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The Future of Nuclear Power

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My subject today is the future of nuclear power. Many of the thoughts in this presentation are indebted to the excellent book "Power to Save the World" by Gwyneth Cravens and to far sighted speeches delivered last year by U.S. Senator Lamar Alexander as well as comments by Dr. Scott Montgomery of the University of Washington.

In the United States, the Soviet Union, Britain, France and China, nuclear reactors were developed first of all to breed plutonium for nuclear weapons. The development of power reactors was delayed in the years immediately after the Second World War because everyone involved in the new atomic energy enterprise believed that high-quality uranium ore was too rare in the world to be diverted from weapons production. Well into the decade, almost the entire U.S. production of uranium and plutonium was dedicated to nuclear weapons. Finally, prospectors unearthed the extensive uranium resources of the Colorado Plateau.

Another delay arose from concerns for secrecy. The Atomic Energy Act of 1946 made atomic energy an absolute monopoly of the federal government. All discoveries were to be considered "born" secret- treated as a secret until formally declassified- and the penalty for divulging atomic secrets was life imprisonment or death. All uranium and plutonium became property of the government, as beached whales once became the property of kings. No one could build or operate a nuclear reactor except under government contract, nor could one be privately owned. These restrictions and mind-sets had to be revised before utilities could own or build nuclear power stations.

It is clear in hindsight that the careful evolutionary development of nuclear power in the United States, including the types of reactors developed and the nurturing of a solid political constituency, was a casualty of the cold war. Early in the 1950's, the Soviet Union announced a power reactor program, and by then the British were developing a power reactor fueled with natural uranium that countries without enrichment facilities might want to buy. In both cases Congress feared the United States might be left behind. It amended the Atomic Energy Act in 1954 to allow private industry to own and operate reactors, and government subsidized construction began on a 60-megawatt demonstration plant at Shippingport, Pennsylvania, the same year.

Uranium oxide, which became the standard fuel for commercial reactors, was less dense than uranium metal and conducts heat much less efficiently. Low enriched uranium oxide, rather than the highly enriched version in the early U.S Navy reactors, was chosen as a power reactor fuel to lessen the risk of diversion to weapons. Since the pressurized-water reactor isn't a breeder, it wastes most of its fuel; that in turn increases the volume of long-lived radioactive isotopes that it does not utilize. To make this compromise competitive in a field dominated by relatively cheap fossil fuels, reactor manufacturers pushed design limits, maximizing temperatures, pressures, and power densities. Tighter design limits led to more frequent shut downs and increased the risk of breakdowns, which in turn required more complex safety systems.

More significant, manufacturers began pursuing economies of scale by selling larger and larger reactors, without fully addressing the changing cost and safety issues such reactors raised. "The largest commercial facility operating in 1963," two policy analysts wrote, "had a capacity of 200 megawatts; only four years later, utilities were ordering reactors of 1,200 megawatts." But the safety equipment that government regulators judged sufficient at 200 megawatts they no longer judged sufficient at 1,200 megawatts. So they began requiring add-on safety systems, escalating engineering and construction costs.

It was these problems, not antinuclear activism, that led to the cancellation of orders and the halt in construction that followed the Arab oil embargo of 1973-74. Orders for some one hundred U.S. nuclear power plants were canceled, but so were orders for eighty-two coal power plants, because the Arab oil embargo stimulated dramatic improvements in energy conservation in the United States and these stalled a long-standing trend of increasing demand. Resistance to nuclear power in the U.S. such as it was- every U.S. nuclear power plant that was completed was licensed- was less concerned with risk and safety than it was with nuclear power's association with nuclear weapons. Anti-nuclearism was primarily a political movement and proponents of nuclear power missed the point when they defended nuclear power on technical grounds alone. Several years ago, with demand once again increasing, the situation for U.S. nuclear power seemed positive: existing plants were being relicensed to extend their operating life; and new reactor construction utilizing newer, safer, and more efficient designs was on the horizon with some thirty new reactors contemplated. However, at this juncture new reactor construction in the United States appears less likely than it did a few years for a number of reasons: the high capital costs of power plants, the lower cost of natural gas and of course the problems in Japan. Hopefully relicensing will continue but likely only after serious safety reviews. It should be noted that France has a different story, with 80 percent nuclear electricity today, energy security in consequence, and air pollution reduced fivefold.

