### Plan

#### The United States federal government should substantially increase loan guarantees for energy produced by integral fast reactors using the S-PRISM design in the United States.

### 1

#### Adv 1: Nuclear leadership

#### Nuclear power is inevitable – Inaction on IFRs is killing US nuclear leadership

**Shuster 11** [Joseph Shuster, founder of Minnesota Valley Engineering and Chemical Engineer, 9-8-2011, "Response to Draft Report From Obama’s Blue Ribbon Commission (BRC) on America’s Nuclear Future dated July 29, 2011," Beyond Fossil Fools]

Contrary to the commission’s declarations on the matter, the U.S. is in danger of losing its once ¶ strong nuclear leadership. As a result we would have less to say about how nuclear materials are ¶ to be managed in the world and that could expose the U.S. to some inconvenient if not downright ¶ dangerous consequences. China is now building a large pilot plant said to be identical to our ¶ successful EBR-II plant that proved the design of the IFR. Meanwhile in the U.S. after complete ¶ success, EBR II was shut down, not for technical reasons but for political reasons during the ¶ Clinton administration, a decision destined to be one of the worst in our nation’s history.¶ Much of the world is already committed to a nuclear future with some countries eagerly waiting ¶ to license the American version of Generation IV Fast Reactors—the IFR. We still have the best ¶ IFR technology in the world but have squandered much of our lead, partly by allowing a largely ¶ unqualified commission two years of useless deliberation. What we really did was give our ¶ competitors an additional two years to catch up.

#### IFR restores leadership on nuclear issues – key to contain proliferation

**Stanford 10** (Dr George S. Stanford, nuclear reactor physicist, retired from Argonne National Laboratory, "IFR FaD context – the need for U.S. implementation of the IFR," 2/18/10) http://bravenewclimate.com/2010/02/18/ifr-fad-context/-http://bravenewclimate.com/2010/02/18/ifr-fad-context/

ON THE NEED FOR U.S. IMPLEMENTATION OF THE INTEGRAL FAST REACTOR¶ The IFR ties into a very big picture — international stability, prevention of war, and avoiding “proliferation” (spread) of nuclear weapons.¶ – The need for energy is the basis of many wars, including the ones we are engaged in right now (Iraq and Afghanistan). If every nation had enough energy to give its people a decent standard of living, that reason for conflict would disappear.¶ – The only sustainable energy source that can provide the bulk of the energy needed is nuclear power.¶ – The current need is for more thermal reactors — the kind we now use.¶ – But for the longer term, to provide the growing amount of energy that will be needed to maintain civilization, the only proven way available today is with fast-reactor technology.¶ – The most promising fast-reactor type is the IFR – metal-fueled, sodium-cooled, with pyroprocessing to recycle its fuel.¶ – Nobody knows yet how much IFR plants would cost to build and operate. Without the commercial-scale demo of the IFR, along with rationalization of the licensing process, any claims about costs are simply hand-waving guesses.¶ \* \* \* \*¶ Background info on proliferation (of nuclear weapons). Please follow the reasoning carefully.¶ – Atomic bombs can be made with highly enriched uranium (90% U-235) or with good-quality plutonium (bomb designers want plutonium that is ~93% Pu-239).¶ – For fuel for an LWR, the uranium only has to be enriched to 3 or 4% U-235.¶ – To make a uranium bomb you don’t need a reactor — but you do need access to an enrichment facility or some other source of highly enriched uranium…¶ – Any kind of nuclear reactor can be used to make weapons-quality plutonium from uranium-238, but the uranium has to have been irradiated for only a very short period. In other words, nobody would try to make a plutonium weapon from ordinary spent fuel, because there are easier ways to get plutonium of much better quality.¶ – Plutonium for a weapon not only has to have good isotopic quality, it also has to be chemically uncontaminated. Thus the lightly irradiated fuel has to be processed to extract the plutonium in a chemically pure form. But mere possession of a reactor is not sufficient for a weapons capability — a facility using a chemical process called PUREX is also needed.¶ – Regardless of how many reactors a country has, it cannot have a weapons capability unless it has either the ability to enrich uranium or to do PUREX-type fuel reprocessing.¶ – Therefore, the spread of weapons capability will be strongly inhibited if the only enrichment and reprocessing facilities are in countries that already have a nuclear arsenal.¶ – But that can only happen if countries with reactors (and soon that will be most of the nations of the world) have absolutely ironclad guarantees that they can get the fuel they need even if they can’t make their own, regardless of how obnoxious their political actions might be.¶ – Such guarantees will have to be backed up by some sort of international arrangement, and that can only come to pass if there is effective leadership for the laborious international negotiations that will have to take place. (For a relevant discussion, see here)¶ – At present, the only nation that has a realistic potential to be such a leader is the United States.¶ – But a country cannot be such a leader in the political arena unless it is also in the technological forefront.¶ – The United States used to be the reactor-technology leader, but it abandoned that role in 1994 when it terminated the development of the IFR.¶ – Since then, other nations — China, India, Japan, South Korea, Russia, France — have proceeded to work on their own fast-reactor versions, which necessarily will involve instituting a fuel-processing capability.¶ – Thus the United States is being left behind, and is rapidly losing its ability to help assure that the global evolution of the technology of nuclear energy proceeds in a safe and orderly manner.¶ – But maybe it’s not too late yet. After all, the IFR is the fast-reactor technology with the post promise (for a variety of reasons), and is ready for a commercial-scale demonstration to settle some uncertainties about how to scale up the pyroprocess as needed, to establish better limits on the expected cost of production units, and to develop an appropriate, expeditious licensing process.¶ – Such a demo will require federal seed money. It’s time to get moving.

#### Several impacts – 1st prolif

#### Transition to IFRs create a global proliferation resistant fuel cycle

**Stanford 10** (Dr George S. Stanford, nuclear reactor physicist, retired from Argonne National Laboratory, "Q%26A on Integral Fast Reactors – safe, abundant, non-polluting power," 9/18/10) [http://bravenewclimate.com/2010/09/18/ifr-fad-7/-http://bravenewclimate.com/2010/09/18/ifr-fad-7/](http://bravenewclimate.com/2010/09/18/ifr-fad-7/-http%3A//bravenewclimate.com/2010/09/18/ifr-fad-7/)

Thermal reactors with reprocessing would do at least a little better.¶ Recycling (it would be with the PUREX process, or an equivalent) could stretch the U-235 supply another few decades—but remember the consequences: growing stockpiles of plutonium, pure plutonium streams in the PUREX plants, and the creation of 100,000-year plutonium mines.¶ If you’re going to talk about “PUREX” and “plutonium mines” you should say what they are. First, what’s PUREX?¶ It’s a chemical process developed for the nuclear weapons program, to separate plutonium from everything else that comes out of a reactor. Weapons require very pure plutonium, and that’s what PUREX delivers. The pyroprocess used in the IFR is very different. It not only does not, it cannot, produce plutonium with the chemical purity needed for weapons.¶ Why do you keep referring to “chemical” purity?¶ Because chemical and isotopic quality are two different things. Plutonium for a weapon has to be pure chemically. Weapons designers also want good isotopic quality—that is, they want at least 93% of their plutonium to consist of the isotope Pu- 239. A chemical process does not separate isotopes.¶ I see. Now, what about the “plutonium mines?”¶ When spent fuel or vitrified reprocessing waste from thermal reactors is buried, the result is a concentrated geological deposit of plutonium. As its radioactivity decays, those deposits are sources of raw material for weapons, becoming increasingly attractive over the next 100,000 years and more (the half-life of Pu-239 being 24,000 years).¶ You listed, back at the beginning, some problems that the IFR would ameliorate. A lot of those problems are obviously related to proliferation of nuclear weapons.¶ Definitely. For instance, although thermal reactors consume more fuel than they produce, and thus are not called “breeders,” they inescapably are prolific breeders of plutonium, as I said. And that poses serious concerns about nuclear proliferation. And proliferation concerns are even greater when fuel from thermal reactors is recycled, since the PUREX method is used. IFRs have neither of those drawbacks.¶ Why does it seem that there is more proliferation-related concern about plutonium than about uranium? Can’t you make bombs from either?¶ Yes. The best isotopes for nuclear explosives are U-235, Pu- 239, and U-233. Only the first two of those, however, have been widely used. All the other actinide isotopes, if present in appreciable quantity, in one way or another complicate the design and construction of bombs and degrade their performance. Adequate isotopic purity is therefore important, and isotopic separation is much more difficult than chemical separation. Even so, with plutonium of almost any isotopic composition it is technically possible to make an explosive (although designers of military weapons demand plutonium that is at least 93% Pu-239), whereas if U-235 is sufficiently diluted with U-238 (which is easy to do and hard to undo), the mixture cannot be used for a bomb.¶ High-quality plutonium is the material of choice for a large and sophisticated nuclear arsenal, while highly enriched uranium would be one of the easier routes to a few crude nuclear explosives.¶ So why the emphasis on plutonium?¶ You’re asking me to read people’s minds, and I’m not good at that. Both uranium and plutonium are of proliferation concern.¶ Where is the best place for plutonium?¶ Where better than in a reactor plant—particularly an IFR facility, where there is never pure plutonium (except some, briefly, when it comes in from dismantled weapons), where the radioactivity levels are lethal, and where the operations are done remotely under an inert, smothering atmosphere? Once enough IFRs are deployed, there never will need to be plutonium outside a reactor plant—except for the then diminishing supply of plutonium left over from decades of thermal-reactor operation.¶ How does the IFR square with U.S. policy of discouraging plutonium production, reprocessing and use?¶ It is entirely consistent with the intent of that policy—to render plutonium as inaccessible for weapons use as possible. The wording of the policy, however, is now obsolete.¶ How so?¶ It was formulated before the IFR’s pyroprocessing and electrorefining technology was known—when “reprocessing” was synonymous with PUREX, which creates plutonium of the chemical purity needed for weapons. Since now there is a fuel cycle that promises to provide far-superior management of plutonium, the policy has been overtaken by events.¶ Why is the IFR better than PUREX? Doesn’t “recycling” mean separation of plutonium, regardless of the method?¶ No, not in the IFR—and that misunderstanding accounts for some of the opposition. The IFR’s pyroprocessing and electrorefining method is not capable of making plutonium that is pure enough for weapons. If a proliferator were to start with IFR material, he or she would have to employ an extra chemical separation step.¶ But there is plutonium in IFRs, along with other fissionable isotopes. Seems to me that a proliferator could take some of that and make a bomb.¶ Some people do say that, but they’re wrong, according to expert bomb designers at Livermore National Laboratory. They looked at the problem in detail, and concluded that plutonium-bearing material taken from anywhere in the IFR cycle was so ornery, because of inherent heat, radioactivity and spontaneous neutrons, that making a bomb with it without chemical separation of the plutonium would be essentially impossible—far, far harder than using today’s reactor-grade plutonium.¶ So? Why wouldn’t they use chemical separation?¶ First of all, they would need a PUREX-type plant—something that does not exist in the IFR cycle.¶ Second, the input material is so fiendishly radioactive that the processing facility would have to be more elaborate than any PUREX plant now in existence. The operations would have to be done entirely by remote control, behind heavy shielding, or the operators would die before getting the job done. The installation would cost millions, and would be very hard to conceal.¶ Third, a routine safeguards regime would readily spot any such modification to an IFR plant, or diversion of highly radioactive material beyond the plant.¶ Fourth, of all the ways there are to get plutonium—of any isotopic quality—this is probably the all-time, hands-down hardest.¶ The Long Term¶ Does the plutonium now existing and being produced by thermal reactors raise any proliferation concerns for the long term?¶ It certainly does. As I said earlier, burying the spent fuel from today’s thermal reactors creates geological deposits of plutonium whose desirability for weapons use is continually improving. Some 30 countries now have thermal-reactor programs, and the number will grow. To conceive of that many custodial programs being maintained effectively for that long is a challenge to the imagination. Since the IFR can consume plutonium, it can completely eliminate this long-term concern.¶ Are there other waste-disposal problems that could be lessened?¶ Yes. Some constituents of the waste from thermal reactors remain appreciably radioactive for thousands of years, leading to 10,000-year stability criteria for disposal sites. Waste disposal would be simpler if that time frame could be shortened. With IFR waste, the time of concern is less than 500 years.¶ What about a 1994 report by the National Academy of Sciences? The Washington Post said that the NAS report “denounces the idea of building new reactors to consume plutonium.”¶ That characterization of the report is a little strong, but it is true that the members of the NAS committee seem not to have been familiar with the plutonium-management potential of the IFR. They did, however, recognize the “plutonium mine” problem. They say (Executive Summary, p.3):¶ Because plutonium in spent fuel or glass logs incorporating high-level wastes still entails a risk of weapons use, and because the barrier to such use diminishes with time as the radioactivity decays, consideration of further steps to reduce the long-term proliferation risks of such materials is required, regardless of what option is chosen for [near-term] disposition of weapons plutonium. This global effort should include continued consideration of more proliferation-resistant nuclear fuel cycles, including concepts that might offer a long-term option for nearly complete elimination of the world’s plutonium stocks. The IFR, obviously, is just such a fuel cycle—a prime candidate for “continued consideration.”

#### We’re on the brink of rapid prolif – access to tech is inevitable and multilateral institutions fail

**CFR 12** [CFR 7-5-2012, "The Global Nuclear Nonproliferation Regime," Council on Foreign Relations]

Nuclear weapons proliferation, whether by state or nonstate actors, poses one of the greatest threats to international security today. Iran's apparent efforts to acquire nuclear weapons, what amounts to North Korean nuclear blackmail, and the revelation of the A.Q. Khan black market nuclear network all underscore the far-from-remote possibility that a terrorist group or a so-called rogue state will acquire weapons of mass destruction or materials for a dirty bomb.¶ The problem of nuclear proliferation is global, and any effective response must also be multilateral. Nine states (China, France, India, Israel, North Korea, Pakistan, Russia, the United Kingdom, and the United States) are known or believed to have nuclear weapons, and more than thirty others (including Japan, Germany, and South Korea) have the technological ability to quickly acquire them. Amid volatile energy costs, the accompanying push to expand nuclear energy, growing concerns about the environmental impact of fossil fuels, and the continued diffusion of scientific and technical knowledge, access to dual-use technologies seems destined to grow.¶ In the background, a nascent global consensus regarding the need for substantial nuclear arms reductions, if not complete nuclear disarmament, has increasingly taken shape. In April 2009, for instance, U.S. president Barack Obama reignited global nonproliferation efforts through a landmark speech in Prague. Subsequently, in September of the same year, the UN Security Council (UNSC) unanimously passed Resolution 1887, which called for accelerated efforts toward total nuclear disarmament. In February 2012, the number of states who have ratified the Comprehensive Test Ban Treaty increased to 157, heightening appeals to countries such as the United States, Israel, and Iran to follow suit.¶ Overall, the existing global nonproliferation regime is a highly developed example of international law. Yet, despite some notable successes, existing multilateral institutions have failed to prevent states such as India, Pakistan, and North Korea from "going nuclear," and seem equally ill-equipped to check Iran as well as potential threats from nonstate, terrorist groups. The current framework must be updated and reinforced if it is to effectively address today's proliferation threats, let alone pave the way for "the peace and security of a world without nuclear weapons."

