Gaia and the 7th
II
Energy

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(33 minutes on 1/27/09)

2. Gaia Energy II: Understanding Nuclear Generated Power

Bulletin Quote and reading:

Three Union soldiers escape from a Confederate prison in a hot-air balloon find themselves discussing what will happen after the world's coal resources are used up.
"They will discover something else, " said Herbert.
"But what will they find?" ask Pencroft.
"Water," replied Harding.
"Water! Water as fuel for steamers and engines! Water to heat water!"
"Yes, but water decomposed into its primitive elements," replied Harding, "and decomposed doubtless, by electricity, which will then have become a powerful and manageable force…water will one day be employed as fuel…will furnish an inexhaustible source of heat and light, of an intensity of which coal is not capable…Water will be the coal of the future." --Jules Verne, *The Mysterious Island* (1874)

Intergenerational Piece:

Early on, before there was life on earth, this earth spirit some people believe in, Gaia, just left stuff laying around--like a messy bedroom. Stuff means just all sorts of stuff. Then some of the stuff began to grow and, at times, grow at the expense of other creatures. Creatures teamed up so what really is walking around today are colonies of organisms.

Most all the creatures just use what's there, what's laying around or growing. But humans can put things together to make new stuff and use other things in different ways. So let's talk about one of things we do.

Kids like to blow things up. Big people like to do that too. But sometimes they start out doing bad things with those explosions and eventually learn to do good things with those explosions.

There was a kid in the school Shirley and I went to that really liked to blow things up. His name is Dennis Honsinger. But he was too young to mess with such stuff and blew all his fingers off one hand and a couple off his other hand. He hadn't learned to do good things with stuff that would blow up.

Black gunpowder was used in bombs to hurt people and do damage. And it was also used in fireworks for fun. It was dangerous stuff and people were afraid of it. Then people found that by doing it right you could put black powder in a hole in rock and blast the rock apart or put it under a stump and blow the stump out of the ground. That helped people clear their farm fields to produce more food and build tunnels to bring clean water from the mountains to the cities. We respect black powder, are careful, and no longer are afraid.

Then there were new bombs, made of dynamite and TNT. Those bombs could do more damage and hurt more people. It was dangerous stuff and people were afraid of it. But people learned that by doing it right, dynamite and TNT could be used for building tunnels as well. This made it possible for people to build bigger tunnels, big enough to drive trains through mountains and to get at minerals far below the earth, minerals out of which they made lots of good things. We respect dynamite and TNT, are careful with it, and are no longer afraid.

Then there was gasoline that people turned into bombs to do damage and hurt people. In some ways, people thought these were better bombs because they started lots of fires and burned down houses and caused more damage. It was dangerous stuff and people were afraid of it. But people learned by doing it right that they could make the explosion happen inside an iron box to spin a wheel. They called it an engine and made a car. But people were afraid because they carried a tank of this dangerous gasoline inside the car and had to fill the tank every once in awhile when the gas ran out. But people found out that that could be done safely so we run all over the place with a tank full of gasoline under our seats and gasoline exploding many times per second inside our engines. We respect gasoline, learned to be careful with it, and are no longer afraid.

Then there was nuclear fission that people turned into bombs to do great damage and hurt people. Every step in the bomb process created more destruction. It was dangerous stuff and people were afraid of it. Many years ago, we UU's worked hard to make sure everyone knew how dangerous this stuff was. But, just like gasoline, people learned how to make the explosion happen slowly inside a steel box to make steam to spin a generator to make electricity. They called it a nuclear reactor and it provided clean power and lots of special radioactive stuff that helps us get well when we are sick, helps us make things in our factories, is in all of our smoke detectors, and helps us do all sorts of things that we now couldn't do without it. Some people respect nuclear energy, are careful with it, and are no longer afraid. But other people don't yet understand it well enough to decide whether they should be afraid or not.

Knowledge helps you decide when to be afraid and when not to be afraid. That's why we all need to learn more about stuff that we think might only hurt us or harm others.

