### ADV 1

#### Advantage One: Proliferation

#### It’s coming now and risks un-deterrable nuclear war

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Given their disproportionate power, nuclear weapons cannot serve to achieve limited policy goals, thus excluding their use as Clausewitzian weapons; further, the possession of nuclear weapons may even inhibit actions which an aggressive non-nuclear power would otherwise contemplate versus a nuclear power. Stalin at the head of a still clearly non-nuclear USSR blockaded Berlin, an action which none of his nuclear armed successors sought to emulate. As a non-nuclear power, Red China bombed Taiwan repeatedly. The worst of it ceased after Beijing acquired nuclear weapons. Possession of nuclear weapons, possibly after a learning curve, appears to selfdeter escalatory aggressive behavior.

Bilateral deterrence between two nuclear powers has long been deemed to moderate direct confrontation and to deflect aggressive behavior towards proxies (11).Although no such theoretical consensus exists vis à vis the possible stability of multi-cornered possession of nuclear weapons, the case has been made by powerful authors such as Ken Waltz or Pierre Gallois (12). In practice, a global multipolar nuclear order was established to some extent since the 1960s, with the USSR, the US and China forming a strategic triangle which was perceived as such by the authors of the Nixon-to-Beijing visit. A regional multipolar dispensation arguably also exists between China, India and Pakistan. These relationships have apparently not led to instabilities greater than (or even as great as) those which have characterized the US-Soviet nuclear standoff.

In short, **prolif**eration has been a manageable, **slow**-motion process, nuclear weapons have not been used nor has the probability of their use appear to have increased (rather the opposite). Its overall status is satisfactory, provided some adjustments are made in terms of securing material from nonstate actors, even if the policy mix sustaining it is messy and occasionally fraught –as so many things are in international life. Difficult case-specific situations such as Iran today will continued to be handled as such, as Iraq was yesterday.

THE PAST IS NOT WHAT IT USED TO BE

The problem with this reassuring reading of the past is that it is not entirely true. Yes, the NPT had a major material effect by gradually making non nuclear the new normal. Yes again, defense guarantees by the US weaned Germany, Italy (13), South Korea, Taiwan and even neutral Sweden away from the nuclear road, followed by the US-French-British assurances to post-Soviet Ukraine. Yes too, various levels of coercion worked in Iraq, Libya and Syria. But no, the practice of even the most ‘classical’ bilateral deterrence was not nearly as reassuring as the mainstream narrative inherited from the Cold War would have it. Nor can we consider that our elements for empirical judgment as methodologically satisfactory in terms of their breadth and depth. These two negatives will be examined in turn.

Nuclear archives, as other sensitive governmental archives, open up usually after an interval of decades and even then with varying levels of culling and redaction. Even oral histories tend to follow this pattern, as ageing witnesses feel freer to speak up. Hence a paradox: when the Soviet- American nuclear confrontation was central to our lives and policies during the Cold War, we didn’t how bad things really where; now that we are beginning to know, there is little public interest given the disappearance of the East-West contest. Yet there are lessons of general interest which can be summarized as follows: 1) the Cuban missile crisis brought us much closer to the brink than the acute sense of danger which prevailed at the time, for reasons which are germane to the current situation: massive **failures of intelligence** on Soviet nuclear preparations and dispositions in Cuba, notably on tactical nukes and on the operational readiness of a number of IRBMs and their warheads; dysfunctional or imperfect command and control arrangements (notably vis à vis Soviet submarines), unintentionally mixed signals on each antagonist’s actions). These are effectively laid out in Michael Dobb’s book, “One Minute to Midnight”(14). 2) the safety and security of nuclear forces are subject to potentially calamitous procedural, technical or operational mishaps and miscalculations, somewhat along the lines of what applies to related endeavors (nuclear power and aerospace). Scott Sagan in his “Limits of Safety”(15) provides compelling research on the American Cold War experience. It would be interesting to have a similar treatment on the Soviet experience…Although it can be argued that today’s nuclear arsenals are much smaller and easier to manage reliable, and that the technology for their control has been vastly improved, several facts remain:

the US has continued to witness serious procedural lapses in the military nuclear arena (16); the de-emphasis of the importance of nuclear weapons in the US force structure is not conducive to treating them with the respect which is due to their destructive power; other nuclear powers do not necessarily benefit from the same technology and learning curves as the older nuclear states, and notably the US; cheek-to-jowl nuclear postures, which prevailed in the Cuban missile crisis and which help explain why World War III nearly occurred, and which characterize India and Pakistan today.

Despite the dearth of detail on Indian and Pakistani nuclear crisis management, we know that the stability of nuclear deterrence between India and Pakistan is by no means a given, with serious risks occurring on several occasions since the mid-1980s(17).

At another level of analysis, we have to recognize the limits of the database on which we ground our policies on nonproliferation. The nuclear age, in terms of operationally usable devices, began in 1945, less than seventy years, less than the age of an old man. The fact that there has been no accidental or deliberate nuclear use during that length of time is nearly twice as reassuring as the fact that it took more than thirty years (18) for a nuclear electricity generating plant to blow up, in the form of the Chernobyl disaster of 1986. But given the destructive potential of nuclear weapons, twice as much reassurance (in the form of no use of nuclear weapons for close to seventy years) is probably not good enough. Furthermore, the Chernobyl disaster involved the same sort of errors of judgment, procedural insufficiencies and crisis-mismanagement visible in Scott Sagan’s book, not only or even mainly, flawed design choices: inadvertence at work, in other words of the sort which could prevail in a time-sensitive, geographically constrained Indo- Pakistani or Middle Eastern conflict. Give it another seventy years to pass judgment?

The same empirical limits apply to the number of actors at play: we have simple bipolar (US-USSR/Russia or India/Pakistan) and complex bipolar (US/France/UK/NATO-Soviet Union/Russia) experience; we’ve had US-Soviet-Chinese or Sino- Indian-Pakistani tripolarity; and we’ve had a number of unipolar moments (one nuclear state vis à vis non-nuclear antagonists). But we mercifully have not had to deal with more complex strategic geometries –yet- in the Middle East or East Asia. We only know what we know, we don’t know what we don’t know.

A historical narrative which is not reassuring and an empirical record that is less than compelling need to inform the manner in which we approach further proliferation.

PROLIFERATION PUSH AND PULL

Ongoing proliferation differs from that of the first halfcentury of the nuclear era in three essential ways: on the demand side, the set of putative nuclear actors is largely focused in the most strategically stressed regions of the world; on the supply side, the actual or potential purveyors of proliferation are no longer principally the first, industrialized, generation of nuclear powers; the technology involved in proliferation is somewhat less demanding than it was during the first nuclear age. Taken together, these changes entail growing risks of nuclear use.

Demand is currently focusing on two regions, the Middle East and East Asia (broadly defined) and involves states and, potentially, non-state actors. In the Middle East, Iran’s nuclear program is the focus of the most intense concerns. A potential consequence in proliferation terms would be to lead regional rivals of Iran to acquire nuclear weapons in term: this concern was vividly in 2007 by the then President of France, Jacques Chirac (19) who specifically mentioned Egypt and Saudi Arabia. The likelihood of such a “proliferation chain-reaction” may have been increased by President Obama’s recent repudiation of containment as an option (20): short of Iran being persuaded or forced to abandon its nuclear ambitions, the neighboring states would presumably have to contemplate security options other than a Cold War style US defense guarantee. Given prior attempts by Iraq, Syria and Libya to become nuclear powers, the probability of a multipolar nuclear Middle East has to be rated as high in case Iran is perceived as having acquired a military nuclear capability. Beyond the Middle East, the possibility of civil war in nuclear-armed Pakistan leading to state failure and the possibility of nukes falling out of the hands of an effective central government. There are historical precedents for such a risk, most notably, but not only(21)in the wake of the collapse of the Soviet Union: timely and lasting action by outside powers, such as the US with the Nunn-Lugar initiative, and the successor states themselves has prevented fissile material from falling into unauthorized hands in significant quantities. Pakistan could pose similar problems in a singularly more hostile domestic environment. As things stand, non-state actors, such as post-Soviet mafiya bosses (interested in resale potential) or Al Qaeda (22) have sought, without apparent success, to benefit from opportunities arising from nuclear disorder in the former USSR and Central Asia. Mercifully, the price Al Qaeda was ready to pay was way below the going rate (upwards of hundreds of $million) for the sorts of services provided by the A.Q.Khan network (see below)to some of his clients.

Although North Korea’s nuclear ambitions appear to be both more self-centered and more containable than is the case for Iran, the possibility of state collapse in combination with regional rivalry leave no room for complacency.

More broadly we are facing the prospect of a multipolar nuclear Middle East, linked to an uncertain nuclear Pakistan already part of a nuclear South Asia tied via China to the Korean nexus in which nuclear America and Russia also have a stake. More broadly still, such a nuclear arc-of-crisis from the Mediterranean to the Sea of Japan, would presumably imply the breakdown of the NPT regime, or at least its reversion to the sort of status it had during the Seventies, when many of its currently significant members had not yet joined (23), unloosening both the demand and supply sides of proliferation.

On the supply side, “old style” proliferation relied on official cooperation between first-generation nuclear or nuclearizing powers, of which the Manhattan project was a forerunner (with American, British and Canadian national contributions and multinational scientific teams), followed inter alia by post-1956 French-Israeli, post-1958 US-UK, pre- 1958 USSR-China cooperation. If India relied heavily on the “unwitting cooperation” , notably on the part of Canada and the US involved in the Atoms for Peace CIRUS research reactor, Pakistan set up the first dedicated, broad spectrum, crossborder trading network to make up for the weakness of its limited industrial base. This import-focused organization thus went beyond traditional espionage-aided efforts (as practiced by the USSR during and after the Manhattan project) or case-by-case purloining or diversion of useful material on the global market (as practiced by Israeli operatives). Even before the Pakistani network had fulfilled its primary task of supplying the national program, it began its transformation into an export-oriented venture.

Libya, Iran, North Korea and a fourth country which remains officially unnamed became the main outlets of what became the world’s first private-sector (albeit government originated and ,presumably, supported)proliferation company which was only wound down after strong Western pressure on Pakistan after 9/11. Although the by-now richly documented A.Q.Khan network (24) appears to have ceased to function in its previous incarnation, it has powerfully demonstrated that there is an international market for proliferation which other operators can expect to exploit. Furthermore, budding, resource-weak nuclear powers have a strong incentive to cover the cost of their investment by selling or bartering their nuclear-related assets, including delivery systems. The fruits of state-tostate cooperation between Iran, North Korea and Pakistan are clearly apparent in the close-to-identical genealogy of their nuclear-capable ballistic missiles of the No- Dong/Ghauri/Shahab families displayed in military parades and test launches. Not all such cooperation consists of televised objects.

Even in the absence of game-changing breakthroughs, technical trends facilitate both demand and supply-side proliferation. For the time being, the plutonium route towards the bomb remains essentially as easy and as difficult as from the earliest years of the nuclear era. Provided a country runs a (difficult-to-hide) research or a power reactor from which low-irradiated fuel can be downloaded at will (such as CANDUtype natural uranium reactors), reprocessing is a comparatively straightforward and undemanding task. Forging and machining a multiple-isotope metal which is notorious for its numerous physical states and chemical toxicity is a substantial challenge, with the companion complications of devising a reliable implosion mechanism. Nuclear testing is highly desirable to establish confidence in the end-result. Opportunities for taking the plutonium-proliferation road may increase somewhat as new techniques (such as pyro-processing) come on stream. Developments in the enriched uranium field have been more substantial in facilitating proliferation. The development of lighter and more efficient centrifuges make it easier for a state to extract enriched uranium speedily in smaller and less visible facilities. Dealing with the resulting military-level HEU is a comparatively undemanding task. The long-heralded advent of industrially effective and reliable laser enrichment technology may eventually further increase ease of access. Downstream difficulties would still remain. Although implosion-mechanisms are not mandatory, they are desirable in order both to reduce the critical mass of U235 for a nuclear explosion and to make for a lighter and smaller more-readily deliverable weapons package.

