so based on that, we formulated some things, and another person from GA got involved—Malcolm LeBar—and we started discussing some of the more technical issues. Then I asked the GA guys to come out to West Texas and see what we have, in the way of an educated population, and what I consider to be a nuclear-friendly environment. So, within two weeks, Arkal Shenoy, director of the MHR group, and Malcolm LaBar, manager of the MHR group, came out, and they were impressed with the community and the level of understanding that we had out here with nuclear energy and radiation. And I think we allayed their fears that even though the University of Texas of the Permian Basin had no Engineering Department yet, we were going to use this facility to build that capability.

Question: That's a good way to do it!

There are some political reasons in the state of Texas that make it very difficult to start any new academic program, because you have to have the students before you can pay the faculty. And of course, you can't pay the faculty before you have the students. It's a chicken-and-egg thing. But this facility will allow us to jumpstart that process, and be able to fund our faculty for, in essence, research, and then spin them off to teach classes.

Question: I think you'll attract students and teachers with this new research reactor.

Again, that's also our hope. We think this facility will. So what we decided we would do is create this high temperature teaching and test reactor research facility; and the keystone in the Los Alamos model would be the reactor

itself—and this reactor, due to its flexibility and all the things it can do. That is: with its high temperature, it can generate electricity using the Brayton gas cycle, as opposed to the Rankin steam cycle that is now used. In addition, it has lots of that good high temperature process heat, where you can thermochemically induce certain reactions to take place, like the production of hydrogen. And once you get hydrogen, then you can make synfuels, or you can just use hydrogen itself. There are a myriad things you can do.

So, we envisioned that we would have the reactor as the keystone; and then we'd have a radiation research facility that would use the reactor to work on new fuel cycles, advanced fuel cycles, to more effectively burn plutonium, thorium fuels. And I like to say, almost the kitchen sink. We're open to looking at any type of fuel cycle in the radiation laboratory.

Another laboratory that we would put in this facility is a high temperature process and materials laboratory. Once you get into this temperature regime, first of all you have a lot of materials problems; and the way you address these is to have a facility to do the required research and development. And since we'll have lots of that 950 degree celsius process heat, we'll have enough to do some good research. We'll also be looking at new processes—for hydrogen production, synfuel (synthetically produced light hydrocarbons) production, coal gasification.

Question: What about isotope production?

Yes, that's in the nuclear part. There's just a whole wealth of new research that can go on.

The third laboratory will be a Brayton Cycle laboratory, where we'll be able to test the use of gas turbines and optimize that.

So we have our core reactor as the keystone facility, and around it we have this series of laboratories, where really good physics, engineering, science, biology can be learned and developed. It will be a great research tool for the United States.

Question: I hope it will pioneer a pattern that other universities could follow, because, really, science is not alive in this country any more.

Of course we realize that, like everyone else does. And our goal then was how to move forward. We realized that we needed a pre-conceptual design if we were ever to obtain money from the Federal government, or from industry, or from anyone. And we determined that it would take about $3 million to do that pre-conceptual design.

Question: But you're going to move very quickly and get that done in six months.

Yes—we raised the $3 million in about two months; our kickoff meeting for raising the money was in December. And the key to that was Dr. Watts being able to entice the communities. If you look at who donated the money, we have an incredible mix of donors, all charitable donations—no equity, not stock. . . .

Question: No strings. . . .

No strings. This is all for the university. And we have a series of individuals, local philanthropists. We got roughly a quarter of a million dollars from them, in amounts from $50,000 down to a couple of thousand. And they were the first people to give us money. We got some civic leaders together and we had a luncheon at the local Petroleum Club in Midland, and we gave them a presentation on how important it would be, not only for West Texas and the Permian Basin, but for the whole country and the world to follow this path.

And the next thing that happened was that the civic leaders went to their communities, and the community of Midland donated $500,000; the community of Andrews donated $500,000; and the community of Odessa donated $500,000. For Midland and Odessa, this came out of Economic Development funds. They believe that this will help provide economic development for the region, which I believe it will. And Andrews managed to scrape up $500,000, half of it from the county and half from the city government.

Question: So that's really a grass roots effort, with broad support.

That's right. We also got $7,500 from a local Rural Electric Company. . . . And the last one and a quarter million came from Thorium Power. So those are the donors.

We also had to involve the University of Texas system, which is responsible for the operation of nine academic institutions and six medical institutions, known as the University of Texas. Their role in this: Barry Bergdorf, the general counsel and vice chancellor for the system, was appointed by the chancellor to lead the effort. The University of Texas system in a situation like this is very important for the overall success. You have to realize that we are the smallest campus in the UT System, and we had no technical capability in physics and engineering until this project came along. So the University system put a "teaming agreement" together. I suggested the campuses that had the engineering programs that would be useful in this endeavor, and they arranged for those campuses to help us—Arlington, Austin, Dallas, and El Paso. And then of course, they also included the communities in this teaming agreement, since they are such an important part. Not only did these communities raise money to support us, but it's their land and their air too.

The people here are "doers"—they are the original Texans. They have minds of their own. They don't want to take a backseat to anyone. We have some incredibly wealthy people out here, who made a lot of money in the oil business by taking risks. They understand risk, but more importantly, they are doers.

Question: So you are protecting the project from environmentalist attack, by building support from the bottom up.

Yes, and we're taking great pains to keep the public informed of every step that we take, of the technologies. Information is the key.

Question: They have everything to gain. . . .

They are still actively involved with this teaming agreement . . . which will help us complete the pre-conceptual design.

We've actually already started, as of when the document was signed Feb. 22; we're going full bore on the pre-conceptual design. That's what we'll

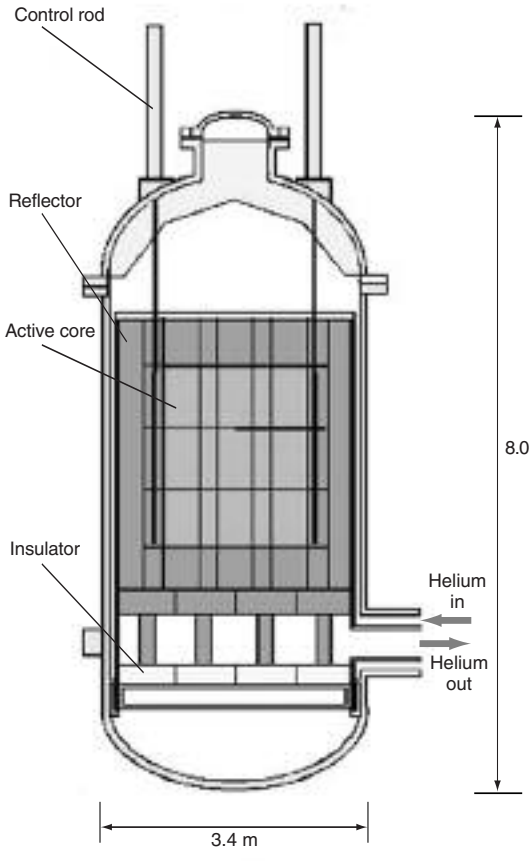
give the University of Texas system, and say that we think that we should move forward in the engineering, licensing, and construction; and before we do that, we'll need the regental approval again. . . .

Question: I would think that you'll be swamped with students, because there isn't another place like that right now, to get in on the round level of working with laboratories and a new reactor—all of those are very exciting things. And as you probably know, research reactors, except for a small number of them, have been shut down.

We'll be the first test reactor for gas reactors, and that's the future. We think it's a great place to be, and a great neighborhood to be in.

Question: What size reactor is planned?

The pre-conceptual design will actually determine that. Part of that will be determined by potential customers. Who will be interested in this type of reactor—who in the government, for example? I would say right now, it's somewhere between 10 and 25 megawatts thermal. That's somewhat larger than a standard research reactor at a university.



Courtesy of General Atomics

Figure 1
SCHEMATIC OF THE GT-MHR UNIVERSITY RESEARCH REACTOR
The GT-MHR University Research Reactor design has the same characteristics as the full-scale reactor: It uses a helium coolant, a graphite moderator, tiny (1 mm) ceramic-coated fuel particles, and the same passive safety characteristics. The fuel particles are stacked in vertical rods, which are arranged in hexagonal graphite blocks in the reactor core. The core is all ceramic, which permits very high temperature operating conditions. No meltdown is possible.

Question: But this will be a working test reactor. . . .

It will be a teaching and test reactor. We think it's very important to give it that name and that mission. We will be a kind of little brother to the NGNP, the Next Generation Nuclear Plant at Idaho National Laboratory. That's also a gas reactor. But that is a technology demonstration. And the belief is that before utilities will buy into a new reactor technology, they want to make sure that the new reactor can work at a high-duty factor, like our current light water reactors (LWR), above 90 percent.

We must prove that this reactor can run 90 percent of the time and reliably generate electricity and hydrogen. And can it do it for several years? That Idaho NGNP is the technology demonstration, that actually demonstrates to the utilities that, yes, we can do this.

Now, we're a little brother, a supporting piece for NGNP. We don't answer the questions that NGNP will. We're teaching engineers and scientists, and developing and testing new technologies that may well be implemented in NGNP.

Question: It seems to me that if the utilities had a brain, they would be supporting this.

Well, we're going to ask them! The key to funding this project is that it not be completely funded by the Federal government.

Question: Or run by the DOE. . . .

We're going to seek funding in several places in the Federal government, but we expect probably a third of this to be financed by private sources—non-Federal-governmental sources. The state of Texas and the communities here have already demonstrated that they're real proponents of this technology. We've already anteed-up $3 million. There's no other area of the country that has said that we believe that this is so important that we're going to put $3 million into it.

Question: That's certainly the case. Really the industrial capability of the country is dying.

So if you look at our communities: The population of Andrews, Texas, is 29,000. Now if you stop to think that a town of 29,000 people is so committed to this technology that they're willing to put up "risk" money of half a million.

Question: But it's their future.

That's right. They are truly a forward-looking community. I can't say enough about any of the citizens here in West Texas, because they put their money where their mouth is. Rather than "not in my backyard," they say, "We'll pay you to come in our backyard." So the communities here are really unique.

And local involvement is one issue, but we're also going to get industry involved. We're going to go out and find businesses that want to support this.

We're going to look for roughly a third of our money from businesses. And the rest of it, we're going to break out between the Department of Energy, the Department of Defense, and other places.

We want to make it so this project does not drain the resources of other things. We believe that it should be funded, but there are other projects that need to be funded also. The NGNP needs to be, and the GNEP [The Bush Administration's Global Nuclear Energy Partnership]. There are a lot of good nuclear programs that need to be funded, and we're all for that.

Question: Nuclear projects tend to get bogged down in all sorts of things, so if this can push ahead with the fourth-generation technology, that's great.

Well, we've already pushed farther ahead than a lot of people thought would happen.

Question: It will be great to have a U.S. fourth-generation project for nuclear engineers to work on.

We're going to need more nuclear engineers—we don't have enough. You know, by 2040, our current nuclear plants will be decommissioned, and nuclear capacity is about 20 percent of our electricity. Furthermore, by 2040, an additional 26 percent will be decommissioned from coal and gas-fired plants. What people don't understand is that all these plants have a finite lifetime, and we're not going to be able to afford to put in all these coal and gas plants. We're going to have to put in a lot more than that 20 percent nuclear; we're going to have to put in 30 to 40 percent nuclear to keep the cost down.

Question: Jim Muckerheide, who is the nuclear engineer for the state of Massachusetts, wrote an article for *21st Century* showing that by 2050, the world would need 6,000 new nuclear plants; and you can't build them all in 2049, you have to really start now. Muckerheide's project called for building all kinds of nuclear plants, but the workhorse of the plan was the high-temperature reactor in both forms, pebble bed and prismatic core.

Not only that, by using high-temperature plants, you have a higher efficiency, so actually you need to build less thermal capacity in order to get the same electrical capacity.

Question: Where will you get your fuel?

As far as licensing a reactor in the United States goes, they want you to use "proven fuel." That's a requirement for timely licensing. There is a source of fuel that has been used for this type of reactor, in Japan. So, I would imagine that one of our first shots may be to look at getting fuel from the Japanese. It's been proven, used. We'll have to really work with the NRC, and show them all the tests that have been done in Japan. But historically, it's extremely difficult to license new and unproven fuels. You need a test reactor to test the new fuel. So we will actually be able to test new fuels and help their development.

We can hypothesize about some of these decisions now, but the pre-conceptual design will more clearly define them.

Question: Can you try different fuel cycles in the reactor? I'm sure you know that General Atomics has a project in Russia that is doing engineering design on a GT-MHR to burn plutonium.

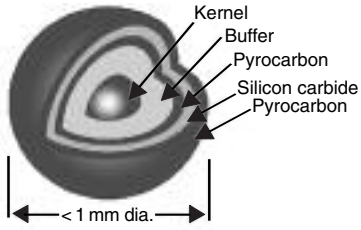
In the pre-conceptual design, our intent is to make this a real test reactor, where you can test all sorts of fuels and fuel cycles. That's our goal. The radiation laboratory will have that as its prime goal. We don't want to just refine uranium fuels in a gas reactor; we want to look at other fuel cycles. We want to look at thorium, we want to look at spent LWR fuels, we want to look at plutonium (the deep burn of plutonium); and we say we will consider all possible fuel cycles. We've done lots of calculations, and there are several that look very promising.

Question: The United States last year shut down the FFTF in Hanford, which was a reactor designed to test new fuels and materials.

We believe that this reactor will fill a real need in this country!

Some people have asked us why we haven't involved other universities in the project. One of the reasons that we haven't gone out and made a consortium is, we believe that once you start doing that, you lose focus. Two guys have a good idea and a good concept, and they ask a third facility or institution to come in, and that third party says, "You really have great ideas, however, let's add this." And so then they get a fourth institution to come in, and they say, "Boy, you three really have some great ideas, but let's add this." And pretty soon, your facility has lost its focus.

What we're trying to do is create a facility that will become a national users facility, operated by a national users group; and the University of Texas of the Permian Basin will take the lead in that. We want people to come in from all over the country. So once we get the reactor constructed, and that reactor has a real purpose and a mission, then we believe it will be really easy to get the users we need, worldwide. But we think it is really important not to include everyone until we get the construction done. We want to keep the facility's focus aimed really tight right now, so that when we do form a national users



Courtesy of General Atomics

Figure 2
COATED PARTICLE FUEL FOR THE GT-MHR
The outer layers of the fuel particle are ceramics, which provide "containment" for the nuclear fuel at the center. The temperature limit of the coating is higher than the temperature that can be achieved by the fuel particle, even in the most severe accident conditions. No fission products can be released.