World electricity use is expected to more than double by the year 2030, as energy grids are currently configured around the world; much of that increase will be provided by the burning of much greater amounts of coal. Yet every year a single 500 megawatt coal-fired plant also sends up into the sky the same amount of carbon dioxide as do 750,000 cars. Coal combustion is responsible for a major share of the world's man-made carbon dioxide, a significant cause of global warming. Anyone who has been to China in recent years was exposed to the immense amount of air pollution that pervades most of Western China. Indeed it is significantly injurious to health. And this coal burning caused smog is so intense that it crosses the Pacific and creates some of the air pollution in California. Approximately 40 percent of the world's electricity is generated by coal, 20 percent by natural gas and around 7 percent from oil combustion. These fossil fuels pour huge quantities of soot, smoke, toxins, radio nuclides, carbon dioxide, methane and other noxious gases into the atmosphere every day. These greenhouse gases it is believed create climate change in the form of global warming which can cause lethal heat waves, violent storms and rising sea levels which some scientists believe will eventually threaten human civilization itself. It is widely believed that alternative energy sources must be developed and deployed which will lead to a predominantly carbon free energy production sector in order to counter this alarming trend.

But how can we ever cut back on fossil fuels when our entire way of life depends so intimately on them? Highways are choked with soot; the U.S. consumes 21 million barrels of oil a day. To purchase oil the United States sends $750,000 a minute to the Middle East. Coal burning power plants are ubiquitous. For every family conscious of the environment there seems to be two dozen developers. For every environmental activist coalition there are a hundred corporations with headquarters in New Jersey, Texas, or Germany solely intent on making a short-term profit. New suburbs are planned everywhere, where will the water come from? That problem has been put off for another generation to solve. When dust comes out of the tap the developers will be long gone. The sprawl seems destined to expand and require more and more water and electricity and burn more and more and more greenhouse gases. And all over the country and the world there are countless dirty cities where once there had been villages or farms or desert or forest or open shoreline.

Our world does not have to continue in this way. We do not have to pollute the earth in order to have modern civilization. Conservation, energy-efficient architecture, transportation and agriculture, stricter pollution regulations, and intelligent, long-term energy planning could all make a big difference locally and globally for humanity and the environment. There are enough resources to create a variety of realistic solutions tailored to local needs, and innovations have already brought improvements. But we need to do far more, and we must act quickly. And in order to protect the planet and civilization, we will also need an extraordinary degree of international cooperation- nature does not recognize any political party or country.

Any pragmatic plan must include more nuclear power. The American Wind Energy Association hopes that by 2020 wind farms will be supplying as much as 6 percent of U.S. electricity. The American Energy Information Administration estimates that the figure will be closer to 0.5 percent. Even with increased conservation of energy, the need for base load electricity will still have to be met by either fossil-fuel or nuclear power. Some estimates indicate that a plant of standardized, steamlined design, with many more built-in passive safety features, and therefore fewer pumps, valves, and other components, could be built in five years. The price per plant comes to at least $8 billion range- the former cost of maintaining the U.S. presence in Iraq for two weeks. Reactors could make hydrogen for fuel cells as well as electricity while burning up waste residues. Although meeting base load demand means that new nuclear plants are likely to be large, designs now come in different sizes; smaller reactors can supply electricity to local consumers or feed supplementary power to the grid during peak demand.