In sum, incremental improvements increase the risk of proliferation. However, non-state actors are not yet, and will not be on the basis of known technical trends, in a position to master the various steps of the two existing military nuclear fuel cycles, which remain the monopoly of states. Nonstate actors would need the active complicity from (or from accomplices within) states, or benefit from the windfall of state collapse, to acquire a military nuclear capability. The threat of nuclear terrorism continues to be subordinated to developments involving state actors, a remark which is not meant to be reassuring since such developments (see above) are increasingly likely as proliferation spreads to new states and as state failure threatens in the ‘arc of proliferation’ extending from the Mediterranean to North-East Asia. Furthermore, non-state actors can be satisfied with levels of nuclear reliability and performance which states could not accept. A difficult-to-deliver or fizzle-prone nuclear device would not provide a state with the level of deterrence needed to shield it from pre-emptive or retaliatory action, whereas a terrorist group would not be seeking such immunity. A road or ship-delivered imperfect device, which would be closer to a radiological bomb than to a fully-fledged atomic weapon would provide its non-state owners with immense potential. The road to a non-state device does not need to be as well-paved.

NUCLEAR FUTURES

‘New’ lessons from a revisited past and current trends in nuclear proliferation, will tie into a number of characteristics of contemporary international relations with potentially destabilizing consequences, leading to an increasing likelihood of nuclear use. Four such characteristics will be singled out here both because of their relevance to nuclear crisis management and because of their growing role in the world system in the age of globalization:

- Strategic upsets

- Limits of imagination

- Unsustainable strains

- Radical aims

The 2008 French Defence and National Security White Paper (25) developed the concept of ‘ruptures stratégiques’ (strategic upsets)to describe the growing tendency of the world system to generate rapid, unexpected, morphing upsets of international security as a consequence of globalization broadly defined against the backdrop of urbanizing populations generating economic growth and environmental and resource constraints. In themselves, such upsets are not novel (see inter alia, a pandemic such as the Black Death in 1348-49, the Great Depression not to mention World Wars or indeed the major and benign strategic upset of 1989-1991) but the very nature of globalization and the relationship between human activity and the Earth’s ability to sustain them) mean more, and more frequent as well as more complex upsets. If this reading is correct –and the Great financial crisis, the Arab revolutions, the accession of China to superpower status can be mentioned as examples which followed the publication of the White paper- ,then the consequences in the nuclear arena will be twofold. First, nuclear doctrines and dispositions which were conceived under a set of circumstances (such as the Cold War or the India-Pakistan balance of power) may rapidly find themselves overtaken by events. For instance it is easier to demonstrate that US and Russian nuclear forces still visibly bear the imprint of their 1950s template than it is to demonstrate their optimal adaptation to post-post-Cold War requirements. Second, more challenges to international security and of a largely unforeseeable nature mean greater strains placed on the ability of nuclear powers to manage crises against the backdrop of their possession of nuclear weapons. In many, indeed most, cases, such ‘ruptures stratégiques’ will no doubt be handled with nuclear weapons appearing as irrelevant: hypothetical security consequences of an epidemic (such as the interhuman transmission of the H5N1 bird flu virus) or prospective conflicts resulting from climate change do not have prima facie nuclear aspects. But beyond the reminder that we don’t know that as a fact, the probability is, under the ‘rupture stratégique’ hypothesis, that there will be more occasions for putting all crisis management, including nuclear, to the test.

Human societies tend to lack the imagination to think through, and to act upon, what have become known as ‘black swan’ events (26): that which has never occurred (or which has happened very rarely and in a wholly different context) is deemed not be in the field of reality, and to which must be added eventualities which are denied because their consequences are to awful to contemplate. The extremes of human misconduct (the incredulity in the face of evidence of the Holocaust, the failure to imagine 9/11) bear testimony to this hard-wired trait of our species. This would not normally warrant mention as a factor of growing salience if not for the recession into time of the original and only use of nuclear weapons in August 1945. Non-use of nuclear weapons may be taken for granted rather than being an absolute taboo. Recent writing on the reputedly limited effects of the Hiroshima and Nagasaki bombs (27) may contribute to such a trend, in the name of reducing the legitimacy of nuclear weapons. Recent (and often compelling) historical accounts of the surrender of the Japanese Empire which downplay the role of the atomic bombings in comparison to early research can produce a similar effect, even if that may not have been the intention (28). However desirable it has been, the end of atmospheric nuclear testing (29) has removed for more than three decades the periodic reminders which such monstrous detonations made as to the uniquely destructive nature of nuclear weapons. There is a real and growing risk that we forget what was obvious to those who first described in 1941 the unique nature of yet-to-be produced nuclear weapons (30). The risk is no doubt higher in those states for which the history of World War II has little relevance and which have not had the will or the opportunity to wrestle at the time or ex post facto with the moral and strategic implications of the nuclear bombing of Japan in 1945.

Unsustainable strains are possibly the single most compelling feature of contemporary proliferation. Tight geographical constraints –with, for instance, New Delhi and Islamabad located within 300 miles of each other-; nuclear multipolarity against the backdrop of multiple, criss-crossing, sources of tension in the Middle East (as opposed to the relative simplicity of the US-Soviet confrontation); the existence of doctrines (such as India’s ‘cold start’) and force postures (such as Pakistan’s broadening array of battlefield nukes)which rest on the expectation of early use; the role of non-state actors as aggravating or triggering factors when they are perceived as operating with the connivance of an antagonist state ( in the past, the assassination of the Austrian Archduke in Sarajevo in 1914; in the future, Hezbollah operatives launching rockets with effect against Israel or Lashkar-e-Taiba commandos doing a ‘Bombay’ redux in India?) : individually or in combination, these factors test crisis management capabilities more severely than anything seen during the Cold War with the partial exception of the Cuban missile crisis. Even the overabundant battlefield nuclear arsenals in Cold War Central Europe, with their iffy weapons’ safety and security arrangements, were less of a challenge: the US and Soviet short-range nuclear weapons so deployed were not putting US and Soviet territory and capitals at risk.

It may be argued that these risk factors are known to potential protagonists and that they therefore will be led to avoid the sort of nuclear brinksmanship which characterized US and Soviet behavior during the Cold War in crises such as the Korean war, Berlin, Cuba or the Yom Kippur war. Unfortunately, the multiple nuclear crises between India and Pakistan demonstrate no such prudence, rather to the contrary. And were such restraint to feed into nuclear policy and crisis planning –along the lines of apparently greater US and Soviet nuclear caution from the mid-Seventies onwards-, the fact would remain that initial intent rarely resists the strains of a complex, multi-actor confrontation between inherently distrustful antagonists. It is also worth reflecting on the fact that during the 1980s, there was real and acute fear in Soviet ruling circles that the West was preparing an out-of-the-blue nuclear strike, a fear which in turn fed into Soviet policies and dispositions (31).

The Cold War was a set of crises and misunderstandings which came within a whisker of a nuclear holocaust; India and Pakistan’s nuclear standoff is deeply unstable not least as a result of the interaction with non-state actors; a multipolar nuclear Middle East would make the Cuban missile crisis look easy in comparison.

Great conflicts tend to occur when one or several of the antagonists views the status quo as sufficiently undesirable and/or unsustainable to prompt forceful pro-action. Notwithstanding widespread perceptions to the contrary, this was not the case of the USSR and the United States during the Cold War. The US had chosen a policy of containment, as opposed to roll-back, of the Soviet Empire within its limits established as a result of World War II. The Soviet Union seized targets of opportunity outside of its 1945 area of control but avoided direct confrontation with US forces. Messianic language from the USSR on the global victory of communism or from the US about the end of the Evil Empire did not take precedence over the prime Soviet concern of preserving the Warsaw Pact and the US pursuit of containment – and, no less crucially, their mutual confidence that they could achieve these aims without going to war one with the other.

No such generalization can be made about the Middle East, a region in which the very existence of a key state (Israel) is challenged while others have gone to war with each other (e.G.Iran-Iraq war, the Gulf War of 1990-1991), or are riven by deep internal conflicts. Actors such as Hezbollah, with its organic and functional links with Islamic Iran and Alawite Syria add to the complexities and dangers. Extreme views and actions vis à vis the strategic status quo are widely prevalent. Although the India-Pakistan relationship corresponds to something akin to the US-Soviet ‘adversarial partnership’, that does not apply to radical non-state actors prevalent in Pakistan with more or less tight links to that country’s military intelligence services (ISI, Inter-Services Intelligence). The potential for danger is compounded by the variety of such groups: the Pashtu-related Pakistani Taliban (TTP), Kashmiri-related groups, Jihadi militants from the core provinces of Punjab and Sind… Their common characteristics are extreme radicalism, high levels of operational proficiency, and shared enmity of India. Their potential for triggering a conflict between the two countries is substantial, above and beyond the intentions of government officials.

#### And, cascading prolif ensures extinction

Kroenig, 12 [May 26th, Matthew Kroenig: Assistant Professor of Government, Georgetown University and Stanton Nuclear Security Fellow, Council on Foreign Relations, The History of Proliferation Optimism: Does It Have A Future? Prepared for the Nonproliferation Policy Education Center, <http://www.npolicy.org/article.php?aid=1182&tid=30>]