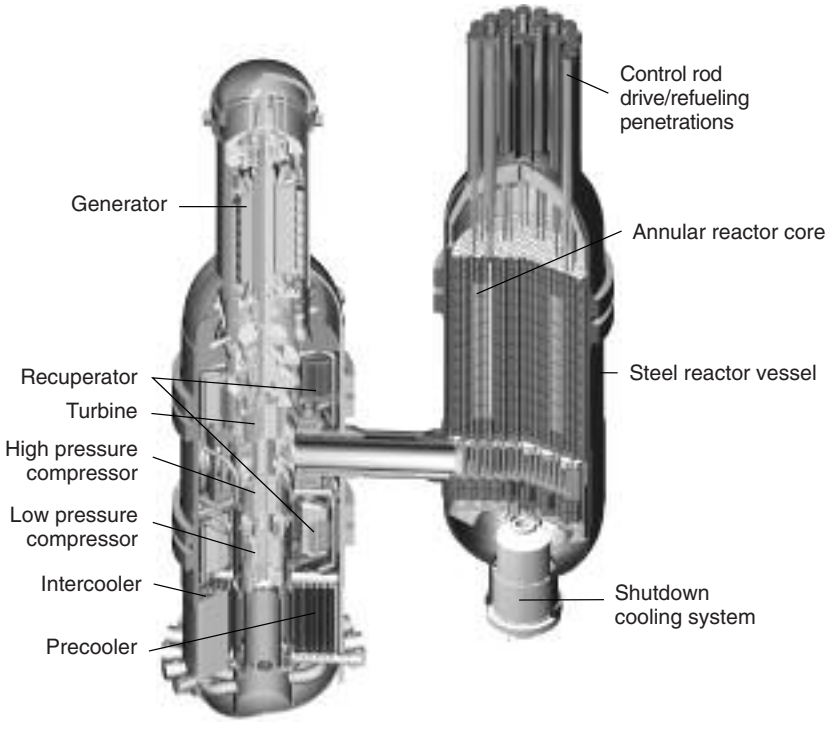


Figure 3
CUTAWAY OF FULL-SIZE GT-MHR

The university research reactor will be a smaller version of this 600 MWt GT-MHR. The advanced gas turbine system, which is based on the modern jet engine, helps make the reactor more efficient than conventional low-temperature power plants, which have a steam cycle. Conventional nuclear plants operate at about 32 percent thermal efficiency, while the GT-MHR can achieve thermal efficiencies of close to 50 percent now, and even higher efficiencies in the future. Other new technologies that increase the GT-MHR efficiency are plate-fin heat exchanger technology and frictionless magnetic bearings.

group, people will be eager to come, because they can see the real opportunities, and the opportunities will be something the country really needs.

Question: So it sounds like you could start construction pretty fast, if everything goes well with the plan.

We have a construction schedule, and if everything goes well, as we've planned, we believe that it's not too optimistic to have this operating at the end of 2012—only six years away. Some people say that that's awfully optimistic, and we just point to how long it took the Chinese and the Japanese. So, we believe that since we are designing this reactor to operate on current state-of-the-art technology, but have the possibility to extend its capability over the next 20 to 30 years—with that philosophy, we can literally be operating by 2012.

Question: You know that projects in the past, at Los Alamos for instance, took political will. If the will is there, you can do it. In the Manhattan Project, we built reactors in a very short time. And in fact, we went ahead and built things that we didn't have the technology to use—the first enrichment plant, for example, didn't have the design for the membrane yet, when the plant was in construction.

We did a lot of things on the fly.

Question: We did it because it had to be done, and if you have the right attitude, which it seems like you do, you'll get it done.

At our signing agreement ceremony this week, Neal Blue, the CEO of General Atomics, started his little talk by saying, "I think I've finally found 'Cando-sville.' "

General Atomics gets people coming through their facility all the time who want to team with them; and Mike Campbell told me that they are very polite with the people, but they seldom—generally never—make any progress.

Question: I'd like to ask you a little bit about yourself.

I received my Ph.D. at Iowa State University, while an Atomic Energy Research Fellow at the Ames Laboratory. And then I worked for a while at Hanford, and came to Los Alamos to calibrate a neutron detector that we'd developed at Hanford. While I was there, I was offered a job at Los Alamos—in the late 1970s, working in the office of the director, Harold Agnew. He and I had a great time.

Starting in 1989, there was just this nuclear vacuum. After Carter killed the Clinch River breeder reactor, that was the death knell.

I stayed in Santa Fe for a while and did some consulting. And then it became apparent that there was more money consulting for the oil business. We were doing shaped-charge work, and since I grew up in West Texas, I knew people in the oil business; so we started doing some shaped-charge work, applying some Los Alamos-type technologies to the oil and gas industry, then with defense contractors and environmental engineering. The last 10 years or so, I've done research for companies all over the world.

P. Pellerin

The damaged Chernobyl plant in 1992.

The Real Chernobyl Folly

by Zbigniew Jaworowski

A preeminent scientist from Poland tells the real story of Chernobyl today, in contrast to the wild lies in most of the media.

Ten days after steam and hydrogen explosions blew up the Chernobyl nuclear reactor, the fire that melted its core died out spontaneously. But the drama of this catastrophe still flourishes, nourished by the politics, authorities, media, and interest groups of ecologists, charity organizations, and scientists. It lives in the collective memory of the world, and induces real health, social, and economic harm to millions of people in Belarus, Russia, and Ukraine. It is intensively exploited by the Greens, and strangles development of the cleanest, safest, and practically inexhaustible energy source—nuclear energy.

Enormous amounts of radioactive dust entered the air from the burning reactor. Nevertheless, this amount of radiactivity was only 0.5 percent of that from all the 543 test nuclear warheads exploded in the atmosphere in past decades. From these test explosions, the highest radiation dose received by the world population was in 1963, 0.113 millisievert (UNSCEAR 2000). In comparison, the radiation dose from the Chernobyl dust received by the inhabitants of the Northern Hemisphere during the first year after the 1986 accident, was 0.045 mSv; that is, less than 2 percent of the average annual natural dose (2.4 mSv per year) (UNSCEAR 1988).

During the next 70 years, this population will be exposed to a total radiation dose from Chernobyl of about 0.14 mSv, or 0.08 percent of the natural lifetime dose of 170 mSv. People living in the most contaminated areas of the former Soviet Union are now exposed to an average Chernobyl dose of about 1 mSv per year.

But all these doses are dwarfed in comparison with natural radiation doses in some parts of the world. For example, in Brazil and southwestern France, natural radiation reaches up to more than 700 mSv per year (UNSCEAR 2000). No harmful health effects have ever been detected in areas with such high natural background radiation. Rather the opposite: In the United States and in China, the incidence of cancers is lower in regions with higher natural radiation than in areas of low natural radiation. (Frigerio et al. 1973; Frigerio and Stowe 1976; Wei 1990).

Among British radiologists who are exposed mainly to X-rays, mortality from all causes and from cancer is about 50 percent lower than in the average male population of England and Wales (Berrington et al. 2001).

Also, in many other population groups which were exposed to low doses of ionizing radiation, a deficit of neoplasmic malignancies was observed.

Worst Harm Was to Minds

Thus, perhaps surprisingly, one can say that the worst harm to the people exposed to the Chernobyl fallout was caused not by radiation, and not to flesh, but to *minds.*

In terms of human losses (31 early deaths), the accident in the Chernobyl nuclear power plant was a minor event, when compared with many other industrial catastrophes. There were more than 10 such catastrophes in the 20th Century, where several hundreds to many thousands died. For example: In 1984, about 20,000 people perished after an explosion at a pesticide factory in Bhopal, India. In 1975, a collapse of the Banqiao dam on the Ru River in China caused 230,000 fatalities. The world does not celebrate the anniversaries of these terrible man-made disasters, but year after year we do so for the Chernobyl accident, which was thousands of time less deadly.

And if we look at accidents related to the electricity-production sector alone, the early fatalities in Chernobyl were lower than those from a majority of other energy sources. They were 3 times lower than fatalities from oil-fired power stations, 13 times lower than those from liquefied gas, and 15 times lower than from hydroelectric stations (not including the Banqiao disaster).

But the political, economic, social, and psychological impact of Chernobyl was enormous. Let's look at what happened, starting with my personal experience.

My Chernobyl Experience

About 9 A.M. on Monday, April 28, 1986, at the entrance of my Institute in Warsaw, I was greeted by a colleague who said: "Look, at 7:00 we received a telex from a monitoring station in northern Poland saying that the beta radioactivity of air is 550,000 times higher there than the day before. I found a similar increase in the air filter from the station in our backyard, and the pavement here is highly radioactive."

This was a terrible shock. My first thought was: **"A NUCLEAR WAR!"** It is curious that all my attention was concentrated on this enormous rise of air radioactivity, although I knew that the dose rate of external gamma radiation penetrating our bodies, on this first day after the Chernobyl accident, was higher only by a factor of 3 than the day before, and was similar to the average natural radiation dose, which for time immemorial human beings have all received from the ground and cosmic radiation.

But in 1986, the impact of a dramatic increase in atmospheric radioactivity dominated my thinking, and that of everybody else. This state of mind led to immediate consequences. First there were various hectic actions, such as the ad hoc coining of different limits for radionuclides in food, water, and so on. These limits varied by a factor of many thousands in different countries, reflecting the emotional state of decision-makers, and political and mercenary factors. For example:

Sweden allowed 30 times more radioactivity in imported vegetables than in domestic ones, and Israel allowed less radioactivity in food from Eastern Europe than food from Western Europe. The Philippines imposed a limit of concentration for cesium-137 in vegetables of 22 bequerels per kilogram, which was 8,600 times lower than in the more pragmatic United Kingdom. In Poland, a group of nuclear physicists and engineers proposed a cesium-137 limit of 27 Bq in 1 kilogram of any food, but, fortunately, the authorities decided more soberly.

Most of these restrictions were meaningless from the point of view of human health, but their costs were enormous. As an example, Norwegian authorities introduced a limit for cesium-137 concentration in reindeer meat and game of 600 and then 6,000 Bq per kg (Henriksen and Saxebol 1988). An average Norwegian eats 0.6 kg of reindeer meat per year. With the higher limit, the radiation dose from this meat would be 0.047 mSv per year. Thus this measure was aimed to protect Norwegians against a radiation dose that is about 200 times *lower* than the natural dose in some regions of Norway (11 mSv per year). The costs of this protection climbed to more than $51 million.

"Thus, perhaps surprisingly, one can say that the worst harm to the people exposed to the Chernobyl fallout was caused not by radiation, and not to flesh, but to *minds*."

Other countries were no better. Professor Klaus Becker, from the German Institute for Standards, estimated recently that this kind of practice, together with its consequences for the nuclear industry, meant that the costs of the Chernobyl accident in Western Europe probably exceed $100 billion.

Unnecessary Evacuation

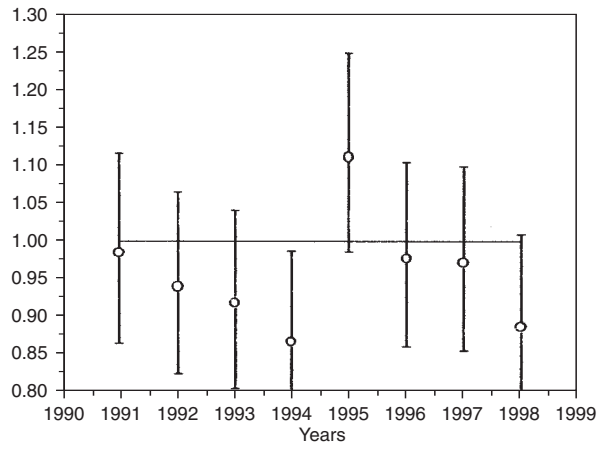
The most nonsensical action, however, was the evacuation of 336,000 people from the contaminated regions of the former Soviet Union, where the radiation dose from Chernobyl fallout was about twice the natural dose. Later, the radiation dose limit at which people were evacuated was decreased even to below the natural radiation level, to some five times lower than the natural radiation at Grand Central Station in New York City. (Grand Central's radiation comes from the natural radiation in its granite building blocks.)

Contaminated regions in the former Soviet Union were delimited, starting with a level of radioactive cesium-137 in the ground of 37 kBq per square meter. The radiation dose received from this source was about 1.6 mSv during the first year after the Chernobyl accident; the lifetime dose (after 70 years) from this source will reach 6 mSv. Note that this radioactivity level is 10 times *lower* than the average content of about 37 natural radionuclides present in a 10-cm thick layer of soil (400 kBq per square meter), and the corresponding Chernobyl lifetime radiation dose is 28 times *lower* than the average natural lifetime dose.

The evacuation caused a great harm to the populations of Belarus, Russia, and Ukraine. It led to mass psychosomatic disturbances, great economic

IAEA

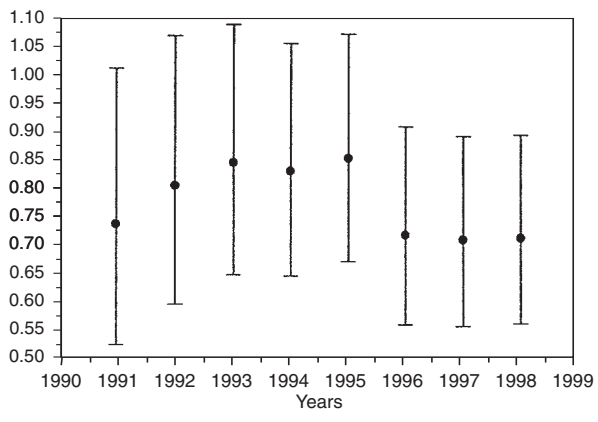
Ukrainian children involved in an epidemiological study by the International Atomic Energy Agency in 1990-1991.



STANDARD INCIDENCE RATIOS FOR ALL SOLID CANCERS IN BRYANSK REGION

The average standard incidence ratios for solid cancers in the Bryansk region (open dots) was 5 percent lower than that of the general population in Russia, which was used as a control group (1.0—horizontal line). In the most exposed group in the Bryansk region (with a mean radiation dose of 40 mGy), the average was 17 percent below the control group.