#### New proliferators will be uniquely destabilizing -- guarantees conflict escalation.

Cimbala, ‘8

[Stephen, Distinguished Prof. Pol. Sci. – Penn. State Brandywine, Comparative Strategy, “Anticipatory Attacks: Nuclear Crisis Stability in Future Asia”, 27, InformaWorld]

If the possibility existed of a mistaken preemption during and immediately after the Cold War, between the experienced nuclear forces and command systems of America and Russia, then it may be a matter of even more concern with regard to states with newer and more opaque forces and command systems. In addition, the Americans and Soviets (and then Russians) had a great deal of experience getting to know one another’s military operational proclivities and doctrinal idiosyncrasies, including those that might influence the decision for or against war. Another consideration, relative to nuclear stability in the present century, is that the Americans and their NATO allies shared with the Soviets and Russians a commonality of culture and historical experience. Future threats to American or Russian security from weapons of mass destruction may be presented by states or nonstate actors motivated by cultural and social predispositions not easily understood by those in the West nor subject to favorable manipulation during a crisis. The spread of nuclear weapons in Asia presents a complicated mosaic of possibilities in this regard. States with nuclear forces of variable force structure, operational experience, and command-control systems will be thrown into a matrix of complex political, social, and cultural crosscurrents contributory to the possibility of war. In addition to the existing nuclear powers in Asia, others may seek nuclear weapons if they feel threatened by regional rivals or hostile alliances. Containment of nuclear proliferation in Asia is a desirable political objective for all of the obvious reasons. Nevertheless, the present century is unlikely to see the nuclear hesitancy or risk aversion that marked the Cold War, in part, because the military and political discipline imposed by the Cold War superpowers no longer exists, but also because states in Asia have new aspirations for regional or global respect.12 The spread of ballistic missiles and other nuclear-capable delivery systems in Asia, or in the Middle East with reach into Asia, is especially dangerous because plausible adversaries live close together and are already engaged in ongoing disputes about territory or other issues.13 The Cold War Americans and Soviets required missiles and airborne delivery systems of intercontinental range to strike at one another’s vitals. But short-range ballistic missiles or fighter-bombers suffice for India and Pakistan to launch attacks at one another with potentially “strategic” effects. China shares borders with Russia, North Korea, India, and Pakistan; Russia, with China and NorthKorea; India, with Pakistan and China; Pakistan, with India and China; and so on. The short flight times of ballistic missiles between the cities or military forces of contiguous states means that very little time will be available for warning and attack assessment by the defender. Conventionally armed missiles could easily be mistaken for a tactical nuclear first use. Fighter-bombers appearing over the horizon could just as easily be carrying nuclear weapons as conventional ordnance. In addition to the challenges posed by shorter flight times and uncertain weapons loads, potential victims of nuclear attack in Asia may also have first strike–vulnerable forces and command-control systems that increase decision pressures for rapid, and possibly mistaken, retaliation. This potpourri of possibilities challenges conventional wisdom about nuclear deterrence and proliferation on the part of policymakers and academic theorists. For policymakers in the United States and NATO, spreading nuclear and other weapons of mass destruction in Asia could profoundly shift the geopolitics of mass destruction from a European center of gravity (in the twentieth century) to an Asian and/or Middle Eastern center of gravity (in the present century).14 This would profoundly shake up prognostications to the effect that wars of mass destruction are now passe, on account of the emergence of the “Revolution in Military Affairs” and its encouragement of information-based warfare.15 Together with this, there has emerged the argument that large-scale war between states or coalitions of states, as opposed to varieties of unconventional warfare and failed states, are exceptional and potentially obsolete.16 The spread of WMD and ballistic missiles in Asia could overturn these expectations for the obsolescence or marginalization of major interstate warfare.

#### Extinction.

Krieger, ‘9

[David, Pres. Nuclear Age Peace Foundation and Councilor – World Future Council, “Still Loving the Bomb After All These Years”, 9-4, https://www.wagingpeace.org/articles/2009/09/04\_krieger\_newsweek\_response.php?krieger]

Jonathan Tepperman’s article in the September 7, 2009 issue of Newsweek, “Why Obama Should Learn to Love the Bomb,” provides a novel but frivolous argument that nuclear weapons “may not, in fact, make the world more dangerous….” Rather, in Tepperman’s world, “The bomb may actually make us safer.” Tepperman shares this world with Kenneth Waltz, a University of California professor emeritus of political science, who Tepperman describes as “the leading ‘nuclear optimist.’” Waltz expresses his optimism in this way: “We’ve now had 64 years of experience since Hiroshima. It’s striking and against all historical precedent that for that substantial period, there has not been any war among nuclear states.” Actually, there were a number of proxy wars between nuclear weapons states, such as those in Korea, Vietnam and Afghanistan, and some near disasters, the most notable being the 1962 Cuban Missile Crisis. Waltz’s logic is akin to observing a man falling from a high rise building, and noting that he had already fallen for 64 floors without anything bad happening to him, and concluding that so far it looked so good that others should try it. Dangerous logic! Tepperman builds upon Waltz’s logic, and concludes “that all states are rational,” even though their leaders may have a lot of bad qualities, including being “stupid, petty, venal, even evil….” He asks us to trust that rationality will always prevail when there is a risk of nuclear retaliation, because these weapons make “the costs of war obvious, inevitable, and unacceptable.” Actually, he is asking us to do more than trust in the rationality of leaders; he is asking us to gamble the future on this proposition. “The iron logic of deterrence and mutually assured destruction is so compelling,” Tepperman argues, “it’s led to what’s known as the nuclear peace….” But if this is a peace worthy of the name, which it isn’t, it certainly is not one on which to risk the future of civilization. One irrational leader with control over a nuclear arsenal could start a nuclear conflagration, resulting in a global Hiroshima. Tepperman celebrates “the iron logic of deterrence,” but deterrence is a theory that is far from rooted in “iron logic.” It is a theory based upon threats that must be effectively communicated and believed. Leaders of Country A with nuclear weapons must communicate to other countries (B, C, etc.) the conditions under which A will retaliate with nuclear weapons. The leaders of the other countries must understand and believe the threat from Country A will, in fact, be carried out. The longer that nuclear weapons are not used, the more other countries may come to believe that they can challenge Country A with impunity from nuclear retaliation. The more that Country A bullies other countries, the greater the incentive for these countries to develop their own nuclear arsenals. Deterrence is unstable and therefore precarious. Most of the countries in the world reject the argument, made most prominently by Kenneth Waltz, that the spread of nuclear weapons makes the world safer. These countries joined together in the Nuclear Non-Proliferation Treaty (NPT) to prevent the spread of nuclear weapons, but they never agreed to maintain indefinitely a system of nuclear apartheid in which some states possess nuclear weapons and others are prohibited from doing so. The principal bargain of the NPT requires the five NPT nuclear weapons states (US, Russia, UK, France and China) to engage in good faith negotiations for nuclear disarmament, and the International Court of Justice interpreted this to mean complete nuclear disarmament in all its aspects. Tepperman seems to be arguing that seeking to prevent the proliferation of nuclear weapons is bad policy, and that nuclear weapons, because of their threat, make efforts at non-proliferation unnecessary and even unwise. If some additional states, including Iran, developed nuclear arsenals, he concludes that wouldn’t be so bad “given the way that bombs tend to mellow behavior.” Those who oppose Tepperman’s favorable disposition toward the bomb, he refers to as “nuclear pessimists.” These would be the people, and I would certainly be one of them, who see nuclear weapons as presenting an urgent danger to our security, our species and our future. Tepperman finds that when viewed from his “nuclear optimist” perspective, “nuclear weapons start to seem a lot less frightening.” “Nuclear peace,” he tells us, “rests on a scary bargain: you accept a small chance that something extremely bad will happen in exchange for a much bigger chance that something very bad – conventional war – won’t happen.” But the “extremely bad” thing he asks us to accept is the end of the human species. Yes, that would be serious. He also doesn’t make the case that in a world without nuclear weapons, the prospects of conventional war would increase dramatically. After all, it is only an unproven supposition that nuclear weapons have prevented wars, or would do so in the future. We have certainly come far too close to the precipice of catastrophic nuclear war. As an ultimate celebration of the faulty logic of deterrence, Tepperman calls for providing any nuclear weapons state with a “survivable second strike option.” Thus, he not only favors nuclear weapons, but finds the security of these weapons to trump human security. Presumably he would have President Obama providing new and secure nuclear weapons to North Korea, Pakistan and any other nuclear weapons states that come along so that they will feel secure enough not to use their weapons in a first-strike attack. Do we really want to bet the human future that Kim Jong-Il and his successors are more rational than Mr. Tepperman?

#### Second – competitiveness

#### US is ceding nuclear competitiveness now – plan key to resolve

**Barton 11** [Charles Barton, Nuclear Green, “Have the Chinese Been Reading Energy from Thorium or Nuclear Green?” 1/31/11]

Last week the Chinese Academy of Science announced that it planned to finance the development of a Chinese Thorium Breeding Molten Salt Reactor (TMSR) or as it is called in the United States, the Liquid Fluoride Thorium Reactor (LFTR). The announcement came in a news report from Weihui.news365.com.cn. The announcement was relayed to Westerners who were interested in Thorium breeding molten salt reactors in a discussion thread comment posted by Chinese Scientist Hua Bai, last Friday. Kirk Sorensen, Brian Wang, and I all posted about Bai's announcement on Sunday, January 30.¶ In addition to these posts, the thread which Hua Bai started contains the revelation that the engineer who heads the Chinese Molten Salt Reactor Project is none other than Jiang Mianheng, a son of Retired Chinese President, Jiang Zemin. In addition to being President of People's China, Jiang was the chairmanship of the powerful Central Military Commission, suggesting the likelihood that Jiang Mianheng has military ties. He is the cofounder of Semiconductor Manufacturing International Corporation, and a former lead researcher in the Chinese Space Program, as well as Vice President of the Chinese Academy of Sciences. The presence of such a well connected Chinese science leader suggests that the Chinese TMSR project is regarded as important by the Chinese leadership. Thus the Chinese leadership, unlike the American Political andscientific leadership has grasped the potential of molten salt nuclear technology.¶ Yesterday, "horos11" commented on my blog, Nuclear Green,¶ I read this, and I didn't know whether to laugh or cry.¶ After all, this site and others have been sounding the clarion call to action on this, and I should be glad that someone finally heeded it and its getting traction in a place that really matters, but I have a sinking feeling that:¶ a. its going to take far less than their planned 20 years¶ b. they are going to succeed beyond their wildest expectations.¶ Which means that the next, giant sucking sound we may hear is the sound of the 5 trillion dollar energy market heading east, further depressing our economy, weakening the dollar (and the euro) and ultimately making the US economy dependent on rescue from the chinese in the future (when they are done rescuing themselves).¶ Yet, in the large scheme of things, this is a definite good, and may be our savior from anthropomorphic climate change.¶ so again, laugh? or cry. I guess its up to how you view things - I guess I'm tentatively laughing at the moment, but mostly from the overwhelming irony of all this.¶ Jason Ribeiro added,¶ I can't help but have a feeling of sour grapes about this. While I congratulate China for doing the obvious, America has its head buried so far in the sand it can't see straight. With all the internet clamor about LFTR that's been going on the internet in the past 3-4 years, it was the non-English speaking Chinese that finally got the message that this was a great idea worth investing in. Our leadership ought to be ashamed of themselves.¶ The Chinese News story on the Thorium Molten Salt Reactor reflects the clear Chinese thinking about the potential role of LFTRs in the future Chinese energy economy. I will paraphrase,¶ "the future of advanced nuclear fission energy - nuclear energy, thorium-based molten salt reactor system" project was officially launched. . . The scientific goal is to developed a new generation of nuclear energy systems [and to achieve commercial] use [in] 20 years or so. We intend to complete the technological research needed for this system and to assert intellectual property rights to this technology. Fossil fuel energy is being depleted, and solar and wind energy are not stable enough, while hydropower development has reached the limit of its potential.. . .¶ Nuclear power seems to offer us a very attractive future energy choice, high energy density, low carbon emissions, and the potential for sustainable development. . . . China has chosen {to make an energy] breakthrough in the direction of molten salt reactors. . . . this liquid fuel reactors has a simple structure and can run at atmospheric pressure, [it can use any fissionable material as fuel} and has other advantages. "This new stove" can be made very small, will operate with stabile nuclear fuel, and will run for several decades before replacement. After the thorium is completely used in the nuclear process the TMSR will produce nuclear waste will be only be one-thousandth of that produced by existing nuclear technologies.¶ As the world is still in the development of a new generation of nuclear reactors, the thorium-based independent research and development of molten salt reactors, will be possible to obtain all intellectual property rights. This will enable China to firmly grasp the lifeline of energy in their own hands.¶ Let the word "nuclear" no longer mean war.¶ In the past, people always talk about "core" colors. The Hiroshima atomic bomb, the Chernobyl nuclear power plant explosion, these are like a lingering nightmare that is marked in human history. But a new generation of nuclear power will take the color green, the mark of peace taking human beings into a new era.¶ Oh Wow! It sounds as if someone in China has been reading Nuclear Green or Energy from Thorium. And there is more!¶ In addition, the "new stove" operating at atmospheric pressure operation, rather than the traditional reactor operating at high pressure, will be simple and safe. "When the furnace temperature exceeds a predetermined value, in the bottom of the MSR core, a frozen plug of salt will automatically melt, releasing the liquid salt in the reactor core into an emergency storage tanks, and terminating the nuclear reaction," scientist Xu Hongjie told reporters, as the cooling agent is fluoride salts (the same salts that also carrying the nuclear fuel), after the liquid salt cools it turns solid, which prevents the nuclear fuel from leaking out of its containment, and thus will not pollute ground water causing an ecological disasters. The added safety opens up new possibilities for reactors, they can be built underground, completely isolating radioactive materials from the reactor, also the underground location will protect the reactor from an enemy's weapon attack. Reactors can be built in large cities, in the wilderness, or in remote villages.¶ Well Kirk Sorensen and I wanted our ideas to become national priorities. We just did not know in what country it would happen first. Unfortunately the leadership of the United States, continues to be determined to lead this nation into the wilderness of powerlessness, while the leadership of communist China is alert to the possibilities of a new energy age. Possibilities that can be realized by molten salt nuclear technology. Lets hope that someone in the White House or Congress wakes up. The Chinese understand the implications of their venture into Molten Salt nuclear technology. The American leadership does not.