Proliferation Optimism: Proliferation optimism was revived in the academy in Kenneth Waltz’s 1979 book, Theory of International Politics.[[1]](#footnote-1)[29] In this, and subsequent works, Waltz argued that the spread of nuclear weapons has beneficial effects on international politics. He maintained that states, fearing a catastrophic nuclear war, will be deterred from going to war with other nuclear-armed states. As more and more states acquire nuclear weapons, therefore, there are fewer states against which other states will be willing to wage war. The spread of nuclear weapons, according to Waltz, leads to greater levels of international stability. Looking to the empirical record, he argued that the introduction of nuclear weapons in 1945 coincided with an unprecedented period of peace among the great powers. While the United States and the Soviet Union engaged in many proxy wars in peripheral geographic regions during the Cold War, they never engaged in direct combat. And, despite regional scuffles involving nuclear-armed states in the Middle East, South Asia, and East Asia, none of these conflicts resulted in a major theater war. This lid on the intensity of conflict, according to Waltz, was the direct result of the stabilizing effect of nuclear weapons. Following in the path blazed by the strategic thinkers reviewed above, Waltz argued that the requirements for deterrence are not high. He argued that, contrary to the behavior of the Cold War superpowers, a state need not build a large arsenal with multiple survivable delivery vehicles in order to deter its adversaries. Rather, he claimed that a few nuclear weapons are sufficient for deterrence. Indeed, he even went further, asserting that any state will be deterred even if it merely suspects its opponent might have a few nuclear weapons because the costs of getting it wrong are simply too high. Not even nuclear accident is a concern according to Waltz because leaders in nuclear-armed states understand that if they ever lost control of nuclear weapons, resulting in an accidental nuclear exchange, the nuclear retaliation they would suffer in response would be catastrophic. Nuclear-armed states, therefore, have strong incentives to maintain control of their nuclear weapons. Not even new nuclear states, without experience in managing nuclear arsenals, would ever allow nuclear weapons to be used or let them fall in the wrong hands. Following Waltz, many other scholars have advanced arguments in the proliferation optimist school. For example, Bruce Bueno de Mesquite and William Riker explore the “merits of selective nuclear proliferation.”[[2]](#footnote-2)[30] John Mearsheimer made the case for a “Ukrainian nuclear deterrent,” following the collapse of the Soviet Union.[[3]](#footnote-3)[31] In the run up to the 2003 Gulf War, John Mearsheimer and Steven Walt argued that we should not worry about a nuclear-armed Iraq because a nuclear-armed Iraq can be deterred.[[4]](#footnote-4)[32] And, in recent years, Barry Posen and many other realists have argued that nuclear proliferation in Iran does not pose a threat, again arguing that a nuclear-armed Iran can be deterred.[[5]](#footnote-5)[33] What’s Wrong with Proliferation Optimism? The proliferation optimist position, while having a distinguished pedigree, has several major problems. Many of these weaknesses have been chronicled in brilliant detail by Scott Sagan and other contemporary proliferation pessimists.[[6]](#footnote-6)[34] Rather than repeat these substantial efforts, I will use this section to offer some original critiques of the recent incarnations of proliferation optimism. First and foremost, proliferation optimists do not appear to understand contemporary deterrence theory. I do not say this lightly in an effort to marginalize or discredit my intellectual opponents. Rather, I make this claim with all due caution and with complete sincerity. A careful review of the contemporary proliferation optimism literature does not reflect an understanding of, or engagement with, the developments in academic deterrence theory in top scholarly journals such as the American Political Science Review and International Organization over the past few decades.[[7]](#footnote-7)[35] While early optimists like Viner and Brodie can be excused for not knowing better, the writings of contemporary proliferation optimists ignore the past fifty years of academic research on nuclear deterrence theory. In the 1940s, Viner, Brodie, and others argued that the advent of Mutually Assured Destruction (MAD) rendered war among major powers obsolete, but nuclear deterrence theory soon advanced beyond that simple understanding.[[8]](#footnote-8)[36] After all, great power political competition does not end with nuclear weapons. And nuclear-armed states still seek to threaten nuclear-armed adversaries. States cannot credibly threaten to launch a suicidal nuclear war, but they still want to coerce their adversaries. This leads to a credibility problem: how can states credibly threaten a nuclear-armed opponent? Since the 1960s academic nuclear deterrence theory has been devoted almost exclusively to answering this question.[[9]](#footnote-9)[37] And, unfortunately for proliferation optimists, the answers do not give us reasons to be optimistic. Thomas Schelling was the first to devise a rational means by which states can threaten nuclear-armed opponents.[[10]](#footnote-10)[38] He argued that leaders cannot credibly threaten to intentionally launch a suicidal nuclear war, but they can make a “threat that leaves something to chance.”[[11]](#footnote-11)[39] They can engage in a process, the nuclear crisis, which increases the risk of nuclear war in an attempt to force a less resolved adversary to back down. As states escalate a nuclear crisis there is an increasingprobability that the conflict will spiral out of control and result in an inadvertent or accidental nuclear exchange. As long as the benefit of winning the crisis is greater than the incremental increase in the risk of nuclear war, threats to escalate nuclear crises are inherently credible. In these games of nuclear brinkmanship, the state that is willing to run the greatest risk of nuclear war before back down will win the crisis as long as it does not end in catastrophe. It is for this reason that Thomas Schelling called great power politics in the nuclear era a “competition in risk taking.”[[12]](#footnote-12)[40] This does not mean that states eagerly bid up the risk of nuclear war. Rather, they face gut-wrenching decisions at each stage of the crisis. They can quit the crisis to avoid nuclear war, but only by ceding an important geopolitical issue to an opponent. Or they can the escalate the crisis in an attempt to prevail, but only at the risk of suffering a possible nuclear exchange. Since 1945 there were have been many high stakes nuclear crises (by my count, there have been twenty) in which “rational” states like the United States run a risk of nuclear war and inch very close to the brink of nuclear war.[[13]](#footnote-13)[41] By asking whether states can be deterred or not, therefore, proliferation optimists are asking the wrong question. The right question to ask is: what risk of nuclear war is a specific state willing to run against a particular opponent in a given crisis? Optimists are likely correct when they assert that Iran will not intentionally commit national suicide by launching a bolt-from-the-blue nuclear attack on the United States or Israel. This does not mean that Iran will never use nuclear weapons, however. Indeed, it is almost inconceivable to think that a nuclear-armed Iran would not, at some point, find itself in a crisis with another nuclear-armed power and that it would not be willing to run any risk of nuclear war in order to achieve its objectives. If a nuclear-armed Iran and the United States or Israel have a geopolitical conflict in the future, over say the internal politics of Syria, an Israeli conflict with Iran’s client Hezbollah, the U.S. presence in the Persian Gulf, passage through the Strait of Hormuz, or some other issue, do we believe that Iran would immediately capitulate? Or is it possible that Iran would push back, possibly even brandishing nuclear weapons in an attempt to deter its adversaries? If the latter, there is a real risk that proliferation to Iran could result in nuclear war. An optimist might counter that nuclear weapons will never be used, even in a crisis situation, because states have such a strong incentive, namely national survival, to ensure that nuclear weapons are not used. But, this objection ignores the fact that leaders operate under competing pressures. Leaders in nuclear-armed states also have very strong incentives to convince their adversaries that nuclear weapons could very well be used. Historically we have seen that in crises, leaders purposely do things like put nuclear weapons on high alert and delegate nuclear launch authority to low level commanders, purposely increasing the risk of accidental nuclear war in an attempt to force less-resolved opponents to back down. Moreover, not even the optimists’ first principles about the irrelevance of nuclear posture stand up to scrutiny. Not all nuclear wars would be equally devastating.[[14]](#footnote-14)[42] Any nuclear exchange would have devastating consequences no doubt, but, if a crisis were to spiral out of control and result in nuclear war, any sane leader would rather be facing a country with five nuclear weapons than one with thirty-five thousand. Similarly, any sane leader would be willing to run a greater risk of nuclear war against the former state than against the latter. Indeed, systematic research has demonstrated that states are willing to run greater risks and, therefore, more likely to win nuclear crises when they enjoy nuclear superiority over their opponent.[[15]](#footnote-15)[43] Proliferation optimists miss this point, however, because they are still mired in 1940s deterrence theory. It is true that no rational leader would choose to launch a nuclear war, but, depending on the context, she would almost certainly be willing to risk one. Nuclear deterrence theorists have proposed a second scenario under which rational leaders could instigate a nuclear exchange: a limited nuclear war.[[16]](#footnote-16)[44] By launching a single nuclear weapon against a small city, for example, it was thought that a nuclear-armed state could signal its willingness to escalate the crisis, while leaving its adversary with enough left to lose to deter the adversary from launching a full-scale nuclear response. In a future crisis between a nuclear-armed China and the United States over Taiwan, for example, China could choose to launch a nuclear attack on Honolulu to demonstrate its seriousness. In that situation, with the continental United States intact, would Washington choose to launch a full-scale nuclear war on China that could result in the destruction of many more American cities? Or would it back down? China might decide to strike hoping that Washington will choose a humiliating retreat over a full-scale nuclear war. If launching a limited nuclear war could be rational, it follows that the spread of nuclear weapons increases the risk of nuclear use. Again, by ignoring contemporary developments in scholarly discourse and relying exclusively on understandings of nuclear deterrence theory that became obsolete decades ago, optimists reveal the shortcomings of their analysis and fail to make a compelling case. The optimists also error by confusing stability for the national interest. Even if the spread of nuclear weapons contributes to greater levels of international stability (which discussions above and below suggest it might not) it does not necessarily follow that the spread of nuclear weapons is in the U.S. interest. There might be other national goals that trump stability, such as reducing to zero the risk of nuclear war in an important geopolitical region. Optimists might argue that South Asia is more stable when India and Pakistan have nuclear weapons, but certainly the risk of nuclear war is higher than if there were no nuclear weapons on the subcontinent. In addition, it is wrong to assume that stability is always in the national interest. Sometimes it is, but sometimes it is not. If stability is obtained because Washington is deterred from using force against a nuclear-armed adversary in a situation where using force could have advanced national goals, stability harms, rather than advances, U.S. national interests. The final gaping weakness in the proliferation optimist argument, however, is that it rests on a logical contradiction. This is particularly ironic, given that many optimists like to portray themselves as hard-headed thinkers, following their premises to their logical conclusions. But, the contradiction at the heart of the optimist argument is glaring and simple to understand: either the probability of nuclear war is zero, or it is nonzero, but it cannot be both. If the probability of nuclear war is zero, then nuclear weapons should have no deterrent effect. States will not be deterred by a nuclear war that could never occur and states should be willing to intentionally launch large-scale wars against nuclear-armed states. In this case, proliferation optimists cannot conclude that the spread of nuclear weapons is stabilizing. If, on the other hand, the probability of nuclear war is nonzero, then there is a real danger that the spread of nuclear weapons increases the probability of a catastrophic nuclear war. If this is true, then proliferation optimists cannot be certain that nuclear weapons will never be used. In sum, the spread of nuclear weapons can either raise the risk of nuclear war and in so doing, deter large-scale conventional conflict. Or there is no danger that nuclear weapons will be used and the spread of nuclear weapons does not increase international instability. But, despite the claims of the proliferation optimists, it is nonsensical to argue that nuclear weapons will never be used and to simultaneously claim that their spread contributes to international stability. Proliferation Anti-obsessionists: Other scholars, who I label “anti-obsessionists” argue that the spread of nuclear weapons has neither been good nor bad for international politics, but rather irrelevant. They argue that academics and policymakers concerned about nuclear proliferation spend too much time and energy obsessing over something, nuclear weapons, that, at the end of the day, are not all that important. In Atomic Obsession, John Mueller argues that widespread fears about the threat of nuclear weapons are overblown.[[17]](#footnote-17)[45] He acknowledges that policymakers and experts have often worried that the spread of nuclear weapons could lead to nuclear war, nuclear terrorism and cascades of nuclear proliferation, but he then sets about systematically dismantling each of these fears. Rather, he contends that nuclear weapons have had little effect on the conduct of international diplomacy and that world history would have been roughly the same had nuclear weapons never been invented. Finally, Mueller concludes by arguing that the real problem is not nuclear proliferation, but nuclear nonproliferation policy because states do harmful things in the name of nonproliferation, like take military action and deny countries access to nuclear technology for peaceful purposes. Similarly, Ward Wilson argues that, despite the belief held by optimists and pessimists alike, nuclear weapons are not useful tools of deterrence.[[18]](#footnote-18)[46] In his study of the end of World War II, for example, Wilson argues that it was not the U.S. use of nuclear weapons on Hiroshima and Nagasaki that forced Japanese surrender, but a variety of other factors, including the Soviet Union’s decision to enter the war. If the actual use of nuclear weapons was not enough to convince a country to capitulate to its opponent he argues, then there is little reason to think that the mere threat of nuclear use has been important to keeping the peace over the past half century. Leaders of nuclear-armed states justify nuclear possession by touting their deterrent benefits, but if nuclear weapons have no deterrent value, there is no reason, Ward claims, not to simply get rid of them. Finally, Anne Harrington de Santana argues that nuclear experts “fetishize” nuclear weapons.