Source: Ivanov et al., 2004



STANDARD MORTALITY RATE FOR SOLID CANCERS AMONG CHERNOBYL EMERGENCY WORKERS

The standard mortality rate among Russian emergency workers at Chernobyl (black dots) shows a deficit in solid cancers compared with the general population of Russia, which was used as a control group (1.0). Between 1990 and 1999, cancer mortality for the emergency workers was 15 to 30 percent less than that of the general population as a whole.

Source: Ivanov et al., 2004

losses, and traumatic social consequences. According to Academician Leonid A. Ilyin, the leading Russian authority on radiation protection, the mass relocation was implemented by the Soviet government under the pressure of populists, ecologists, and self-appointed specialists, against the advice of the best Soviet scientists.

In addition to the 28 fatalities among rescue workers and the employees of the power station, caused by very high doses of radiation, and 3 deaths that were due to other reasons, the only real adverse health consequence of the Chernobyl catastrophe among about 5 million people living in the contaminated regions is epidemics of psychosomatic diseases: diseases of the digestive and circulatory systems, and other post-traumatic stress disorders, such as sleep disturbance, headache, depression, anxiety, escapism, learned helplessness, unwillingness to cooperate, overdependence, alcohol and drug abuse, and suicides.

The Radiophobia Disaster

These diseases and disturbances were not caused by irradiation from Chernobyl fallout, but by *radiophobia* (an irrational fear of radiation), aggravated by wrong administrative decisions, and even by increased medical attention. Paradoxically, such attention leads to diagnosis of subclinical changes that persistently attract the attention of the patient.

The administrative decisions made caused several million people to believe that they are the victims of Chernobyl, although the average annual radiation dose they received from Chernobyl radiation is only about one-third of the average natural dose. This victimization was the main factor behind the economic losses caused by the Chernobyl catastrophe, which are estimated to have reached $148 billion by 2000 for the Ukraine, and to reach $235 billion by 2016 for Belarus.

In Western Europe, psychological factors, and the neglect of radiological protection in the curriculum of medical studies, probably led to the abortion of some 100,000 to 200,000 wanted pregnancies, soon after the accident, where physicians wrongly advised patients that Chernobyl radiation posed a health risk to unborn children (Ketchum 1987).

In 2000, the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), the most authoritative body in these matters, and in 2006, the United Nations Chernobyl Forum (a group composed of representatives of eight U.N. organizations, the World Bank, and the governments of Belarus, Russia, and Ukraine), stated in their documents that except for thyroid cancers, there was no increase in the incidence of solid cancers and leukemia, and no increase in genetic diseases observed in the highly contaminated areas.

The Screening Effect

I believe that the increased incidence of thyroid cancers is the result of a screening effect. The reported increase in observed thyroid cancers in children was first observed in the Bryansk region (Russia) already in 1987, only one year after the accident, which is too early to be in agreement with what we know about radiation-induced cancers. The maximum incidence of these cancers (0.027 percent) was observed also in the Bryansk region, in 1994.

In normal populations, there is a very high incidence of occult thyroid cancers (those with no clinical symptoms, which are discovered at the post mortem, or by the use of USG diagnostic tests). In the United States, 13 percent of the population have occult thyroid cancers; the figures are 28 percent in Japan, and 35 percent in Finland. In Finland, occult thyroid cancers are observed in 2.4 percent of children (Harach et al. 1985); that is, some 90 times more than the maximum found in the Bryansk region in 1994.

According to regulations of the Belarusian Ministry of Health, the thyroids of all persons who were less than 18 years old in 1986, and also of each inhabitant of contaminated areas, must be screened every year (Parshkov et al. 2004). More than 90 percent of the children in contaminated areas are now screened for thyroid cancers every year. It is obvious that such a vast-scale screening program resulted in finding the occult cancers.

IAEA

A Russian woman takes her food to be checked for radiation during the epidemiological study of the International Chernobyl Project in 1990-1991.

Lower Mortality

Data published by Ivanov et al. (2004) and cited in the Chernobyl Forum documents (Forum 2005; Forum 2006) show a 15 to 30 percent *lower* mortality among the Chernobyl emergency workers, and a 5 percent lower average solid cancer incidence among the people in the Bryansk district (the most contaminated area in Russia) in comparison with the general Russian population (see figures).

In the most exposed group of this population (those receiving a dose of 5 mSv per year), there was a 17 percent lower incidence of all solid cancers. Nor did the incidence of hereditary disorders increase. These data, rather than a linear no-threshold, or LNT, assumption (see below) provide a good basis for a realistic projection of the future health of millions of people officially labelled as Chernobyl victims. The final conclusion of the UNSCEAR 2000 report is that these people need not live in fear of serious health consequences, and the report forecasts that generally positive prospects for the future health of most individuals should prevail.

The Chernobyl Forum Assessment

The publications of the United Nations Chernobyl Forum present a mostly balanced overview of the Chernobyl health problems, with three important exceptions. First, the documents ignore the problem of occult thyroid cancers, downplaying the screening effect, and attributing most of the thyroid cancers to radiation.

The second exception is the problem of patients with acute radiation disease. From among 134 persons with this disease, who were exposed to extremely high radiation doses, 31 died soon after the accident. Among the 103 survivors, 19 have died up to the year 2004, mostly from such disorders as lung gangrene, coronary heart disease, tuberculosis, liver cirrhosis, fat embolism, and so on, which can hardly be defined as caused by ionizing radiation.

Nevertheless, the Chernobyl Forum presents these deaths as a result of high irradiation, thus bringing the total to about 50 victims of acute irradiation. After many a summer, all the 103 survivors will eventually die. The Chernobyl Forum's philosophy would then count them all, bringing the death toll from high irradiation to a round total of 134 victims.

In fact, however, the mortality rate among these 103 survivors was 1.08 percent per year, that is, less than the average mortality rate in the three affected countries, which was 1.5 percent in 2000 (GUS 2001).

And finally, the third exception to the Chernobyl Forum documents: The Forum projects future cancer fatalities, caused by low-level Chernobyl radiation, of from 4,000 to exactly 9,935 deaths. This projection is not based on trends in cancer mortality or cancer incidence observed during the past 20 years. As discussed above, according to the epidemiological studies cited by the Chernobyl Forum, there was no increase but rather a *decrease* in both these epidemiological parameters found among exposed people. It is obvious that these are the trends that should be used for realistic projections of future health.

Instead, the Chernobyl Forum performed an arithmetical exercise, spanning 95 years, of multiplying small short- and long-term doses of 7mSv, by a great number of people, and a radiation risk factor deduced from Hiroshima and Nagasaki studies. In these two cities, people were irradiated with doses more than 100 times higher than most of the victims of Chernobyl doses in a hundred-millionth fraction of a second, and not during a few days, or many years, as during or after the Chernobyl disaster.

Long-term irradiation is much less harmful than short-term (acute) radiation. Radiogenic cancers were never observed below an acute dose of 100 mSv. The exercise was based on an outdated concept of collective dose and the linear no-threshold assumption which states that even a near-zero dose of radiation can induce harm.

Immoral Extrapolations

This assumption was never proven by scientific evidence, and in fact it is a fraudulent academic exercise. Inhabitants of the two Japanese cities were irradiated in a hundred-millionth fraction of a second with doses that were orders of magnitude higher those received by people living in regions covered by the dust from Chernobyl, in a time period longer by a factor of 2 billion. The result is nothing more than a lying fantasy.

A six-foot chicken and other monstrosities continue to be attributed to "radiation" by the media and environmentalist groups.

Several scientific and radiation-protection bodies, including the former chairman of the International Commission on Radiological Protection, advised against making such calculations. Just the act of publishing these numbers is harmful and serves to solidify Chernobyl fears. Now, no efforts to explain to the public the intricacies of radiation-risk assessments, and to compare these numbers with the much higher level of spontaneous cancer deaths and so on, will help.

The past 20 years have proved that such hypothetical efforts are worthless, a kind of day-dreaming. Making such calculations keeps a lot of people well and busy, but such work was rightly defined by one of the founders of radiological protection, Dr. Lauriston S. Taylor, as the "deeply immoral uses of our scientific heritage" (Taylor 1980). Unfortunately, this phrase fits some parts of the Chernobyl Forum documents.

It is, reassuring, however, that 16 years after the Chernobyl catastrophe, another group formed by four United Nations organizations (UNDP, WHO, UNICEF and UN-OCHA) in its 2002 report, based on UNSCEAR studies, dared to state clearly, that a great part of billions of dollars used on mitigation of the consequences of the Chernobyl accident was spent incorrectly, not improving but actually deteriorating the situation of 7 millions of so-called victims of Chernobyl, making permanent the psychological effects of the catastrophe; and that authorities made wrong decisions.

The report (UNDP 2002) recommended that the three post-Soviet countries, and the international organizations break from the current policy. The basis of such a policy, that is, the expectation of mass radiation health effects, was not only futile, the report stated, but the enormous resources sacrificed for remediation of the assumed effects were uselessly lost.

The report presented 35 practical recommendations, needed to stop the vicious cycle of Chernobyl frustration, social degradation, pauperization, and epidemic psychosomatic disorders. They suggest a reversal of the present concentration of attention on nonexistent radiation hazards, permitting the relocated persons to come back to their old settlements, and removing almost all restrictions.

A Political Minefield

But here we enter a political minefield. How will people accept the taking-away of 50 to 70 various benefits, including a cash subsidy of up to about $40 per month, which they poetically call a "coffin bonus"? How do you explain to such people that they were made to believe that they were victims of what is actually a nonexistent hazard, that mass evacuations were an irresponsible error, that for 20 years people were unnecessarily exposed to suffering and need, that vast areas were unnecessarily barred from use, and that the resources of their countries were incredibly squandered?

In many publications, one can read that the Chernobyl catastrophe had serious political implications, and became a factor in the dismantling of the Soviet Union. Would fulfilling the recommendations of the UNDP 2000 report result in a political catharsis, and perhaps induce violent reactions?

This is probably not valid for Russia, where a more rational approach to Chernobyl prevails. But the political class of Belarus and Ukraine for years has demonstrated a much more emotional and less honest approach. When the 2000 UNSCEAR report (which documented that there were no serious health hazards to the public as a result of the Chernobyl accident) was presented to the United Nations General Assembly, the delegations of Belarus and Ukraine forcefully protested. This resulted in 2002 in the organization of the Chernobyl Forum, and influenced its work.

Today, the Chernobyl rumble, and its emotions, are beginning to settle down. In centuries to come, the catastrophe will be remembered as a proof that nuclear power is a safe means of energy production.

Prof. Zbigniew Jaworowski, M.D., Ph.D., D.Sc., is the chairman of the Scientific Council of the Central Laboratory for Radiological Protection in Warsaw. A multidisciplinary scientist, he has studied pollution with radionuclides and heavy metals, and he has served as chairman of the United Nations Scientific Committee on the Effects of Atomic Radiation. Two of his previous articles on Chernobyl appear on the 21st Century *website, http://www.21stcenturysciencetech.com.*

References

A. Berrington, S.C. Darby, H.A. Weiss, and R. Doll, 2001. "100 Years of Observation on British Radiologists: Mortality from Cancer and other Causes 1897-1997." *The British Journal of Radiology*, Vol. 74, pp. 507-519.

Continued on page 72

ALBERT WOHLSTETTER'S LEGACY

Wohlstetter was even stranger than the "Dr. Strangelove" depicted in the 1964 movie of that name. An early draft of the film was titled "The Delicate Balance of Terror," the same title as Wohlstetter's best-known unclassified work. Here, a still from the film.

The Neo-Cons, Not Carter, Killed Nuclear Energy

by Marjorie Mazel Hecht

The conventional wisdom in the nuclear community and in general is that President Jimmy Carter drove the nail in the civilian nuclear coffin when he stopped the reprocessing of nuclear fuel in 1976. But this is wrong. The dishonor does not belong to Carter. The policy that ended nuclear reprocessing was first promoted under the Ford Presidency, in a 1975 policy paper written under Ford's chief of staff Dick Cheney. And long before the Ford Administration, the idea that civilian nuclear power was bad, and that reprocessing should be stopped, was extensively argued by Albert Wohlstetter, one of the most ghoulish, secretive, and influential of U.S. nuclear strategists, from the late 1950s to his death in 1997.

Wohlstetter was a University of Chicago mathematician-logician and a RAND consultant, who kept himself in the shadows as he mentored some of the most public of today's neo-conservatives—Paul Wolfowitz, Richard Perle, and Zalmay Khalilzad, to name a few. In Wohlstetter's circle of influence were also Ahmed Chalabi (whom Wohlstetter championed), Sen. Henry "Scoop" Jackson (D-Wash.), Sen. Robert Dole (R-Kan.), and Margaret Thatcher. Wohlstetter himself was a follower of Bertrand Russell, not only in mathematics, but in world outlook. The pseudo-peacenik Russell had called for a preemptive strike against the Soviet Union, after World War II and before the Soviets developed the bomb, as a prelude to his plan for bullying nations into a one-world government. Russell, a raving Malthusian, opposed economic development, especially in the Third World.

Admirer Jude Wanniski wrote of Wohlstetter in an obituary, "[I]t is no exaggeration, I think, to say that Wohlstetter was the most influential *unknown* man in the world for the past half century, and easily in the top ten in importance of all men."

"Albert's decisions were not automatically made official policy at the White House," Wanniski wrote, "but Albert's genius and his following were such in the places where it counted in the Establishment that if his views were resisted for more than a few months, it was an oddity." Wanniski also noted that "every editorial on America's geopolitical strategy that appeared in the *Wall Street Journal* during the last 25 years was the product of Albert's genius."

Like Bertrand Russell, Wohlstetter saw the world in terms of a bounded chessboard of U.S. and Soviet nuclear missiles, where his clever gaming strategies would ensure that more of "them" were killed than of "us." His strategic policies were madder than MAD (Mutually Assured Destruction), which he found too juvenile in concept. Instead, he supported flexibility—the preemptive strike, high-precision weaponry with precision target-

Courtesy of the University of Chicago.

Albert Wohlstetter in a photo from the 1960s.