#### Ceding nuclear leadership creates an energy disadvantage vis a vi other countries, destroys perception of competitiveness

**Barton 10** (Charles Barton, Nuclear Green "Keeping up with China: The Economic Advantage of Molten Salt Nuclear Technology," 12/1/10)

American and European nuclear development can either proceed by following the cost lowering paths being pioneered in Asia, or begin to develop low cost innovative nuclear plans. Since low labor costs, represent the most significant Chinese and Indian cost advantage, it is unlikely that European and American reactor manufacturers will be able to compete with the Asians on labor costs. Labor costs for conventional reactors can be lowered by factory construction of reactor componant moduels, but the Chinese are clearly ahead of the West in that game. Yet the weakness of the Chinese system is the relatively large amount of field labor that the manufacture of large reactors requires.¶ The Chines system is to introduce labor saving devices where ever and when ever possible, but clearly shifting labor from the field to a factory still offers cost advantages. The more labor which can be performed in the factory, the more labor cost savings are possible. Other savings advantages are possible by simplifying reactor design, and lowering materials input. Building a reactor with less materials and fewer parts lowers nuclear costs directly and indirectly. Decreasing core size per unit of power output also can contribute a cost advantage. Direct saving relate to the cost of parts and matetials, but fewer parts and less material also means less labor is required to put things together, since there is less to put together. In addition a small reactor core structure, would, all other things being equal, require a smaller housing. Larger cores mean more structural housing expenses.¶ While the Pebel Bed Modular Reactor has a relatively simple core design, the actual core is quite large, because of the cooling inefficiency of helium. Thus, the simplisity of the PBMR core is ballanced by its size, its total materials input, and the size of its housing. The large core and housing requirements of the PBMR also adds to its labor costs, especially its field labor cost. Thus while the simplisity of the PBMR core design would seem to suggest a low cost, this expectation is unlikely to br born out in practice.¶ Transportation limits ability to shift production from the field to the factory. An analysis preformed by the University of Tennessee's, and the Massachusettes Institute of Technology's Departments of Nuclear Engineering looked at the 335 MW Westinghouse IRIS reactor. The analysis found,¶ A rough estimate of the weight for a 1000 MWt modular reactor and its secondary system, similar to the Westinghouse IRIS plant, is taken as the summation of all of the major components in the analysis. Many of the smaller subcomponents have been neglected. The containment structure contributes ~2.81E6 kg (3100 tons). The primary reactor vessel and the turbo-generator contribute ~1.45E6 kg (1600 tons) each. The heat exchange equipment and piping contribute ~6.78E5 kg (747 tons). Therefore, the total weight of the major plant components is~ 6.39E6 kg (7047 tons).¶ The weight and width of the IRIS would place constraints of barge transportation of the IRIS on the Tennessee and Ohio Rivers. The report stated,¶ The Westinghouse barge mounted IRIS reactor modules were limited in size based on input from the University of Tennessee. The barge dimension limitations were established to be 30 meters (98’-5”) wide, 100 meters (328’-1”) long, with a 2.74 meter (9’) draft. These dimensions establish the barge maximum displacement at 8,220 metric tons. In addition, the barge(s) are limited to ~20 meters (65’-7”) in height above the water surface, so that they fit under crossing bridges and can be floated up the Mississippi, Ohio, and Tennessee Rivers as far as the city of Chattanooga, Tennessee. Further movement above Chattanooga is currently limited by the locks at the Chickamauga Reservoir dam.¶ The above barge displacement limitation will impose severe limits on how much structural support and shield concrete can be placed in the barge modules at the shipyard. For example, the estimated weight of concrete in the IRIS containment and the surrounding cylindrical shield structure alone greatly exceeds the total allowable barge displacement. This however does not mean that barge- mounted pressurized water reactors (PWRs) are not feasible. It does mean that barge-mounted PWRs need to employ steel structures that are then used as the forms for the addition of needed concrete after the barge has been floated into its final location and founded.¶ Thus for the IRIS, barge transportation presented problems, and rail transportation was unthinkable. The core of the 125 MW B&W mPower reactor is rail transportable, but final onsite mPower assembly/construction became a significant undertaking, with a consequent increase in overall cost. The core unit does include a pressure vessel and heat exchange mounted above the actual reactor, but many other mPower component modules must be transported seperately and assembled on site.¶ The IIRIS project demonstrates the unlikelihood of whole small reactors being transported to the field ready for energy production without some field construction. This might be possible, however, for mini reactors that are two small to be viewed as a plausible substitute for the fossil fuel powered electrical plants currently supplying electricity for the grid. This then leaves us with¶ with a gap between the cost savings potential of factory manufacture, and the costly process of onsite assembly. B&W the manufacturers of the small 125 MW MPower reactor still has not clarified what percentage of the manufacturing process would be factory based. It is clear, however that B&W knows where it is comming from and what its problems are, as Rod Adams tells us:¶ I spoke in more detail to Chris Mowry and listened as he explained how his company's research on the history of the nuclear enterprise in the US had revealed that 30% of the material and labor cost of the existing units came from the supplied components while 70% was related to the site construction effort. He described how the preponderance of site work had influenced the cost uncertainty that has helped to discourage new nuclear plant construction for so many years.¶ What Mowey did not tell Adams is what percentage of the materials and labor costs will be shifted to the factory as mPower reactors are produced. There have been hints that a significant percentage of the mPower manufacturing process, perhaps as much as 50% will still take place on site. B&W still is working on the design of their manufacturing process, and thus do not yet know all of the details. Clearly then more work needs to be done on controlling onsite costs.¶ Finally, a shift to advanced technology will can lower manufacturing costs. Compared to Light Water reactors, Liquid metal cooled reactors use less material and perhaps less labor, but pool type liqiod metal reactors are not compact. Compared to Liquid Metal cooled reactors, Molten Salt cooled reactor will have more compact cores. Shifting to closed cycle gas turbines will decrease construction costs. The added safety of Molten Salt cooled reactors will increase reactor simplification, and thus further lower labor and materials related construction costs.¶ The recycling of old power plant locations will also offer some savings. Decreasing manufacturing time will lower interest costs. ¶ All in all there are a lot of reasons to expect lower nuclear manufacturing costs with Generation IV nuclear power plants, and at present no one has come up with a good reason for expecting Molten Salt cooled reactors to cost more than traditional NPPs. The argument, however, is not iron clad. Even if no one has pointed out plasuible errors in it, we need to introduce the caviot that expectations frenquently are not meet. It is possible, for example that the NRC might impose unreasonable expectations on molten salt cooled reactors. Demanding, for example, that they include the same safety features as LWRs, even though they do not have many LWR safety problems. But the potential savings on the cost of energy by adopting molten salt nuclear technology is substantial, and should not be ignored. ¶ To return to the problem posed by Brian Wang, the problem of lower Asian nuclear construction costs. If Europe and the United States cannot meet the Asican energy cost challenge, their economies will encounter a significant decline. Because of Labor cost advantages, it is unlikely that Generation III nuclear plants will ever cost less to build in the United States or Europe than in Asia. in order to keep the American and European economies competitive, the United States and Europe must adopt a low cost, factory manufactured nuclear technology. Molten Salt nuclear technology represents the lowest cost approach, and is highly consistent with factory manufacture and other cost lowering approaches. Couple to that the outstanding safety of molten salt nuclear technology, the potential for dramatically lowering the creation of nuclear waste, and the obsticles to nuclear proliferation posed by molten salt nuclear rechnology, and we see a real potential for keeping the American and European economies competitive, at least as far as energy costs are concerned.

#### That prevents great power wars – perception is key

**Baru 9** - Visiting Professor at the Lee Kuan Yew School of Public Policy in Singapore (Sanjaya, “Year of the power shift?,”

http://www.india-seminar.com/2009/593/593\_sanjaya\_baru.htm

**T**here is no doubt that economics alone will not determine the balance of global power, but there is no doubt either that economics has come to matter for more.¶ The management of the economy, and of the treasury, has been a vital aspect of statecraft from time immemorial. Kautilya’s *Arthashastra* says, ‘From the strength of the treasury the army is born. …men without wealth do not attain their objectives even after hundreds of trials… Only through wealth can material gains be acquired, as elephants (wild) can be captured only by elephants (tamed)… A state with depleted resources, even if acquired, becomes only a liability.’4 Hence, economic policies and performance do have strategic consequences.5¶ In the modern era, the idea that strong economic performance is the foundation of power was argued most persuasively by historian Paul Kennedy. ‘Victory (in war),’ Kennedy claimed, ‘has repeatedly gone to the side with more flourishing productive base.’6 Drawing attention to the interrelationships between economic wealth, technological innovation, and the ability of states to efficiently mobilize economic and technological resources for power projection and national defence, Kennedy argued that nations that were able to better combine military and economic strength scored over others.¶ ‘The fact remains,’ Kennedy argued, ‘that all of the major shifts in the world’s *military-power* balance have followed alterations in the *productive* balances; and further, that the rising and falling of the various empires and states in the international system has been confirmed by the outcomes of the major Great Power wars, where victory has always gone to the side with the greatest material resources.’7¶ **I**n Kennedy’s view the geopolitical consequences of an economic crisis or even decline would be transmitted through a nation’s inability to find adequate financial resources to simultaneously sustain economic growth and military power – the classic ‘guns vs butter’ dilemma.¶ Apart from such fiscal disempowerment of the state, economic under-performance would also reduce a nation’s attraction as a market, a source of capital and technology, and as a ‘knowledge power’. As power shifted from Europe to America, so did the knowledge base of the global economy. As China’s power rises, so does its profile as a ‘knowledge economy’.¶ Impressed by such arguments the China Academy of Social Sciences developed the concept of Comprehensive National Power (CNP) to get China’s political and military leadership to focus more clearly on economic and technological performance than on military power alone in its quest for Great Power status.8¶ While China’s impressive economic performance and the consequent rise in China’s global profile has forced strategic analysts to acknowledge this link, the recovery of the US economy in the 1990s had reduced the appeal of the Kennedy thesis in Washington DC. We must expect a revival of interest in Kennedy’s arguments in the current context.¶ **A** historian of power who took Kennedy seriously, Niall Ferguson, has helped keep the focus on the geopolitical implications of economic performance. In his masterly survey of the role of finance in the projection of state power, Ferguson defines the ‘square of power’ as the tax bureaucracy, the parliament, the national debt and the central bank. These four institutions of ‘fiscal empowerment’ of the state enable nations to project power by mobilizing and deploying financial resources to that end.9 ¶ Ferguson shows how vital sound economic management is to strategic policy and national power. More recently, Ferguson has been drawing a parallel between the role of debt and financial crises in the decline of the Ottoman and Soviet empires and that of the United States of America. In an early comment on the present financial crisis, Ferguson wrote:¶ ‘We are indeed living through a global shift in the balance of power very similar to that which occurred in the 1870s. This is the story of how an over-extended empire sought to cope with an external debt crisis by selling off revenue streams to foreign investors. The empire that suffered these setbacks in the 1870s was the Ottoman empire. Today it is the US… It remains to be seen how quickly today’s financial shift will be followed by a comparable geopolitical shift in favour of the new export and energy empires of the east. Suffice to say that the historical analogy does not bode well for America’s quasi-imperial network of bases and allies across the Middle East and Asia. Debtor empires sooner or later have to do more than just sell shares to satisfy their creditors*. …*as in the 1870s the balance of financial power is shifting. Then, the move was from the ancient Oriental empires (not only the Ottoman but also the Persian and Chinese) to Western Europe. Today the shift is from the US – and other western financial centres – to the autocracies of the Middle East and East Asia.’10 ¶ An economic or financial crisis may not trigger the decline of an empire. It can certainly speed up a process already underway. In the case of the Soviet Union the financial crunch caused by the Afghan war came on top of years of economic under-performance and the loss of political legitimacy of the Soviet state. In a democratic society like the United States the political legitimacy of the state is constantly renewed through periodic elections. Thus, the election of Barack Obama may serve to renew the legitimacy of the state and by doing so enable the state to undertake measures that restore health to the economy. This the Soviet state was unable to do under Gorbachev even though he repudiated the Brezhnev legacy and distanced himself from it.¶ Hence, one must not become an economic determinist and historic parallels need not always be relevant. Politics can intervene and offer solutions. Political economy and politics, in the form of Keynesian economics and the ‘New Deal’, did intervene to influence the geopolitical implications of the Great Depression. Whether they will do so once again in today’s America remains to be seen.

#### Independently key to heg

**Gelb, 10** - currently president emeritus of the Council on Foreign Relations, (Leslie, Fashioning a Realistic Strategy for the Twenty-First Century,” Fletcher Forum of World Affairs vol.34:2 summer 2010 http://fletcher.tufts.edu/forum/archives/pdfs/34-2pdfs/Gelb.pdf)

**LESLIE H. GELB:** Power is what it always has been. It is the ability to get someone to do something they do not want to do by means of your resources and your position. It was always that. There is no such thing in my mind as “soft” power or “hard” power or “smart” power or “dumb” power. It is people who are hard or soft or smart or dumb. Power is power. And people use it wisely or poorly. Now, what has changed is the composition of power in international affairs. For almost all of history, international power was achieved in the form of military power and military force. Now, particularly in the last fifty years or so, it has become more and more economic. So power consists of economic power, military power, and diplomatic power, but the emphasis has shifted from military power (for almost all of history) to now, more economic power. And, as President Obama said in his West Point speech several months ago, our economy is the basis of our international power in general and our military power in particular. That is where it all comes from. Whether other states listen to us and act on what we say depends a good deal on their perception of the strength of the American economy. A big problem for us in the last few years has been the perception that our economy is in decline.

#### Heg solves extinction

**Barnett 2011** – Former Senior Strategic Researcher and Professor in the Warfare Analysis & Research Department, Center for Naval Warfare Studies, U.S. Naval War College, worked as the Assistant for Strategic Futures in the Office of Force Transformation in the DOD (3/7, Thomas, World Politics Review, “The New Rules: Leadership Fatigue Puts U.S., and Globalization, at Crossroads”, <http://www.worldpoliticsreview.com/articles/8099/the-new-rules-leadership-fatigue-puts-u-s-and-globalization-at-crossroads>, credit to LDK)

Events in Libya are a further reminder for Americans that we stand at a crossroads in our continuing evolution as the world's sole full-service superpower. Unfortunately, we are increasingly seeking change without cost, and shirking from risk because we are tired of the responsibility. We don't know who we are anymore, and our president is a big part of that problem. Instead of leading us, he explains to us. Barack Obama would have us believe that he is practicing strategic patience. But many experts and ordinary citizens alike have concluded that he is actually beset by strategic incoherence -- in effect, a man overmatched by the job.  It is worth first examining the larger picture: We live in a time of arguably the greatest structural change in the global order yet endured, with this historical moment's most amazing feature being its relative and absolute lack of mass violence. That is something to consider when Americans contemplate military intervention in Libya, because if we do take the step to prevent larger-scale killing by engaging in some killing of our own, we will not be adding to some fantastically imagined global death count stemming from the ongoing "megalomania" and "evil" of American "empire." We'll be engaging in the same sort of system-administering activity that has marked our stunningly successful stewardship of global order since World War II.  Let me be more blunt: As the guardian of globalization, the U.S. military has been the greatest force for peace the world has ever known. Had America been removed from the global dynamics that governed the 20th century, the mass murder never would have ended. Indeed, it's entirely conceivable there would now be no identifiable human civilization left, once nuclear weapons entered the killing equation.  But the world did not keep sliding down that path of perpetual war. Instead, America stepped up and changed everything by ushering in our now-perpetual great-power peace. We introduced the international liberal trade order known as globalization and played loyal Leviathan over its spread. What resulted was the collapse of empires, an explosion of democracy, the persistent spread of human rights, the liberation of women, the doubling of life expectancy, a roughly 10-fold increase in adjusted global GDP and a profound and persistent reduction in battle deaths from state-based conflicts.