The nuclear renaissance is definitely happening elsewhere: 200 new nuclear power plants planned for China, over a hundred in India, a number in South Korea, an ambitious program in the United Arab Emirates and so on. It does not appear likely that there programs will be deterred by the Japanese incident. Whether the U.S. will participate in this remains to be seen. But nuclear power just to maintain its 20 percent share of the American electricity pie chart, the industry will have to add thirty-five new reactors by 2030. Continuing technological improvements and the high standards originated for the nuclear industry and reinforced after the failure at Three Mile Island have helped create a very strong current culture of safety. And after September 11, 2001 all U.S. reactors had their safety systems, evaluated, improved and expanded. The NRC will continue to exert control over nuclear utilities; it has evaluated the fleet's ability to deal effectively with terrorist attacks and has pledged to scrutinize new plant designs accordingly. The agency's and the industry's best interests lie in maintaining a strong safety record and encouraging nuclear utilities to continue to police one another. As politicians of both parties are beginning to understand, along with some members of the environmental lobby, America must make decisions soon about nuclear power. Natural gas will not do it. It does have carbon emissions, only less, and the shale gas, which has been the focus of the renewed interest in natural gas, can only be harvested by a process known as hydrofracking, which is highly damaging to the water table. To prevent the future rise of carbon dioxide emissions, by 2100 the world will require ten times the number of reactors we have today. Although reactor technology was forged in the United States, the country's leadership in that role has weakened. France, Japan, and other countries have added innovations and are continuing to build new nuclear plants, whereas until very recently the only large-scale additions in the United States have been fossil-fuel plants.

As more countries develop, they will be inclined to use fossil fuels unless the industrialized nations serve as exemplars in greenhouse gas mitigation and also help supply alternatives. Given the present trend, with Germany, China, and others building large numbers of coal-fired plants, we can expect their waste to continue to be pumped into the environment and the toll of preventable death and disease to rise. Emissions control technology has been a low priority and applications of it worldwide have been few. In the United States, carbon waste goes unregulated and large-volume sequestration of CO2 remains just a plan, with drawbacks, such as leakage, that have yet to be addressed. Voluntary efforts on the part of American industry to control greenhouse gases have been rare. New American coal-fired plants- around 154- that have been proposed for the near term will cost $136 billion. They'll be constructed along traditional lines and will still be burning coal fifty years or more from now... if the coal supply lasts that long. The DOE foresees over 300 new coal-fired plants in operation by 2030.

Some say we should stop using so much electricity, and certainly we can be thriftier. Some say, as we have seen, that we should replace fossil fuels with wind and solar power- and renewables can indeed play a role. But until technology for storing energy from them advances, we will have to keep getting most of our electricity from fossil fuels and nuclear plants. To alleviate human suffering, to help people live longer, healthier lives, electricity is essential and today fossil fuels are usually what developing countries employ to make it.

Around 140 new nuclear plants are in the works in other countries, although if one includes those in the planning stage, there are at least 185 contemplated for China and around 530 world-wide. According to what officials have been saying some of this may be delayed because of Japan but probably not much. China, India, Korea, Japan and some Middle Eastern countries as well believe they need nuclear power and will not be deterred. But the United States, without nuclear energy to make sufficient electricity, hydrogen, or synthetic fuels cleanly, is likely to remain a major contributor of greenhouses gases and continue to become bogged down in distant wars over dwindling oil and gas suppliers, perhaps as a result of ustaining more attacks on American soil. Because of general ignorance and misinformation about radiation and the realities about the risks and benefits of large-scale forms of energy generation, the U.S. is in danger of making poor choices and blindly accepting energy policies that harm the planet and darken the prospects of our children and grand-children.

Nuclear power, once established, is not intrinsically more expensive than other means of electricity generation. France sells cheap electricity to other countries from its nuclear plants. Over the long run, uranium is and will continue to be inexpensive. There is enough of it to last indefinitely, as well as the technology to keep recycling uranium fuel if necessary and to burn useless residues in reactors. If global climate change is to effectively fought there is no substitute for nuclear power for base load power for the foreseeable future. However, some argue that renewables can eventually do the job. Therefore brief look at renewables perhaps would be useful.