[[19]](#footnote-19)[47] Just like capitalists, according to Karl Marx, bestow magical qualities on money, thus fetishizing it, she argues that leaders and national security experts do the same thing to nuclear weapons. Nuclear deterrence as a critical component of national security strategy, according to Harrington de Santana, is not inherent in the technology of nuclear weapons themselves, but is rather the result of how leaders in countries around the world think about them. In short, she argues, “Nuclear weapons are powerful because we treat them as powerful.”[[20]](#footnote-20)[48] But, she maintains, we could just as easily “defetish” them, treating them as unimportant and, therefore, rendering them obsolete. She concludes that “Perhaps some day, the deactivated nuclear weapons on display in museums across the United States will be nothing more than a reminder of how powerful nuclear weapons used to be.”[[21]](#footnote-21)[49] The anti-obsessionists make some thought-provoking points and may help to reign in some of the most hyperbolic accounts of the effect of nuclear proliferation. They remind us, for example, that our worst fears have not been realized, at least not yet. Yet, by taking the next step and arguing that nuclear weapons have been, and will continue to be, irrelevant, they go too far. Their arguments call to mind the story about the man who jumps to his death from the top of a New York City skyscraper and, when asked how things are going as he passes the 15th story window, replies, “so far so good.” The idea that world history would have been largely unchanged had nuclear weapons not been invented is a provocative one, but it is also unfalsifiable. There is good reason to believe that world history would have been different, and in many ways better, had certain countries not acquired nuclear weapons. Let’s take Pakistan as an example. Pakistan officially joined the ranks of the nuclear powers in May 1998 when it followed India in conducting a series of nuclear tests. Since then, Pakistan has been a poster child for the possible negative consequences of nuclear proliferation. Pakistan’s nuclear weapons have led to further nuclear proliferation as Pakistan, with the help of rogue scientist A.Q. Khan, transferred uranium enrichment technology to Iran, Libya, and North Korea.[[22]](#footnote-22)[50] Indeed, part of the reason that North Korea and Iran are so far along with their uranium enrichment programs is because they got help from Pakistan. Pakistan has also become more aggressive since acquiring nuclear weapons, displaying an increased willingness to sponsor cross-border incursions into India with terrorists and irregular forces.[[23]](#footnote-23)[51] In a number of high-stakes nuclear crises between India and Pakistan, U.S. officials worried that the conflicts could escalate to a nuclear exchange and intervened diplomatically to prevent Armageddon on the subcontinent. The U.S. government also worries about the safety and security of Pakistan’s nuclear arsenal, fearing that Pakistan’s nukes could fall into the hands of terrorists in the event of a state collapse or a break down in nuclear security. And we still have not witnessed the full range of consequences arising from Pakistani nuclear proliferation. Islamabad has only possessed the bomb for a little over a decade, but they are likely to keep it for decades to come, meaning that we could still have a nuclear war involving Pakistan. In short, Pakistan’s nuclear capability has already had deleterious effects on U.S. national security and these threats are only likely to grow over time. In addition, the anti-obsessionists are incorrect to argue that the cure of U.S. nuclear nonproliferation policy is worse than the disease of proliferation. Many observers would agree with Mueller that the U.S. invasion of Iraq in 2003 was a disaster, costing much in the way of blood and treasure and offering little strategic benefit. But the Iraq War is hardly representative of U.S. nonproliferation policy. For the most part, nonproliferation policy operates in the mundane realm of legal frameworks, negotiations, inspections, sanctions, and a variety of other tools. Even occasional preventive military strikes on nuclear facilities have been far less calamitous than the Iraq War. Indeed, the Israeli strikes on nuclear reactors in Iraq and Syria in 1981 and 2007, respectively, produced no meaningful military retaliation and a muted international response. Moreover, the idea that the Iraq War was primarily about nuclear nonproliferation is a contestable one, with Saddam Hussein’s history of aggression, the unsustainability of maintaining the pre-war containment regime indefinitely, Saddam’s ties to terrorist groups, his past possession and use of chemical and biological weapons, and the window of opportunity created by September 11th, all serving as possible prompts for U.S. military action in the Spring of 2003. The claim that nonproliferation policy is dangerous because it denies developing countries access to nuclear energy also rests on shaky ground. If anything, the global nonproliferation regime has, on balance, increased access to nuclear technology. Does anyone really believe that countries like Algeria, Congo, and Vietnam would have nuclear reactors today were it not for Atoms for Peace, Article IV of the NPT, and other appendages of the nonproliferation regime that have provided developing states with nuclear technology in exchange for promises to forgo nuclear weapons development? Moreover, the sensitive fuel-cycle technology denied by the Nuclear Suppliers Group (NSG) and other supply control regimes is not even necessary to the development of a vibrant nuclear energy program as the many countries that have fuel-cycle services provided by foreign nuclear suppliers clearly demonstrate. Finally, the notion that nuclear energy is somehow the key to lifting developing countries from third to first world status does not pass the laugh test. Given the large upfront investments, the cost of back-end fuel management and storage, and the ever-present danger of environmental catastrophe exemplified most recently by the Fukushima disaster in Japan, many argue that nuclear energy is not a cost-effective source of energy (if all the externalities are taken into account) for any country, not to mention those developing states least able to manage these myriad challenges. Taken together, therefore, the argument that nuclear nonproliferation policy is more dangerous than the consequences of nuclear proliferation, including possible nuclear war, is untenable. Indeed, it would certainly come as a surprise to the mild mannered diplomats and scientists who staff the International Atomic Energy Agency, the global focal point of the nuclear nonproliferation regime, located in Vienna, Austria. The anti-obsessionsists, like the optimists, also walk themselves into logical contradictions. In this case, their policy recommendations do not necessarily follow from their analyses. Ward argues that nuclear weapons are irrelevant and, therefore, we should eliminate them.[[24]](#footnote-24)[52] But, if nuclear weapons are really so irrelevant, why not just keep them lying around? They will not cause any problems if they are as meaningless as anti-obsessionists claim and it is certainly more cost effective to do nothing than to negotiate complicated international treaties and dismantle thousands of warheads, delivery vehicles, and their associated facilities. Finally, the idea that nuclear weapons are only important because we think they are powerful is arresting, but false. There are properties inherent in nuclear weapons that can be used to create military effects that simply cannot, at least not yet, be replicated with conventional munitions. If a military planner wants to quickly destroy a city on the other side of the planet, his only option today is a nuclear weapon mounted on an ICBM. Therefore, if the collective “we” suddenly decided to “defetishize” nuclear weapons by treating them as unimportant, it is implausible that some leader somewhere would not independently come to the idea that nuclear weapons could advance his or her country’s national security and thereby re-fetishize them. In short, the optimists and anti-obsessionists have brought an important perspective to the nonproliferation debate. Their arguments are provocative and they raise the bar for those who wish to argue that the spread of nuclear weapons is indeed a problem. Nevertheless, their counterintuitive arguments are not enough to wish away the enormous security challenges posed by the spread of the world’s most dangerous weapons. These myriad threats will be considered in the next section. Why Nuclear Proliferation Is a Problem The spread of nuclear weapons poses a number of severe threats to international peace and U.S. national security including: nuclear war, nuclear terrorism, emboldened nuclear powers, constrained freedom of action, weakened alliances, and further nuclear proliferation. This section explores each of these threats in turn. Nuclear War. The greatest threat posed by the spread of nuclear weapons is nuclear war. The more states in possession of nuclear weapons, the greater the probability that somewhere, someday, there is a catastrophic nuclear war. A nuclear exchange between the two superpowers during the Cold War could have arguably resulted in human extinction and a nuclear exchange between states with smaller nuclear arsenals, such as India and Pakistan, could still result in millions of deaths and casualties, billions of dollars of economic devastation, environmental degradation, and a parade of other horrors. To date, nuclear weapons have only been used in warfare once. In 1945, the United States used one nuclear weapon each on Hiroshima and Nagasaki, bringing World War II to a close. Many analysts point to sixty-five-plus-year tradition of nuclear non-use as evidence that nuclear weapons are unusable, but it would be naïve to think that nuclear weapons will never be used again. After all, analysts in the 1990s argued that worldwide economic downturns like the great depression were a thing of the past, only to be surprised by the dot-com bubble bursting in the later 1990s and the Great Recession of the late Naughts.[[25]](#footnote-25)[53] This author, for one, would be surprised if nuclear weapons are not used in my lifetime. Before reaching a state of MAD, new nuclear states go through a transition period in which they lack a secure-second strike capability. In this context, one or both states might believe that it has an incentive to use nuclear weapons first. For example, if Iran acquires nuclear weapons neither Iran, nor its nuclear-armed rival, Israel, will have a secure, second-strike capability. Even though it is believed to have a large arsenal, given its small size and lack of strategic depth, Israel might not be confident that it could absorb a nuclear strike and respond with a devastating counterstrike. Similarly, Iran might eventually be able to build a large and survivable nuclear arsenal, but, when it first crosses the nuclear threshold, Tehran will have a small and vulnerable nuclear force. In these pre-MAD situations, there are at least three ways that nuclear war could occur. First, the state with the nuclear advantage might believe it has a splendid first strike capability. In a crisis, Israel might, therefore, decide to launch a preemptive nuclear strike to disarm Iran’s nuclear capabilities and eliminate the threat of nuclear war against Israel. Indeed, this incentive might be further increased by Israel’s aggressive strategic culture that emphasizes preemptive action. Second, the state with a small and vulnerable nuclear arsenal, in this case Iran, might feel use ‘em or loose ‘em pressures. That is, if Tehran believes that Israel might launch a preemptive strike, Iran might decide to strike first rather than risk having its entire nuclear arsenal destroyed. Third, as Thomas Schelling has argued, nuclear war could result due to the reciprocal fear of surprise attack.[[26]](#footnote-26)[54] If there are advantages to striking first, one state might start a nuclear war in the belief that war is inevitable and that it would be better to go first than to go second. In a future Israeli-Iranian crisis, for example, Israel and Iran might both prefer to avoid a nuclear war, but decide to strike first rather than suffer a devastating first attack from an opponent. Even in a world of MAD, there is a risk of nuclear war. Rational deterrence theory assumes nuclear-armed states are governed by rational leaders that would not intentionally launch a suicidal nuclear war. This assumption appears to have applied to past and current nuclear powers, but there is no guarantee that it will continue to hold in the future. For example, Iran’s theocratic government, despite its inflammatory rhetoric, has followed a fairly pragmatic foreign policy since 1979, but it contains leaders who genuinely hold millenarian religious worldviews who could one day ascend to power and have their finger on the nuclear trigger. We cannot rule out the possibility that, as nuclear weapons continue to spread, one leader will choose to launch a nuclear war, knowing full well that it could result in self-destruction. One does not need to resort to irrationality, however, to imagine a nuclear war under MAD. Nuclear weapons may deter leaders from intentionally launching full-scale wars, but they do not mean the end of international politics. As was discussed above, nuclear-armed states still have conflicts of interest and leaders still seek to coerce nuclear-armed adversaries. This leads to the credibility problem that is at the heart of modern deterrence theory: how can you threaten to launch a suicidal nuclear war? Deterrence theorists have devised at least two answers to this question. First, as stated above, leaders can choose to launch a limited nuclear war.[[27]](#footnote-27)[55] This strategy might be especially attractive to states in a position of conventional military inferiority that might have an incentive to escalate a crisis quickly. During the Cold War, the United States was willing to use nuclear weapons first to stop a Soviet invasion of Western Europe given NATO’s conventional inferiority in continental Europe. As Russia’s conventional military power has deteriorated since the end of the Cold War, Moscow has come to rely more heavily on nuclear use in its strategic doctrine. Indeed, Russian strategy calls for the use of nuclear weapons early in a conflict (something that most Western strategists would consider to be escalatory) as a way to de-escalate a crisis. Similarly, Pakistan’s military plans for nuclear use in the event of an invasion from conventionally stronger India. And finally, Chinese generals openly talk about the possibility of nuclear use against a U.S. superpower in a possible East Asia contingency. Second, as was also discussed above leaders can make a “threat that leaves something to chance.”[[28]](#footnote-28)[56] They can initiate a nuclear crisis. By playing these risky games of nuclear brinkmanship, states can increases the risk of nuclear war in an attempt to force a less resolved adversary to back down. Historical crises have not resulted in nuclear war, but many of them, including the 1962 Cuban Missile Crisis, have come close. And scholars have documented historical incidents when accidents could have led to war.[[29]](#footnote-29)[57] When we think about future nuclear crisis dyads, such as India and Pakistan and Iran and Israel, there are fewer sources of stability that existed during the Cold War, meaning that there is a very real risk that a future Middle East crisis could result in a devastating nuclear exchange.