### 2

#### Warming is real and anthropogenic – carbon dioxide increase, polar ice records, melting glaciers, sea level rise

**Prothero 12** [Donald R. Prothero, Professor of Geology at Occidental College and Lecturer in Geobiology at the California Institute of Technology, 3-1-2012, "How We Know Global Warming is Real and Human Caused," Skeptic, vol 17 no 2, EBSCO]

Converging Lines of Evidence¶ How do we know that global warming is real and primarily human caused? There are numerous lines of evidence that converge toward this conclusion.¶ 1. Carbon Dioxide Increase.¶ Carbon dioxide in our atmosphere has increased at an unprecedented rate in the past 200 years. Not one data set collected over a long enough span of time shows otherwise. Mann et al. (1999) compiled the past 900 years' worth of temperature data from tree rings, ice cores, corals, and direct measurements in the past few centuries, and the sudden increase of temperature of the past century stands out like a sore thumb. This famous graph is now known as the "hockey stick" because it is long and straight through most of its length, then bends sharply upward at the end like the blade of a hockey stick. Other graphs show that climate was very stable within a narrow range of variation through the past 1000, 2000, or even 10,000 years since the end of the last Ice Age. There were minor warming events during the Climatic Optimum about 7000 years ago, the Medieval Warm Period, and the slight cooling of the Little Ice Age in die 1700s and 1800s. But the magnitude and rapidity of the warming represented by the last 200 years is simply unmatched in all of human history. More revealing, die timing of this warming coincides with the Industrial Revolution, when humans first began massive deforestation and released carbon dioxide into the atmosphere by burning an unprecedented amount of coal, gas, and oil.¶ 2. Melting Polar Ice Caps.¶ The polar icecaps are thinning and breaking up at an alarming rate. In 2000, my former graduate advisor Malcolm McKenna was one of the first humans to fly over the North Pole in summer time and see no ice, just open water. The Arctic ice cap has been frozen solid for at least the past 3 million years (and maybe longer),4 but now the entire ice sheet is breaking up so fast that by 2030 (and possibly sooner) less than half of the Arctic will be ice covered in the summer.5 As one can see from watching the news, this is an ecological disaster for everything that lives up there, from the polar bears to the seals and walruses to the animals they feed upon, to the 4 million people whose world is melting beneath their feet. The Antarctic is thawing even faster. In February-March 2002, the Larsen B ice shelf - over 3000 square km (the size of Rhode Island) and 220 m (700 feet) thick- broke up in just a few months, a story typical of nearly all the ice shelves in Antarctica. The Larsen B shelf had survived all the previous ice ages and interglacial warming episodes over the past 3 million years, and even the warmest periods of the last 10,000 years- yet it and nearly all the other thick ice sheets on the Arctic, Greenland, and Antarctic are vanishing at a rate never before seen in geologic history.¶ 3. Melting Glaciers.¶ Glaciers are all retreating at the highest rates ever documented. Many of those glaciers, along with snow melt, especially in the Himalayas, Andes, Alps, and Sierras, provide most of the freshwater that the populations below the mountains depend upon - yet this fresh water supply is vanishing. Just think about the percentage of world's population in southern Asia (especially India) that depend on Himalayan snowmelt for their fresh water. The implications are staggering. The permafrost that once remained solidly frozen even in the summer has now Üiawed, damaging the Inuit villages on the Arctic coast and threatening all our pipelines to die North Slope of Alaska. This is catastrophic not only for life on the permafrost, but as it thaws, the permafrost releases huge amounts of greenhouse gases which are one of the major contributors to global warming. Not only is the ice vanishing, but we have seen record heat waves over and over again, killing thousands of people, as each year joins the list of the hottest years on record. (2010 just topped that list as the hottest year, surpassing the previous record in 2009, and we shall know about 2011 soon enough). Natural animal and plant populations are being devastated all over the globe as their environments change.6 Many animals respond by moving their ranges to formerly cold climates, so now places that once did not have to worry about disease-bearing mosquitoes are infested as the climate warms and allows them to breed further north.¶ 4. Sea Level Rise.¶ All that melted ice eventually ends up in the ocean, causing sea levels to rise, as it has many times in the geologic past. At present, the sea level is rising about 3-4 mm per year, more than ten times the rate of 0.10.2 mm/year that has occurred over the past 3000 years. Geological data show Üiat ttie sea level was virtually unchanged over the past 10,000 years since the present interglacial began. A few mm here or there doesn't impress people, until you consider that the rate is accelerating and that most scientists predict sea levels will rise 80-130 cm in just the next century. A sea level rise of 1.3 m (almost 4 feet) would drown many of the world's low-elevation cities, such as Venice and New Orleans, and low-lying countries such as the Netherlands or Bangladesh. A number of tiny island nations such as Vanuatu and the Maldives, which barely poke out above the ocean now, are already vanishing beneath the waves. Eventually their entire population will have to move someplace else.7 Even a small sea level rise might not drown all these areas, but they are much more vulnerable to the large waves of a storm surge (as happened with Hurricane Katrina), which could do much more damage than sea level rise alone. If sea level rose by 6 m (20 feet), most of die world's coastal plains and low-lying areas (such as the Louisiana bayous, Florida, and most of the world's river deltas) would be drowned.¶ Most of the world's population lives in lowelevation coastal cities such as New York, Boston, Philadelphia, Baltimore, Washington, D.C., Miami, and Shanghai. All of those cities would be partially or completely under water with such a sea level rise. If all the glacial ice caps melted completely (as they have several times before during past greenhouse episodes in the geologic past), sea level would rise by 65 m (215 feet)! The entire Mississippi Valley would flood, so you could dock an ocean liner in Cairo, Illinois. Such a sea level rise would drown nearly every coastal region under hundreds of feet of water, and inundate New York City, London and Paris. All that would remain would be the tall landmarks such as the Empire State Building, Big Ben, and the Eiffel Tower. You could tie your boats to these pinnacles, but the rest of these drowned cities would lie deep underwater.

#### Causes extinction – war

Sawin 12 [Janet Sawin, Senior Director of the Energy and Climate Change Program at the WorldWatch Institute, Aug 2012, “Climate Change Poses Greater Security Threat than Terrorism]

As early as 1988, scientists cautioned that human tinkering with the Earth's climate amounted to "an unintended, uncontrolled globally pervasive experiment whose ultimate consequences could be second only to a global nuclear war." Since then, hundreds of scientific studies have documented ever-mounting evidence that human activities are altering the climate around the world. A growing number of international leaders now warn that climate change is, in the words of U.K. Chief Scientific Advisor David King, "the most severe problem that we are facing today—more serious even than the threat of terrorism." Climate change will likely trigger severe disruptions with ever-widening consequences for local, regional, and global security. Droughts, famines, and weather-related disasters could claim thousands or even millions of lives and exacerbate existing tensions within and among nations, fomenting diplomatic and trade disputes. In the worst case, further warming will reduce the capacities of Earth's natural systems and elevate already-rising sea levels, which could threaten the very survival of low-lying island nations, destabilize the global economy and geopolitical balance, and incite violent conflict. Already, there is growing evidence that climate change is affecting the life-support systems on which humans and other species depend. And these impacts are arriving faster than many climate scientists predicted. Recent studies have revealed changes in the breeding and migratory patterns of animals worldwide, from sea turtles to polar bears. Mountain glaciers are shrinking at ever-faster rates, threatening water supplies for millions of people and plant and animal species. Average global sea level has risen 20-25 centimeters (8-10 inches) since 1901, due mainly to thermal expansion; more than 2.5 centimeters (one inch) of this rise occurred over the past decade. A recent report by the International Climate Change Taskforce, co-chaired by Republican U.S. Senator Olympia Snowe, concludes that climate change is the "single most important long term issue that the planet faces." It warns that if average global temperatures increase more than two degrees Celsius—which will likely occur in a matter of decades if we continue with business-as-usual—the world will reach the "point of no return," where societies may be unable to cope with the accelerating rates of change. Existing threats to security will be amplified as climate change has increasing impacts on regional water supplies, agricultural productivity, human and ecosystem health, infrastructure, financial flows and economies, and patterns of international migration. Specific threats to human welfare and global security include: ► Climate change will undermine efforts to mitigate world poverty, directly threatening people's homes and livelihoods through increased storms, droughts, disease, and other stressors. Not only could this impede development, it might also increase national and regional instability and intensify income disparities between rich and poor. This, in turn, could lead to military confrontations over distribution of the world's wealth, or could feed terrorism or transnational crime. ► Rising temperatures, droughts, and floods, and the increasing acidity of ocean waters, coupled with an expanding human population, could further stress an already limited global food supply, dramatically increasing food prices and potentially triggering internal unrest or the use of food as a weapon. Even the modest warming experienced to date has affected fisheries and agricultural productivity, with a 10 percent decrease in corn yields across the U.S. Midwest seen per degree of warming. ► Altered rainfall patterns could heighten tensions over the use of shared water bodies and increase the likelihood of violent conflict over water resources. It is estimated that about 1.4 billion people already live in areas that are water-stressed. Up to 5 billion people (most of the world's current population) could be living in such regions by 2025. ► Widespread impacts of climate change could lead to waves of migration, threatening international stability. One study estimates that by 2050, as many as 150 million people may have fled coastlines vulnerable to rising sea levels, storms or floods, or agricultural land too arid to cultivate. Historically, migration to urban areas has stressed limited services and infrastructure, inciting crime or insurgency movements, while migration across borders has frequently led to violent clashes over land and resources.

#### Warming causes extinction

**Sify 2010 –** Sydney newspaper citing Ove Hoegh-Guldberg, professor at University of Queensland and Director of the Global Change Institute, and John Bruno, associate professor of Marine Science at UNC (Sify News, “Could unbridled climate changes lead to human extinction?”, <http://www.sify.com/news/could-unbridled-climate-changes-lead-to-human-extinction-news-international-kgtrOhdaahc.html>, WEA)

The findings of the comprehensive report: 'The impact of climate change on the world's marine ecosystems' emerged from a synthesis of recent research on the world's oceans, carried out by two of the world's leading marine scientists. One of the authors of the report is Ove Hoegh-Guldberg, professor at The University of Queensland and the director of its Global Change Institute (GCI). 'We may see sudden, unexpected changes that have serious ramifications for the overall well-being of humans, including the capacity of the planet to support people. This is further evidence that we are well on the way to the next great extinction event,' says Hoegh-Guldberg. 'The findings have enormous implications for mankind, particularly if the trend continues. The earth's ocean, which produces half of the oxygen we breathe and absorbs 30 per cent of human-generated carbon dioxide, is equivalent to its heart and lungs. This study shows worrying signs of ill-health. It's as if the earth has been smoking two packs of cigarettes a day!,' he added. 'We are entering a period in which the ocean services upon which humanity depends are undergoing massive change and in some cases beginning to fail', he added. The 'fundamental and comprehensive' changes to marine life identified in the report include rapidly warming and acidifying oceans, changes in water circulation and expansion of dead zones within the ocean depths. These are driving major changes in marine ecosystems: less abundant coral reefs, sea grasses and mangroves (important fish nurseries); fewer, smaller fish; a breakdown in food chains; changes in the distribution of marine life; and more frequent diseases and pests among marine organisms. Study co-author John F Bruno, associate professor in marine science at The University of North Carolina, says greenhouse gas emissions are modifying many physical and geochemical aspects of the planet's oceans, in ways 'unprecedented in nearly a million years'. 'This is causing fundamental and comprehensive changes to the way marine ecosystems function,' Bruno warned, according to a GCI release. These findings were published in Science

#### The IFR is the only way to reduce coal emissions sufficiently to avert the worst climate disasters

**Kirsch 9** (Steve Kirsch, Bachelor of Science and a Master of Science in electrical engineering and computer science from the Massachusetts Institute of Technology, American serial entrepreneur who has started six companies: Mouse Systems, Frame Technology, Infoseek, Propel, Abaca, and OneID, "Why We Should Build an Integral Fast Reactor Now," 11/25/9) http://skirsch.wordpress.com/2009/11/25/ifr/

To prevent a climate disaster, we must eliminate virtually all coal plant emissions worldwide in 25 years. The best way and, for all practical purposes, the only way to get all countries off of coal is not with coercion; it is to make them want to replace their coal burners by giving them a plug-compatible technology that is less expensive. The IFR can do this. It is plug-compatible with the burners in a coal plant (see Nuclear Power: Going Fast). No other technology can upgrade a coal plant so it is greenhouse gas free while reducing operating costs at the same time. In fact, no other technology can achieve either of these goals. The IFR can achieve both.¶ The bottom line is that without the IFR (or a yet-to-be-invented technology with similar ability to replace the coal burner with a cheaper alternative), it is unlikely that we’ll be able to keep CO2 under 450 ppm.¶ Today, the IFR is the only technology with the potential to displace the coal burner. That is why restarting the IFR is so critical and why Jim Hansen has listed it as one of the top five things we must do to avert a climate disaster.[4]¶ Without eliminating virtually all coal emissions by 2030, the sum total of all of our other climate mitigation efforts will be inconsequential. Hansen often refers to the near complete phase-out of carbon emissions from coal plants worldwide by 2030 as the sine qua non for climate stabilization (see for example, the top of page 6 in his August 4, 2008 trip report).¶ To stay under 450ppm, we would have to install about 13,000 GWe of new carbon-free power over the next 25 years. That number was calculated by Nathan Lewis of Caltech for the Atlantic, but others such as Saul Griffith have independently derived a very similar number and White House Science Advisor John Holdren used 5,600 GWe to 7,200 GWe in his presentation to the Energy Bar Association Annual Meeting on April 23, 2009. That means that if we want to save the planet, we must install more than 1 GWe per day of clean power every single day for the next 25 years. That is a very, very tough goal. It is equivalent to building one large nuclear reactor per day, or 1,500 huge wind turbines per day, or 80,000 37 foot diameter solar dishes covering 100 square miles every day, or some linear combination of these or other carbon free power generation technologies. Note that the required rate is actually higher than this because Hansen and Rajendra Pachauri, the chair of the IPCC, now both agree that 350ppm is a more realistic “not to exceed” number (and we’ve already exceeded it).¶ Today, we are nowhere close to that installation rate with renewables alone. For example, in 2008, the average power delivered by solar worldwide was only 2 GWe (which is to be distinguished from the peak solar capacity of 13.4GWe). That is why every renewable expert at the 2009 Aspen Institute Environment Forum agreed that nuclear must be part of the solution. Al Gore also acknowledges that nuclear must play an important role.¶ Nuclear has always been the world’s largest source of carbon free power. In the US, for example, even though we haven’t built a new nuclear plant in the US for 30 years, nuclear still supplies 70% of our clean power!¶ Nuclear can be installed very rapidly; much more rapidly than renewables. For example, about two thirds of the currently operating 440 reactors around the world came online during a 10 year period between 1980 and 1990. So our best chance of meeting the required installation of new power goal and saving the planet is with an aggressive nuclear program.¶ Unlike renewables, nuclear generates base load power, reliably, regardless of weather. Nuclear also uses very little land area. It does not require the installation of new power lines since it can be installed where the power is needed. However, even with a very aggressive plan involving nuclear, it will still be extremely difficult to install clean power fast enough.¶ Unfortunately, even in the US, we have no plan to install the clean power we need fast enough to save the planet. Even if every country were to agree tomorrow to completely eliminate their coal plant emissions by 2030, how do we think they are actually going to achieve that? There is no White House plan that explains this. There is no DOE plan. There is no plan or strategy. The deadlines will come and go and most countries will profusely apologize for not meeting their goals, just like we have with most of the signers of the Kyoto Protocol today. Apologies are nice, but they will not restore the environment.¶ We need a strategy that is believable, practical, and affordable for countries to adopt. The IFR offers our best hope of being a centerpiece in such a strategy because it the only technology we know of that can provide an economically compelling reason to change.¶ At a speech at MIT on October 23, 2009, President Obama said “And that’s why the world is now engaged in a peaceful competition to determine the technologies that will power the 21st century. … The nation that wins this competition will be the nation that leads the global economy. I am convinced of that. And I want America to be that nation, it’s that simple.”¶ Nuclear is our best clean power technology and the IFR is our best nuclear technology. The Gen IV International Forum (GIF) did a study in 2001-2002 of 19 different reactor designs on 15 different criteria and 24 metrics. The IFR ranked #1 overall. Over 242 experts from around the world participated in the study. It was the most comprehensive evaluation of competitive nuclear designs ever done. Top DOE nuclear management ignored the study because it didn’t endorse the design the Bush administration wanted.¶ The IFR has been sitting on the shelf for 15 years and the DOE currently has no plans to change that.¶ How does the US expect to be a leader in clean energy by ignoring our best nuclear technology? Nobody I’ve talked to has been able to answer that question.¶ We have the technology (it was running for 30 years before we were ordered to tear it down). And we have the money: The Recovery Act has $80 billion dollars. Why aren’t we building a demo plant?¶ IFRs are better than conventional nuclear in every dimension. Here are a few:¶ Efficiency: IFRs are over 100 times more efficient than conventional nuclear. It extracts nearly 100% of the energy from nuclear material. Today’s nuclear reactors extract less than 1%. So you need only 1 ton of actinides each year to feed an IFR (we can use existing nuclear waste for this), whereas you need 100 tons of freshly mined uranium each year to extract enough material to feed a conventional nuclear plant.¶ Unlimited power forever: IFRs can use virtually any actinide for fuel. Fast reactors with reprocessing are so efficient that even if we restrict ourselves to just our existing uranium resources, we can power the entire planet forever (the Sun will consume the Earth before we run out of material to fuel fast reactors). If we limited ourselves to using just our DU “waste” currently in storage, then using the IFR we can power the US for over 1,500 years without doing any new mining of uranium.[5]¶ Exploits our largest energy resource: In the US, there is 10 times as much energy in the depleted uranium (DU) that is just sitting there as there is coal in the ground. This DU waste is our largest natural energy resource…but only if we have fast reactors. Otherwise, it is just waste. With fast reactors, virtually all our nuclear waste (from nuclear power plants, leftover from enrichment, and from decommissioned nuclear weapons)[6] becomes an energy asset worth about $30 trillion dollars…that’s not a typo…$30 trillion, not billion.[7] An 11 year old child was able to determine this from publicly available information in 2004.