Main Talk:

This morning's presentation is the second in the series for which my working title is Gaia and the 7th. In Gaia I, we covered what some consider nearly a religion, focused upon our earth as an interdependent web of existence with a natural tendency toward adjusting for ever-changing influences, terrestrial or extra-terrestrial, to maintain a hospitable environment for life. Gaia can represent natural forces, a super-human controller, or magical influences as one prefers. We touched upon the two energy sources behind that life: first is solar energy which includes wind and the resultant products of photo-synthesis, both fossil fuels and recent growth such as wood and other bio-fuels and, second, is the energy source we tagged as Gaia energy, the energy from the breakdown of elements from an ancient exploded star from which earth was formed that accounts for about 60% of the internal heat of our planet that helps keep our celestial home from becoming a frozen rock. The creatures of the earth, including us, have heavily tapped the first source, solar, by munching lettuce or catching rabbits that do, or just staying warm under the sun. As to the second source, Gaia energy, humans have only touched the abundance that is available. UU's seventh principle leads us forward. Let's do a quick review and then move on with this Terrestrial Energy discussion using, among other sources, some of the words from William Tucker's book by that name.

In the late 1970's, James Lovelock published his controversial book, *Gaia: a New Look at Life on Earth* in which he says that Gaia is "the model, in which the Earth's living matter, air, oceans and land surface form a complex system which can be seen as a single organism and which has the capacity to keep our planet a fit place for life." Whether or not you wish to believe there is a driving force, superhuman or not, behind the Gaia concept, it is a useful tool with which to think about our home planet having the resources to keep itself in balance. Humans and other species have influenced that interdependent system to varying degrees over millions of years.

The Gaia principle makes the point that earth itself is not at risk although life continually changes the earth's systems. A good example is the plants that thrived to unprecedented size in an atmosphere that had triple the carbon dioxide of today while producing their waste gas, <u>their</u> pollution called oxygen, replacing the CO_2 they needed, thus ending their era in the earth's history. Their aspiration increased cloud cover cooling the earth. Gaia adjusts, opening a new door of opportunity to the evolution of oxygen-breathing creatures thus keeping the earth in relative balance. The interdependent web was modified as it has been from the multitudinous types of bacteria, ancient sea creatures, and land giants, all in turn. All the while, the continents joining and breaking apart as they floated around on our earth’s liquid core with India crashing into Asia buckling up the Himalayas and Antarctica drifting from the tropics to the highly chilled zone.

Our seventh principle says, “We, the members of the Unitarian Universalist Association, covenant to affirm and promote respect for the interdependent web of existence of which we are a part.” Repeat: “of which we are a part.” Based upon 3.5 billion years of history of life upon our earth, that part is not guaranteed. Those huge leafy plants all those hundreds of millions of years ago that became our oil and gas of today were of a different interdependent web of existence--same earth, different web. But humans are a unique sort, at least we think we are because of the way we think. Over the relatively miniscule time of the last few centuries, humans have begun to appreciate how they can change the interdependent web of existence of which they are a part, change it to either enhance or decrease the human part we play in that web. In the last 10,000 years, our impact has included an unbelievably wide increase in the variety and quantity of dogs, goats, hogs, and plants we use for food—and no more do-do birds, carrier pigeons, nor Tasmanian tigers.

Two primary human activities drive the major part of our influence on the interdependent web—food and energy needs. That second and essentially unlimited source of energy, terrestrial energy or Gaia energy, is the subject of what follows. If we are to apply our seventh principle, either in support or opposition to expanding the use of this abundant energy source, we individually need to test what we think we know about this form of energy vs. what is actually known or not known about it.

The interior of the earth is a very hot place. At only 80 miles beneath us, rock turns liquid. Further down the temperature reaches 7000 degrees C, hotter than the surface of the sun, near to the newly found solid iron core. Scientists understand that 40% of this heat is from the massive compressive forces but the other 60%, or possibly more since the science isn’t yet proven, is the slow radiating breakdown of two of the ninety naturally occurring elements found in the earth—uranium and thorium. If it were only possible, we could drill on down to tap into this terrestrial heat. Or we can just gather some of these two elements, this stuff, that is strewn everywhere on the surface and initiate fission in a nuclear reactor.

Hyperion's John Deal said his company's reactors don't pose a threat. "Only the United States is so wealthy and so pacified that they have not even bothered to learn the science around nuclear energy," Deal said. "Americans still treat radiation like they treated witches and witchcraft back in the 17th century." That’s a pretty heavy accusation. Before we get our hackles up, we need to ask ourselves if it was really clear which side the Unitarian membership took in the Salem witch trials in the late 1600’s? You might not like the answer. Later UU’s, searching for the truth, helped our fellow citizens reason our way through witchcraft as they were among the leaders of the Enlightenment of the 1700’s. Some think our independent web currently needs some help with a bit of energy enlightenment.