In the United States nuclear power produces 20 percent of electric power today, but 69 percent of carbon free electricity. To produce 20 percent of U.S. electricity from wind would cover an area the size of West Virginia utilizing 186,000 turbines 150 meters high and require 19,000 miles of transmission lines. Their flashing lights could be seen for 35 kilometers and they would be deployed on ridge lines and coast lines. An unbroken chain of giant wind turbines along the 3500 kilometer Apalachain Trail in the eastern United States would produce no more electricity than four nuclear power reactors on four square miles of land- and, of course, the reactors would still be needed when the wind did not blow. And further as to the environment, it is estimated that the existing 25,000 wind turbines kill 75,000 to 275,000 birds per year. Imagine what 186,000 turbines would do. The John Muir Trust in Scotland after an in-depth analysis recently concluded that wind turbines "cannot be relied upon" to produce significant levels of power generation. While wind industry and government agencies claim that wind turbine power generation will generate on average 30 percent of their rated capacity over a year, the Trust's research found that wind generation was below 20 percent more than half the time and below 10 percent capacity over one-third the time.

Solar energy also consumes a lot of space. The big solar thermal plants in the Western desert in the United States consist of mirrors to focus the suns rays and take up more than thirty square miles, around nine kilometers on a side, to produce 1000 megawatts which can be produced by a nuclear plant in one square mile. And solar power is of course only available when the sun shines. To generate this same amount of energy, 1000 megawatts, by wind would require 270 square miles of 150 meter wind turbines. But of course wind and solar energy is only available part of the time so 1000 megawatts is really much less. And this electricity can't be stored in commercial quantities with current technology. Some argue for biomass as the answer but to support a 1000 megawatt biomass plant on a sustainable basis would require a forest the size of the 550,000 acre Great Smokey Mountains National Park.

Thus, renewables are an important energy source but an ancillary one. And, further, nuclear power is the safest way to generate electricity. The effects of the accident, caused by the enormous earthquake- fifth most powerful in recorded history- and the ensuing tsunami at the Fukushima Daiichi in Japan nuclear plant grow by the week, creating a lengthening catalogue of worries and proving once again that nuclear power frightens people as few other technologies do. But when the dead and sickened are added up, how dangerous is it really?

The partial meltdown in Japan has injured 23 people and exposed as many as 21 to levels of radiation higher than is considered safe to receive in one year. Two workers were killed by the earthquake or tsunami, not the nuclear accident. No people in the "plume zone" outside the plant have been contaminated to a degree that is expected to affect their health, based on radiation readings so far.

In the months after the world's worst nuclear disaster, in Chernobyl in 1986, about 50 people died. In the next-biggest accident, at Three Mile Island in 1979, no one did.

History suggests that nuclear power rarely kills and causes little illness. That's also the conclusion engineers reach when they model scenarios for thousands of potential accidents.

Making electricity from nuclear power turns out to be far less damaging to human health than making it from coal, oil or even clean-burning natural gas, according to numerous analyses.

Compared with nuclear power, coal is responsible for five times as many worker deaths from accidents, 470 times as many deaths due to air pollution among members of the public, and more than 1,000 times as many cases of serious illness, according to a study of the health effects of electricity generation in Europe.

In analyzing the health effects of power generation it is important to consider not just the direct costs but the many hidden ones borne by individuals, communities and governments. For power plants (and also hydroelectric dams and wind farms), this includes the land to site them; construction, operation and decommissioning costs; and the humans who are killed or injured along the way. That means accidents and black lung disease in coal miners; radiation exposure in uranium miners and millers; and deaths and burns in oil-rig fires. This also includes what happens to the public — such things as the prevalence of; asthma, respiratory disease and heart attacks caused by smokestack soot and gases; and emissions' effects on agricultural production.

Now a closer look at the nuclear accident in Japan.

Fukushima Dai'ichi remains in a largely controlled, stable but still emergency condition, with no major changes but continuing stop-gap measures. Some residents within the 20-mile evacuation zone may be allowed back to their homes in order to retrieve personal items. Japanese authorities, retrospectively, with no new reports of problems have raised the level of threat to seven, the highest level, putting in on par with Chernobyl but of course it is nothing like Chernobyl. Indeed calling this event a seven on the IAEA scale, even if technically correct, is one of the most profound public miscommunications in recent memory. The Japanese authorities Fukushima has released ten percent of the radiation of Chernobyl but this is misleading. Chernobyl released its radiation in seconds, Fukushima over a month. Most of the radiation disappears rapidly, it would be more accurate to say a fraction of one percent of Chernobyl.