#### Alternative methods can’t solve warming

**Kirsch 9** (Steve Kirsch, Bachelor of Science and a Master of Science in electrical engineering and computer science from the Massachusetts Institute of Technology, American serial entrepreneur who has started six companies: Mouse Systems, Frame Technology, Infoseek, Propel, Abaca, and OneID, "How Does Obama Expect to Solve the Climate Crisis Without a Plan?" 7/16/9) [http://www.huffingtonpost.com/steve-kirsch/how-does-obama-expect-to\_b\_236588.html-http://www.huffingtonpost.com/steve-kirsch/how-does-obama-expect-to\_b\_236588.html](http://www.huffingtonpost.com/steve-kirsch/how-does-obama-expect-to_b_236588.html-http%3A//www.huffingtonpost.com/steve-kirsch/how-does-obama-expect-to_b_236588.html)

The ship is sinking slowly and we are quickly running out of time to develop and implement any such plan if we are to have any hope of saving the planet. What we need is a plan we can all believe in. A plan where our country's smartest people all nod their heads in agreement and say, "Yes, this is a solid, viable plan for keeping CO2 levels from touching 425ppm and averting a global climate catastrophe."¶ ¶ At his Senate testimony a few days ago, noted climate scientist James Hansen made it crystal clear once again that the only way to avert an irreversible climate meltdown and save the planet is to phase out virtually all coal plants worldwide over a 20 year period from 2010 to 2030. Indeed, if we don't virtually eliminate the use of coal worldwide, everything else we do will be as effective as re-arranging deck chairs on the Titanic.¶ ¶ Plans that won't work¶ ¶ Unfortunately, nobody has proposed a realistic and practical plan to eliminate coal use worldwide or anywhere close to that. There is no White House URL with such a plan. No environmental group has a workable plan either.¶ ¶ Hoping that everyone will abandon their coal plants and replace them with a renewable power mix isn't a viable strategy -- we've proven that in the U.S. Heck, even if the Waxman-Markey bill passes Congress (a big "if"), it is so weak that it won't do much at all to eliminate coal plants. So even though we have Democrats controlling all three branches of government, it is almost impossible to get even a weak climate bill passed.¶ ¶ If we can't pass strong climate legislation in the U.S. with all the stars aligned, how can we expect anyone else to do it? So expecting all countries to pass a 100% renewable portfolio standard (which is far far beyond that contemplated in the current energy bill) just isn't possible. Secondly, even if you could mandate it politically in every country, from a practical standpoint, you'd never be able to implement it in time. And there are lots of experts in this country, including Secretary Chu, who say it's impossible without nuclear (a point which I am strongly in agreement with).¶ ¶ Hoping that everyone will spontaneously adopt carbon capture and sequestration (CCS) is also a non-starter solution. First of all, CCS doesn't exist at commercial scale. Secondly, even if we could make it work at scale, and even it could be magically retrofitted on every coal plant (which we don't know how to do), it would require all countries to agree to add about 30% in extra cost for no perceivable benefit. At the recent G8 conference, India and China have made it clear yet again that they aren't going to agree to emission goals.¶ ¶ Saying that we'll invent some magical new technology that will rescue us at the last minute is a bad solution. That's at best a poor contingency plan.¶ ¶ The point is this: It should be apparent to us that we aren't going to be able to solve the climate crisis by either "force" (economic coercion or legislation) or by international agreement. And relying on technologies like CCS that may never work is a really bad idea.¶ ¶ The only remaining way to solve the crisis is to make it economically irresistible for countries to "do the right thing." The best way to do that is to give the world a way to generate electric power that is economically more attractive than coal with the same benefits as coal (compact power plants, 24x7 generation, can be sited almost anywhere, etc). Even better is if the new technology can simply replace the existing burner in a coal plant. That way, they'll want to switch. No coercion is required.

### 3

#### Argonne National Lab has a severe shortfall of quality scientists now – the best and brightest aren’t replacing retirees

Grossenbacher 08[CQ Congressional Testimony, April 23, 2008, John, Laboratory Director Idaho National Laboratory, “NUCLEAR POWER,” SECTION: CAPITOL HILL HEARING TESTIMONY, Statement of John J. Grossenbacher Laboratory Director Idaho National Laboratory, Committee on House Science and Technology, Lexis]

While all of the programs I've highlighted for you individually and collectively do much to advance the state of the art in nuclear science and technology, and enable the continued global expansion of nuclear power, there is a great area of challenge confronting nuclear energy's future. As with most other technologically intensive U.S. industries - it has to do with human capital and sustaining critical science and technology infrastructure. My laboratory, its fellow labs and the commercial nuclear power sector all face a troubling reality - a significant portion of our work force is nearing retirement age and the pipeline of qualified potential replacements is not sufficiently full. Since I'm well aware of this committee's interests in science education, I'd like to update you on what the Department and its labs are doing to inspire our next generation of nuclear scientists, engineers and technicians. Fundamentally, the Office of Nuclear Energy has made the decision to invite direct university partnership in the shared execution of all its R&D programs and will set aside a significant amount of its funds for that purpose. Already, nuclear science and engineering programs at U.S. universities are involved in the Office of Nuclear Energy's R&D, but this move will enable and encourage even greater participation in DOE's nuclear R&D programs. In addition, all NE-supported labs annually bring hundreds of our nation's best and brightest undergraduate and graduate students on as interns or through other mechanisms to conduct real research. For example, at INL we offer internships, fellowships, joint faculty appointments and summer workshops that focus on specific research topics or issues that pertain to maintaining a qualified workforce. This year, we are offering a fuels and materials workshop for researchers and a 10-week training course for engineers interested in the field of reactor operations. Last year, DOE designated INL's Advanced Test Reactor as a national scientific user facility, enabling us to open the facility to greater use by universities and industry and to supporting more educational opportunities. ATR is a unique test reactor that offers the ability to test fuels and materials in nine different prototypic environments operated simultaneously. With this initiative, we join other national labs such as Argonne National Laboratory and Oak Ridge National Laboratory in offering nuclear science and engineering assets to universities, industry and the broader nuclear energy research community. Finally, national laboratories face their own set of challenges in sustaining nuclear science and technology infrastructure - the test reactors, hot cells, accelerators, laboratories and other research facilities that were developed largely in support of prior missions. To obtain a more complete understanding of the status of these assets, the Office of Nuclear Energy commissioned a review by Battelle to examine the nuclear science and technology infrastructure at the national laboratories and report back later this year on findings and recommendations on a strategy for future resource allocation that will enable a balanced, yet sufficient approach to future investment in infrastructure.

#### The plan attracts the best and brightest back to Argonne – successful demonstration of IFR spurs collaborative nuclear interdisciplinary research

Blees 8 [Tom Blees 2008 “Prescription for the Planet: The painless remedy for our energy and environmental crises” Pg. 367]

21. Restart nuclear power development research at national labs like Argonne, concentrating on small reactor designs like the nuclear battery ideas discussed earlier. Given the cost and difficulty of extending power grids over millions of square miles of developing countries, the advantages of distributed generation in transforming the energy environment of such countries can hardly be exaggerated. It is a great pity that many of the physicists and engineers who were scattered when the Argonne IFR project was peremptorily terminated chose to retire. Rebuilding that brain trust should be, well, a no-brainer. If one but looks at the incredible challenges those talented people were able to meet, it seems perfectly reasonable to suppose that a focus on small sealed reactor development could likewise result in similar success. Some of those working on the AHTR and other seemingly unneeded projects could well transition to R&D that fits into the new paradigm. Japanese companies are already eager to build nuclear batteries, and there should be every effort to work in concert with them and other researchers as we develop these new technologies. The options this sort of collaborative research would open up for the many varied types of energy needs around the world would be incalculable.

#### Successful demonstration projects and collaborative interdisciplinary research is necessary to attract the best and brightest scientists to Argonne and fully complete products

**ANL 8** [Argonne National Laboratory INSTITUTIONAL PLAN FY2004-FY2008, operated by The University of Chicago for the¶ United States Department of Energy’s Office of Science]

Our planning is based on five key¶ assumptions:¶ • DOE’s national laboratories must act¶ increasingly as a synergistic system, with the¶ laboratories managing their collective¶ competencies, increasing their overall costeffectiveness, and partnering on major¶ initiatives among themselves and with the¶ private and academic sectors.¶ • Sponsors, regulators, and the public will¶ continue to require that we demonstrate¶ responsible corporate citizenship. This¶ imperative includes being a good and trustworthy neighbor, conducting operations costeffectively and responsibly, and meeting or¶ exceeding regulatory requirements.¶ • Argonne must compete on its merits for¶ federal funding, for the “best and brightest”¶ employees, and for the modern infrastructure¶ needed for future success. Important factors in¶ this competition will be scientific and¶ technological excellence, cost-effectiveness,¶ mission contributions, record of performance,¶ and a working environment that enables high¶ performance from a diverse and talented¶ workforce.¶ • Robust links with universities, industry,¶ federal laboratories, and the general scientific¶ and technical community (within the¶ United States and abroad) are essential if we¶ are to maintain our leadership and fully¶ exploit advances made throughout the world.¶ • Computing, computational science, and¶ communications and information technology¶ will advance rapidly, will become seamlessly¶ intertwined with experimental science, and¶ will thereby revolutionize many fields of¶ research and applications that are central to¶ the missions of DOE and Argonne.

#### Attracting leading scientists to Argonne key to successful development of the Advanced Photon Source

**Fischetti** et all **9** [“Proceedings of the¶ Advanced Photon Source Renewal Workshop”¶ Hickory Ridge Marriott Conference Hotel¶ Presentation to Department of Energy¶ October 20-21, 2008¶ February 2009¶ Robert F. Fischetti Argonne National Laboratory, Biosciences Division;¶ APS Life Sciences Council representative¶ Paul H. Fuoss Argonne National Laboratory, Materials Science Division;¶ APS Users Organization representative¶ Rodney E. Gerig Argonne National Laboratory, Photon Sciences, Denis T. Keane Northwestern University;¶ DuPont-Northwestern-Dow Collaborative Access Team;¶ APS Partner User Council representative¶ John F. Maclean Argonne National Laboratory, APS Engineering Division¶ Dennis M. Mills, Chair Argonne National Laboratory, Photon Sciences, Dan A. Neumann National Institute of Standards and Technology; APS Scientific Advisory Committee representative¶ George Srajer Argonne National Laboratory, X-ray Science Division]

Scientific Community¶ An enhanced catalyst research beamline with capabilities for in situ XAFS, powder¶ diffraction, and kinetics measurements would benefit the entire catalysis community,¶ i.e., government research laboratories, academia, and industry. The beamline and its¶ staff would also serve as a focal point for expanding catalyst research to other APS¶ beamlines using advanced techniques not routinely applied to catalyst systems, e.g.,¶ SAXS, XES, RIXS, and HERF spectroscopy. Development of these latter methods¶ would position the APS as a leader in this area and attract leading scientists from all¶ over the world. It is expected that new users would initially characterize their materials and identify appropriate systems for specialized techniques.¶ Fig. 4. Cell for in situ x-ray absorption studies of fuel cell¶ catalysts. Standard Fuel Cell Technologies cell hardware¶ was machined to allow x-ray fluorescence studies of cathode electrocatalysts in an operating membrane-electrode¶ assembly (fuel cell). (Argonne National Laboratory photograph)Throughout the U.S. and the world, there are countless research groups working to¶ develop the enabling material in fuel cell catalysis: an oxygen reduction electrocatalyst that is less expensive and more durable than platinum [36-38]. A few of these¶ groups utilize synchrotron-based x-ray techniques to characterize their electrocatalysts; however, these studies are almost exclusively in environments mimicking the¶ reactive environment or are ex situ. A notable exception is the catalyst development¶ effort being led by Los Alamos National Laboratory, which encompasses many approaches and involves many university and national laboratories. As part of this project, Argonne researchers have developed the capability to characterize catalysts¶ containing low-atomic-number elements in an operating fuel cell using XAFS at the¶ APS. Utilizing this cell (Fig. 4), Argonne scientists have determined the active site in¶ a cobalt-containing catalyst. This capability would be extremely useful to other catalyst development teams around the country and the world, and it is envisioned that a¶ dedicated APS electrocatalysis beamline could be designed and made available to¶ these teams. The neutron source at the National Institute of Standards and Technology (NIST) has a beamline dedicated to studies of water transport in fuel cells, which¶ has provided invaluable information for fuel cell materials design. The APS beamline¶ would be the catalyst counterpart to the NIST beamline.¶ A molecular-level understanding of the interactions and correlations that occur in solution and between solution phases is essential to building a predictive capability of a¶ metal ion’s solubility, reactivity, kinetics, and energetics. Until the recent availability¶ of tunable, high-energy x-rays this understanding has been significantly limited by¶ the absence of structural probes. The APS, with its high flux of high-energy x-rays, is¶ the ideal synchrotron source to provide this new information, which is critical to the¶ advancement of solution chemistry. The utility of high-energy x-rays is currently¶ being demonstrated as part of an APS Partner User Proposal (PUP-52), and has received high visibility, including an Inorganic Chemistry feature cover [34]. This effort¶ is interesting a cadre of solution chemists that, to date, have not been part of the user¶ base at synchrotron facilities. The extension of high-energy capabilities from simple¶ PDF experiments to more complex liquid-liquid interfaces is expected to significantly¶ broaden this new interest group into areas including soft-matter studies.

#### APS solves chemical industry

**Fischetti** et all **9** [“Proceedings of the¶ Advanced Photon Source Renewal Workshop”¶ Hickory Ridge Marriott Conference Hotel¶ Presentation to Department of Energy¶ October 20-21, 2008¶ February 2009¶ Robert F. Fischetti Argonne National Laboratory, Biosciences Division;¶ APS Life Sciences Council representative¶ Paul H. Fuoss Argonne National Laboratory, Materials Science Division;¶ APS Users Organization representative¶ Rodney E. Gerig Argonne National Laboratory, Photon Sciences, Denis T. Keane Northwestern University;¶ DuPont-Northwestern-Dow Collaborative Access Team;¶ APS Partner User Council representative¶ John F. Maclean Argonne National Laboratory, APS Engineering Division¶ Dennis M. Mills, Chair Argonne National Laboratory, Photon Sciences, Dan A. Neumann National Institute of Standards and Technology; APS Scientific Advisory Committee representative¶ George Srajer Argonne National Laboratory, X-ray Science Division]

Within solutions themselves, self-assembly and ordering of ions or molecules at interfaces is important in many biotic and abiotic processes. Phase-transfer catalysis,¶ pharmaceutical drug delivery, many electrochemical processes, nanoparticle synthesis, and numerous chemical reactions take place at the interface between two immiscible liquids. Important environmental processes that rely upon interactions at interfaces include tertiary oil recovery, solvent extraction of radionuclides from nuclear¶ waste, and permeation liquid membranes used for the cleanup of ions in the environment. For example, biological membranes at aqueous-aqueous boundaries are fundamental to cell chemistry and processes. In the area of separations science—a¶ cornerstone of the chemical industry—solvent extraction and other metals separations technologies rely heavily on the transfer of metal ions across an interface.¶ Significance of the APS¶ Understanding solution and materials chemistry requires knowledge of structure at¶ the atomic level. Most of the standard structural characterization tools provide highquality information on bulk, periodic, or crystalline materials. Equally high-quality¶ characterization is needed for amorphous materials, solutions, and complex nanostructures. Synchrotron-based techniques can now be used to characterize samples¶ irrespective of their state of crystallinity via different scattering and spectroscopic¶ methods. X-rays are providing structural details at length scales that encompass¶ local structure from about an ion to the long-range ordering present in well-formed¶ crystalline materials, and have found applications in solutions, glasses, liquids, poorquality crystals, powders (which can be multiphase), assemblies of micro-crystals, adsorbed surface layers, etc. Moreover, the evolution of structure under reaction¶ conditions is also an important feature of a catalytic system that needs to be investigated and understood. Techniques most often used for analysis of catalytic materials¶ include x-ray diffraction and scattering, pair distribution function (PDF), small-angle¶ scattering (SAXS) and x-ray absorption spectroscopy (EXAFS and x-ray absorption¶ near-edge fine structure, XANES).¶ Current APS techniques and potential upgrades in capabilities¶ Synchrotron x-ray powder diffraction (SXRPD) is a core competency for structural¶ analysis of catalytic nanoparticles. The major application of SXRPD is structural¶ analysis of new catalytic materials using Rietveld refinement (e.g., zeolites and mixed oxides). In recent years, there has also been much interest in in situ catalyst¶ research. Having a beamline with capabilities for in situ measurements would be¶ highly advantageous to the catalysis community, as many metallic nanoparticles are¶ highly oxidized in ambient air.