Let’s start with an assessment of whether tapping into this Gaia energy, terrestrial energy, or nuclear energy, whatever we want to call it is worth the effort from the standpoint of power output. A gallon of gas, a solar-sourced fuel, will run a car about 30 miles. That's chemical energy. If we could tap the binding energy stored in the nucleus of those same gas molecules, we can drive that car 60 million miles, almost to Mars. Think 2 million times the energy density of fossil fuels. The 500 MW North Omaha power plant consumes a 110 rail car train of coal every three days at 125 tons per rail car and dominates <u>two square miles of land</u>, mostly to handle the coal. The Cooper Nuclear power plant, 30 miles south of Omaha, receives two semi-trucks every three years carrying 18 foot long fuel rods assemblies that are so mildly radioactive that they are handled safely with gloves. And the Cooper facility generates 50% more electrical power than the coal plant with no sulfur, no soot, no mercury, no particulate matter, no ash, no slag and no greenhouse gases. I've not been there but other such facilities I've visited occupy a spot about the size of the bean field along my drive. While coal was revolutionizing manufacturing and transportation, coal mining was turning out to be one of the most dangerous occupations ever undertaken. In the 20th century alone, 100,000 workers died mining coal. If we can replace huge coal mine holes in the earth and mile long trains hauling coal across the country, one leaving Cheyenne, Wyoming <u>every 6 minutes</u>, with a <u>couple truck loads of fuel</u> replacing <u>every 300 trains</u>, and stop all those emissions to boot, I hope you agree that we would be very remiss in not taking a close look at that opportunity. The subject is timely. There are now 40 countries moving toward or expanding nuclear power generation and there are proposals in the U.S. governmental approval pipeline for 27 new reactors last time I checked. This energy leaves such a small footprint and is so different from the energy from the sun which has fueled human and other creatures' needs for millions of years that it is no surprise that there has been such a lag in U.S. public understanding.

You might say, and rightly so, "Ya, but what about the potential for accidents and what about radioactive waste?" We need to look into both of those issues. Today it's safety and accidents while I'll just touch on the second one, nuclear waste. Then cover waste in detail in the final Gaia Energy discussion on October 11. But first, as John Deal says, we need to get a little bit of a handle on how this equipment works and a realistic grasp on the some-times scare word, radiation, so we can claim knowledge and not get sucked into the witch hunt.

Electricity comes from spinning a generator. In a hydroelectric dam, running water over what is essentially a water wheel does the spinning. With gas, it is combustion within a gas turbine that spins the generator. In all other commercial electrical plants, heat produces steam shot through a fan that spins the generators whether that steam heat is from oil, coal, or nuclear fission. Oil and coal plants modulate the addition of their fuel and air going into the burners to keep from generating too much heat too fast and overheating the container in which that fuel is burned. Similarly, a nuclear burner uses water to control the amount of heat generated. Commercial reactors use water for three reasons. It cools the fuel rods so they don't overheat, distort, melt, or otherwise move from their precise position in relation to each other for optimum efficiency. It carries away the heat to create steam to spin the electric generator. And it moderates the speed of the neutrons which, without the slowing down by bumping into water molecules, would be moving too fast to be absorbed by other uranium atoms and the heat producing chain reaction would not occur. If the coolant water is lost, the chain reaction stops. If the rods distort or melt, they end up out of their precise position which further slows the process. What remains is leftover or decay heat. The byproducts will continue to decay briefly hitting high temperatures then holding at temperatures around 400 to 500 degrees F for weeks. This is what happened at Three Mile Island when a rather crude valve by today's standards stuck open and the antiquated gauges didn't let the operators know what happened or what to do about it. The molten rods don't melt through the chromium-and-steel lining of the egg-shaped reactor vessel and head for China like in the scare-movie *China Syndrome.* The temperature doesn't rise above 2750 where steel melts or 2,900 F where concrete flows. The *China Syndrome* reactor "run away" can't happen. A meltdown of the fuel rods at TMI is truly a serious industrial disaster that was brought on by <u>poorly trained personnel</u> and <u>difficult to interpret monitoring equipment</u> that led to their mistake, both are things of the past. The melted rods are highly radioactive and workers could not enter the Three Mile Island containment building for five years and then only for short periods of time. One of the two containment buildings was ruined but, unlike most serious industrial accidents, no one died or was even slightly injured. Three decades of careful monitoring of the Harrisburg area have found no trace of health effects on the surrounding population. Even with the relatively primitive technology of the time, there was an ample margin for error. Three Mile Island was a frightening experience for the public, what is not understood by the general public is always scarier than what is. Swamped with misunderstandings about what really happened and its dangers, it was a frightening experience from which we emerged without any serious consequences for the reactor operators or the people of the area.