#### And, an expanding domestic industry is key to the perception of technological leadership which solves prolif

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The health of the U.S. civil nuclear infrastructure can have an important bearing in a variety of ways on the ability of the United States to advance its nonproliferation objectives. During the Atoms for Peace Program and until the 1970s, the U.S. was the dominant supplier in the international commercial nuclear power market, and it exercised a strong leadership role in shaping the global nonproliferation regime. In those early days, the U.S. also had what was essentially a monopoly in the nuclear fuel supply market. This capability, among others, allowed the U.S. to promote the widespread acceptance of nonproliferation norms and restraints, including international safeguards and physical protection measures, and, most notably, the Treaty on the Non-Proliferation of Nuclear Weapons (NPT). The United States concluded agreements for cooperation in peaceful nuclear energy with other states, which require strict safeguards, physical protection and other nonproliferation controls on their civil nuclear programs. Today due to its political, military and economic position in the world, the United States continues to exercise great weight in nonproliferation matters. However, the ability of the United States to promote its nonproliferation objectives through peaceful nuclear cooperation with other countries has declined**.** The fact that no new nuclear power plant orders have been placed in over three decades has led to erosion in the capabilities of the U.S. civil nuclear infrastructure. Moreover, during the same period, the U.S. share of the global nuclear market has declined significantly, and several other countries have launched their own nuclear power programs and have become major international suppliers in their own right. It is highly significant that all but one of the U.S. nuclear power plant vendors and nuclear fuel designers and manufactures for light water reactors have now been acquired by their non-U.S. based competitors. Thus, while the U.S. remains a participant in the international market for commercial nuclear power, it no longer enjoys a dominant role as it did four decades ago. To the extent that U.S. nuclear plant vendors and nuclear fuel designers 2 and manufacturers are able to reassert themselves on a technical and commercial basis, opportunities for U.S. influence with respect to nuclear nonproliferation can be expected to increase. However, the fact that there are other suppliers that can now provide plants and nuclear fuel technology and services on a competitive commercial basis suggests that the U.S. will have to work especially hard to maintain and, in some cases, rebuild its nuclear infrastructure, if it wishes to exercise its influence in international nuclear affairs. The influence of the United States internationally could be enhanced significantly if the U.S. is able to achieve success in its Nuclear Power 2010 program and place several new orders in the next decade and beyond. There is a clear upsurge of interest in nuclear power in various parts of the world. As a consequence, if the U.S. aspires to participate in these programs and to shape them in ways that are most conducive to nonproliferation, it will need to promote the health and viability of the American nuclear infrastructure. Perhaps more importantly, if it wishes to exert a positive influence in shaping the nonproliferation policies of other countries, it can do so more effectively by being an active supplier to and partner in the evolution of those programs. Concurrent with the prospective growth in the use of nuclear power, the global nonproliferation regime is facing some direct assaults that are unprecedented in nature. International confidence in the effectiveness of nuclear export controls was shaken by the disclosures of the nuclear operations of A.Q. Khan. These developments underscore the importance of maintaining the greatest integrity and effectiveness of the nuclear export conditions applied by the major suppliers. They also underscore the importance of the U.S. maintaining effective policies to achieve these objectives. Constructive U.S. influence will be best achieved to the extent that the U.S. is perceived as a major technological leader, supplier and partner in the field of nuclear technology. As the sole superpower, the U.S. will have considerable, on-going influence on the international nonproliferation regime, regardless of how active and successful it is in the nuclear export market. However, the erosion of the U.S. nuclear infrastructure has begun to weaken the ability of the U.S. to participate actively in the international nuclear market. If the U.S. becomes more dependent on foreign nuclear suppliers or if it leaves the international 3 nuclear market to other suppliers, the ability of the U.S. to influence nonproliferation policy will diminish. It is, therefore, essential that the United States have vibrant nuclear reactor, enrichment services, and spent fuel storage and disposal industries that can not only meet the needs of U.S. utilities but will also enable the United States to promote effective safeguards and other nonproliferation controls through close peaceful nuclear cooperation with other countries. U.S. nuclear exports can be used to influence other states’ nuclear programs through the nonproliferation commitments that the U.S. requires. The U.S. has so-called consent rights over the enrichment, reprocessing and alteration in form or content of the nuclear materials that it has provided to other countries, as well as to the nuclear materials that are produced from the nuclear materials and equipment that the U.S. has supplied. Further, the ability of the U.S. to develop improved and advanced nuclear technologies will depend on its ability to provide consistent and vigorous support for nuclear R&D programs that will enjoy solid bipartisan political support in order that they can be sustained from one administration to another. As the U.S. Government expends taxpayer funds on the Nuclear Power 2010 program, the Global Nuclear Energy Partnership, the Generation IV initiative and other programs, it should consider the benefit to the U.S. industrial base and to U.S. non-proliferation posture as criteria in project design and source selection where possible. Finally, the ability of the United States to resolve its own difficulties in managing its spent fuel and nuclear wastes will be crucial to maintaining the credibility of the U.S. nuclear power program and will be vital to implementing important new nonproliferation initiatives designed to discourage the spread of sensitive nuclear facilities to other countries.

**Our internal link is historically proven**

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Historically, the ability of the U.S. to help prevent the spread of nuclear weapons has stemmed from many factors, not least of which has been the political, military and economic power that the US has exercised in international affairs. The U.S. has used many tools to promote its nonproliferation objectives. One important instrument that the U.S. has employed for decades in building the international nonproliferation system has been its ability to provide nuclear fuel, nuclear power plants and fuel cycle services to countries on a reliable and stable basis, under strict nonproliferation controls and conditions. In the early days of the nuclear era, the U.S. essentially had a monopoly in the nuclear fuel supply market. This capability, among others, allowed the U.S. to promote the widespread acceptance of nonproliferation norms and restraints, including international safeguards and physical protection measures, and, most notably, the NPT. The United States concluded agreements for cooperation in peaceful nuclear energy with other states, which require strict safeguards, physical protection and other nonproliferation controls on their civil nuclear programs. Moreover, the strength of U.S. civil nuclear capabilities gave it an important seat at the international table, not only in negotiating the norms that should 10 govern the conduct of civil nuclear power programs to protect against their misuse or diversion to nuclear weapons, but also in shaping the key elements of the global nonproliferation regime. In addition domestic U.S. nuclear programs have enabled the United States to make important contributions to achieving technical improvements in international safeguards, physical protection, and nuclear detection systems. However, the challenges now confronting the international nonproliferation regime come at a time when the U.S. commercial share of the global nuclear market has declined and when there are serious concerns about the health of the U.S. nuclear infrastructure.

**And, nuclear power is expanding which threatens the nonprolif regime, only leadership and effective export control can solve**

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Consumer countries are likely to turn for support and assistance to those states possessing the most vigorous domestic nuclear power programs that are placing new power plant orders, extending international fuel cycle services, and maintaining leadership roles in supporting innovative improvements in advanced technologies. This suggests that the influence of the United States internationally could be enhanced significantly if the U.S. is able to achieve success in its Nuclear Power 2010 program and place several new orders in the next decade and beyond. Conversely, if the 2010 initiative falters, or if U.S. companies only are given subordinate roles in processing new plant orders, then this can only further weaken the U.S. nuclear infrastructure as well as the stature of the U.S. in the international nuclear community. Experts believe that the U.S. nuclear infrastructure is capable of sustaining the goals of the 2010 program, but this will require the resolution of a number of formidable problems, including arrangements for the acquisition of long lead time components and coping with anticipated shortages of experienced personnel. Maintaining the U.S. as a Significant Global Supplier The health of the U.S. civil nuclear infrastructure will also be crucial to the success of U.S. efforts to play a significant role as a nuclear supplier and to advance its nonproliferation objectives. There is a clear and compelling upsurge of interest in nuclear power in various parts of the world that is independent of U.S. policy and prerogatives. As a consequence, if the U.S. aspires to participate in these programs and to shape them in ways that are most conducive to nonproliferation, it will need to promote the health and viability of the American nuclear infrastructure. Perhaps more importantly, if it wishes to 23 exert a positive influence in shaping the nonproliferation policies of other countries, it can do so more effectively by being an active supplier to and partner in the evolution of those programs. Concurrent with the prospective growth in the use of nuclear power, the global nonproliferation regime is facing some direct assaults that are unprecedented in nature. International confidence in the effectiveness of nuclear export controls was shaken by the disclosures of the nuclear operations of A.Q. Khan. These developments underscore the importance of maintaining the greatest integrity and effectiveness of the nuclear export conditions applied by the major suppliers. They also underscore the importance of the U.S. maintaining effective policies to achieve these objectives. Constructive U.S. influence will be best achieved to the extent that the U.S. is perceived as a major technological leader, supplier and partner in the field of nuclear technology. As the sole superpower, the U.S. will have considerable, on-going influence on the international nonproliferation regime, regardless of how active and successful it is in the nuclear export market. However, if the U.S. nuclear infrastructure continues to erode, it will weaken the ability of the U.S. to participate actively in the international nuclear market. If the U.S. becomes more dependent on foreign nuclear suppliers or if it leaves the international nuclear market to other suppliers, the ability of the U.S. to influence nonproliferation policy will diminish. It is, therefore, essential that the United States have vibrant nuclear reactor, uranium enrichment, and spent fuel storage and disposal industries that can not only meet the needs of U.S. utilities but will also enable the United States to promote effective safeguards and other nonproliferation controls through close peaceful nuclear cooperation other countries. The U.S. should establish a high priority goal to rebuild an indigenous nuclear industry and support its growth in domestic and international markets. U.S. nuclear exports can be used to influence other states’ nuclear programs through the nonproliferation commitments that the U.S. requires. The U.S. has so-called consent rights over the enrichment, reprocessing and alteration in form or content of the nuclear materials that it has provided to other countries, as well as to the nuclear materials that are produced from the nuclear materials and equipment that the U.S. has supplied. 24 The percentage of nuclear materials, including separated plutonium, that are subject to U.S. consent rights will diminish over time as new suppliers of nuclear materials and facilities take a larger share of the international nuclear market. Unless the U.S. is able to compete effectively in the international market as a supplier of nuclear fuels, equipment and technology, the quantity of the nuclear materials around the globe that the U.S. has control over will diminish significantly in the future. This may not immediately weaken the effectiveness of the nonproliferation regime since all the major suppliers have adopted the export guidelines of the Nuclear Supplier Group. However, only the U.S., Australia and Canada have consent rights over enrichment and reprocessing of the nuclear materials subject to their agreements. Consequently, if there is a major decline in the U.S. share of the international nuclear market, the U.S. may not be as effective as it has been in helping to ensure a rigorous system of export controls. Nuclear R&D Further, the revitalization of the U.S. nuclear infrastructure will depend on the U.S. ability to provide sustained bipartisan support for nuclear R&D programs in order that they can be sustained from one administration to another. The ability of the United States to continue to make significant contributions to the improvement of safeguards, physical protection and proliferation resistance of nuclear systems is dependent, at least in part, on the continued health of the U.S. technological base. This assumes close collaboration between industry and the national laboratories, which could be increased through greater use of Cooperative Agreements between U.S. firms and national laboratories. GNEP contains some important new ideas that could advance U.S. nonproliferation objectives. Envisioned within both GNEP and the U.S.-led Generation IV Initiative is the development and deployment of nextgeneration nuclear power plant designs that, if completed, could help restore a U.S. competitive edge in nuclear system supply. As the U.S. Government expends taxpayer funds on the Nuclear Power 2010 program, the Global Nuclear Energy Partnership, the Generation IV initiative and other programs, it should consider the benefit to the U.S. industrial base and the benefit to U.S. non-proliferation posture as criteria in project design and selection where possible.

#### And, federal action is necessary to reverse industry decline and manage international nuclear adoption

Wallace and Williams, 12 [Michael, Senior Adviser, U.S. Nuclear Energy Project, Sarah, CSIS, “Nuclear Energy in America: Preventing It’s Early Demise,” <http://csis.org/files/publication/120417_gf_wallace_williams.pdf>]

America’s nuclear energy industry is in decline. Low natural gas prices, financing hurdles, new safety and security requirements, failure to resolve the waste issue and other factors are hastening the day when existing reactors become uneconomic, making it virtually impossible to build new ones. Two generations after the United States took this wholly new and highly sophisticated technology from laboratory experiment to successful commercialization, our nation is in danger of losing an industry of unique strategic importance, unique potential for misuse, and unique promise for addressing the environmental and energy security demands of the future. The pace of this decline, moreover, could be more rapid than most policymakers and stakeholders anticipate. With 104 operating reactors and the world’s largest base of installed nuclear capacity, it has been widely assumed that the United States—even without building many new plants—would continue to have a large presence in this industry for some decades to come, especially if existing units receive further license extensions. Instead, current market conditions are such that growing numbers of these units are operating on small or even negative profit margins and could be retired early. Our nation is in danger of losing an industry of unique strategic importance, unique potential for misuse, and unique promise for addressing the environmental and energy security demands of the future.60 | Center for Strategic and International Studies Meanwhile, China, India, Russia, and other countries are looking to significantly expand their nuclear energy commitments. By 2016, China could have 50 nuclear power plants in operation, compared with only 14 in 2011. India could add 8 new plants and Russia 10 in the same time frame. These trends are expected to accelerate out to 2030, by which time China, India, and Russia could account for nearly 40 percent of global nuclear generating capacity. Meanwhile, several smaller nations, mostly in Asia and the Middle East, are planning to get into the nuclear energy business for the first time. In all, as many as 15 new nations could have this technology within the next two decades. Meanwhile, America’s share of global nuclear generation is expected to shrink, from about 25 percent today to about 14 percent in 2030, and—if current trends continue—to less than 10 percent by mid-century. With the center of gravity for global nuclear investment shifting to a new set of players, the United States and the international community face a difficult set of challenges: stemming the spread of nuclear weapons-usable materials and know-how; preventing further catastrophic nuclear accidents; providing for safe, long-term nuclear waste management; and protecting U.S. energy security and economic competitiveness. In this context, federal action to reverse the American nuclear industry’s impending decline is a national security imperative. The United States cannot afford to become irrelevant in a new nuclear age. Our nation’s commercial nuclear industry, its military nuclear capabilities, and its strong regulatory institutions can be seen as three legs of a stool. All three legs are needed to support America’s future prosperity and security and to shape an international environment that is conducive to our long-term interests. Three specific aspects of U.S. leadership are particularly important. First, managing the national and global security risks associated with the spread of nuclear technology to countries that don’t necessarily share the same perspective on issues of nonproliferation and nuclear security or may lack the resources to implement effective SHARE OF NET GLOBAL NUCLEAR GENERATION 1980-2030 Source: Energy Information Agency (EIA) databaseGlobal Forecast 2012 | 61 safeguards in this area. An approach that relies on influence and involvement through a viable domestic industry is likely to be more effective and less expensive than trying to contain these risks militarily. Second, setting global norms and standards for safety, security, operations, and emergency response. As the world learned with past nuclear accidents and more recently with Fukushima, a major accident anywhere can have lasting repercussions everywhere. As with nonproliferation and security, America’s ability to exert leadership and influence in this area is directly linked to the strength of our domestic industry and our active involvement in the global nuclear enterprise. A strong domestic civilian industry and regulatory structure have immediate national security significance in that they help support the nuclear capabilities of the U.S. Navy, national laboratories, weapons complex, and research institutions. Third, in the past, the U.S. government could exert influence by striking export agreements with countries whose regulatory and legal frameworks reflected and were consistent with our own nonproliferation standards and commitments. At the same time, our nation set the global standard for effective, independent safety regulation (in the form of the Nuclear Regulatory Commission), led international efforts to reduce proliferation risks (through the 1970 NPT Treaty and other initiatives), and provided a model for industry self-regulation. The results were not perfect, but America’s institutional support for global nonproliferation goals and the regulatory behaviors it modeled clearly helped shape the way nuclear technology was adopted and used elsewhere around the world. This influence seems certain to wane if the United States is no longer a major supplier or user of nuclear technology. With existing nonproliferation and safety and security regimes looking increasingly inadequate in this rapidly changing global nuclear landscape, American leadership and leverage is more important and more central to our national security interests than ever. To maintain its leadership role in the development, design, and operation of a growing global nuclear energy infrastructure, the next administration, whether Democrat or Republican, must recognize the invaluable role played by the commercial U.S. nuclear industry and take action to prevent its early demise.