#### A strong chemical industry prevents extinction

**Baum ’99** (Rudy M., C&EN Washington, Chemical and Engineering News, Millennium Special Report, 12-6, http://pubs.acs.org/hotartcl/cenear/991206/7749spintro2.html)

Here is the fundamental challenge we face: The world's growing and aging population must be fed and clothed and housed and transported in ways that do not perpetuate the environmental devastation wrought by the first waves of industrialization of the 19th and 20th centuries. As we increase our output of goods and services, as we increase our consumption of energy, as we meet the imperative of raising the standard of living for the poorest among us, we must learn to carry out our economic activities sustainably. There are optimists out there, C&EN readers among them, who believe that the history of civilization is a long string of technological triumphs of humans over the limits of nature. In this view, the idea of a "carrying capacity" for Earth—a limit to the number of humans Earth's resources can support—is a fiction because technological advances will continuously obviate previously perceived limits. This view has historical merit. Dire predictions made in the 1960s about the exhaustion of resources ranging from petroleum to chromium to fresh water by the end of the 1980s or 1990s have proven utterly wrong. While I do not count myself as one of the technological pessimists who see technology as a mixed blessing at best and an unmitigated evil at worst, I do not count myself among the technological optimists either. There are environmental challenges of transcendent complexity that I fear may overcome **us and our** Earth before technological progress can come to our rescue. Global climate change, the accelerating destruction of terrestrial and oceanic habitats, the catastrophic loss of species across the plant and animal kingdoms—these are problems that are not obviously amenable to straightforward technological solutions. But I know this, too: Science and technology have brought us to where we are, and only science and technology, coupled with innovative social and economic thinking, can take us to where we need to be in the coming millennium. Chemists, chemistry, and the chemical industry—what we at C&EN call the chemical enterprise—will play central roles in addressing these challenges. The first section of this Special Report is a series called "Millennial Musings" in which a wide variety of representatives from the chemical enterprise share their thoughts about the future of our science and industry. The five essays that follow explore the contributions the chemical enterprise is making right now to ensure that we will successfully meet the challenges of the 21st century. The essays do not attempt to predict the future. Taken as a whole, they do not pretend to be a comprehensive examination of the efforts of our science and our industry to tackle the challenges I've outlined above. Rather, they paint, in broad brush strokes, a portrait of scientists, engineers, and business managers struggling to make a vital contribution to humanity's future. The first essay, by Senior Editor Marc S. Reisch, is a case study of the chemical industry's ongoing transformation to sustainable production. Although it is not well known to the general public, the chemical industry is at the forefront of corporate efforts to reduce waste from production streams to zero. Industry giants DuPont and Dow Chemical are taking major strides worldwide to manufacture chemicals while minimizing the environmental "footprint" of their facilities. This is an ethic that starts at the top of corporate structure. Indeed, Reisch quotes Dow President and Chief Executive Officer William S. Stavropolous: "We must integrate elements that historically have been seen as at odds with one another: the triple bottom line of sustainability—economic and social and environmental needs." DuPont Chairman and CEO Charles (Chad) O. Holliday envisions a future in which "biological processes use renewable resources as feedstocks, use solar energy to drive growth, absorb carbon dioxide from the atmosphere, use low-temperature and low-pressure processes, and produce waste that is less toxic." But sustainability is more than just a philosophy at these two chemical companies. Reisch describes ongoing Dow and DuPont initiatives that are making sustainability a reality at Dow facilities in Michigan and Germany and at DuPont's massive plant site near Richmond, Va. Another manifestation of the chemical industry's evolution is its embrace of life sciences. Genetic engineering is a revolutionary technology. In the 1970s, research advances fundamentally shifted our perception of DNA. While it had always been clear that deoxyribonucleic acid was a chemical, it was not a chemical that could be manipulated like other chemicals—clipped precisely, altered, stitched back together again into a functioning molecule. Recombinant DNA techniques began the transformation of DNA into just such a chemical, and the reverberations of that change are likely to be felt well into the next century. Genetic engineering has entered the fabric of modern science and technology. It is one of the basic tools chemists and biologists use to understand life at the molecular level. It provides new avenues to pharmaceuticals and new approaches to treat disease. It expands enormously agronomists' ability to introduce traits into crops, a capability seized on by numerous chemical companies. There is no doubt that this powerful new tool will play a major role in feeding the world's population in the coming century, but its adoption has hit some bumps in the road. In the second essay, Editor-at-Large Michael Heylin examines how the promise of agricultural biotechnology has gotten tangled up in real public fear of genetic manipulation and corporate control over food. The third essay, by Senior Editor Mairin B. Brennan, looks at chemists embarking on what is perhaps the greatest intellectual quest in the history of science—humans' attempt to understand the detailed chemistry of the human brain, and with it, human consciousness. While this quest is, at one level, basic research at its most pure, it also has enormous practical significance. Brennan focuses on one such practical aspect: the effort to understand neurodegenerative diseases like Alzheimer's disease and Parkinson's disease that predominantly plague older humans and are likely to become increasingly difficult public health problems among an aging population. Science and technology are always two-edged swords. They bestow the power to create and the power to destroy. In addition to its enormous potential for health and agriculture, genetic engineering conceivably could be used to create horrific biological warfare agents. In the fourth essay of this Millennium Special Report, Senior Correspondent Lois R. Ember examines the challenge of developing methods to counter the threat of such biological weapons. "Science and technology will eventually produce sensors able to detect the presence or release of biological agents, or devices that aid in forecasting, remediating, and ameliorating bioattacks," Ember writes. Finally, Contributing Editor Wil Lepkowski discusses the most mundane, the most marvelous, and the most essential molecule on Earth, H2O. Providing clean water to Earth's population is already difficult—and tragically, not always accomplished. Lepkowski looks in depth at the situation in Bangladesh—where a well-meaning UN program to deliver clean water from wells has poisoned millions with arsenic. Chemists are working to develop better ways to detect arsenic in drinking water at meaningful concentrations and ways to remove it that will work in a poor, developing country. And he explores the evolving water management philosophy, and the science that underpins it, that will be needed to provide adequate water for all its vital uses. In the past two centuries, our science has transformed the world. Chemistry is a wondrous tool that has allowed us to understand the structure of matter and gives us the ability to manipulate that structure to suit our own purposes. It allows us to dissect the molecules of life to see what makes them, and us, tick. It is providing a glimpse into workings of what may be the most complex structure in the universe, the human brain, and with it hints about what constitutes consciousness. In the coming decades, we will use chemistry to delve ever deeper into these mysteries and provide for humanity's basic and not-so-basic needs.

#### APS solves human embryonic development and fertility

**Xu 8** [“A Nuclear Receptor with Implications for a Host of Diseases”, Schoen W. Kruse, Kelly Suino-Powell, X. Edward Zhou, Jennifer E. Kretschman, Ross Reynolds, Clemens Vonrhein, Yong Xu, Liliang Wang, Sophia Y. Tsai, Ming-Jer Tsai, and H. Eric Xu, Press released of ‘Identification of COUP-TFII Orphan Nuclear Receptor as a Retinoic Acid–Activated Receptor,” PLoS Biology 6 (9), e277 (September 2008), Sept 25, 2008]

The crystal structure of the COUP-TFII receptor.¶ The molecular structure of a nuclear receptor that regulates the expression of specific genes within cells may serve as a drug target for diseases related to heart and blood-vessel development, human embryonic development, and female infertility, according to a team of researchers from the Van Andel Institute (VAI), Grand Valley State University, Global Phasing Ltd., and Baylor College of Medicine. The researchers, using an x-ray beamline at the U.S. Department of Energy’s Advanced Photon Source (APS) at Argonne National Laboratory, also found that the receptor, named COUP-TFII, is activated by retinoic acid, a form of Vitamin A.¶ "Not only does the structural information provide a basis for drug design in any diseases where COUP-TFII plays a role, but it also can provide insight into the entire subfamily of receptors to which COUP-TFII belongs, which could have implications for additional associated diseases," said Eric Xu of VAI, who with his colleagues authored the article on this study that was published in PLoS Biology.¶ The researchers determined the molecular structure of COUP-TFII via x-ray crystallography carried out at the DuPont-Northwestern-Dow Collaborative Access Team 5-ID-B,C,D beamline at the APS. Structural information such as this can help drug developers fit therapeutics more perfectly to the receptors they bind to for maximum potency, and can also aid in manipulating drugs to produce fewer side effects.¶ The findings could also have implications for cancer therapy. "Since COUP-TFII plays a role in embryonic blood vessel development, it might play a similar role in tumors and cancer growth," said Schoen Kruse, also from VAI and lead author of the study. "Formation of new blood supply in tumors is a stepping stone in the ability of cancers to grow and metastasize within the body."¶ The signal-triggering molecules, known as ligands — which activate nuclear receptors — have been discovered for most receptors, but not for a subset of “orphan” nuclear receptors whose ligand remains unknown. This study's finding that COUP-TFII is activated by retinoic acid is significant since the receptor previously belonged to this subset of orphan receptors.

#### Inevitable extinction otherwise

**Plimmer 11** [2011, Andrew Plimmer, “Are We Poisoning Ourselves Into Extinction?”, environmental activist from Australia]

Are We Poisoning Ourselves Into Extinction? ¶ Have you heard any of the disquieting reports on worldwide infertility and wondered if we are in the process of making the human race extinct with our continued usage of environmental toxins that affect both male and female infertility?¶ Besides affecting fertility, toxins have been proven to increase the risk of miscarriage in pregnant women.¶ If you aren’t up to speed on this scary topic, here are a few factoids that you may find startling, if not downright terrifying:¶ In 1938, only one half of 1% of males were functionally sterile. Functionally sterile means that the sperm count of a man is below 20 million viable sperm per milliliter of semen. Today, that percentage has increased 15 fold and is now between 8 and 12%. ¶ Dr. Cecil Jacobson ,Reproductive Genetics Center, Vienna, Virginia¶ Miscarriage is more likely to occur in women whose partners have a low sperm count. An average of 48% of the father’s sperm involved in female miscarriages were abnormal…some with two heads and two tails, for instance. By the same token, males who fathered normal pregnancies had 25% higher sperm counts and a mere 5% of abnormal sperm.¶ Drs. Mirjam Furuhjelm and Birgit Jonson ,Dept. of Obst. and Gyn., Sabbatsberg Hospital, Karolinska Institute, Stockholm, Sweden¶ In 1988, a study conducted by the United States National Center for Health Statistics estimated that of women aged 15-44, approximately 8.5% had a less than normal chance of becoming pregnant. ¶ Dr. Howard Jones , New England Journal of Medicine ,December 2, 1993 pg. 1710¶ Miscarriage rates are significantly higher among women living near agricultural areas where certain pesticides are used on crops. In fact, there is a huge 40% to 120% increase of miscarriage due to birth defects.¶ Epidemiology, March 2001¶ Pesticides are linked to male infertility. Studies have shown that infertile men are 10 times more likely to be employed in agricultural jobs using pesticides than men engaged in another, pesticide-free, line of work.¶ American Journal of Industrial Medicine, Vol. 24:587-592, 1983¶ The pesticide Chlordane was found to lower sperm count and damage the part of the male testicles that produce sperm. ¶ Drs. Khawla J. Balash, Muthanna A. Al-Omar ,Univ. of Baghdad, Biological Research Center¶ Approximately 75% of all American homes contain the pesticide Chlordane in the breathable air! ¶ Teratogenesis, Carcinogenesis, & Mutagenesis, Vol. 7:527-540, 1987¶ Women employed in microelectronics assembly using the cleaning solvents xylene, acetone, trichlorethylene, petroleum distillates and others have been found to have spontaneous abortion rates more than 4X normal. ¶ British Journal of Industrial Medicine, Vol. 47:400-404, 1990

#### Funding is irrelevant – scientists are motivated by prestige given by specific projects

**National Acadamies Press 12** [2012, Improving the Recruitment, Retention, and Utilization of Federal Scientists and Engineers: A Report to the Carnegie Commision on Science, Technology and Government, <http://www.nap.edu/openbook.php?record_id=2102&page=37>]

There have been no significant changes in NIST's workforce quality indicators—undergraduate grade-point averages, quality of graduate schools, and performance appraisal ratings—which traditionally have been high. Turnover rates, already very low, have not changed,¶ although surveys of leavers indicate that salary has become a less important reason for leaving. Department of Agriculture Demonstration The committee also heard presentations by officials from the U.S. Department of Agriculture (USDA) and its Agricultural Research Service (ARS) about a personnel demonstration project begun in mid-1990 in 140 experimental and 70 comparison sites of the Forest Service and the ARS. The project is largely a testing of a comprehensive simplification and decentralization of the hiring system, but it does include recruitment bonuses and relocation expenses and use of an extended probationary period for scientists in research positions.14 The committee heard that the recruitment incentives have been rarely used, although they were important in attracting a microbiologist and a plant physiologist. It is too early to evaluate the results of the longer probationary period on the retention and productivity of research scientists. Lessons While they are only quasi-experiments, and they do not measure the effects of the interventions on organizational effectiveness, other effects of the various interventions have been measured, the Navy and NIST demonstration projects are consistent with the proposition that a more flexible pay and position structure improves the ability of federal agencies to recruit more qualified scientists and engineers and to reward and motivate good performers and thus retain them. They also show that the direct cost of such efforts is modest, in part because the agencies can (and do, because of budget constraints) tailor the compensation package to each case rather than increase salaries across the board. In addition, the differences among the demonstrations designed by each agency to 14 The extended probationary period does not apply to foresters and other scientists not in research positions.¶ OCR for page 56¶ Improving the Recruitment, Retention, and Utilization of Federal Scientists and Engineers: A Report to the Carnegie Commision on Science, Technology and Government meet its needs show that the various mechanisms can and should be adapted to the particular conditions facing each agency. Thus the agencies faced with implementing FEPCA should consider it an opportunity to design their own recruitment and retention programs. Unfortunately, FEPCA does not include all the devices and flexibilities being used by the demonstration projects. Additional steps needed beyond FEPCA to improve the federal government's capacity to recruit well-qualified scientific and technological personnel are recommended in the last chapter. First, the next chapter discusses the flexibilities offered under FEPCA to agencies faced with attracting and keeping well-qualified scientists and engineers and identifies potential obstacles to effective implementation of FEPCA.