The same can <u>not</u> be said of Chernobyl.

Chernobyl consisted of four operating units. Blatantly confident of Soviet science, the engineers had not even bothered to build containment structures around their commercial power generation reactors which we have done since 1955. Moreover, one of the main purposes of the reactor was to produce plutonium for nuclear bombs. Water moderated reactors produce the "wrong" kind of plutonium. In order to produce the "right" kind of plutonium, graphite was substituted for water as the moderator, a dangerous practice. With graphite, if coolant is lost, the reaction actually speeds up. And graphite is carbon and is flammable.

On April 26, 1986, two teams of operators were struggling with each other to use the plant for two contradictory purposes. One team was supplying power to the grid while the other was running an experiment to determine whether the momentum remaining in the turbines would be enough to power the cooling system during an accidental shutdown. In the tussle over the reactor, the water in the cooling system stopped circulating momentarily. It quickly overheated, sending a burst of steam through the turbines. This revved up the power, which overheated the core even more. The fuel rods melted, dropping right into the remaining coolant. This caused a dreaded flash steam explosion blowing the lid off the reactor. The explosion ignited a fire in the graphite moderator. A plume of radioactive smoke rose into the updraft to over 3000 feet into the air. Prevailing winds spread the cloud across the Ukraine, neighboring Byelorussia and

Eastern Europe as far as Poland. The Russians refused to acknowledge the accident until radioactive debris was detected in Sweden.

People within 10 miles of the plant received a dose of radiation up to 200 times the normal background radiation each of us experiences every day. Elsewhere the fallout was lighter but enough to be detectable. Most of this was Iodine-131, strontium-90, and cesium-137—all dangerous because they are taken up in the food chain. Iodine 131 is particularly harmful in children as it migrates to the thyroid. About 4,000 close-by Urkrainian children developed thyroid cancer and 10 eventually died. Very minor amounts of various radioactivity wafted around the world. Actually sensitive instruments measured a higher bump over the normal background radioactivity over Harrrisburg, PA as a result of Chernobyl than from Three Mile Island.

Hundreds of clean-up workers were rushed to the scene. After two days, they managed to extinguish the fire by helicopter bombing the reactor with 5,000 tons of lead, boron, sand and clay. A concrete foundation was quickly constructed under the reactor to prevent ground water contamination. Then workers built an enormous concrete and steel sarcophagus over the damage reactor. Some of the workers were sent in unprotected to throw radioactive debris off the roof. Thirty one workers died from the fire and acute radiation poisoning. During the three month clean-up, thirteen more died. Up to 200,000 people were evacuated from the affected areas for various periods of time as an additional precaution. The removal of 20% of the farm land of Byelorussia from production, the dislocation of people, resulting poor nutrition, fear, and anxiety took an enormous psychological toll.

For once, the Communist regime asked for international help. A friend from our winters we spend in Texas and who has been inside the Chernobyl sarcophagus participating in the analysis and remedial action plans tells me we brought the Russian helicopter pilot here to do what we could for him beginning with our radiation exposure diagnostic facility in D.C.—think of a hi-tech dentist's chair in a super-shielded small closet where many probes come out of the ceiling and walls to measure residual radiation in various spots all around the body—looks like the set for a Sci-Fi horror movie. He was then transferred to a radiation response hospital at University of Washington where we cared for him until he died. The International Atomic Energy Agency became involved, upgrading operating and safety standards throughout the Soviet Union and Eastern Europe. Some historians argue that, by discrediting the leadership and opening the empire to international contacts, Chernobyl actually hastened the downfall of the USSR.