The leak of dangerous, highly radioactive water flowing directly into the sea has been plugged. Lightly contaminated water for a time was released into the ocean in order to create storage space for the highly radioactive water that has accumulated within the immediate vicinity of the reactor buildings. This has now ceased, approximately 10,000 tons (=2.4 million gallons) of this water was delivered to the sea.

Radiation levels at the margins of the plant itself, meanwhile, have continued to decline, or remain low, as have levels to the south, west, north, and northwest in and beyond the evacuation zone. Levels in the ocean, reportedly, remain below regulatory limits, but have increased slightly in the last two days, probably due to the leaking high-radioactive water from the plant. There is not now nor has there been any threat to human health from this reactor incident off of the actual reactor site itself. The reported problem with tap water for incidents involved water which would be considered safe in any country. The contamination of spinach by radiation for example reported by the media as a threat at one point was such that if you're even ate the spinach every day for a year you would receive the equivalent of one CT scan. Aerial monitoring along N-S and E-W transects off the coast from the plant, at altitudes averaging 1,070 m, register levels below 0.05 micro Sv., very low readings. However, certainly, much work- on site- remains to be done to bring this incident to an end.

A point to make here is that information comprises the incident no less than cooling problems. This truth, noted many times by scholars in media studies, emerges from the truth that representations of an event, especially while it is still unfolding, constitute a central dimension to the event itself, how it is experienced, imagined, and responded to in terms of specific decisions and actions, and thus how it feeds upon itself. Media information does not replace the physical reality, of course. But, through the news and now the blogosphere and other parts of the online universe, it can be the primary experience for the great majority of observers who are not directly affected. The internet and social networking in general make this even more intensely so than in the past.

One might say that there are countries that we could call nuclearphobic and nuclearphilic. Sometimes they even live in the same neighborhood. Germany, as anyone in the industry will tell you, has been nuclearphobic for many years, certainly since the 1970s, when the Green Party found in anti-nuclearism a rallying cause.

As a nuclearphilic nation, France has not at all been without its own protest movement. Marches and demonstrations involving thousands took place in the early 1970s, culminating in the mass protest at the Super-Phoenix breeder reactor site in Creys-Malville, 1977. But anti-nuclearism here was far more restricted in its social groups than in Germany. It is revealing that, on the subject of Chernobyl, French people tend to blame the Russians for what happened, not, as in other nations, the technology. A common French response: the Russians were not up to the task; French engineers are.

France and Germany show that each nation deals with the nuclear option in its own way, according to aspects of its history, national identity, and political technological culture. France has shown the world that nuclear energy can run a nation's power system without disaster, and can do so decade after decade. South Korea is actively pursuing a French model--aiming at using standardized reactor designs to lower costs, improve maintenance and operations, and make nuclear responsible for up to 60% of its total electricity, while also becoming a true center of expertise.

The German example of turning away from nuclear power will appeal to some, undoubtedly. But it is countered at every step by the French, and soon the South Korean, and other examples. Aside from more autocratic nations, where nuclear power can simply be chosen and imposed, it will be interesting to see how this option to address the three horsemen of energy security, need for electricity, and climate change will be individually adopted or resisted by the new generation of interested nations.

Some argue that until present stores of spent nuclear fuel are safely put away, new nuclear plants must not be built. But some nuclear waste is being safely stored right now in New Mexico in the U.S., and there are some workable solutions for its long-term sequestration. The Waste Isolation Pilot Plant in New Mexico has demonstrated to the world that nuclear waste can be securely transported and isolated in a virtually inaccessible location. Many nations lack suitable geological formations or the wherewithal to construct such a repository, but international cooperation, along with new deep-drilling technology that has considerably advanced our ability to gain access to deep-ocean sediments, could one day lead to permanent disposal of waste with no future uses in sites where it would be naturally shielded and immobilized for millions of years.