### Solvency

#### Contention 4: Solvency

#### Loan guarantees solve – conservative arguments about cronyism and risk underestimation ignore 20 years of loan guarantee data to the contrary

**Griffith and Caperton, 12** - John Griffith is a Policy Analyst with the Economic Policy team at the Center for American Progress. Richard Caperton is the Director of Clean Energy Investment at the Center (Major Analysis: Federal Loans And Loan Guarantees Have A Huge Benefit But A Low And Predicatable Cost, 5/3, <http://thinkprogress.org/climate/2012/05/03/475978/major-analysis-federal-loans-and-loan-guarantees-have-a-huge-benefit-but-a-low-and-predicatable-cost/>)

These programs typically run at very low cost to taxpayers. On average, every $1 allocated to loan and guarantee programs generates more than $99 of economic activity from individuals, businesses, nonprofits, and state and local governments, according to our analysis.¶ But in the wake of certain widely publicized credit blunders, most notably this past summer’s bankruptcy announcement from solar company Solyndra LLC, some have called into question Washington’s ability to manage financial risk. Conservative critics contend that the government is incapable of accurately pricing risk, and that political pressure encourages government agencies to routinely underestimate the risk to taxpayers when extending credit.¶ Government underpricing of risk is a convenient theory for free-market ideologues but it runs contrary to the overwhelming evidence.¶ Our review of federal government credit programs back to 1992 shows that on average the government is quite accurate in its risk pricing. In fact, the majority of government credit programs cost less than originally estimated, not more. Specifically, we found that:¶ Based on initial estimates over the past 20 years, the government expected its credit programs to cost taxpayers 79 cents for every $100 loaned or guaranteed. Based on recently updated data, those cost predictions were reasonably accurate but slightly underestimated. The current budgetary impact of these programs is about 94 cents per $100 loaned or guaranteed.¶ There’s little evidence that credit programs are biased toward underpricing risk. In fact, a little more than half of all nonemergency federal credit programs will cost the government less than what they are expected to over the life of the program.¶ The remainder is accounted for by the losses suffered by the Federal Housing Administration on loans made in 2008 during the peak of the housing crisis. Excluding that book of loans, all nonemergency federal credit programs cost slightly less than expected.¶ Conservative critics often portray a world in which government bureaucrats haphazardly issue loans and loan guarantees without considering taxpayer exposure to risk. That’s simply not the case. This issue brief explains how the government prices credit risk in the federal budget, how well those cost estimates have reflected reality over the years, and why the government is in a particularly good position to assume certain types of risk.¶ Budgeting for credit risk¶ Federal government agencies adhere to strict budget and accounting standards to carefully assess the risks and potential losses associated with credit programs. Here’s how it works.¶ Before an agency can issue any loans or loan guarantees, Congress must first authorize and allocate funding for the program. In most cases Congress starts by determining how much money the program will be authorized to guarantee or loan and then appropriates a certain percentage of that amount to cover the program’s expected cost to the government. That cost estimate—assessed by both the agency administering the program and the president’s Office of Management and Budget—takes into account expected repayments, defaults, recoveries, and any interest or fees collected over the life of the loan, adjusted to current dollars.¶ The net cost to the federal government as a percentage of total dollars loaned or guaranteed is known as the subsidy rate. As an example, say Congress approves a $100 million loan guarantee program within the Department of Agriculture. The department models expected market conditions and loan activity and then estimates a subsidy rate, which the Office of Management and Budget independently estimates as a check on the agency’s methodology. Let’s say the estimated subsidy rate is 0.75 percent. That means the government expects to take a net loss of 75 cents for every $100 it guarantees over the life of those loans. To cover expected losses on the $100 million in loan guarantees, the government sets aside $750,000 in a special account at the Treasury Department. This is similar to a loan loss reserve at a private bank.¶ Each subsequent year, the Office of Management and Budget and the agencies recalculate the subsidy rate to reflect actual loan performance, current economic conditions, and anything else administrators may have learned about a program. These revised numbers are reported in the president’s budget each year, which gives us a pretty good idea of each program’s “actual” costs and the government’s ability to assess financial risk.¶ If conservative claims were accurate in saying that the federal government cannot accurately price for risk, then one would expect the initial cost estimates to be significantly lower than the more recent re-estimates. Using the Department of Agriculture example above, if the critics were right, the re-estimated subsidy rate would presumably be much higher than 0.75 percent, and actual outlays would be higher than estimated. Let’s see how the government’s risk estimates actually stack up.¶ Government risk estimates are quite accurate¶ To test this theory, we analyzed credit data published in the president’s 2013 budget. We compared initial and updated cost estimates, also known as subsidy re-estimates, for each book of nonemergency loans and loan guarantees for each federal credit program since 1992, the first year for which comprehensive data are available.¶ We limit our analysis to nonemergency credit programs, omitting programs created in response to the recent financial crisis. This includes programs created through the Troubled Asset Relief Program—the so-called Wall Street rescue package passed by Congress at the height of the housing and financial crises—and the U.S. Department of the Treasury’s purchase of securities issued by the two troubled housing finance giants Fannie Mae and Freddie Mac. Both of these programs are temporary, atypically large, and are accounted for in the federal budget using different standards than all other credit programs.¶ If we had included these “emergency” programs, it would drastically skew the overall results—but skew them in favor of our basic argument. Based on our analysis of data published in the 2013 budget, these programs will cost the government about $130 billion less than initially expected. So their inclusion would make it seem as though the government significantly overestimated the cost of all credit programs over the past 20 years, which is not the case.¶ We also exclude any federal credit program that is not listed in the federal credit supplement of president’s budget, and any program that did not publish a subsidy re-estimate in the 2013 budget. We do this both because complete data are unavailable for these programs and because their costs are not recorded in the federal budget. Notably, this includes insurance programs through the Federal Deposit Insurance Corporation, mortgage guarantees offered by the two housing finance giants Fannie Mae and Freddie Mac (both now under government conservatorship), and guarantees on mortgage-backed securities offered by the government corporation Ginnie Mae.¶ Here’s what we found out about nonemergency federal credit programs. Federal agencies have issued $5.7 trillion worth of these loans or loan guarantees since 1992. Based on our analysis of initial estimates, the government expected these programs to cost taxpayers about 79 cents for every $100 loaned or guaranteed, or a 0.79 percent subsidy rate overall.¶ Of course, no one expects those estimates to be perfect. Many of these loans such as home mortgages or funding for large infrastructure projects take decades to pay back. Government financial analysts are charged with the difficult task of modeling payments, defaults, recoveries, and market conditions for the entire life of the loan, so some error has to be expected.¶ But as it turns out, the initial estimates weren’t very far off. The current budgetary impact of these credit programs is about 94 cents per $100 loaned or guaranteed, or a 0.94 percent subsidy rate, according to our analysis of updated subsidy estimates. To put that in a budgetary context, while issuing nearly $6 trillion in loans and guarantees over the past 20 years, the government initially predicted about $45 billion in total costs to taxpayers, but the actual costs were slightly higher—about $53 billion.¶ That difference—$8 billion over two decades or $400 million per year—might seem high at first. But it amounts to just 0.15 percent of the total dollars loaned or guaranteed by the government and 0.02 percent of all government spending over that period.(see Figure 1)¶ Of course, the federal government’s performance on individual programs varied substantially. Some programs overestimate risks, while others underestimate. But as mentioned above, some conservatives argue that political pressures cause the government to systemically underprice costs to taxpayers when issuing loans or guarantees.¶ The data show this to be untrue. Of the 104 nonemergency credit programs administered since 1992, our analysis shows that most have actually overestimated total subsidy costs. Fifty-six programs overpriced risk over their lifetimes, while 48 programs underpriced risk. (see Figure 2)¶ Our analysis only takes into account lifetime costs for each program, not the federal government’s ability to estimate costs on an individual year’s portfolio of loans. Indeed, critics often point to individual data points such as the Solyndra bankruptcy as evidence of the government’s inability to price financial risk. But what matters most is actually the net budgetary impact over time of these inaccuracies, which is what is measured in Figure 1.¶ Overall these overestimates and underestimates—whether across programs or in individual books of business—tend to roughly balance out in the long run, give or take a reasonable margin of error. As we show in the following section, however, all of these underestimated losses can actually be attributed to a single year of mortgage guarantees made at the height of the housing crisis.

#### Government support is vital-~--it overcomes financial barriers to nuclear that the market cannot

Yanosek 12 Kassia, entrepreneur-in-residence at Stanford University’s Steyer-Taylor Center for Energy Policy and Finance and a private equity investor in the energy sector as a principal at Quadrant Management and Founder of Tana Energy Capital LLC, " Financing Nuclear Power in the US", Spring, energyclub.stanford.edu/index.php/Journal/Financing\_Nuclear\_Power\_by\_Kassia\_Yanosek

Over the course of the last decade, it appeared that concerns about carbon emissions, aging coal fleets, and a desire for a diversified generation base were reviving the U.S. utility sector interest in building new nuclear plants. Government and companies worked closely on design certification for Generation III reactors, helping to streamline the licensing process. New loan guarantees from the federal government targeted for nuclear projects were created as part of the 2005 Energy Policy Act. Consequently, dozens of projects entered the planning stages. Following more than 30 years in which no new units were built, it looked as if the U.S. nuclear industry was making significant headway. However, it is yet to be seen how many new nuclear projects will actually make it beyond blueprints due to one of the largest barriers to new nuclear construction: financing risk. Large upfront capital costs, a complex regulatory process, uncertain construction timelines, and technology challenges result in a risk/return profile for nuclear projects that is unattractive for the capital markets without supplementary government or ratepayer support. To many investors, nuclear seems too capital-intensive. Nuclear energy has attractive qualities in comparison to other sources of electricity. A primary motivation to pursue the development of nuclear energy in the U.S. has been its low operating fuel costs compared with coal, oil, and gas-fired plants. Over the lifetime of a generating station, fuel makes up 78% of the total costs of a coal-fired plant. For a combined cycle gas-fired plant, the figure is 89%. According to the Nuclear Energy Institute, the costs for nuclear are approximately 14%, and include processing, enrichment, and fuel management/disposal costs. Today’s low natural gas prices have enhanced the prospects of gas-fired power, but utilities still remain cautious about over-investing in new natural gas generation given the historical volatility of prices. Furthermore, nuclear reactors provide baseload power at scale, which means that these plants produce continuous, reliable power to consistently meet demand. In contrast, renewable energies such as wind or solar are only available when the wind blows or the sun shines, and without storage, these are not suitable for large-scale use. Finally, nuclear energy produces no carbon emissions, which is an attractive attribute for utilities that foresee a carbon tax being imposed in the near future. Given nuclear’s benefits, one may wonder why no new nuclear units have been ordered since the 1970s. This hiatus is in great part due to nuclear’s high cost comparative to other alternatives, and its unique set of risks. As a result, financing nuclear has necessitated government involvement, as the cost of nuclear typically exceeds that of the cost of conventional generation technologies such as coal and natural gas fired generation on a levelized cost of energy (LCOE) basis. LCOE represents the present value of the total cost of building and operating a generating plant over its financial life, converted to equal annual payments and amortized over expected annual generation, and is used to compare across different power generation technologies. For both regulated utilities and independent power producers, nuclear is unattractive if the levelized cost exceeds that of other technologies, since state utility commissions direct regulated utilities to build new capacity using the technology with the lowest LCOE. Furthermore, capital costs are inherently high, ranging in the billions or tens of billions of dollars, and are compounded by financing charges during long construction times. Without government support, financing nuclear is currently notpossible in the capital markets. Recently, Constellation Energy and NRG separately pulled the plug on new multi-billion dollar plants, citing financing problems. Projects, however, will get done on a one-off basis. Southern Company’s Vogtle Plant in Eastern Georgia is likely to be the sponsor of the first new generation to be constructed, taking advantage of local regulatory and federal support. Two new reactors of next-generation technology are in the permitting stage, which will bring online 2,200 megawatts (MW) of new capacity, and will cost $14 billion. The project will take advantage of tax credits and loan guarantees provided in the 2005 Energy Policy Act.

#### And, loan guarantees solve nuclear expansion – shows investors the government has skin in the game, and incentivizes quick agency approval

Adams 10—Publisher of Atomic insights Was in the Navy for 33 years Spent time at the Naval Academy Has experience designing and running small nuclear plants (Rod, Concrete Action to Follow Strongly Supportive Words On Building New Nuclear Power Plants, atomicinsights.com/2010/01/concrete-action-to-follow-strongly-supportive-words-on-building-new-nuclear-power-plants.html)

Loan guarantees are important to the nuclear industry because the currently available models are large, capital intensive projects that need a stable regulatory and financial environment. The projects can be financed because they will produce a regular stream of income that can service the debt and still provide a profit, but that is only true if the banks are assured that the government will not step in at an inopportune time to halt progress and slow down the revenue generation part of the project. Bankers do not forget history or losses very easily; they want to make sure that government decisions like those that halted Shoreham, Barnwell’s recycling facility or the Clinch River Breeder Reactor program are not going to be repeated this time around. For the multi-billion dollar projects being proposed, bankers demand the reassurance that comes when the government is officially supportive and has some “skin in the game” that makes frivolous bureaucratic decisions to erect barriers very expensive for the agency that makes that decision. I have reviewed the conditions established for the guarantee programs pretty carefully – at one time, my company ([Adams Atomic Engines, Inc.](http://www.atomicengines.com)) was considering filing an application. The loan conditions are strict and do a good job of protecting government interests. They were not appropriate for a tiny company, but I can see where a large company would have less trouble complying with the rules and conditions. The conditions do allow low or no cost intervention in the case of negligence or safety issues, but they put the government on the hook for delays that come from bad bureaucratic decision making.

#### Plan is modeled internationally

**Blees et al** 11 (Tom Blees1, Yoon Chang2, Robert Serafin3, Jerry Peterson4, Joe Shuster1, Charles Archambeau5, Randolph Ware3, 6, Tom Wigley3,7, Barry W. Brook7, 1Science Council for Global Initiatives, 2Argonne National Laboratory, 3National Center for Atmospheric Research, 4University of Colorado, 5Technology Research Associates, 6Cooperative Institute for Research in the Environmental Sciences, 7(climate professor) University of Adelaide, "Advanced nuclear power systems to mitigate climate change (Part III)," 2/24/11) [http://bravenewclimate.com/2011/02/24/advanced-nuclear-power-systems-to-mitigate-climate-change/-http://bravenewclimate.com/2011/02/24/advanced-nuclear-power-systems-to-mitigate-climate-change/](http://bravenewclimate.com/2011/02/24/advanced-nuclear-power-systems-to-mitigate-climate-change/-http%3A//bravenewclimate.com/2011/02/24/advanced-nuclear-power-systems-to-mitigate-climate-change/)

There are many compelling reasons to pursue the rapid demonstration of a full-scale IFR, as a lead-in to a subsequent global deployment of this technology within a relatively short time frame. Certainly the urgency of climate change can be a potent tool in winning over environmentalists to this idea. Yet political expediency—due to widespread skepticism of anthropogenic causes for climate change—suggests that the arguments for rolling out IFRs can be effectively tailored to their audience. Energy security—especially with favorable economics—is a primary interest of every nation.¶ The impressive safety features of new nuclear power plant designs should encourage a rapid uptick in construction without concern for the spent fuel they will produce, for all of it will quickly be used up once IFRs begin to be deployed. It is certainly manageable until that time. Burying spent fuel in non-retrievable geologic depositories should be avoided, since it represents a valuable clean energy resource that can last for centuries even if used on a grand scale.¶ Many countries are now beginning to pursue fast reactor technology without the cooperation of the United States, laboriously (and expensively) re-learning the lessons of what does and doesn’t work. If this continues, we will see a variety of different fast reactor designs, some of which will be less safe than others. Why are we forcing other nations to reinvent the wheel? Since the USA invested years of effort and billions of dollars to develop what is arguably the world’s safest and most efficient fast reactor system in the IFR, and since several nations have asked us to share this technology with them (Russia, China, South Korea, Japan, India), there is a golden opportunity here to develop a common goal—a standardized design, and a framework for international control of fast reactor technology and the fissile material that fuels them. This opportunity should be a top priority in the coming decade, if we are serious about replacing fossil fuels worldwide with sufficient pace to effectively mitigate climate change and other environmental and geopolitical crises of the 21st century.