Stuart Lewis/EIRNS

Helene C. Stikkel/DOD

Wohlstetter's Weenies: Although Wohlstetter kept to the shadows, his protégés are very public. Clockwise: Richard Perle, former chairman of the Defense Policy Board, an advisory panel to the Pentagon; Paul Wolfowitz, former Deputy Defense Secretary, now president of the World Bank; Zalmay Khalilzad, U.S. Ambassador to Iraq; and Ahmed Chalabi, former leader of the Iraqi National Congress.

Stuart Lewis/EIRNS

Stuart Lewis/EIRNS

ting, and "nimble" military units. This is precisely the thinking behind Secretary of Defense Donald Rumsfeld's revamping of the U.S. military, which was designed by longtime Pentagon consultant Andrew Marshall, another Wohlstetterite.

Wohlstetter rated his scenarios in terms of their death tolls, with the aim of allowing America to come out with the least damage. And, like Russell, while he loved playing with nuclear weapons, Wohlstetter hated *civilian* nuclear energy: He saw that it had the potential to allow unlimited population growth, which was impermissible in his worldview.

Unlike other nuclear strategists and Dr. Strangeloves, Wohlstetter writes relatively clearly, though tediously and exhaustively logically, often using statistical arguments to "prove" his points. He has no understanding of physical economy or of development, just crude cost-benefit analyses. His view of human beings in all this is that of a grade-B cowboy film—good guys versus bad guys, where everything possible must be done to keep control in the hands of his good guys: the financial oligarchy or, as President Eisenhower labelled it, the "military-industrial complex." It is no surprise, therefore, that his prize student, Paul Wolfowitz, wrote his doctoral dissertation under Wohlstetter (published in 1972) arguing at length that nuclear desalination for the Mideast was a very bad idea—costly, unnecessary, and dangerous.

A Delicate Balance of Insanity

Wohlstetter's first acclaimed paper, published in 1958, was "The Delicate Balance of Terror," which reportedly so enthralled Richard Perle, then a high school chum of Wohlstetter's daughter, that it got Perle started on his "Prince of Darkness" career as a Wohlstetterite.

While Wohlstetter was working on Pentagon contracts, calculating kill-ratios of missiles and chessboard missile moves, he developed the argument that civilian nuclear power was no good in itself, that it would only lead to the ability to make nuclear bombs, and that nonproliferation had to be enforced to make sure that bad guys didn't get any nuclear bombs. To put this policy across, he used his mathematical skills to scare people, in classified briefings with military and other government officials, as well as Congressmen, which trickled down to the general public.

One of Wohlstetter's last public articles, published on April 4, 1995, by his longtime neo-con friend Robert Bartley, editor of the *Wall Street Journal,* argued that the Non-Proliferation Treaty was bad, because it makes it easier for nations without nuclear weapons to gain access to them—using plutonium produced in civilian nuclear reactors. "It has long been plain that plutonium for electric power has a large negative value. The civilian benefits are a myth. The military dangers are real and immediate."

This is the essence of what Wohlstetter promoted in the 1960s and 1970s. He created the myth that civilian benefits of nuclear energy "are a myth." As the *Wall*

Street Journal identified Wohlstetter in his 1995 op-ed, he "headed the 1975 study that led the U.S. to abandon the use of plutonium fuel for civilian power reactors."

Atoms for War

In the 1960s, when the civilian nuclear program was still moving forward under the philosophy of Atoms for Peace, launched by President Eisenhower in his famous 1953 speech at the United Nations, Wohlstetter pushed his "atoms for war" policy. While FDR Democrats and Republicans were elaborating visions of what the atom could do for peace in the world, providing energy, desalinated water, and process heat for industry, Wohlstetter marshalled his math to stop civilian atoms.

In 1967, Wohlstetter was the invited luncheon speaker at a Manhattan Project 25th anniversary event at the University of Chicago. He told the assembled nuclear scientists that there were no short-term civilian benefits to nuclear energy. The scientists who created the bomb, he said, wanted to find compensatory benefits for humankind for their wartime creation of destruction. But, he warned, "Some of these civilian uses have a large war potential. . . . [T]here is a massive overlap between the technology of civilian nuclear energy and that of weapons production. The good military atom therefore doesn't displace the bad military one. Expanding civilian use in general makes it easier, quicker, and cheaper to get bombs. . . . An essential trouble with nuclear plowshares, therefore, is that they can be beaten into nuclear swords. . . ."

Wohlstetter noted that the nuclear energy forecast in 1967 envisioned that by 1980, nuclear would supply 25 percent of U.S. electricity, with large reactors at costs competitive with electricity from fossil fuels. And then this "genius" informed the nuclear scientists: "Nonetheless it has been clear that such important benefits fall short of ushering in the golden age. They will not abolish want and are unlikely to reduce the great inequalities between rich and poor countries." As to why this was the case, Wohlstetter noted that energy costs are just a small percentage of the gross national product, and "cheap energy can help, but is not the key to economic progress."

Wohlstetter was particularly concerned that the Middle East remain free of nuclear power plants to desalt water, and to convey to his scientist audience that poor countries would not be able to gain from capital-intensive power reactors. As for breeder reactors, Wohlstetter's view was only negative. Instead of seeing the benefit of a reactor that produced more fuel than it consumed, he said that if breeder reactors came into operation as the U.S. Atomic Energy Commission expected by 2000, "there may be a million bombs worth of civilian plutonium in the world, doubling every ten years."

As negative as was this 1967 speech, it was short, and at least mentioned that in

The Inside Job Against Nuclear Energy

While Albert Wohlstetter's nuclear report put a hold on nuclear development from the top down, other forces were squeezing nuclear development from the bottom and middle levels of policy-making. Such a squeeze required the right sort of bureaucrat and the right bureaucracy to carry out the anti-nuclear thrust, and so the Ford Administration at the end of 1974, removed Dixy Lee Ray, the pro-nuclear chairman of the Atomic Energy Commission; and Congress abolished the agency, and reorganized energy policy into a mishmash agency known as the Energy Research and Development Administration.

(Dr. Dixy Lee Ray, who had been brought into the Atomic Energy Commission by President Nixon in 1972, was a scientist and an FDR Democrat, who fought to expand nuclear and educate the public about every aspect of nuclear technology. She went on to become governor of Washington state, and she continued to fight for nuclear energy expansion.)

Under the Carter Administration, nuclear energy was squeezed again, into being just another energy office in the new Department of Energy, headed by "energy czar" James Schlesinger, a Wohlstetter colleague at RAND who was then, and still is, anti-nuclear. The regulatory oversight for nuclear energy was given to the newly created Nuclear Regulatory Commission.

In this same time period, 1975, the Ford Foundation released a 450-page tome on nuclear energy, "Nuclear Power: Issues and Choices; Report of the Nuclear Energy Policy Study Group," purporting to be "fair" but arrived at by a group of Establishment academics, many of whom had the same Russellite credentials as Wohlstetter. As the overview to this report states, "We believe the consequences of the proliferation of nuclear weapons are so serious compared to the limited economic benefits of nuclear energy that we would be prepared to recommend stopping nuclear power in the United States if we thought this would prevent further proliferation." The overview went on to say, however, that such a course of action could "increase the likelihood of proliferation, since the United States would lose influence over the nature of nuclear power development abroad."

The most striking aspect of the Ford Foundation study is that it has the same Mickey Mouse approach to economics as Wohlstetter et al. There is no concept of physical economy or a "science driver." Everything is measured in strict cost-benefit terms, without any idea of development.

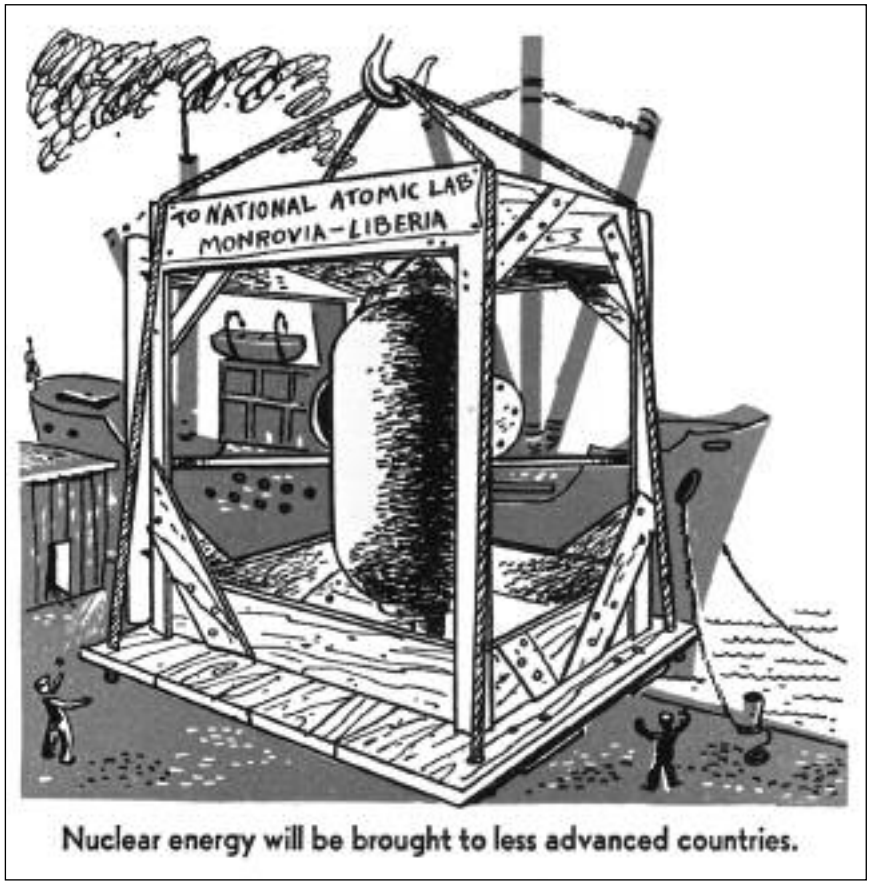
On the ground level in this period, was a growing swarm of environmentalist groups, hatched by the counterculture and the campus turmoil during the Vietnam War period. These were the most visible of the anti-nuclear forces, in the media and on the street. But the policies they carried out came straight from the neo-con pen of the shadowy Albert Wohlstetter and the lower-down Establishment figures who conducted the Ford Foundation study. The environmentalists and the so-called "left" were the legs, not the head of the anti-nuclear movement.

the long-range future, nuclear energy might have some benefit. In Wohlstetter's 1975 report, "Moving Toward Life in a Nuclear Armed Crowd?" the message is incessantly negative—for 286 pages. This report was prepared for the U.S. Arms Control and Disarmament Agency "to provide a clear definition of trends in the spread of nuclear technology, and a precise analysis of the problems (political, military, and economic) that these trends pose for policy."

Wohlstetter and his co-authors presented a statistical Mickey Mouse economic analysis of nuclear energy, which was designed to prove that civilian nuclear power is too costly, that reprocessing spent nuclear fuel is not essential and a money loser, that breeder reactors are too dangerous even to be seriously considered, and that nuclear energy retards development in the developing sector. In these pages is everything the anti-nuclear environmentalists and lawmakers could draw on to make sure that Wohlstetter got his anti-nuclear way. The overriding argument for Wohlstetter was that civilian nuclear energy can only be meaningfully measured in bomb-production capacity.

The report particularly targetted the Less Developed Countries (LDCs). "Investment in nuclear energy is a poor choice among alternatives for the economic development for the LDCs," the report stated. "It diverts capital from more productive uses. . . . [I]nstead of speeding economic development and slowing the spread of military technology, as we had hoped for decades, the subsidized transfer of nuclear technology has slowed development and may speed the spread."

For Wohlstetter et al., the benefits of nuclear energy were "exaggerated" because of the emotions connected to the dropping of the bombs on Hiroshima and Nagasaki. "In fact," the report stated, "if we could have detached ourselves" from these emotions, "we might have more easily questioned that subsidizing civilian nuclear energy was the way to stop the spread of the military technology. Since civilian and military nuclear energy programs overlap so extensively, a more plausible course might have been to subsidize research and development on the improvement of fossil fuels or of more exotic non-nuclear alternatives such as solar electric or geothermal power."



The nuclear optimism that scared Wohlstetter: This illustration is from a children's book in the 1960s, describing the benefits of nuclear energy.

Taking note of the nuclear optimism still in operation, the Wohlstetter report listed the projections for civilian nuclear plants in the 1990s, and then offered suggestions of how such growth could be derailed—exactly what occurred. "This large growth is not inevitable," the report stated. "It presumes the carrying through of plans, negotiations, and constructions not yet committed and of varying degrees of firmness; some have had setbacks. The growth, moreover, is open to influence, a subject for the elaboration of policy of supplier as well as recipient governments."

Unflagging Pessimism

Wohlstetter's pessimism was unflagging. The report reiterated in every section how "nuclear power promises very limited economic benefits to less developed countries." "In all likelihood," the report wishfully stated, "history will reveal that once again the nuclear optimists have greatly overestimated the future growth of nuclear power." And another favorite theme: "Every time a new country obtains a nuclear power reactor, it is moving significantly closer to a nuclear weapon development capability, since the plutonium produced by all nuclear reactors can be made into nuclear weapons."

Like Wohlstetter's tediously exhaustive strategic analyses, this report reviewed every aspect of how every country might be able to make bombs with their civilian nuclear reactors, and what might be done to constrain this. The main constraints from the Wohlstetter point of view were simple: stop nuclear technology, stop reprocessing, don't even think about breeder reactors, load on the statistics equating power plants with bombs, and don't mention any new technology development. His constraints worked. From this evil-minded Russellite neo-con, who remained in the shadows, came the antinuclear policies that have kept nuclear technology suppressed for 30 or more years.

A SPECULATOR, A PRINCE, AND A NEO-CON

Who's Sabotaging the PBMR?

by Dean Andromidas

There is an ongoing international campaign to block South Africa's development of the Pebble Bed Modular Reactor (PBMR), the small high-temperature nuclear reactor that promises to produce cheap and abundant energy for all of Africa. The campaign brings together mega-speculator George Soros, the U.S. neo-cons, the Danish government, and the Prince Consort to the Danish Queen.

The PBMR is a joint venture of South Africa's state electricity company Eskom, the state-owned Industrial Development Authority, and Westinghouse, which was recently sold by British Nuclear Fuels to the Japanese company Toshiba. The inherently safe nuclear reactor design, which would produce between 110 and 165 megawatts of electric power, represents the ideal solution for bringing cheap electrical power to vast areas of Africa, Asia, and Ibero-America, where millions of people continue to live in a "dark age" because of the lack of electricity.