People in the nuclear world sometimes say that nuclear power does not have to be perfect- it just had to be cleaner, safer, and more efficient than fossil-fuel generated power. And, of course, it is so. Some speak about how nuclear plants, while displacing greenhouse gas production and meeting electricity needs, could buy some time to make technological advances that would bring superior methods of producing clean energy. Others say fission as we now employ it is in fact that longed-for superior method. But, even if we use all of our ingenuity and will power to apply a broad spectrum of solutions, even if we can reduce our greenhouse gas emissions by a large factor, it will still take the earth centuries to recover there has been so much damage. But if we do nothing we'll be collaborating in a suicidal act of selfishness that could well result in the destruction of the only home we have.

As explained earlier, renewables while important and useful will likely never be able to be sufficiently abundant and reliable to provide base load power for the electric grid in the United States. Base load power, upon which economies depend, must always be there, it must be reliable. Most other countries, while there may be exceptions, are in the same situation. Thus, the prime, likely the only, candidate to provide large amounts of base load electricity on a carbon free basis in the United States and most of the rest of the world is nuclear power. Indeed nuclear power is a necessary and likely central part of any effort to effectively address climate change. Nuclear power, like anything else, operated by human being, cannot be held to a standard of perfection eliminating any possibility of accident- this cannot be a standard, it should be a goal. It is important to cease holding this energy source so high among all others in terms of threat, using such a double standard does significant damage. The nuclear power option is now inseparable from the threat of climate change. It is this anticipated crisis of the future that has replaced global nuclear war itself as the shadow of greatest magnitude.

President Obama in his speech in Prague in 2009 made clear that an essential part of the Nuclear Non-proliferation Treaty (NPT) basic bargain is international support for the peaceful use of nuclear energy. This is increasingly important as the world is threatened by climate change. But realizing the potential of nuclear power to meet the world's growing energy needs and the same time help to combat global warming is only possible if nuclear power can be completely separated from weapons, thereafter everything after must be done to strengthen the NPT and advance the cause of nuclear weapon non-proliferation and eventual elimination.

There are improvements across the spectrum of technology in the nuclear industry. Generation III and III plus reactors are significantly safer and more efficient than the older Generation II reactors which are widely deployed. But these reactors can be considerably improved in their efficiency and safety by using advanced, innovative fuels such as have been developed by my Company Lightbridge Corporation. Permit me to relate to you a little company history.

In the 1930s Dr. Edward Teller, the father of the hydrogen bomb, was a young professor of physics at George Washington University. One of his students—in his view the most capable student he ever had—was Dr. Alvin Radkowsky. Later, after the end of the Second World War, then Captain, later Admiral, H. G. Rickover, was advocating the development of a nuclear-powered U.S. Navy. Rickover needed for this objective very specially designed nuclear reactors. For this Rickover turned to Dr. Teller for advice; who could design such facilities for him? Dr. Teller recommended his former star student, Dr. Alvin Radkowsky. Thus, Dr. Radkowsky became the Chief Scientist of the Rickover nuclear Navy, for 25 years serving scientific leader of the most successful nuclear program in history.

After his retirement in the 1980s, Dr. Teller asked Dr. Radkowsky to meet with him in New York. At this meeting, Dr. Teller said to Dr. Radkowsky that nuclear power was destined to spread all over the world and would not be confined to so-called "safe" countries committed to nonproliferation policies and also there was and would be increasing amounts of plutonium present in various countries accompanying the reduction in weapon stockpiles. A nuclear fuel needed to be developed that, unlike conventional uranium nuclear fuel, would make no weapon-usable material in its spent fuel. Also, a nuclear fuel was needed that could be combined with plutonium and produce electricity, while disposing of the plutonium. As the best nuclear fuel designer in history it was up to Dr. Radkowsky to undertake this task, Teller said.