#### And, new tech is the lynchpin of prolif leadership – the alternative is cascading prolif and terrorism

NESG, 05 [report by the Nuclear Energy Study Group of the American Physical Society Panel on Public Affairs, “Nuclear Power And Proliferation Resistance: Securing Benefits, Limiting Risk,” May, <http://www.aps.org/policy/reports/popa-reports/proliferation-resistance/upload/proliferation.pdf>]

Nuclear Power, Nuclear Proliferation and National Security The technologies and materials used in the manufacture of nuclear weapons overlap with those used in peaceful nuclear power applications. The extent to which nuclear power will be an acceptable and enduring option to meeting future energy requirements in many regions of the world will therefore depend in part upon the ability to minimize the associated proliferation risks. The elements of a nuclear power system include: facilities that mine and mill uranium ore, facilities that enrich uranium to create fuel, fuel fabrication facilities, reactors that burn that fuel to generate electricity, possibly facilities to reprocess the spent fuel,6 and waste storage sites. Nuclear reactors themselves are not the primary proliferation risk. The principal proliferation concern among the various elements of a nuclear power system are the enrichment and reprocessing facilities, which can produce materials directly usable in weapons. In addition, the spent fuel is a potential source of plutonium that must be safeguarded to prevent its clandestine separation for use in weapons, and fresh low-enriched uranium (LEU) fuel materials are a potential source for clandestine enrichment to nuclear weapons grade material. Further, poorly secured nuclear materials, including plutonium separated for fabrication into reactor fuel, present a risk of proliferation through theft and transfer to another country or terrorist group. The **challenges to the non-proliferation regime** are evident worldwide. Negotiations are under way to persuade Iran to abandon a uranium enrichment program, heavy water production plant and high-power research reactor that Iran claims are for civilian use but could easily be used to produce high-enriched uranium and plutonium for nuclear weapons. In North Korea, negotiations continue on termination of its nuclear weapons program and the associated reprocessing and enrichment activities. Much of Russia’s approximately 2 million pounds of weapons usable uranium and plutonium from both military and civilian nuclear energy programs may not be satisfactorily secured.7 Also, the smuggling network run by A.Q. Khan, who in the 1970s diverted uranium enrichment technology from a European consortium for use in Pakistan’s nuclear weapons program, reportedly sold enrichment technology to several countries, including Libya. This recent history leaves little doubt that civilian nuclear technology and materials can be misused, sold, stolen, or used as a cover for development of a nuclear weapons production capability. Figure 2 illustrates four primary pathways from nuclear-power programs to nuclear-weapons proliferation: theft, sale, diversion, and breakout.8 Addressing the Proliferation Risks of Nuclear Power There are a number of diplomatic, economic, military, and scientific and technical (S&T) approaches to reducing the proliferation risks of nuclear power.9 President Bush made a two part proposal to restrict the spread of enrichment and reprocessing technologies: 1) the world's leading nuclear exporters should ensure that states have reliable access at reasonable cost to fuel for civilian reactors, so long as those states renounce enrichment and reprocessing; and 2) The 40 nations of the Nuclear Suppliers Group should refuse to sell enrichment and reprocessing equipment and technologies to any state that does not already possess full-scale, functioning enrichment and reprocessing plants.10 IAEA director, Mohammed ElBaradei proposed a 5-year moratorium on construction of new enrichment or reprocessing plants while an effort is made to establish a multi-national alternative to nationally owned plants.11 Such fuel assurances and pledges to restrict sales are important components of a strategy to reduce the proliferation risks of nuclear power. 12 However, no single diplomatic, military, economic, or technical initiative alone will be able to fully deal with the proliferation challenge. The best prospect for achieving non-proliferation goals while expanding nuclear power is to engage all appropriate means and to maximize their respective contributions.13 From a technical point of view, nuclear power cannot be made “proliferation proof”. However, numerous steps can be taken -- and must be taken -- to make it as “proliferation-resistant” as reasonably possible. This is an urgent global security problem. China is poised to greatly expand its nuclear power program and Indonesia, Vietnam and Egypt have all declared an interest in building civilian nuclear power plants. **Without technological advances** and institutional changes, it will be easier for countries motivated to proliferate to take advantage of the global expansion of nuclear power or for terrorists to access nuclear materials. Iran’s developing nuclear program indicates the urgent need to enhance the proliferation resistance of nuclear power. Thus, whether or not the United States constructs new nuclear power plants over the next quarter century, it is vital to US national security that the US remain engaged in the development of proliferation-resistant nuclear-energy technologies and of technologies that can support any new arrangements to safeguard and internationalize the fuel-cycle and strengthen international institutions.

#### Thorium reactors are key –

#### They are prolif resistant and spur elimination of global plutonium stockpiles

Donohue, 8/27/12 [Nathan Donohue is a research intern for the Project on Nuclear Issues, CSIS, “Thorium and its Value in Nonproliferation”, <http://csis.org/blog/thorium-and-its-value-nonproliferation>]

The Federation of American Scientists (FAS) recently featured an article on their Science Wonk blog entitled “[What about thorium?](http://www.fas.org/blogs/sciencewonk/2012/08/what-about-thorium/)” As the article discussed, thorium is an element, which like uranium, has the ability to be utilized to produce nuclear power. More importantly, thorium fueled reactors are reported to be more proliferation resistant than uranium fueled reactors. However, despite these assertions, thorium has almost universally been ignored in favor of uranium based nuclear power reactors. The purpose of this piece is to conduct a review of thorium and to develop a better understanding of thorium’s nonproliferation benefits as it relates to nuclear power production. As FAS notes, natural thorium is a fertile material, while not itself fissionable, can be converted into a fissile material suitable to sustain a nuclear fission chain reaction. Accordingly, when natural thorium captures neutrons it becomes a new isotope of thorium which then goes through a process of decay where over a period of weeks, the thorium actually turns into **uranium in the form of U-233**. Unlike natural thorium, this U-233 is a fissile material suitable to sustain a nuclear fission chain reaction. The use of thorium to produce nuclear power is not a new concept. Research into thorium began in the late 1950’s and in 1965, Alvin Weinberg, the head of the Oak Ridge National Laboratory, and his team [built](http://www.wired.com/magazine/2009/12/ff_new_nukes/) a working thorium reactor using a molten salt bath design. Thorium was [used](http://www.neimagazine.com/story.asp?storyCode=2054564) to power one of the first commercial nuclear power plants in the U.S. in Shippingport, Pennsylvania in 1977. Nevertheless, research into thorium never found a foothold in the U.S. nuclear power infrastructure. By 1973, thorium research and development was fading to the uranium based focus of the U.S. nuclear industry, which was in the process of developing 41 new nuclear plants, all of which used uranium. The Shippingport facility was one of the last vestiges of thorium research in the U.S. for decades. Recently there has been a renewed focus on thorium based nuclear power, specifically in regards to the benefits related to spent fuel, [including](http://www.iaea.org/Publications/Magazines/Bulletin/Bull511/51104894344.pdf) research involving the European Commission, India, Canada, Slovakia, the Russian Federation, China, France and the Republic of Korea. The utilization of thorium is purported to have the ability to reduce spent fuel waste by upwards of 50% while at the same time reducing the amount of plutonium within the fuel. To that end, thorium fuel designs are regarded as a better alternative for power production in terms of the plutonium proliferation risk inherent in spent fuel from uranium-fueled reactors. For example, all 104 reactors in the U.S. use uranium fuel. In these reactors, when the uranium in the form of U-238 captures extra neutrons, it goes through a [process](http://nuclearweaponarchive.org/Library/Plutonium/index.html) of decay whereby **plutonium in the form of Pu-239** is produced. The spent fuel can then be reprocessed to isolate and remove this plutonium, which can then be used in the core of a nuclear weapon. Roughly **13 kilograms** (kg) of reactor grade plutonium is necessary to power a nuclear weapon. In total, these 104 U.S. reactors accumulate roughly 2,000 tons of spent fuel per year. The 2,000 tons of waste produced annually by these nuclear utilities, contains roughly [25,520](http://www.fas.org/rlg/980826-pu.htm) kg of plutonium or enough plutonium to build 1,963 nuclear weapons a year. Globally, the total world generation of reactor-grade plutonium in spent fuel is equal to roughly [70](http://www.world-nuclear.org/info/inf15.html) tons annually; more than two times what the U.S. produces. Conversely, there is the thorium seed and blanket design. This reactor [concept](http://www.wired.com/magazine/2009/12/ff_new_nukes/) is based on a design comprised of inner seed rods of uranium which provide neutrons to an outer blanket of thorium-uranium dioxide rods, creating U-233, which in turn powers the nuclear reactor. The important difference with this design is in the nature of the spent fuel. As advocates of thorium such as the U.S. company Lightbridge purport, this process would [realize](http://www.oecd-nea.org/science/meetings/arwif2001/57.pdf) a significant reduction in the “quantity and quality” of plutonium produced within the spent fuel, achieving upwards of an 80% reduction in plutonium. For [example](http://www.americanscientist.org/issues/feature/2003/5/thorium-fuel-for-nuclear-energy/5.), “a thorium-fueled reactor …would produce a total of 92 kilograms of plutonium per gigawatt-year of electricity generated, whereas a conventional water-cooled reactor would result in 232 kilograms.” In addition to a lower percentage of plutonium in the spent fuel, the composition of the plutonium produced is different as well, [featuring](http://www.oecd-nea.org/science/meetings/arwif2001/57.pdf.) a higher content of the plutonium isotopes Pu-238, Pu-240, and Pu-242. Weapons-grade plutonium requires roughly 90% plutonium in the form of Pu-239. Plutonium with higher contents of Pu-238 and Pu-240 is inherently unpredictable, and can spontaneously fission, making it “difficult or impossible to compress a bomb core containing several kilograms of plutonium to supercriticality before the bomb [disassembles] with a greatly reduced yield.” This reduces the reliability of a given nuclear weapon, thus making the thorium process less suitable for the development of plutonium for a nuclear weapon**.** The International Atomic Energy Agency [considers](http://hdl.handle.net/1721.1/29956) plutonium containing more than 81% Pu-238 “not weapons-usable.” Although thorium offers the ability to reduce the plutonium risk inherent in spent fuel, it does not eliminate the need for enriched uranium. Specifically, Lightbridge’s seed and blanket fuel technology would [require](http://www.ltbridge.com/assets/Thorium_Fuel_Fact_Sheet.pdf) uranium enriched to less than 20 % in both the seed and blanket fuel rods. Equally significant, the U-233 that is produced in the seed and blanket design poses its own proliferation concern. A nuclear weapon can be constructed with a significant quantity of U-233, which the IAEA defines as [8](http://moltensalt.org/references/static/downloads/pdf/ORNL-6952.pdf) **kg of U-233**, and both the U.S. and India have [detonated](http://en.wikipedia.org/wiki/Nuclear_weapons_testing) nuclear devices which utilized U-233. At the same time though, U-233 produced through this design also contains a small amount of the uranium isotope U-232, which emits a powerful, highly penetrating gamma ray. As [noted](http://www.iaea.org/Publications/Magazines/Bulletin/Bull511/51104894344.pdf) by Ray Sollychin, the Executive Director of the Neopanora Institute-Network of Energy Technologies, this reportedly makes “U233 weapons significantly more difficult to conceal and much more dangerous to handle.” In addition, reactors which use a thorium based seed and blanket design are engineered so that the U-233 which is produced is simultaneously denatured or blended with U-238, further reducing its suitability for a nuclear weapon. Moreover, the blanket is designed to remain within the reactor for upwards of nine to twelve years. This allows for the U-233 that is produced within the blanket to burn “[in situ](http://hdl.handle.net/1721.1/29956).” Lastly, any attempt to prematurely remove the blanket and separate the U-233 from the U-238, U-234 and U-236 isotopes [will](http://hdl.handle.net/1721.1/29956) also “remove the fissile U-235 from the resulting enriched steam,” once again making it unsuitable for a nuclear weapon. From this brief review of thorium and its properties, it appears clear that from a proliferation standpoint, that thorium fueled reactors provide for a safer nuclear power production process. In fact, it begs the question why thorium was overlooked in the first place. The simple answer is that the U.S. nuclear infrastructure was originally designed to facilitate mass quantities of plutonium for the production of a nuclear weapons arsenal. According to an [article](http://www.wired.com/magazine/2009/12/ff_new_nukes/) by Richard Martin in Wired magazine, “Locked in a struggle with a nuclear- armed Soviet Union, the U.S. government in the 60’s chose to build uranium-fueled reactors — in part because they produce plutonium that can be refined into weapons-grade material.” During the Cold War, maintaining nuclear parity with the Soviets was an overarching goal. Yet, with the end of the Cold War, the focus has shifted from acquiring nuclear weapons to stymying their development by both state and non-state actors. Therefore, the plutonium byproduct of the global nuclear power infrastructure has now become a liability and a proliferation risk. As the IAEA has [noted](http://www-pub.iaea.org/mtcd/publications/pdf/te_1450_web.pdf), “for nuclear power to be accepted as a significant contributor of primary energy in the next century, it should be based on a fuel cycle, which is highly proliferation-resistant.” For this reason, further research and development of thorium needs to be explored, not only in terms of seed and blanket technology but other thorium based designs as well, [including](http://www.iaea.org/Publications/Magazines/Bulletin/Bull511/51104894344.pdf) thorium-based Pebble Bed Reactor, fast reactors (liquid metal cooled and gas cooled); and advanced designs such as Molten Salt Reactor and Accelerator Driven System.