Eskom, the South African state electricity company and major shareholder in the project, plans to begin building a demonstration reactor by 2007. In South Africa alone, the company intends to build at least 30 reactors to expand the nation's electricity grid to the 30-40 percent of the population lacking electric power.

While for Africans the prospect of abundant power can only be welcomed with open arms, for powerful international financial interests, such a prospect poses a far greater "existential threat" than any nuclear-armed "rogue state." As the speculative financial bubble of the world financial system is on the verge of bursting, the control of the massive raw materials of Africa, including its gold, diamonds, oil, copper, and uranium, is essential to the very survival of the international financiers. It is the massive flows of funds buying up these resources which have led to the "resource wars" of the last decade, especially those that have hit central Africa, the Democratic Republic of the Congo, and the Great Lakes region.

Stuart Lewis/EIRNS

Mega-speculator George Soros funds the South African environmentalist groups to attack economic development projects like the PBMR, and thus protect his raw materials looting.

It is not surprising, in this context, that the Bush Administration's international "War on Terror" has set up bases in Africa's Sahel, where rich deposits of gas have been discovered, as well as uranium and other strategic raw materials.

A preliminary investigation by *Executive Intelligence Review* has revealed that the "usual suspects" are intimately involved in this operation. They are the environmentalists, backed by powerful international financial and political interests who operate like gangsters.

Soros: The 'Capo di Tutti Capi'

At the top, operating like a racketeering mafia boss, is mega-speculator George Soros, who finances local environmentalists and other useful dupes, and deploys them as tough guys to attack nuclear energy as "unsustainable." At the same time, these deployables promote so-called "sustainable" technologies, like wind turbines and solar energy, both of which are totally incapable of sustaining an industrial economy.

Since the collapse of the high-tech bubble in 2000, Soros has shifted his investment strategy from high-risk currency speculation to investment in physical assets, especially raw materials, gold, silver, and so on. Africa plays a large role in this strategy. With George's brother Paul Soros, investments have been made in African mining companies and state-owned companies which governments are being forced to privatize by conditionalities imposed on them by the World Bank and the International Monetary Fund. Valuable assets, including mines, plan-

tations, and other agro-investments, have been bought up by Soros and the international corporations he supports financially.

Through his "Open Society" network of foundations, Soros organizes the "street" against the government and power centers that stand in the way of his financial operations. Thus, he puts into power those leaders who will implement the appropriate free-market laws. One celebrated example was the so-called Orange Revolution in Ukraine.

In South Africa, George Soros operates through his Open Society Foundation, based near Cape Town. The Foundation's major source of funding is from the profits of the Soros Fund Management, LLC and other entities from which Soros rakes in billions of dollars annually. According to U.S. Securities Exchange Commission filings dated Sept. 30, 2005, among the many companies in which Soros Fund Management holds millions of dollars in stock are mining companies with huge assets in Africa. These include Anglogold Ashanti Ltd., which controls one of the largest gold mines in the world, which the government of Ghana was forced to privatize, and Barrick Gold, the Canadian company that bankrolled the overthrow of the Mobutu regime, leading to a decade of civil war in the Democratic Republic of the Congo. Other companies include Newmont Mining, which has mines in Ghana, and the Ibero-American-based Apex Silver, in which Soros holds very large interests and has placed his brother Paul on its board of directors.

Although Soros has publicly compared President George W. Bush to Adolf Hitler, that has not stopped him from holding stock in the Iraq War mega-profiteer firm Halliburton, whose former CEO was Vice President Dick Cheney.

Another Soros stockholding directly related to our story is in the Exelon Corporation, whose decision to withdraw its investment from the PBMR project in April 2002 almost led to the project's collapse.

Sabotage

In 1999, when the process for gaining the authorization for the building of a PBMR demonstration plant was under way, the Soros apparatus moved to sabotage it.

www.sandia.gov

Rigmor Mydtskov/www.denmark.dk

Henrik, the Prince Consort of Denmark, has championed windmills as a Danish export, especially in the developing sector, and funded the opposition to the PBMR. Above, one of Denmark's royally subsidized windfarms on the southwest coast.

The Environmental Justice Project of the Legal Resources Centre, which is funded by Soros's Open Society Foundation, commissioned one Stephen Thomas to write a report trashing the PBMR and nuclear energy in general in 1999. At the time, Thomas worked at the Science Policy Research Unit of the University of Sussex, in Great Britain; he now works for the Public Service International Research Unit of the University of Greenwich, also in Great Britain. The report was then handed over to Earthlife Africa, a South Africa-based environmentalist organization which used the report as documentation for a court action to prevent approval for going forward with the PBMR demonstration plant.

This court action was supported not only by the Legal Resources Centre, but by the Open Democracy Advice Centre, which provided legal and financial assistance. This latter entity is also financed by Soros's Open Society Foundation. It is a joint venture of the Black Sash Trust and the Institute for Democracy, both of which are also financed by the Open Society Foundation.

The Thomas report, which has gone through several versions, is a piece of sophistry, which makes no attempt to deal with the technological feasibility of the project. For instance, in an earlier version of the report, Thomas trashes high-temperature-reactor technology as problematic, citing how the Chinese program was allegedly moribund. In its latest version, the report cites the same "moribund" Chinese program as representing a major potential competition to the South African PBMR!

But the key point of Thomas's report is

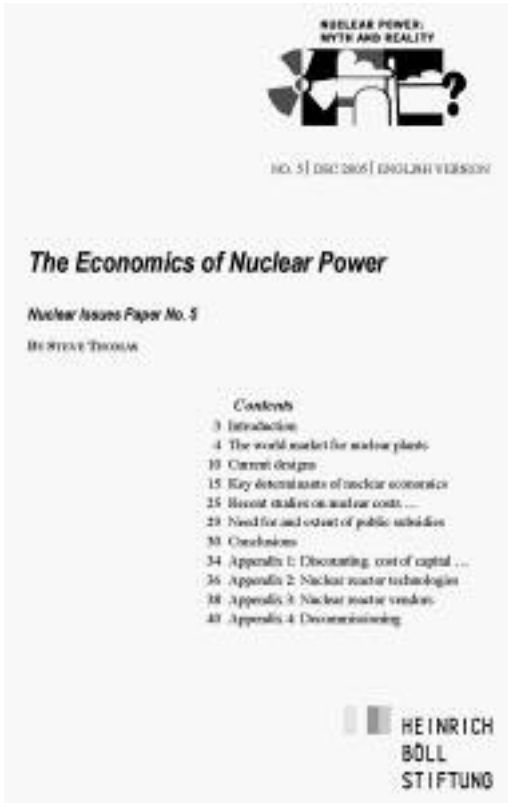
its analysis that nuclear power is not compatible with energy liberalization and privatization of state electricity companies like Eskom. It asserts that Eskom will inevitably face being broken up and privatized. Thomas's 1999 report states: "The momentum for liberalization throughout the world now seems unstoppable and, sooner or later, Eskom is going to have to give up its monopoly status and run its business under competitive pressures."

But Thomas makes clear that these "pressures" are the higher profit-rates the radical, globalized free market is demanding. Thomas draws the comparison with the privatized British utilities: "Government-owned utilities have usually been able to invest money at very low rates of return on capital partly because new power stations were seen as a safe investment and partly because, for a variety of reasons, governments have tended to require a lower rate of return on capital than private industry. Thus, in Britain before privatisation, the national utility, the CEGB, could invest at a 5 per cent real (net of inflation) rate of return and recover the costs over 35 years. After privatisation, it is known that private investors are looking for about 12-15 per cent real return and recover the capital over 15-20 years."

This is exactly what George Soros and globalization are all about: Destroy the institutions of the nation-state in the name of higher profits. It is not just the PBMR that these financiers oppose, but the very idea of a state-owned public sector, because it serves as a driver for real economic development instead of profits that will be taken out of the country.

Since 1999, when Thomas's words were written, the world has seen Enron and other such disasters which have done much to discredit privatization and deregulation of the energy sector.

Earthlife Africa and the Legal Resources Centre were able to block the approval of the PBMR's environmental impact study on a technicality, forcing the study to be redone. But they lost another case, in which they had demanded the release of the minutes of the meetings of the government commission that was formed to assess the environmental impact of PBMR. This latter case was thrown out of court in January 2006 and Earthlife had to pay the costs. The judges ruled that the study by Thomas, which was submitted as evidence, had "no probative value." Earthlife also lost its appeal of the decision on this case this month.



"No probative value," was the verdict of a South African court on one of Steve Thomas's reports on nuclear energy. Here the title page from his December 2005 report.

Windmills and the Prince

Soros is not the only financial backer of the anti-PBMR campaign. The other is the Kingdom of Denmark and the Consort to the Queen, Prince Henrik. The Danish International Development Agency (DANIDA), which is the Danish government's official aid organization, is also funding the operation. DANIDA finances the Environmental Justice Project of the Legal Resources Centre as well as Earthlife Africa's Sustainable Energy and Climate Change Project. The latter is also financed by the World Wildlife Fund Denmark, the Danish chapter of the World Wide Fund for Nature, whose founder and chairman is Prince Henrik. (The other founders of the WWF were also European royalty—Britain's Prince Philip and the Netherlands' Prince Bernhard.)

Like Soros's "philanthropy," this aid is not to help the "little people," but has a real profit motive: killing off the competition. Denmark is the largest world exporter of wind turbines, and since 1984 DANIDA has been financing projects throughout the developing world, where Danish-made wind turbines are being built.

For example, DANIDA was instrumental in establishing the wind turbine industry in India and lent support to India's "wind energy pioneer," Rakesh Bakshi, upon whom, in 1997, was conferred the "Diploma of the National Association for Danish Enterprise and His Royal Highness Prince Henrik's Medal of Honour."

Where DANIDA financing goes, the Danish wind turbine companies closely follow, and Danish wind turbine manufacturers, like Vestas, have established Indian subsidiaries.

The DANIDA projects are being carried out throughout the world, including Africa. One of the most extensive is in Egypt, where DANIDA helped fund the Zafarana wind farm, along with the German government's Kreditanstalt für Wiederaufbau (Bank for Reconstruction). The project's 105 turbines are supplied by the Danish-Germany company Nordex. In South Africa, DANIDA financed a wind farm in Darling, which is situated in the Western Cape, and an experimental wind station of three turbines operated by Eskom.

It is significant that German government financing was secured at the time when the Green Party was a coalition partner in the government led by Gerhard Schröder. The Green Party's Heinrich Böll Foundation is actively supporting the anti-PBMR campaign in South Africa and has financed South African environmental activist David Fig to write a book attacking the South Africa nuclear industry.

The Unsustainability of 'Sustainable' Energy

A glance at the Danish wind turbine industry demonstrates that, without government sponsorship and subsidy, the industry would rapidly collapse, because an electric generator that depends on wind is by definition totally inefficient—especially when there's no wind.

As the top exporters, the Danes have several companies ranging from small wind turbines to monsters that would even frighten Don Quixote.

It is a very special industry. Take Gaia Wind, which produces small 11-kilowatt wind turbines. Named after the Earth goddess, it was set up by the Gaia Trust, founded by Ross Jackson, an American expatriate and "spiritualist" living in Denmark. Jackson is a retired speculator who first financed the trust through his Gaiacorp, one of the world's first hedge funds dealing with special forms of currency derivatives. Gaia Wind, along with the Danish wind-turbine consultancy Kentec, won funding from DANIDA for a feasibility study in Africa.

On the other side of the spectrum is Vestas Wind Systems, the largest wind-turbine manufacturer in Denmark, which makes monster 4.5-megawatt ocean wind turbines. Its history parallels the growth pattern of the industry, which has been based on political and financial backing of the Danish and other governments.

Vestas started making wind turbines in 1978, experiencing a lackluster sales record until 1981, when California passed special tax legislation that made investment in wind turbines profitable. The company expanded until it had 800 employees, while providing the U.S. market with 2,500 wind turbines. But when the California tax legislation expired in 1985, Vestas went from riches to rags, and in 1987, the company was reorganized, retaining only 60 workers.

Although this collapse is testimony that the industry is only "sustainable" through government support, its revival was through government support as well.

According to Vestas's website, in 1989 "powerful political forces seek to strengthen the Danish wind turbine industry." These "powerful political forces" not only in Denmark but in neighboring Germany, shifted their governments' policies away from nuclear energy into wind, solar, and other alternative energy sources with tax incentives, financial support, and legislation decreeing that thousands of megawatts of energy had to be generated by wind turbines, whether or not technically or commercially viable. Vestas soon captured one-third of the huge German market, which expanded greatly after the German Green party entered the government in 1998.

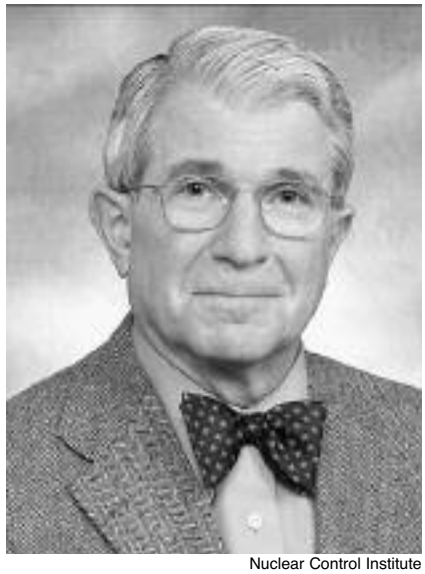
Vestas then grew to employ 10,000 people with subsidiaries all over the world. Many of its projects in the developing sector are financed by DANIDA. But while foreign sales boomed, in 2001, a new government came to power and put an end to government support. The Danish internal market collapsed to the point that in 2004, only five wind turbines were erected in all of Denmark. This situation changed only after the Parliament passed legislation in 2004 mandating an additional 750 megawatts of new wind power.

It is one thing for rich countries like Germany and Denmark to make insane decisions to throw away taxpayers' money on wind turbines, and quite another for the countries of Africa, most of which are desperately poor, to expend limited resources on an inefficient and dead-end technology.

The PBMR and the Neo-Cons

Meanwhile, in the United States, the attack on the PBMR came from two very related sources.

The first was a report used in the above-mentioned Earthlife Africa case, which was written in 1999 by Dr. Edwin S. Lyman of the Nuclear Control Institute of Washington, D.C. The South African court stated that this report was written



Nuclear Control Institute

The Nuclear Control Institute's Paul Leventhal, like the late Albert Wohlstetter, defines civilian nuclear plants as bombs in the making.