Dr. Radkowsky pursued this objective and after a number of years had created a thorium-based nuclear fuel design that accomplished both goals. With patents on proliferation resistant thorium-based fuel as well as the plutonium-consuming variants, Thorium Power, now Lightbridge Corporation, in 1992 was founded to develop and commercialize these inventions of Dr. Radkowsky. The work on the initial research and development of this fuel design was carried out at the Kurchatov Institute in Moscow with the strong support of the U.S. DOE. Dr. Radkowsky served as Chief Scientist of the company and a board member from the company's founding in 1992 until his death in 2002. The Lightbridge thorium-based fuel designs produces no weapons usable material in its spent fuel and it also has a ninety percent reduction in radio toxicity of its spent fuel compared to conventional fuels.

Recently, building on its work with metallic fuel designs in developing the thorium based fuel in Russia, Lightbridge announced the creation of nuclear fuel based on a metallic design that can deliver much more power with same fuel core size. More specifically it would be ten percent for existing reactors without change, 17 percent with some modifications and 30 percent for new build. This design can use either a thorium fuel cycle or an all uranium fuel cycle. This increase in power output could generate significant cost savings on a per kilowatthour basis, making it economically attractive to nuclear operators to adopt this fuel design. This can be especially attractive in the United States when no new reactors are expected to be built but much more power is needed. These uprate fuel designs, like the thorium fuel design, have waste management improvements in that the radio toxicity of spent fuel is reduced by 70 percent. Due to substantial synergies between the all-metal and thorium-based fuel designs, the all-metal fuel technology can become a stepping stone toward deployment of thorium-based nuclear fuel.

Recently, the United Arab Emirates began the most notable nuclear power program in the last 20 years. The UAE program in addition to being large is serving as a model for future programs. The UAE has renounced on a legally binding basis, in its White Paper on Peaceful Nuclear Energy Policy, in its basic law concerning the peaceful uses of nuclear energy, and in its 123 Agreement for nuclear cooperation with the United States, both domestic uranium enrichment and plutonium reprocessing. In addition in the White Paper the UAE expresses strong support for proliferation-resistant nuclear technologies stating "As the UAE seeks to explore technology options for any nuclear program, high importance will be placed on innovative reactors and fuel cycle technologies that exhibit enhanced proliferation resistance."

The nuclear renaissance is a reality in much of the world. With the threat of global warming on the horizon, the potential for serious world-wide air pollution, the political problems surrounding fossil fuels and the enormous increase in energy demand throughout the world, nuclear power must be a growing part of the energy production mix. The introduction of unceased power non-proliferative fuels will help strengthen the safety and efficiency of nuclear power, as its use expands. And as said it is possible also to substantially reduce the problem of nuclear waste with their fuel designs.

So with effort and consistent world-wide cooperation nuclear power can be consistently improved, further nuclear weapon proliferation can be prevented, progress can be made toward the eventual elimination of nuclear weapons and the benefits of the peaceful atom be made available virtually everywhere.

I will close with a little story recounted by Gwyneth Cravens in her book. You all know the tale of the man who has been warned that a flood was coming. The man says, "It's all right—God will save me." As the flood approaches, the police come to his house and tell him to evacuate. He chooses to stay, saying, "God will save me." When the water reaches half way up his house, rescuers come by with a rowboat, and he refuses it, saying, "God will save me." Finally he is on the roof of his house and his feet are getting wet. A helicopter comes to take him to safety, but he waves it off saying : God will save me." Finally the rising water inundates the entire house and he drowns. When he gets to heaven and meets God, he demands an explanation. "Why didn't you save me?" God replies, "I sent someone to tell you to evacuate. I sent you a rowboat. I sent a helicopter. You turned down every chance I gave you."

One day God may say to us: I gave you the brainiest men and women in human history to come up with an understanding of the atom and its nucleus. I gave you enough uranium and thorium to last you for thousands of years. I gave you an understanding of how when uranium decays it releases energy. You didn't need to invent anything else. You had everything you needed to provide energy for yourselves and your descendants without harming the environment. What else did you want?"