So what were the consequences? In 2005, the UN convened a panel of 100 scientists to do an intensive study of the accident on the eve of its 20th anniversary. According to the 600-page Chernobyl report, the impacts were surprisingly mild. The report put the number of near-term deaths at fewer than fifty, mostly among emergency workers. Plus the additional 4,000 cases of thyroid cancer in the surrounding population which is easily treated and cured but ten still died. (The condition can be avoided by taking thyroid pills immediately after exposure or telling people not to drink milk from the effected area, but

Soviet authorities were not prepared.) In terms of long lasting effects, the UN panel found no fertility problems or increases in birth defects in neighboring populations. It also found no upsurge in cancer, although it did estimate that radiation exposures might eventually lead to an additional 4,000 cancers beyond this 20 year threshold among the 100,000 cancers that would normally be expected in the population. An unknown few of those additional cancers may lead to premature death. There was, however, an increase in psychological problems among the affected population compounded by the insufficient communication about radiation effects and by the social disruption and economic depression that followed the break-up of the Soviet Union. A recent National Geographic report even noted a regionally higher incidence of alcoholism that may be related to this depression and anxiety.

Agenda driven organizations that had been lambasting nuclear power claimed the report a "whitewash" and rallied to prepare counter reports. Amazingly, these highly qualified, world-renowned 100 scientists of a world agency can say Chernobyl caused sixty deaths so far and the anti-nuclear groups claim 200,000. The basis of some organizations thinking, especially Greenpeace, is that there is "no safe dose" of radiation and that any exposure to low levels of radiation will inevitably cause cancer, a position they feel compelled to defend. *This flies in the face of much evidence from centuries of intentional radiation in the curative hot springs around the world along with reams of scientific laboratory and other testing beginning with Madame Curie through to all the nuclear powered ships, commercial power plants, university and research reactors, remote electrical sources, and space probe experience right up to the present. We humans* *experience about 300 millirems of radiation per year—double or more at higher altitudes like Denver where less atmosphere absorbs radiation from space and multiples more in regions with lots of granite, volcanic activity, and other geological formations plentiful in radioactive elements. Some amount of radiation exposure above the average in humans actually correlates with improved health and longevity. Only deep mine workers, those with high exposure to radon that also smoke cigarettes, show a radiation level correlation with cancer. Studies show the radon particles, in combination with the compounds in cigarette smoke, attach themselves to the lining of the lungs and accumulate. In non-smokers, there is no accumulation.*

So where are we today in the minds of the most knowledgeable? In 1972, Alvin Weinberg, who was a part of the beginnings of nuclear fission with the Manhattan Project in the last century, called nuclear technology a "Faustian bargain". In this century, he was quoted as saying that we made mistakes first time around. Quoting now. "All of us (scientists) were disappointed when the country turned away from nuclear power. In 1994 I said we can move on by meeting four requirements. First confine reactors to few sites. But build 4 or 5 on each site. We have 60 sites now so we may need very few more. Second, improve security. We've done a very good job before 9/11 and our plants are now even more secure and protected. Third, we need to professionalize our plant operators (like we do our airline pilots). Now this has changed as well in the last two decades. We've become very professional. Finally, I said we have to separate the business of generating electricity from the business of selling it. Rather than having utilities just happen to own and run nuclear reactors, now through deregulation, we've created an industry (of experts) that deals exclusively with nuclear power. That's another big step forward." (By the way, this step alone has brought our current reactors from 60% efficiency to over 90% efficiency, the equivalent of having built 23 new 1000 MW nuclear power plants. This has been accomplished by just improved management and technological upgrades.) Altogether then, Dr. Weinberg says, I think we've done pretty much what we needed in order to begin a Second Nuclear Era. The only problem now is public opinion. All you hear is the same arguments over and over. You've got to change people's understanding of what nuclear energy is all about.

Enthusiasm for doing something about global warming usually wanes rapidly if it means paying more for gas, turning off air conditioning, or driving tiny, less safe cars. The way of life around the globe does not seem up for negotiation. Of the 170 countries that signed the Kyoto Protocol, only six have achieved their goal of reducing emissions to 1990 levels. The vast majority have gone right on pumping CO2 into the atmosphere. France with its nuclear infrastructure providing 80% of its electricity is one of the few that is in compliance. Denmark and Germany, while in earlier times under activist pressure vowed to shut down its nuclear plants, under the guidance of a more knowledgeable public have quietly continued to upgrade them and are now buying additional nuclear generated electricity from France. Always more volatile Italy, in response to those same activist pressures, closed its nuclear plants. On May 23, 2008, the NY Times reported Italy announced the building of many new nuclear plants to be initiated over the next five years as their old ones were now too obsolete to be updated and reopened. Of course Italy's anti-nuclear groups immediately attacked. Ian Hore-

Lally of the World Nuclear Association reports in that same NY Times article that the trend to build new plants is, in his words, "most dramatic, and is growing all across Europe—Holland, Belgium, Sweden, Germany, and more."