NUCLEAR CONTROL INSTITUTE

CONCLUSIONS

Barriers to new nuclear deployment are numerous and formidable

Proposed PBMR licensing schedule insufficient to allow resolution of safety issues

Highly questionable whether nuclear power can successfully and safely imitate gas turbine deployment model

Nuclear Control Institute

The last slide from a 2001 presentation by Dr. Edwin Lyman, then of the Nuclear Control Institute, summarizing his thoughts on the PBMR.

Chernobyl

Continued from page 63

Forum, 2005. "Chernobyl's Legacy: Health, Environmental and Socio-Economic Impacts and Recommendations to the Governments of Belarus, the Russian Federation, and Ukraine," U.N. Chernobyl Forum.

Forum, 2006. "Health Effects of the Chernobyl Accident and Special Health Care Programmes," U.N. Chernobyl Forum, Expert Group "Health" (EGH).

N.A. Frigerio, K.F. Eckerman, and R.S. Stowe, 1973. *The Argonne Radiological Impact Program (ARIP),* Part I, "Carcinogenic Hazard from Low-level, Low-rate Radiation," ANL/ES-26 Part I (Argonne, Ill.: Argonne National Laboratory).

N.A. Frigerio and R.S. Stowe, 1976. "Carcinogenic and Genetic Hazard from Background Radiation," *Biological and Environmental Effects of Low-Level Radiation* Chicago: International Atomic Energy Agency, pp. 385-393.

GUS, 2001. *Statistical Yearbook of the Republic of Poland,* Vol. 61 (Warsaw: Central Statistical Office), pp. 1-734.

H.R. Harach, K.O. Franssila, and V.M. Wasenius, 1985. "Occult Papillary Carcinoma of the Thyroid—A 'Normal' Finding in Finland. A Systematic Study," *Cancer,* Vol. 56, pp. 531-538.

T. Henriksen and G. Saxebol, 1988. "Fallout and Radiation Doses in Norway after the Chernobyl Accident," *Environment International,* Special Issue: The Chernobyl Accident: Regional and Global Impacts, Guest Editor Zbigniew Jaworowski, Vol. 14, No. 2, pp. 157-163.

V.K. Ivanov, A.F. Tsyb, S. Ivanov, and V. Pokrovsky, 2004. "Medical Radiological Conse$_q$uences of the Chernobyl Catastrophe in Russia," *NAUKA,* St. Petersburg, pp. 1-387.

L.E. Ketchum, 1987. "Lessons of Chernobyl: SNM members try to decontaminate the world threatened by fallout. Experts face challenge of educating public about risk and radiation." J. *Nuclear Medicine,* Vol. 28, pp. 933-42.

E.M. Parshkov, V.A. Sokolov, A.F. Tsyb, A.D. Proshin, and J.G. Barnes, 2004. "Radiation-induced Thyroid Cancer: What We Know and What We Really Understand," *Int. J. Low Radiation,* Vol. 1, No. 3, pp. 267-278.

L.S. Taylor, 1980. "Some Non-Scientific Influences on Radiation Protection Standards and Practice," 5th International Congress of the International Radiation Protection Association, The Israel Health Physics Society, Jerusalem, pp. 307-319.

UNDP, 2002. "The Human Conse$_q$uences of the Chernobyl Nuclear Accident: A Strategy for Recovery." Chernobyl Report-Final 240102, United Nations Development Programme (UNDP) and the U.N. Children's Fund (UNICEF) with the support of the U.N. Office for Co-ordination of Humanitarian Affairs (OCHA) and the World Health Organization, pp. 1-75.

UNSCEAR, 1988. *Sources, Effects, and Risks of Ionizing Radiation,* New York: United Nations Scientific Committee on the Effects of Atomic Radiation.

UNSCEAR, 2000. Sources and Effects of Ionizing Radiation. (New York: United Nations Scientific Committee on the Effects of Atomic Radiation).

L. Wei, Y. Zha, Z. Tao, W. He, D. Chen, Y. Yuan, 1990. "Epidemiological Investigation of Radiological Effects in High Background Radiation Areas of Yangjiang, China. *J. Radiat. Res.,* Vol. 31, pp. 119-136.

in such a highly technical style that it was unintelligible!

What is the Nuclear Control Institute? Run by Paul Leventhal, it is committed to stopping all nuclear power because it will allegedly lead to nuclear proliferation. This is the line now promoted by the neo-conservatives in and around the Bush Administration. It was pioneered by the late Albert Wohlstetter, one of the demigods of the neo-cons, who equated civilian nuclear reactors with atomic bombs. Wohlstetter's chief disciple was Paul Wolfowitz, former Deputy Secretary of Defense and now head of the World Bank. Wolfowitz, who wrote his doctoral thesis under Wohlstetter as an attack on nuclear desalination in the Mideast, is deeply committed to preventing any development of nuclear energy in the Third World.

Unlike the Danes, Leventhal doesn't push wind turbines, but preemptive strikes. He is a member of the Iran Policy Committee, which calls for "regime change" in Iran. This committee is the extreme of the extreme. One board member, for example, is Gen. Paul Vallely (ret.), who was featured in *EIR*'s special report on the "spoon-benders" in the U.S. military (see "Cheney's 'Spoon-Bender' Pushing Nuclear Armageddon," *EIR,* Aug. 26, 2005). Vallely is not only for air strikes, but also for ground assaults against Iran.

It is curious that EarthLife Africa and the Legal Resources Centre, both of which claim to support the "little people," would team up with such an extreme group as the Nuclear Control Institute.

The second U.S. attempt to derail the PBMR was through the withdrawal of the U.S. energy company Exelon. The move came after the project's chief sponsor in Exelon, Corbin A. McNeill, retired as chief executive officer and chairman in 2002. McNeill's support for PBMR dates back to when he was chairman of PECO energy company, which later merged with Unicom Corporation to form Exelon in 2000. A retired captain of the U.S. fleet of nuclear submarines, McNeill was an enthusiastic supporter of the PBMR project. He especially saw the project as ideal for the countries of the developing sector.

McNeill's successor, John W. Rowe, immediately cancelled Exelon's support of the project on the grounds that it did not fit into his strategic plan for the company. A lawyer by training, Rowe is a very different type of CEO than McNeill, and did not share the latter's passionate commitment to nuclear energy, despite the fact that Exelon is the largest operator of nuclear power stations in the United States. According to industry sources, Rowe is a fanatical believer in the "shareholder value" ideology which underpins globalization and radical free-market policies.

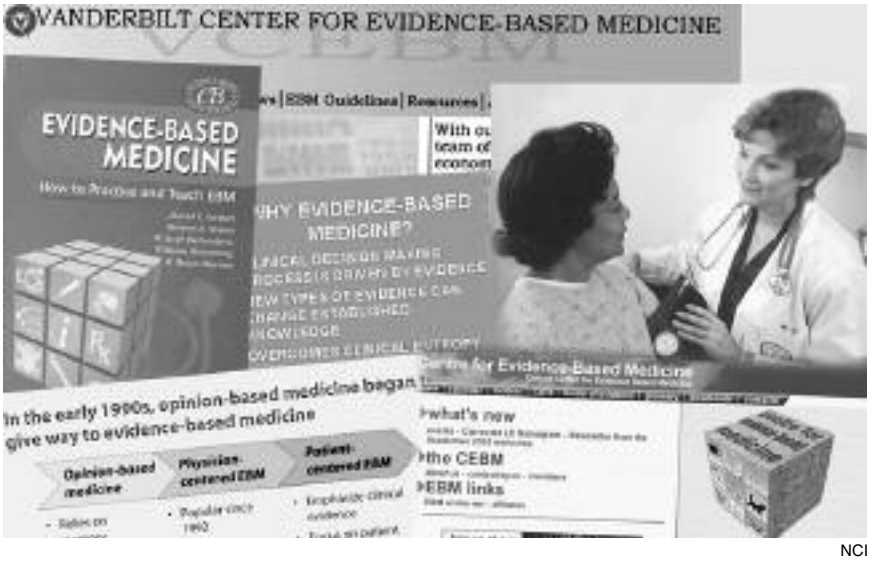
Unlike the retired military officer McNeill, Rowe is a man of the business establishment, fancies himself a philanthropist, and belongs to all the right clubs. But politically he is close to the neo-cons, just like Leventhal. Until recently, he was a trustee of the American Enterprise Institute, better known as the Temple of Doom, a center of the neo-conservative movement in Washington, where both Dick Cheney and Donald Rumsfeld worked. Rowe participated in many of the seminars, conferences, and other affairs held in the Institute's "Wohlstetter Hall," and perhaps met there another frequenter of these events, Paul Leventhal.

Rowe also sits on the National Commission on Energy Policy, along with R. James Woolsey, a Wohlstetterite and former CIA director, now very prominent among the neo-conservatives who want the United States to launch a strike against Iran.

There is now a renewed debate throughout Europe and the United States on nuclear energy. Finland is already building the first new nuclear power station in Europe in 10 years. Russia and China have announced the intention to build dozens of new nuclear power stations over the next quarter century. Africa has to become part of this process if it hopes to survive the ravages of globalization.

The PBMR project is on the front lines of that fight, and intends to win.

Dean Andromidas, based in Wiesbaden, Germany, is an analyst and writer for Executive Intelligence Review.



NCI

An obsolete image of doctor and patient? In the not too distant past, medicine was an art and the doctor based decisions on a combination of experience and diagnostic information.

How Statistics Fail Medicine: The Strange Case of Aspirin

by Cathy Helgason, M.D.

Most persons are not familiar with the paradox facing the physician when trying to apply the results of medical scientific discoveries to the individual patient. In the not too distant past, the decision to apply a new diagnostic test or treatment to a patient was based on the expertise of the physician gained from treating other patients, and his training and knowledge of biology and physiology. Thus, medicine was an art. But this was to change with the advent of what is called evidence-based medicine (EBM).

Around the early 1980s, medicine took a bizarre turn, and physicians lost their credibility with their patients and each other. The buzzword for medical decisions was *objectivity,* and the expertise of the physician was to become mistrusted. Objectivity meant that any diagnostic or treatment decision must be founded in the results of large, double-blind, randomized clinical trials, and any creative interpretation of unique patient characteristics is proscribed. This would ensure that any outstanding physician was put in his place, and that special expenditure of money regarding any patient presenting with unusual symptoms would not occur. Thus, the HMO system gained control over the activities of both physicians and patients in an effort aimed toward shareholder profits.

Even stranger became the mass support for, and brainwashing of, academic physicians into this system of EBM. These physicians promote this approach arguing that it will ensure common terms of discourse, consciously denying creative or competing approaches to scientific inquiry. After all, science has been taken over by the assumptions, postulates, and axioms of probability theory. Evidence-based medicine is founded in probability theory-based statistics (PTBS), the sure road to "objectivity," because its methods and results are separated from the context of any unique patient or physician. This is because PT deals only with known variables in its analysis, ignoring unrepresented and unknown context.

In addition, in order for variables to be statistically handled, they are separated from one another and their context—the patient—when they are placed into distributions. But, anyone who faces a situation where diagnosis and treatment of a patient is concerned knows that that person has special characteristics and that unknown factors can influence how his medical condition evolves over time.

The very foundation of probability theory-based statistics is a total denial of the concept of causation, for the supposed benefit of certainty. But, what physicians adhering to evidence-based medicine refuse to recognize, is that that certainty is false when it is applied to decisions regarding the individual patient: False because of failure to acknowledge invisible factors that may affect the clinical course, and refusal to acknowledge the unique complexity and interaction of known and unknown variables in the individual patient. But, where expertise is not recognized, it is not needed, absolving the physician of any causal responsibility for his patient.

The Case of Aspirin

An example of how EBM has affected the use of a common drug, aspirin (acetylsalicylic acid), for the prevention of heart attack and stroke, illustrates the paradox. In 1993-1994, our group sought to better understand why certain patients, in spite of taking their dose of aspirin, returned to the hospital with another stroke.

While EBM was asking what common dose of aspirin for the population was effective in statistically preventing stroke, we wanted to know why a particular patient failed to obtain its supposed therapeutic effect. We wondered if it was necessary to individualize the dose of aspirin to the patient, while recognizing that other possible explanations for aspirin failure included, but might not be limited to, non-compliance, a disease process that could not respond to aspirin, and multiple causes for stroke of which aspirin was only one necessary drug for treatment where others had not been prescribed.

This approach was creative because it

sought to find out the answer to a clinical problem for each individual patient without using PTBS. It resulted in two publications, which under the current reign of EBM, would have never been printed today.[1,2]

To better understand our approach to the problem, one must understand the biological effect of aspirin. Aspirin has many possible mechanisms by which it could interrupt the cause of heart attack and stroke, but the one effect considered all important at the time was its effect on a blood cell called the platelet. Platelets participate in blood clot formation, a process called thrombosis, by becoming activated to secrete certain substances and aggregating or sticking together.

When someone cuts himself, this is a mechanism for repair. When the process causes a blood vessel to become blocked, as in heart attack or stroke, the platelets do this at the site of vessel wall damage, usually where atherosclerosis exists. Aspirin inhibits this process by inhibition of an enzyme called cyclooxygenase, which in turn inhibits platelet stimulation by agonists such as epinephrine and collagen. Aspirin is not expected to inhibit adenosine diphosphate-stimulated platelet aggregation, a process interrupted by clopidogrel, another so-called anti-platelet drug commonly used for prevention of heart attack and stroke.

Aspirin can have some effects which might be considered negative for prevention of vessel occlusion, such as its inhibition of an enzyme called prostacyclin in the vessel wall. Prostacyclin itself inhibits platelet aggregation and causes the vessel to dilate, thereby increasing blood flow to the organ it supplies.

These facts suggest that to achieve the desired effect of aspirin for prevention of thrombus formation in any one person, the dose of the drug must be carefully tailored to inhibit platelet aggregation, but allow prostacyclin to work. The beauty of the situation is that, through a simple blood test, one can measure what is going on in a patient's blood in this regard. Thus, we tested *ex vivo* the effect of aspirin over time in patients who were taking the drug for prevention of stroke. The classic test for this is the method of Born, which has been used clinically for years by ours and other groups, and is described in our publications of 1993-1994.[1,2]

The Dose Counts

The results of our study were displeasing. We found that different persons required a different dosage of aspirin to achieve the desired biological effect, and that this effect could change over time, requiring repeated testing and dosage adjustment. These results caused displeasure because they showed that aspirin was like any other drug, and required the attention of the physician, the patient, and the lab.