#### And, plutonium disposal is possible only with Thorium – solves terrorism which causes extinction

Rhodes 12 [February, Professor Chris Rhodes is a writer and researcher. He studied chemistry at Sussex University, earning both a B.Sc and a Doctoral degree (D.Phil.); rising to become the youngest professor of physical chemistry in the U.K. at the age of 34. A prolific author, Chris has published more than 400 research and popular science articles (some in national newspapers: The Independent and The Daily Telegraph) He has recently published his first novel, "University Shambles" was published in April 2009 (Melrose Books), “Hopes Build for Thorium Nuclear Energy”, <http://oilprice.com/Alternative-Energy/Nuclear-Power/Hopes-Build-for-Thorium-Nuclear-Energy.html>]

There is much written to the effect that thorium might prove a more viable nuclear fuel, and an energy industry based upon it, than the current uranium-based process which serves to provide both energy and weapons - including "depleted uranium" for armaments and missiles. There are different ways in which energy might be extracted from thorium, one of which is the accelerator-driven system (ADS). Such accelerators need massive amounts of electricity to run them, as all particle accelerators do, but these are required to produce a beam of protons of such intensity that until 10 years ago the prevailing technology meant that it could not have been done. As noted below, an alternative means to use thorium as a fuel is in a liquid fluoride reactor (LFR), also termed a molten salt reactor, which avoids the use of solid oxide nuclear fuels. Indeed, China has made the decision to develop an LFR-based thorium-power programme, to be active by 2020.¶ Rather like nuclear fusion, the working ADS technology is some way off, and may never happen, although Professor Egil Lillestol of Bergen University in Norway is pushing that the world should use thorium in such ADS reactors. Using thorium as a nuclear fuel is a laudable idea, as is amply demonstrated in the blog "Energy from Thorium" (<http://thoriumenergy.blogspot.com/>). However, the European Union has pulled the plug on funding for the thorium ADS programme, which was directed by Professor Carlo Rubbia, the Nobel Prize winner, who has now abandoned his efforts to press forward the programme, and instead concentrated on solar energy, which was another of his activities. Rubbia had appointed Lillestol as leader of the CERN physics division over two decades ago, in 1989, who believes that the cause is not lost.¶ Thorium has many advantages, not the least being its greater abundance than uranium. It is often quoted that there is three times as much thorium as there is uranium. Uranium is around 2 - 3 parts per million in abundance in most soils, and this proportion rises especially where phosphate rocks are present, to anywhere between 50 and 1000 ppm. This is still only in the range 0.005% - 0.1% and so even the best soils are not obvious places to look for uranium. However, somewhere around 6 ppm as an average for thorium in the Earth's crust is a reasonable estimate. There are thorium mineral deposits that contain up to 12% of the element, located at the following tonnages in Turkey (380,000), Australia (300,000), India (290,000), Canada and the US combined (260,000)... and Norway (170,000), perhaps explaining part of Lillestol's enthusiasm for thorium based nuclear power. Indeed, Norway is very well endowed with natural fuel resources, including gas, oil, coal, and it would appear, thorium.¶ An alternative technology to the ADS is the "Liquid Fluoride Reactor" (LFR), which is described and discussed in considerable detail on the <http://thoriumenergy.blogspot.com/> blog, and reading this has convinced me that the LFR may provide the best means to achieve our future nuclear energy programme. Thorium exists naturally as thorium-232, which is not of itself a viable nuclear fuel. However, by absorption of relatively low energy "slow" neutrons, it is converted to protactinium 233, which must be removed from the reactor (otherwise it absorbs another neutron and becomes protactinium 234) and allowed to decay over about 28 days to uranium 233, which is fissile, and can be returned to the reactor as a fuel, and to breed more uranium 233 from thorium. The "breeding" cycle can be kicked-off using plutonium say, to provide the initial supply of neutrons, and indeed the LFR would be a useful way of disposing of weapons grade plutonium and uranium from the world's stockpiles while converting it into useful energy.¶ The LFR makes in-situ reprocessing possible, much more easily than is the case for solid-fuel based reactors. I believe there have been two working LFR's to date, and if implemented, the technology would avoid using uranium-plutonium fast breeder reactors, which need high energy "fast" neutrons to convert uranium 238 which is not fissile to plutonium 239 which is. The LFR is inherently safer and does not require liquid sodium as a coolant, while it also **avoids the risk of plutonium getting into the hands of terrorists**. It is worth noting that while uranium 235 and plutonium 239 could be shielded to avoid detection as a "bomb in a suitcase", uranium 233 could not, because it is always contaminated with uranium 232, which is a strong gamma-ray emitter, and is far less easily concealed.¶ It has been claimed that thorium produces "250 times more energy per unit of weight" than uranium. Now this isn't simply a "logs versus coal on the fire" kind of argument, but presumably refers to the fact that while essentially all the thorium can be used as a fuel, the uranium must be enriched in uranium 235, the rest being "thrown away" and hence wasted as "depleted" uranium 238 (unless it is bred into plutonium). If both the thorium and uranium were used to breed uranium 233 or plutonium 239, then presumably their relative "heat output" weight for weight should be about the same as final fission fuels? If this is wrong, will someone please explain this to me as I should be interested to know?¶ However, allowing that the LFR in-situ reprocessing is a far easier and less dangerous procedure, the simple sums are that contained in 248 million tonnes of natural uranium, available as a reserve, are 1.79 million tonnes of uranium 235 + 246.2 million tonnes of uranium 238. Hence by enrichment 35 million tonnes (Mt) of uranium containing 3.2% uranium 235 (from the original 0.71%) are obtained. This "enriched fraction" would contain 1.12 Mt of (235) + 33.88 Mt of (238), leaving in the other "depleted" fraction 248 - 35 Mt = 213 Mt of the original 248 Mt, and containing 0.67 Mt (235) + 212.3 Mt (238). Thus we have accessed 1.79 - 0.67 = 1.12 Mt of (235) = 1.12/224 = 4.52 x 10\*-3 or 0.452% of the original total uranium. Thus on a relative basis thorium (assuming 100% of it can be used) is 100/0.452 = 221 times as good weight for weight, which is close to the figure claimed, and a small variation in enrichment to a slightly higher level as is sometimes done probably would get us to an advantage factor of 250!¶ Plutonium is a by-product of normal operation of a uranium-fuelled fission reactor. 95 to 97% of the fuel in the reactor is uranium 238. Some of this uranium is converted to plutonium 239 and plutonium 241 - usually about 1000 kg forms after a year of operation. At the end of the cycle (a year to 2 years, typically), very little uranium 235 is left and about 30% of the power produced by the reactor actually comes from plutonium. Hence a degree of "breeding" happens intrinsically and so the practical advantage of uranium raises its head from 1/250 (accepting that figure) to 1/192, which still weighs enormously in favour of thorium!¶ As a rough estimate, 1.4 million tonnes of thorium (about one third the world uranium claimed, which is enough to last another 50 years as a fission fuel) would keep us going for about 200/3 x 50 = 3,333 years. Even if we were to produce all the world's electricity from nuclear that is currently produced using fossil fuels (which would certainly cut our CO2 emissions), we would be O.K. for 3,333/4 = 833 years. More thorium would doubtless be found if it were looked for, and so the basic raw material is not at issue. Being more abundant in most deposits than uranium, its extraction would place less pressure on other fossil fuel resources used for mining and extracting it. Indeed, thorium-electricity could be piped in for that purpose.¶ It all sounds great: however, the infrastructure would be huge to switch over entirely to thorium, as it would to switch to anything else including hydrogen and biofuels. It is this that is the huge mountain of resistance there will be to all kinds of new technology. My belief is that through cuts in energy use following post peak oil (and peak gas), we may be able to produce liquid fuels from coal, possibly using electricity produced from thorium, Thorium produces less of a nuclear waste problem finally, since fewer actinides result from the thorium fuel cycle than that from uranium. Renewables should be implemented wherever possible too, in the final energy mix that will be the fulcrum on which the survival of human civilization is poised.