#### IFR’s S-PRISM design is really safe

**Blees et al 11** (Tom Blees1, Yoon Chang2, Robert Serafin3, Jerry Peterson4, Joe Shuster1, Charles Archambeau5, Randolph Ware3, 6, Tom Wigley3,7, Barry W. Brook7, 1Science Council for Global Initiatives, 2Argonne National Laboratory, 3National Center for Atmospheric Research, 4University of Colorado, 5Technology Research Associates, 6Cooperative Institute for Research in the Environmental Sciences, 7(climate professor) University of Adelaide, "Advanced nuclear power systems to mitigate climate change (Part III)," 2/24/11) http://bravenewclimate.com/2011/02/24/advanced-nuclear-power-systems-to-mitigate-climate-change/-http://bravenewclimate.com/2011/02/24/advanced-nuclear-power-systems-to-mitigate-climate-change/

Metal Fuel: The Ultimate Safety Valve¶ One of the most important of the many superlatives of the IFR is its use of a metal fuel comprised of uranium, plutonium and zirconium, and the ingenious manner in which the Argonne team solved the problems of fuel expansion and fuel fabrication, as well as the potentially dangerous overheating scenario. Unlike the fuel fabrication of oxide-fueled reactors that requires the dimensions of the fuel pellets to be uniform to very exacting tolerances, the metal fuel for the IFR can be simply injected into molds and then cooled and inserted into metal tubes (cladding) with a great deal of dimensional tolerance, with a sodium bond filling any voids. If an accident situation occurs that would cause the core to overheat, such as a loss of coolant flow accident, the metal fuel itself will expand, causing neutron leakage to terminate the chain reaction, relying on nothing but the laws of physics.¶ The passive safety characteristics of the IFR were tested in EBR-II on April 3, 1986, against two of the most severe accident events postulated for nuclear power plants. The first test (the Loss of Flow Test) simulated a complete station blackout, so that power was lost to all cooling systems. The second test (the Loss of Heat Sink Test) simulated the loss of ability to remove heat from the plant by shutting off power to the secondary cooling system. In both of these tests, the normal safety systems were not allowed to function and the operators did not interfere. The tests were run with the reactor initially at full power.¶ In both tests, the passive safety features simply shut down the reactor with no damage. The fuel and coolant remained within safe temperature limits as the reactor quickly shut itself down in both cases. Relying only on passive characteristics, EBR-II smoothly returned to a safe condition without activation of any control rods and without action by the reactor operators. The same features responsible for this remarkable performance in EBR-II will be incorporated into the design of future IFR plants, regardless of how large they may be [xi].¶ While the IFR was under development, a consortium of prominent American companies led by General Electric collaborated with the IFR team to design a commercial-scale reactor based upon the EBR-II research. This design, currently in the hands of GE, is called the PRISM (Power Reactor Innovative Small Module). A somewhat larger version (with a power rating of 380 MWe) is called the S-PRISM. As with all new nuclear reactor designs (and many other potentially hazardous industrial projects), probabilistic risk assessment studies were conducted for the S-PRISM. Among other parameters, the PRA study estimated the frequency with which one could expect a core meltdown. This occurrence was so statistically improbable as to defy imagination. Of course such a number must be divided by the number of reactors in service in order to convey the actual frequency of a hypothetical meltdown. Even so, if one posits that all the energy humanity requires were to be supplies solely by IFRs (an unlikely scenario but one that is entirely possible), the world could expect a core meltdown about once every 435,000 years [xii]. Even if the risk assessment understated the odds by a factor of a thousand, this would still be a reactor design that even the most paranoid could feel good about.

#### IFR fuel can be obtained from seawater – makes energy infinite

Archambeauet all 11 [The Integral Fast Reactor (IFR): An Optimized Source for Global Energy Needs, Charles Archambeau, Science Council for Global Initiatives, Randolph Ware, Cooperative Institute for Research in Environmental Sciences, Tom Blees, National Center for Atmospheric Research, Barry Brook, University of Adelaide, Jerry Peterson, Argonne National Laboratory,¶ Yoon Chang, University of Colorado, February 2011]

The pyroprocessor unit can be used as a stand-alone system to process LWR waste from¶ any open cycle reactor into fuel for IFR closed cycle reactors. The depleted Uranium¶ produced by the enrichment of Uranium ore can also be processed to generate additional¶ IFR fuel. The current amount of LWR waste, plus the amount of depleted Uranium in¶ stock piles world-wide, is sufficient to supply fuel to all the IFR plants needed and in fact¶ to supply the world's required energy for about 1000 years.3 The problem of storage of¶ current LWR waste and depleted Uranium waste from refining of mined Uranium is¶ therefore solved by pyroprocessor generation of IFR fuel, along with a relatively small¶ mass of short-lived fission products which can be easily and safely stored. Uranium can¶ also be extracted from sea water using IFR power sources (see, for example, Cohen, 1983).¶ Because Uranium is constantly added to seawater by erosion processes, then the IFR fuel¶ source is effectively unlimited. Therefore, IFR power plants do not require fuel from¶ regular mining operations, as does a LWR powered plant, but can use pyroprocessor¶ generated fuel essentially indefinitely. In this sense the IFR is a "renewable" energy source¶ which can be expanded, essentially indefinitely, to meet demand.

#### Manhattan Project approach key to catalyze quick investment in IFRs – perception is non-unique, there is government investment now

**Kirsch 9** [Steve Kirsch, founder and CEO of multiple tech companies collectively worth over %241 billion and MS in Electrical Engineering and Computer Science from MIT, November 2009, "Why We Should Build an Integral Fast Reactor Now,"]

Q. If this is really so good, how come GE isn't building S-PRISM on their own nickel?¶ Nobody wants to risk it since it isn't a slam dunk. You don't get a reward if you solve global warming. And government funding doesn't seem to be so easy. DOE tried to get funding for GNEP (which included IFR technology) and got shot down (so far).¶ GE is a large conservative corporation. They already service a fleet of lightwater reactors, are building more of them around the world, and have the promise of yet more. It's hard enough in this country to move into new levels of reactor technology without trying to leapfrog straight into the 4th generation. Their 3rd generation ESBWR is in the 5th round of NRC certification, whereas the S-PRISM (a souped up and more developed version of the PRISM) isn't at the starting gate. These things take years at the glacial pace of the NRC, though of course if President Obama decided to go all Manhattan project on it we could most definitely get there quickly enough. If GE started pushing 4th generation breeder reactors, can you imagine the hue and cry from the antie groups? What's their incentive to do that? If they're convinced that ultimately we'll end up at 4th generation reactors anyway and they can make plenty of dough and keep a low profile just taking the go slow approach, don't you imagine that's exactly what they'll do? Besides, conceivably another country with whom we have nuclear technology sharing agreements might very well certify and build it before the NRC ever gets out of the starting gate, which would make it much easier for the eventual NRC certification. Q. If this is really so good, how come someone in government isn't trying to get it restarted?¶ The DOE is attempting to resuscitate fast-reactor technology, as part of the GNEP (Global Nuclear Energy Partnership) initiative. See¶ http://www.gnep.energy.gov/gnepPRs/gnepPR011007.html, and http://www.gnep.energy.gov/.¶ The IFR is one form of fast-reactor technology (metallic fuel with pyroprocessing), but there are others -- inferior, according to the IFR scientists. The important thing these days is to get the U.S. back into a leadership role in the development and management of nuclear power, recognizing that recycling in fast reactors is necessary if the long-lived waste is to be consumed, and if the full energy potential of the uranium is to be exploited. The GNEP would resuscitate fast-reactor technology in this country.

#### Current loan guarantees aren’t enough – more on new reactor types are key to catalyze nuclear construction and solve nuclear leadership

**Belogolova 12** [National Journal Daily, July 19, 2012, “U.S. Nuclear Industry Seen Needing a Boost”, Olga Belogolova, lexis, khirn]

A robust nuclear-energy industry should be a high priority for the country's energy and national-security policy given the importance of the sector to global nonproliferation, according to a new report released on Thursday by the Bipartisan Policy Center's Nuclear Initiative . Specifically, the United States needs to lead in the licensing and development **of new reactors** and on safety reforms, management of spent nuclear fuel, the nuclear-export market, and research and development in the nuclear sector, according to the report led by former Sen. Pete Domenici, R-N.M., and former Energy Department Assistant Secretary for Nuclear Energy Warren (Pete) Miller. But leadership on nuclear issues could prove to be a challenge for the United States. Although the country has long led the charge on civilian nuclear power, the combination of a slowed electricity market, the lack of sweeping climate legislation, a natural-gas boom, and last year's Fukushima Daiichi nuclear accident in Japan have created obstacles for the development of new nuclear power in the United States in recent years. While the Nuclear Regulatory Commission this year has approved four new reactors for the Vogtle and Summer nuclear plants in Georgia and South Carolina, respectively, there are likely to only be a few more plants licensed in the United States in the near future. The story is very different on the international level. After Fukushima, countries such as Germany, Italy, Switzerland, and of course Japan have paused or slowed down their nuclear-energy development, but that hasn't stopped the rest of the world. Many other nations such as China, India, South Korea, and Russia have reaffirmed plans to expand their fleets of nuclear reactors, while some countries in the Middle East have even announced plans to develop nuclear energy for the first time. China alone, which has 26 new reactors under development, is expected to account for 40 percent of planned nuclear construction globally. The United States might be a leader now, accounting for nearly one-third of global nuclear generation, but it won't be long before others come out ahead of us, especially given how long it takes to construct new reactors, Domenici and Miller explained. "It will be increasingly difficult for the United States to maintain its technological leadership without some near-term domestic demand for new construction," they write in the report. In order to control the proliferation of nuclear weapons, the United States **needs to remain involved in everything** that happens to nuclear materials, from the export of nuclear fuel for energy use to the disposal of spent fuel. Given the global picture, Domenici and Miller suggest a shift in U.S. policies in order to ensure that the U.S. nuclear energy program is not stuck at a near-standstill. "Market signals alone are unlikely to result in a diverse fuel mix, so helping to maintain and improve a range of electricity supply options remains a role for federal policy," the two write in the report. "In particular, U.S. policy should be aimed at helping to preserve nuclear energy as an important technology option for near- or longer-term deployment." The vast shale-gas reserves in the United States and new technology to tap them will probably keep natural-gas prices low for the foreseeable future, making financing of more expensive nuclear power more difficult. **Federal loan guarantees have long been viewed as crucial to growing the nuclear industry**, but the Energy Department has dragged its feet on these conditional loans, especially after the bankruptcy of the federally funded solar firm Solyndra so much so that some companies have decided not to wait around and see what happens. Southern Company, which is building the first two new reactors to be approved in decades at its Vogtle nuclear plant in Georgia, on Thursday said that it is now considering doing so without federal support. The company had been waiting for an $8.33 billion loan guarantee to build the two new reactors, but Southern CEO Tom Fanning told Reuters on Thursday that talks with DOE were going slowly and they might not be willing to wait any longer.

#### Loan guarantees attract private capital – increases are key

**Peskoe 12** [Ari Peskoe, associate in the law firm of McDermott Will and Emery LLP and focuses his practice on regulatory, legislative, compliance, and transactional issues related to energy markets, 4-20-2012, "A Solution Looking For a Problem: Building More Nuclear Reactors after Vogtle," The Electricty Journal, vol 25 issue 3, Science Direct]

Given the checkered history of reactor construction projects,56 private lenders are understandably skittish about lending billions of dollars to develop a new reactor. Construction of the Vogtle and SCANA reactors will be a critical test, and significant cost overruns on these two projects could doom the prospects for construction of additional reactors. Even if the construction of Vogtle and SCANA are on budget, it will likely still be difficult for future project developers to raise enough debt financing without government support.57 Federal loan guarantees shift “a large part of the learning costs and construction risks” from private lenders to the federal government by ensuring that lenders receive payment in the event that the developer defaults on repayments.58 Appropriations for the guarantees authorized by the Energy Policy Act of 2005 will soon run out, so future guarantees will require congressional action.59¶ Loan guarantees cost the federal government little or nothing unless there is an event of default.60 Creating a long-term guarantee program would be entirely consistent with the government's historic role in accepting risks and liabilities of nuclear power. Although it has not been implemented effectively, the Nuclear Waste Policy Act (NWPA) of 1982 requires the DOE to transport nuclear waste from privately owned reactors to permanent government storage facilities.61 Concerned about a “cloud of bankruptcy” hanging over its operations,62 the nascent nuclear industry pushed Congress to pass the Price-Anderson Act in 1957, which indemnifies the industry against claims arising from a nuclear incident. Both the NWPA and the Price-Anderson Act socialize costs of nuclear energy. In the case of the NWPA, the industry pays the DOE a tenth of a penny for each kilowatt-hour of nuclear energy sold to fund waste disposal activities.63 The Price-Anderson Act also requires generators to contribute to a fund, but the federal treasury would likely cover much of the liabilities associate with a nuclear disaster.64

#### **IFR’s are really cheap – existing coal plants can be retrofitted – solves warming**

Archambeauet all 11 [The Integral Fast Reactor (IFR): An Optimized Source for Global Energy Needs, Charles Archambeau, Science Council for Global Initiatives, Randolph Ware, Cooperative Institute for Research in Environmental Sciences, Tom Blees, National Center for Atmospheric Research, Barry Brook, University of Adelaide, Jerry Peterson, Argonne National Laboratory,¶ Yoon Chang, University of Colorado, February 2011]

The new features of the IFR systems with pyroprocessing are such that the cost of¶ electrical energy production is estimated to be quite low, in the range below $.01 per¶ kilowatt-hour for an IFR. (For comparison, natural gas fuel cost was at $.05 per kilowatthour,¶ and coal was at about $.03 per kilowatt-hour, while LWR nuclear power was at $.02¶ per kilowatt-hour.) The G.E. estimated building cost of the S-Prism reactor (Fletcher,¶ 2006) is $1300/kw, where this cost assumes some cost savings due to mass production and¶ modular construction. For a commercial level gigawatt reactor (using 3 modular S-Prism¶ reactors with 380 MW of power from each) the cost would total $1.3 billion dollars per¶ one gigawatt plant. These nuclear plants are essentially carbon dioxide emissions free, and¶ in general produce no atmospheric pollution. Further, all the Uranium fuel can be provided¶ from processing the stock piles of spent and depleted Uranium fuel. Therefore, no Uranium¶ mining and associated pollution will occur. Likewise, IFR waste material is minimal and¶ short-lived so that no pollution will occur from this source. Consequently, significant¶ reduction in greenhouse gases, and a variety of other dangerous pollutants, can be¶ immediately achieved if these IFR plants are used to replace the furnaces in coal burning¶ power plants which exist in profusion world-wide. Here the infrastructure at existing coal fueled plants, such as electric power lines, water sources and conduits, steam turbines, etc.,¶ can all be simply converted and used in the nuclear powered plant. Hence, costs of¶ building complete power plants and their electrical connections to the grid can be¶ minimized while the impact on global warming and pollution related diseases can be¶ maximized by replacing the worst of the polluters. Further, it is urgent that we move¶ quickly to strongly and immediately control CO2 gas emissions to drastically slow global¶ warming. Clearly, the costs are not prohibitive since construction of one large stand-alone¶ pyroprocessing plant, at about 6 billion dollars, and only about 10 of the large IFR¶ powered plants, costing under 20 billion dollars, will go a long way toward strongly¶ dampening the massive production of CO2 emissions from existing electricity power plants¶ in the U.S.