The results were not surprising. All other drugs used for prevention of stroke and heart attack need dosage adjustment over time, according to the results of repeated testing; for example, antihypertensives used for blood pressure control, lipid-lowering agents for control of cholesterol, insulin or oral diabetes drugs used for blood glucose control. Correct dosing of aspirin for the individual patient was going to require the vigilance of the physician, compliance of the patient, and expenditure of time and money to maintain the goal effect.

Our story ends with the admission that, instead of considering the conclusion that aspirin must be dosed like any other drug, multiple large double-blind randomized clinical trials requiring millions of dollars were launched to test what common dose of aspirin was right for all patients, what the common dosage of aspirin was for all that would achieve the desired biologic effect, and which common biological effect was right for all persons.[3-7] While none of these trials has disputed our findings, and indeed the trials have confirmed our findings for the population, the results of these trials still cannot answer the question: Is the dose of aspirin, that I as the physician am prescribing, the correct one for the unique biology and medical disease to prevent a heart attack or stroke in this particular patient?

The complexity of the biology of the patient cannot be addressed by PTBS and EBM. Beyond the changing ability over time of aspirin to affect platelet aggregation, there are many other reasons for the failure of aspirin to prevent heart attack and stroke. Some other reasons include: (1) noncompliance of the patient, (2) decreased effect on inflammatory factors at the arterial wall, (3) aspirin modulation of thrombolysis (dissolving thrombus), (4) red blood cell aggregation and its inhibition, and (5) genetic polymorphisms.

Each of these causal methods by which aspirin can inhibit thrombus formation may be required to a certain degree in any one individual patient. The methods may interact in a certain way in the individual patient. How they are affected by aspirin may change over time in any given patient.

Other tools of science, not limited to neural networks, such as fuzzy logic, cellular automata, and, of course, methods created by the talent of an individual with unique insight, could be used to better understand and control this process. But these methods are forbidden in spite of the fact that the complexity of the biological processes involved in thrombus formation in individual patients is neither portrayed nor interpretable by probability-based statistics and the large double blind randomized trial.

Dr. Helgason's primary area of research interest is the topic of causation, which was an outgrowth of her studies on individualized diagnosis and therapy for patients with stroke. She is Professor of Neurology at the University of Illinois College of Medicine at Chicago.

Notes

1. C.M. Helgason, K.L. Tortorice, S.R. Winkler, D.W. Penney, J.J. Schuler, J.J. McClelland, L.D. Brace, 1993. "Aspirin Response and Failure in Cerebral Infarction," *Stroke,* Vol. 24, pp. 345-350.
2. C.M. Helgason, K.M. Bolin, J.A. Hoff, S.R. Winkler, A. Mangat, K.L. Tortorice, L.D. Brace, 1994. "Development of Aspirin Resistance in Persons with Previous Stroke," *Stroke,* Vol. 25, pp. 2331-2336.
3. K.H. Grotemeyer, 1993. "Two Year Follow Up of Aspirin Responders and Aspirin Non-Responders. A pilot study including 180 post stroke patients. *Thrombosis Res.* Vol. 71, pp. 397-403.
4. G.F. Hobikoglu, T. Norgaz, H. Aksu, O. Ozer, M. Erturk, Z. Nurkalem, A. Narin, 2005. "High Fre$_q$uency of Aspirin Resistance in Patients with Acute Coronary Syndrome." Tohoku *J. Exp. Med.,* Vol. 207, pp. 59-64.
5. R. Altman, R. Luciardi, J. Munataner, R. Herrera, 2004. "The Anti-Thrombotic Profile of Aspirin: Aspirin Resistance, or Simply Failure?" *Thrombosi Journal,* Vol. 2, pp. 1477-9560.
6. C. Borna, E. Lazarowski, C. von Heusden, H. Oheln and D. Erlenge, 2005. "Resistance to Aspirin Is Increased by ST Elevation Myocardial Infarction and Correlates with Adensosine Diphosphate Levels," *Thrombo. J.,* Vol. 3, pp. 10-22.
7. F. Pulcinelli, P. Pignatelli, A. Celestini, S. Riondino, P.P. Gazzaniga, F. Violi, 2004. "Inhibition of Platelet Aggregation by Aspirin Progressively Decreases in Long-Term Treated Patients," *JACC2004,* Vol. 43, pp. 979-984.

2005 INDEX

21st CENTURY SCIENCE & TECHNOLOGY

Volume 18

AUTHOR INDEX

SUBJECT INDEX

Agriculture

Ancient Discovery

Astronomy and Astrophysics

Pedagogy

Physics

Science and the Youth Movement

Science Policy

Scientific Classics

Space Science, Technology, and Exploration

BOOKS REVIEWED

John Dobson Debunks the Big Bang

by Charles Hughes

MOVIE REVIEW

A Sidewalk Astronomer: A Film About Astronomy, Cosmology and John Dobson
by Jacobs Entertainment, Inc.
DVD and VHS, 78 min
$39.95 (incl. domestic S&H)
Available from www.telescopepictures.com
or Jacobs Entertainment, Inc.
P.O. Box 774, Harrison, N.Y. 10528

Here is a spectacular, and masterfully produced presentation, starring the inventor of the Dobson telescope, who boldly and humorously devastates two sacred cows of cosmology, the Big Bang and the expanding universe interpretation of the red shift. For Dobson, the whole universe is alive, bounded and not infinite, and the speed of light is not a "speed" at all.

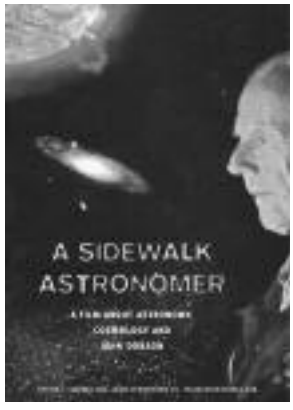
The film opens with a street scene, showing Dobson's art in engaging the mostly self-absorbed passersby to stop and look through his telescope. The wit and humor of his repartee draw you into the film, and it only gets better.

John Dobson has been called the most influential person in amateur astronomy in the last 50 years. Now, at age 91, he continues with the sidewalk astronomy he began in tours and lectures, and is always ready to teach a new amateur how to build one of the very large telescopes he became famous for.

Sidewalk Astronomers

Dobson began his innovations in amateur telescope-making in 1958, while a monk at a Vedantic monastery in San Francisco, and soon began taking his telescopes out on the streets to show the wonders of the universe to people of the city. He was expelled from the monastery in 1967 for his night absences and un-monkish behavior. He built his first very large telescope while still at the monastery, out of scrap wood and cardboard, using a 12-inch scrapped marine porthole for the mirror. He ground and polished this glass by hand. When it was completed, he aimed it at the Moon, and was so surprised by the sight that he decided that that everyone must see this for himself.

In order to get telescopes out on the streets, Dobson helped found an organization called the San Francisco Sidewalk Astronomers. So we see Dobson as the show commences, on the corner of 24th and Noe Streets in San Francisco, showing people the Moon through one of his homemade telescopes:



"That is the way it would look one hour before landing," John tells a youthful group.

"As I always say the exterior decorator does lovely work," he replies to the oohs and ahs.

"That crater you are looking at is as big as Texas."

"The universe is mostly hydrogen and ignorance." John explains the statement: "One reason that we do this is so people can see beyond their genetic programming."

We see Dobson next at the Stelafane Amateur Telescope Maker's convention in Vermont, in August 2003. This is the oldest and most famous such event, founded in the 1920s by Russell Porter, the father of the amateur telescope-making movement in the U.S.A.

David Levy, discoverer of 21 comets and leader of the amateur astronomy community, thanks Dobson for the incredible contribution he has made. Dobson explains that when he first started showing people how to make telescopes, he was asked, "Who is John Dobson? Is he an astronomer?"

John replied, "No, but when it comes to making telescopes out of junk, I'll stand my own ground."

The 'Big Bang'

Asked by a student about the age of the universe, Dobson discusses the "Big Bang" theory. "There are too many problems, such as getting everything out of nothing—that's the biggest problem." Describing in detail some of the other problems with the "Big Bang," Dobson sums it up: "We used to change the model to match the physics. That is *not* what they're doing now. They're changing the physics to match the model."

John describes his alternative to the "Big Bang," which he calls his "recycling" theory of the universe. The universe is not infinite, but bounded. "If the stuff recycles from the border, we don't have to have a beginning. It could be going like this all the time."

"It's alive," says Dobson, "The whole Universe is alive: The defining characteristic of a living organism is that it directs a stream of negative entropy upon itself, and, damn it all, the Universe does the same thing."

In a discussion of the speed of light, Dobson says it is not a speed, but the ratio of space to time. Time, says Dobson, is nature's way of keeping everything from happening at once. Space is nature's way of keeping everything from happening in the same place.

Dobson tells a joke about Adam and Eve. Adam asked God why he made Eve so attractive. "God replies, "So you'd like her." Adam then asks God,"But why did you make her so stupid?" God replies, "So she'd like you." He also tells a joke about scientists who think that they can create life. God is curious, so they take him down to the lab. The scientist says to God "First you take some dirt." God replies, "Get your own dirt."

The Dobson Story

Dobson was born in 1915 in Beijing, China. His maternal grandfather was the founder of Beijing University. His mother was a musician; his father taught zoology at the university. In 1927, Dobson's parents moved with him to the United States amid political chaos in China. He attended college at the University of California at Berkeley, graduating in 1943 with a degree in Chemistry.

Motivated by a desire to see the universe as closely as possible, he became

interested in telescopes, but noticed that the small-aperture devices available to amateurs did not gather enough light to show celestial objects such as nebula and galaxies in their true details of brightness and color. The solution would be the use of very large optics made from cheap glass portholes of 12- to 24-inch diameter.

Such large optics, mounted the usual way in the pre-Dobson era, would require a mount weighing a ton or more! Dobsons's solution was a simple system where the telescope tube had truncheons on the sides like a cannon barrel. The tube was carried in a notched box which rotated on a wood base. The scope had two degrees of freedom, elevation of the tube, and rotation on the base. That was all it needed.

Producer Jeffrey Jacobs, president of Jacobs Entertainment, has been active in the independent film industry for 35 years. He met John Dobson in 1986 when he first looked through one of his telescopes. "He displays endless wonder," says Jacobs. "When I found out that no one had made a documentary about him, I knew that I had to do it."

San Francisco Sidewalk Astronomers

John Dobson: the most influential person in amateur astronomy in the last 50 years.

Courtesy of Charles Hughes

A Dobsonian telescope built by the author.

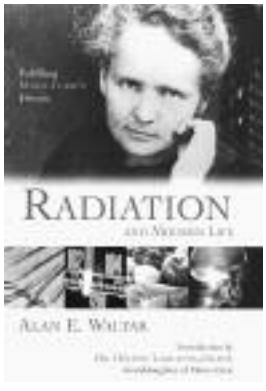
Creating a Nuclear Renaissance With the Truth

by Greg Murphy

Radiation and Modern Life
by Alan Waltar
Amherst, N.Y.: Prometheus Books, 2004
Hardcover, 336 pp., $24.95

This book represents a real effort to get out the truth about radiation, and nuclear power in general. This approach should be used as a way to organize a grassroots campaign to create a nuclear renaissance, in opposition to what the American Nuclear Society (ANS) has proposed—a campaign based on the statements of Gaia madman James Lovelock, who turned pro-nuclear out of his fear of global warming.

The American Nuclear Society, and the nuclear community in general, think that they must appeal to authority figures like Lovelock, instead of simply building a campaign based on *telling the truth.* The ANS and other nuclear representatives treat nuclear power and radiation as some form of mysticism that everyday people can not understand. In this way, they allow the anti-human and anti-nuclear environmentalists to set the terms of the debate.



Ammunition

Alan Waltar's book provides the ammunition to destroy some, if not all, of the myths about radiation and nuclear power, and does so with easy-to-understand language, with examples of how radiation and nuclear science affect and improve our lives everyday.

Today's college students in the field of nuclear engineering, as well as a small group of old-timers, readily tell you that the biggest mistake in the early days of developing nuclear science and nuclear power was not telling the truth about radiation. The industry failed to fight for nuclear power plants and labs by not levelling with the population about how really *small* the danger of radiation is: and that failure allowed the nuclear industry to be all but shut down.

Waltar's book goes a long way to address that issue.

The book is put together with a real ordering principle, which makes it a very useful reference book. It opens with an excellent introduction by Héléne Langevin-Joliot, which sets the tone of the book. The introduction needs to be highlighted as a lesson to people how the discoveries and their applications do really advance mankind and civilization.

Waltar arranged the book in sections—agriculture, medicine, space exploration, and so on—and in each section he explains how radiation or nuclear energy has advanced the progress in that field. Each section builds on the next, with a thought of what is possible in the future from discoveries that are known, toward discoveries yet to be found. The author provides facts and charts to illustrate his points, but the best thing is his

sense of humor, using anecdotal stories and humorous examples to explain the more technical terms and ideas.

For this reason, the book is a good place to start for people who are concerned about radiation and nuclear power, and want to learn more. This writer, in fact, learned many new ways that radiation is used to better our lives. For example, did you know that radiation is used to sterilize contact lens solution?

The Curie Tradition

Dr. Héléne Langevin Joliot, who wrote the introduction, is a French scientist and granddaughter of Marie and Pierre Curie. Her introduction begins with how a simple discovery by her grandfather of the piezoelectric effect made it possible to measure the radiation that is given off by elements like uranium; and this led to the discovery of radium.

She continues recounting the discoveries of her grandmother, as well as those of her mother, Irène, who discovered artificial radiation. Langevin-Joliot uses these discoveries as a backdrop to point to the need for nuclear power and further discoveries to brighten the future for all mankind. She includes a special call for the youth of the world to take seriously the study of science, and make the vision of Marie Curie come to life.

Langevin-Joliot concludes with a section from her grandfather's Nobel Prize lecture: "One can imagine that in criminal hands, radium could become very dangerous, and here one must ask oneself if humanity gains anything by learning the secret of nature, if humanity is ready to profit from this or whether such knowledge may not be destructive for it. I am one who thinks like Alfred Nobel, that humanity will draw more good than evil from new discoveries."