Solar energy is extremely dilute. Fossil fuels are 2 to 50 times more concentrated than the various forms of solar energy which is why it takes a wall-to-wall 100 square miles of direct solar generated energy to replace each fossil fuel plant—when the sun is shining. A passing cloud or the setting sun turns the power off. Nuclear energy is 2 million times more concentrated than fossil fuels which is why solar energy is going to take a lot of land, bays, and estuaries to collect and store that energy in a usable form be that photovoltaic collectors, solar concentrators, or windmills. This massive land usage is a very distressing situation to many people in the U.S. and around the world for an electrical generation facility that is productive usually less than 30 percent of the time. Low grade energy systems can get us only so far. As the late Dr. D. L. Ray who chaired the Atomic Energy Commission in the 70's used to put it, "You can hold a match under a pot of water forever and it won't boil." Direct solar is like that match, low density energy. Energy specialists Peter Huber and Mark Mills, authors of *The Bottomless Well* may be the first to put their finger on the effectiveness of electricity as an energy source. "You can't make new steel alloys in old-fashioned coke ovens—they're not hot enough, you need an electric-arc furnace. You can't weld buildings together with hot irons—you need an electric welding gun. You can't operate a microwave oven with rooftop solar voltaic panels. You can barely run an oxygen pump for your child's aquarium." Ironically, one of the biggest beneficiaries of high-quality electricity has been energy conservation. Huge advances have come from using high powered computers to match consumption with production, eliminating waste. Solar collector promoter, Amory Lovins, in his opposition to the need for large electrical generating plants providing electricity for home and businesses labeled the big plants akin to cutting butter with a chainsaw. But he couldn't see the futility of trying to cut steel with a butter knife.

A solar-nuclear alliance makes the most sense. Solar where space is readily available near the point of usage for when the sun shines and/or the wind blows with nuclear proving the always reliable base load requirements with a spinning reserve for the grid while doing other useful things with its plentiful, low-cost electricity solving many of the world's other challenges. Those things can be desalinization for clean fresh drinking water and hydrogen generation by electrolysis for our portable energy needs replacing gasoline--just as Jules Verne's predicted, fuel from water.

We don't have time this morning to gain a deeper understanding of the issue of gathering nuclear fuel and handling nuclear waste. We will delve into this subject on October 11. But let me leave you with this—much of the rest of the world operating Gaia energy fueled power plants are amused at Americans' infatuation with and fear of nuclear waste. They merely reprocess and burn it in their nuclear power plants as additional fuel, this stuff that Americans store and call nuclear waste. Of the couple percent that they can't burn, they save some of the isotopes for later medical and industrial applications although most such isotopes come from specifically designed reactors. The remaining is put in long-term storage until it can be reprocessed as well. For your information, since we in the U.S. are not allowed to reprocess reactor fuel, we must get most of our medical isotopes from a special small Canadian reactor for each of our 40,000 nuclear medicine procedures each day. France's nuclear storage facility is about the size of high school gymnasium and is located in the seaside town of La Hague while we here are fighting over hollowing out a mountain ridge in the Nevada wastelands. Let's get deeper into the nuclear waste issue in October 11.

Burning up the forests of the old world of Europe, Asia, and Africa did not change the thousands-year-old path of overall human existence pursuing new sources of energy, new ways to use that energy toward a better life. To expect the world's six billion and growing people to act differently from their forbearers is a bad bet. An equally bad bet is to think they will not be successful in that pursuit. The clean, compact, and plentiful energy is there, Gaia energy, that came from an exploding star 4 billion or so years ago, that is currently fueling the depths of our home planet, playing its part in creating the conditions we have become used to, comfortable with, and certainly wish to preserve. "We, the members of the Unitarian Universalist Association, covenant to affirm and promote respect for the interdependent web of existence of which we are a part." A primary way of following that principle is to reduce our footprint on the environment, the impact upon our fellow travelers. We need knowledge to know how to do that. Our nation now operates 600 coal plants with 150 more on the drawing boards. The utilities prefer coal plants in part because it doesn't arouse much public opposition. Is it possible that, in our lack of understanding of the science of utilizing Gaia energy instead of coal, we people of America have somehow dragged our feet too long? **end**