The answer to the problems of new discoveries, Langevin-Joliot writes, is to understand, and we need to continue with the scientific research necessary to achieve solutions that will optimally benefit society.

This thought goes a long way to provide the optimism that is necessary to build a nuclear renaissance with the truth.

A Medical System from Hell

The Patient from Hell: How I Worked with My Doctors to Get the Best of Modern Medicine and How You Can Too
Stephen H. Schneider, Ph.D. with Janica Lane
Cambridge, Mass.: Da Capo Press, 2005
Hardcover, 300 pp., $25.00

Well-known climate scientist Stephen Schneider has written about his harrowing but successful battle against a rare form of cancer, mantle cell lymphoma, with the double aim of pointing out the stupidity of the HMO mindset that rules the U.S. medical system, and helping other patients advocate to get the best possible care.

Anyone who has had cancer or another serious illness, or who has been involved with negotiating the medical care for a seriously ill person, will identify with the problems Schneider discusses. As Schneider notes at the beginning, today's health care is practiced as "medicine by the numbers" where doctors treat and prescribe for the "statistically average patient," and not the non-average individual before them, who may very well benefit from innovative measures. (Schneider did.)

The other anti-patient issue that Schneider trenchantly describes is the cost-benefit mentality, where the primary factor governing treatment is saving money for the institution or HMO giving care, and not what's best for the patient. How Schneider got around this limitation probably saved his life. "If modern medical institutions can bring themselves to realize that a patient's chances of survival could increase dramatically if spending on that patient's treatments rose from, say $300,000 to $305,000 (less than 2 percent), a revolution in first-world health care could ensue," he writes.

Schneider cautions that he is not anti-doctor; he is talking about the patient or patient-advocate working with the doctor to come up with an optimal treatment plan for the particular patient—a plan that is not necessarily the same as the standard protocol.

Some Ironies

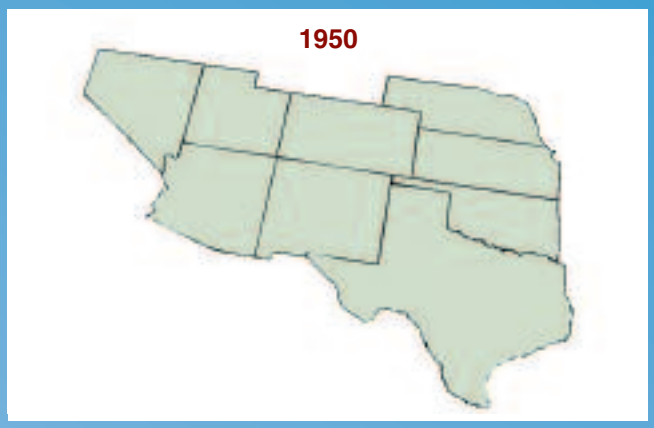
I greatly sympathize with Schneider; his was not an easy fight, and he and his wife, like many others fighting a deadly disease, more than once lived through hell. But as I read the several "commercials" sprinkled throughout the narrative for his thesis of man-induced global warming, I wondered why Schneider still so devoutly believes in the concept of a statistically "average" temperature for a world that has such uniquely different climate zones, and such complex, very long-term astronomical cycles. Climate science would benefit from a return to a more traditional science basis—but that's not where the research money or the culture is today.

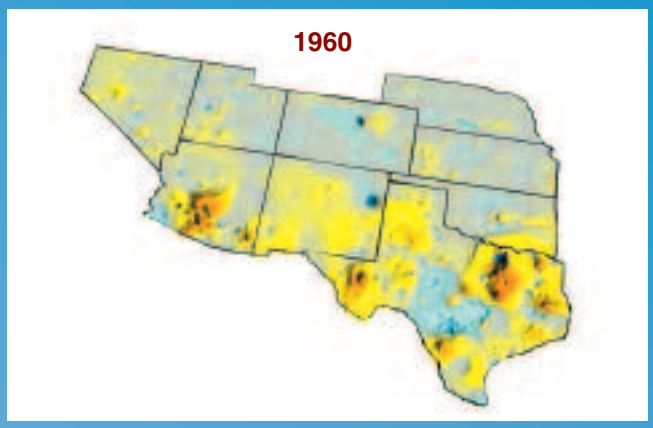
So, we have the irony (1) that both climate science and U.S. health care are driven by profit-seeking, not by truth-seeking, and certainly not by a desire to promote the general welfare; and (2) that both climate science and U.S. health care operate on the basis of a nonexistent statistical universe.

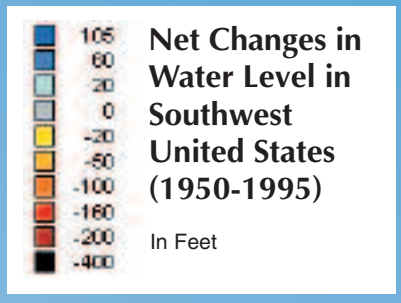
Another irony was to see the devoted support Schneider received throughout his ordeal from one of the most ardent anti-population fanatics, biologist Dr. Paul Ehrlich (he's the one who thinks we need to reduce the human population by two-thirds, to 2 billion)!

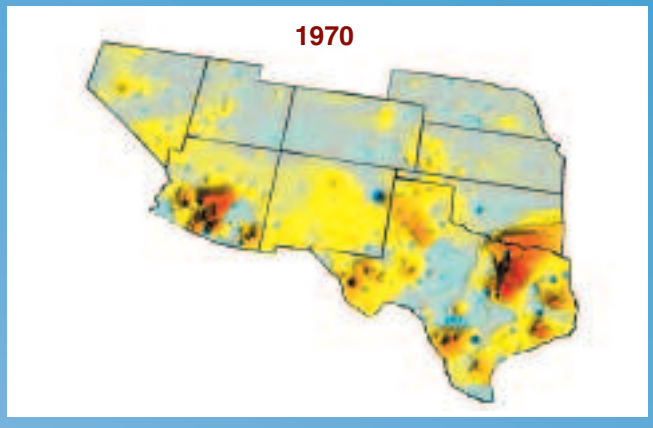
Overall, I think this book can be helpful for a patient or advocate fighting a dread disease and trying to get the best possible care. But the larger fight is a political one to establish a health system where you don't have to be a "patient from hell"—or a well-known scientist—to overcome a deadly illness.

—Marjorie Mazel Hecht







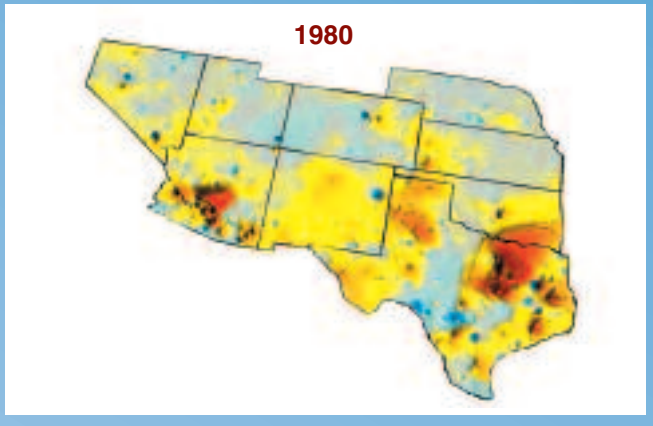


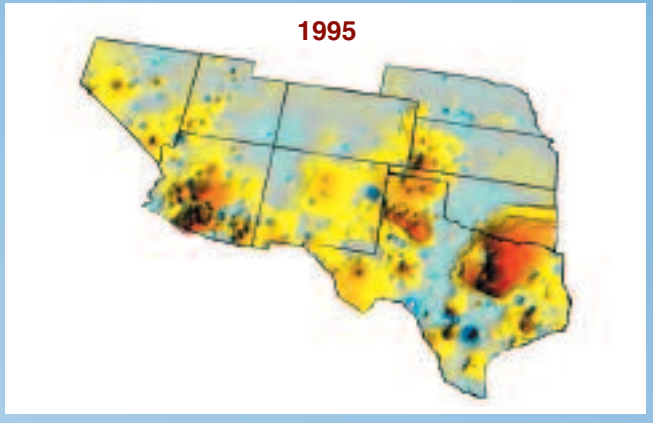
U.S. Groundwater Levels at Critical Low

The continued use of fossil groundwater has already reached the point where farms in the Southwest can no longer irrigate crops, because of declining groundwater levels and rising energy costs. A switch to a science driver economy using nuclear desalination and large-scale water diversion projects is necessary to meet the current and future demands of agriculture, and ultimately for the survival of the nation as a whole.

This sequence, prepared by Andrew Langsner, represents net changes in water level in the U.S. Southwest, taking the year 1950 as the base.

Data Source: U.S. Geological Survey

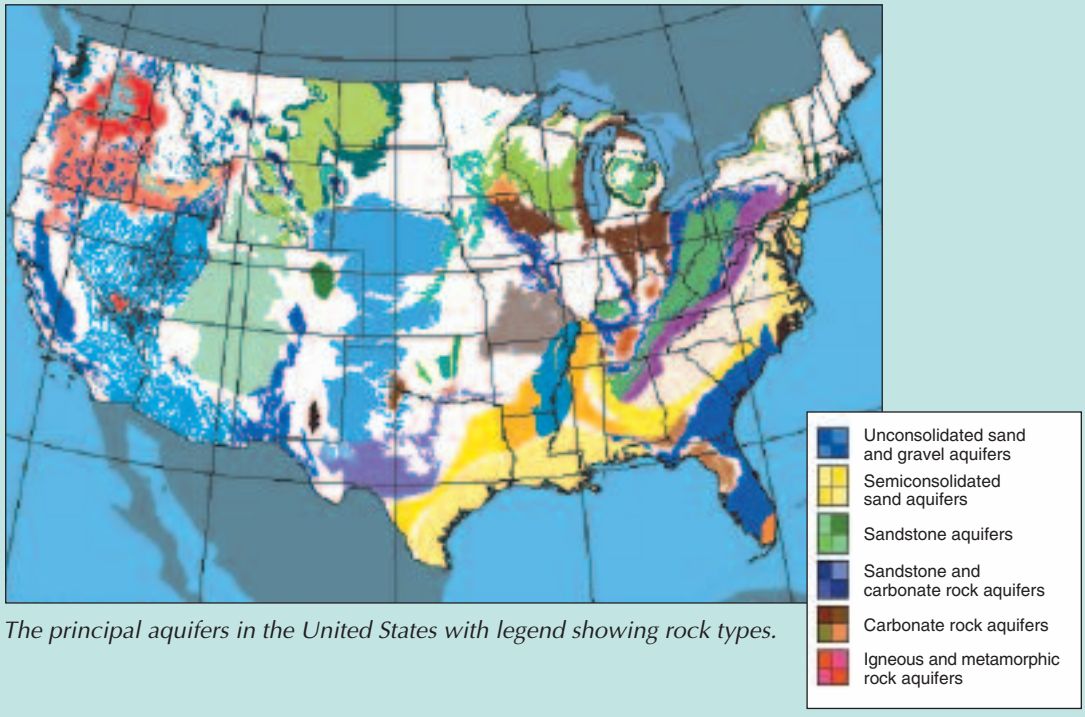




In This Issue

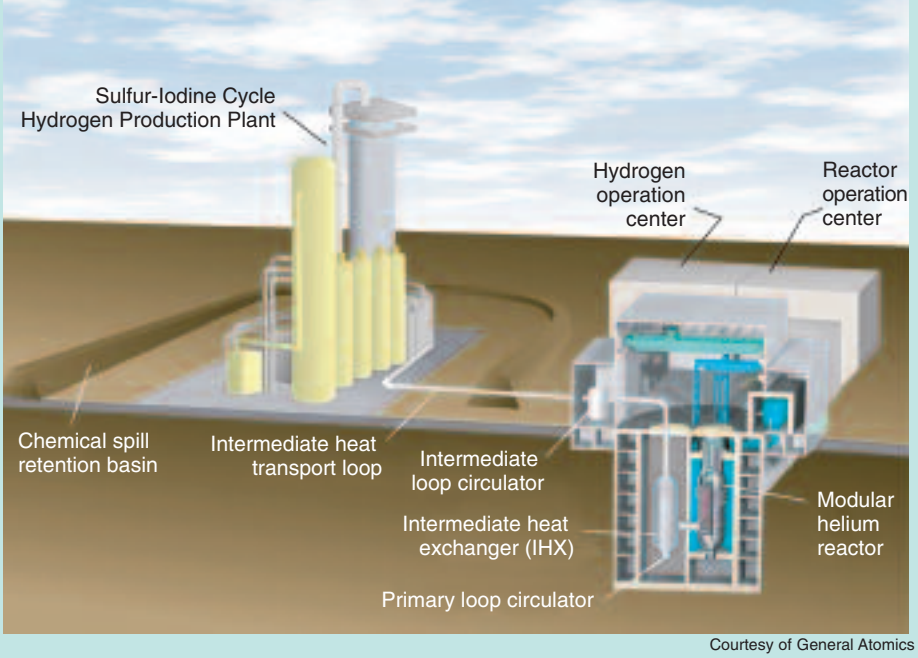
NUCLEAR POWER CAN PRODUCE FRESHWATER

Water shortages from depletion of fossil reserves threaten large populations in India, China, and the United States. We can solve the problem by producing freshwater from nuclear desalination, a proven technology whose time has come, and undertaking large-scale water engineering projects. Noted Australian civil engineer Lance Endersbee, LaRouche Youth Movement leader Creighton Cody Jones, and Christine Craig describe the problem and its solution in our feature section.



Source: Adapted by Joe Smalley from nationalatlas.gov (Map Maker)

The principal aquifers in the United States with legend showing rock types.



Courtesy of General Atomics

HYDROGEN FROM NUCLEAR POWER CAN REPLACE OIL

Hydrogen separated from water by nuclear power is the most efficient and least expensive way to replace oil-dependency. International expert Masao Hori reviews the various methods for producing hydrogen using nuclear power, and the vehicles that it can power. The Sulfur-Iodine cycle, which uses coupled chemical reactions and the heat from the high-temperature gas-cooled reactor, is the most promising thermochemical method for hydrogen production.

This General Atomics design couples a modular helium reactor, the GT-MHR, to a sulfur-iodine cycle hydrogen production plant.