#### And, dual use tech makes other reactor types prolif prone – the plan is key to tech transfers

Hargraves, 12 [July, Robert, Robert Hargraves has written articles and made presentations about the liquid fluoride thorium reactor and energy cheaper than from coal – the only realistic way to dissuade nations from burning fossil fuels. His presentation “Aim High” about the technology and social benefits of the liquid fluoride thorium reactor has been presented to audiences at Dartmouth ILEAD, Thayer School of Engineering, Brown University, Columbia Earth Institute, Williams College, Royal Institution, the Thorium Energy Alliance, the International Thorium Energy Association, Google, the American Nuclear Society, and the Presidents Blue Ribbon Commission of America’s Nuclear Future. With coauthor Ralph Moir he has written articles for the American Physical Society Forum on Physics and Society: Liquid Fuel Nuclear Reactors (Jan 2011) and American Scientist: Liquid Fluoride Thorium Reactors (July 2010). Robert Hargraves is a study leader for energy policy at Dartmouth ILEAD. He was chief information officer at Boston Scientific Corporation and previously a senior consultant with Arthur D. Little. He founded a computer software firm, DTSS Incorporated while at Dartmouth College where he was assistant professor of mathematics and associate director of the computation center. He graduated from Brown University (PhD Physics 1967) and Dartmouth College (AB Mathematics and Physics 1961). THORIUM: energy cheaper than coal, ISBN: 1478161299, purchased online at Amazon.com]

Advanced nuclear power must be proliferation resistant. Nuclear weapons can cause terrible destruction of whole cities and contaminate entire regions, so expansion of nuclear power must come with assurances that the risk of proliferation of nuclear weapons is not increased. The technology for making such weapons is widely known, although the process is difficult and expensive. Building commercial nuclear power plants has not led to weapons development; nations that have nuclear weapons have developed them with purposeful programs and facilities. However dual-use technologies such as centrifuge enrichment of U-235 that can make fuel for PWRs can be adapted to make highly enriched uranium for weapons. After President Eisenhower’s Atoms for Peace speech the US helped nations to acquire the knowledge and materials to use nuclear technology for peaceful purposes. Unexpectedly this knowledge led India to develop nuclear weapons instead. Selling advanced nuclear power plants worldwide does not require providing each nation with the technical skills and materials to build nuclear power plants or nuclear weapons. Consider the airplane and jet engine industry: nations want prestigious national airlines. Fully 83 countries, from Algeria to Yemen, operate airlines using the Boeing 747 airliner, yet these nations do not have their own airframe or engine production or maintenance capabilities. General Electric makes a business of maintaining and overhauling engines at GE’s own service centers. This is a technology-transfer-resistant model suitable for LFTR installation and maintenance. The liquid fluoride thorium reactor is proliferation resistant. LFTR requires fissile material to be transported to the site for startup, but not thereafter. LFTR then creates and burns fissile U-233 that conceivably could be used instead for a nuclear weapon. Would this ever happen? China, USA, Russia, India, UK, France, Pakistan, and Israel, which account for 57% of global CO2 emissions, already have nuclear weapons and no incentive to subvert LFTR technology. So just implementing LFTRs in these nations would be a big step in addressing global warming. Many additional nations, such as Canada, Japan, and South Africa, have the capability to build nuclear weapons but have chosen not to, so there is no incentive for them to subvert LFTR technology for this purpose. Should LFTRs be implemented in other non-weapons states? Certainly terrorists could not steal this uranium dissolved in a molten salt solution along with even more radioactive fission products inside a sealed reactor. IAEA safeguards include physical security, accounting and control of all nuclear materials, surveillance to detect tampering, and intrusive inspections. LFTR’s neutron economy contributes to securing its inventory of nuclear materials. Neutron absorption by uranium-233 produces about 2.4 neutrons per fission—one to drive a subsequent fission and another to drive the conversion of Th-232 to U-233 in the blanket molten salt. Taking into account neutron losses from capture by protactinium and other nuclei, a well-designed LFTR reactor will direct just about 1.00 neutrons per fission to thorium transmutation. This delicate balance doesn’t create excess U-233, just enough to generate fuel indefinitely. If this conversion ratio could be increased to 1.01, a 100 MW LFTR might generate kilogram of excess U-233 per year. If meaningful quantities of uranium-233 are misdirected for non-peaceful purposes, the reactor will report the diversion by stopping because of insufficient U-233 to maintain a chain reaction. Yet a sovereign nation or revolutionary group might expel IAEA observers, stop the LFTR, and attempt to remove the U-233 for weapons. Accomplishing this would require that skilled engineers, working in a radioactive environment, modify the reactor's fluorination equipment to separate uranium from the fuel salt instead of the thorium blanket salt. What would happen to them? The neutrons that produce U-233 also produce contaminating U-232, whose decay products emit 2.6 MeV penetrating gamma radiation, hazardous to weapons builders and obvious to detection monitors. The U-232 decays via a cascade of elements to thallium- 208, which builds up and emits the radiation. Depending on design specifics, the proportion of U-232 would be about 0.13% for a commercial power reactor. A year after separation, a weapons worker one meter from a subcritical 5 kg sphere of such U-233 would receive a radiation dose of 43 mSv/hr, compared to 0.003 mSv/hr from plutonium, even less from U-235. Death becomes probable after 72 hours exposure. After ten years this radiation triples. A resulting weapons would be highly radioactive and therefore dangerous to military workers nearby. The penetrating 2.6 MeV gamma radiation is an easily detected marker revealing the presence of such U-233, possibly even from a satellite. U-232 can not be removed chemically, and centrifuge separation from U-233 would make the centrifuges too radioactive to maintain. Conceivably, nuclear experts might try to stop the reactor, chemically extract the uranium, and devise chemistry to remove the intermediate elements of the U-232 decay chain before the thallium is formed, except that the isotopes are continually replaced by U-232 decay. They might try to quickly separate the small amount of Pa-233 from the uranium and let it decay to pure U-233, but they would have to design and build a special chemical plant within the radioactive reactor. Bomb-makers might attempt quickly fabricate a weapon from newly separated U-233 before radiation hazards become lethal; even so there will be sufficient U-232 contamination that penetrating 2.6 MeV gamma rays will be readily detected. The challenge of developing and perfecting such new processes will be more difficult and expensive than creating a purpose-built weapons factory with known technology, such as centrifuge enrichment of U-235 conducted in Iran or PUREX for extracting plutonium from solid fuel irradiated in LWRs. Bruce Hoglund wrote a fuller report of the challenges to would-be bomb makers, and there is a discussion in the comments of the energy from thorium blog, both linked in the references section. A LFTR operating under IAEA safeguards might additionally be protected by injecting U-238 from a remotely controlled tank of U-238. The U-238 would dilute (denature) the U-233 to make it useless for weapons, but it would also stop the reactor and ruin the fuel salt for further use. For personnel safety, any U-233 material operations must be accomplished by remote handling equipment within a radioactively shielded hot cell. This can be designed to make it very hard for any insiders or outsiders to remove material from the hot cell. Another hurdle for the would-be pilferer uranium from 700° C molten salt is the retained radioactive fission products. Even with a l-hour cooling period to allow decay of the short-lived isotopes, the salt still releases ~350 W/liter of heat. That heat comes from deadly ionizing radiation that would kill a nearby pilferer in minutes unless shielded by meters of concrete or water or heavy lead. This fission product radiation is the same self protection that protects spent LWR fuel from theft. The single-fluid DMSR is highly proliferation resistant. The DMSR contains enough U-238 mixed with fissile U-233 and U-235 that the uranium can not sustain the rapid fission reaction necessary for a nuclear weapon. Uranium enriched to less than 20% U-235 is termed LEU, low-enriched uranium. The LEU fuel is not suitable for a nuclear weapon, which typically requires over 90% U-235. The DMSR with at least 80% U-238 is said to be denatured with it. The DMSR has less chemical processing equipment than the two- fluid LFTR, which uses fluorine chemistry to direct U-233 generated in the thorium blanket to the core. The DMSR has no chemical processing equipment in the reactor plant that might somehow be modified to divert U-233 for a weapons program. Because of the substantial amount of U-238 in the DMSR, it does breed plutonium from neutron capture, just as does a standard LWR. Some Pu-239 fissions. However the fissile Pu-239 isotope that might be desired for a weapon is only 31% of the plutonium, mixed with other isotopes (Pu-238, 240, 241, 242) that make the plutonium unsuitable for a weapon. Because the plutonium is dissolved in the fuel salt, there is no opportunity to remove it early to obtain weapons grade Pu-239 before neutrons convert it to other isotopes, as in a LWR, CANDU, RBMK, or military plutonium production reactor. Further, plutonium’s chemistry makes it difficult to remove from the salt. Also, the salt contains highly radioactive fission products as well as U-232, whose decay daughters emit a penetrating 2.6 MeV gamma ray. DMSR is the most proliferation-resistant nuclear reactor. There are easier paths than U-233 to make nuclear weapons. Pakistan has illustrated how a developing nation can make uranium weapons using centrifuge enrichment; in a dual path it simultaneously developed the methods to extract weapons grade plutonium from uranium reactors. India and North Korea developed plutonium weapons from heavy water or graphite moderated reactors with online fuel exchange capability. Iran has built centrifuge enrichment plants capable of making highly enriched U-235 for nuclear weapons. These proven weapons paths eliminate the incentive for nations to try to develop nuclear weapons via the technically challenging and expensive U-233 path. Only a determined, well-funded effort on the scale of a national program could overcome the obstacles to illicit use of uranium- 232/233 produced in a LFTR reactor. Such an effort would certainly find that it was less problematic to pursue the enrichment of natural uranium or the breeding of plutonium. LFTR reduces existing weapons proliferation risks. Deploying LFTRs on a global scale will not increase the risk of nuclear weapons proliferation, but rather decrease it. Starting up LFTRs with existing plutonium can consume inventories of this weapons-capable material. The thorium-uranium fuel cycle reduces demand for U-235 enrichment plants, which can make weapons material nearly as easily as power reactor fuel. Abundant energy cheaper than coal can increase prosperity and enable lifestyles that lead to sustainable populations, reducing the potential for wars over resources.

#### And, only thorium prevents uranium acquisition

Hargraves & Moir, ’10 [Robert, teaches energy policy at the Institute for Lifelong Education at Dartmouth College, CIO at Boston Scientific, doing medical devices, graduate degree in physics -- Brown University, received a graduate degree in physics, Brown University, has published 10 papers on molten-salt reactors during his career at Lawrence Livermore National Laboratory, Sc.D. in nuclear engineering from MIT, July-August, “Liquid Fluoride Thorium Reactors: An old idea in nuclear power gets reexamined,” The American Scientist]

Cost competitiveness is a weighty consideration for nuclear power development, but it exists on a somewhat different level from the life-and-death considerations of waste management, safety and nonproliferation. Escalating the role of nuclear power in the world must be anchored to decisively eliminating the illicit diversion of nuclear materials. When the idea of thorium power was first revived in recent years, the focus of discussion was its inherent proliferation resistance (see the September–October 2003 issue of American Scientist; Mujid S. Kazimi, “Thorium Fuel for Nuclear Energy”). The uranium-233 produced from thorium- 232 is necessarily accompanied by uranium-232, a proliferation prophylactic. Uranium-232 has a relatively short half-life of 73.6 years, burning itself out by producing decay products that include strong emitters of high energy gamma radiation. The gamma emissions are easily detectable and highly destructive to ordnance components, circuitry and especially personnel. Uranium-232 is chemically identical to and essentially inseparable from uranium-233. The neutron economy of LFTR designs also contributes to securing its inventory of nuclear materials. In the LFTR core, neutron absorption by uranium-233 produces slightly more than two neutrons per fission—one to drive a subsequent fission and another to drive the conversion of thorium-232 to uranium-233 in the blanket solution. Over a wide range of energies, uranium-233 emits an average of 2.4 neutrons for each one absorbed. However, taking into account the overall fission rate per capture, capture by other nuclei and so on, a well designed LFTR reactor should be able to direct about 1.08 neutrons per fission to thorium transmutation. This delicate poise doesn’t create excess, just enough to generate fuel indefinitely. If meaningful quantities of uranium-233 are misdirected for nonpeaceful purposes, the reactor will report the diversion by winding down because of insufficient fissile product produced in the blanket. Only a determined, well-funded effort on the scale of a national program could overcome the obstacles to illicit use of uranium-232/233 produced in a LFTR reactor. Such an effort would certainly find that it was less problematic to pursue the enrichment of natural uranium or the generation of plutonium. In a world where widespread adoption of LFTR technology undermines the entire, hugely expensive enterprise of uranium enrichment—the necessary first step on the way to plutonium production— bad actors could find their choices narrowing down to unusable uranium and unobtainable plutonium.

### ADV 2

#### Advantage Two: Resource Wars

#### Thorium expansion reduces global water stress and results in effective desalination

Hargraves, 12 [July, Robert, Robert Hargraves has written articles and made presentations about the liquid fluoride thorium reactor and energy cheaper than from coal – the only realistic way to dissuade nations from burning fossil fuels. His presentation “Aim High” about the technology and social benefits of the liquid fluoride thorium reactor has been presented to audiences at Dartmouth ILEAD, Thayer School of Engineering, Brown University, Columbia Earth Institute, Williams College, Royal Institution, the Thorium Energy Alliance, the International Thorium Energy Association, Google, the American Nuclear Society, and the Presidents Blue Ribbon Commission of America’s Nuclear Future. With coauthor Ralph Moir he has written articles for the American Physical Society Forum on Physics and Society: Liquid Fuel Nuclear Reactors (Jan 2011) and American Scientist: Liquid Fluoride Thorium Reactors (July 2010). Robert Hargraves is a study leader for energy policy at Dartmouth ILEAD. He was chief information officer at Boston Scientific Corporation and previously a senior consultant with Arthur D. Little. He founded a computer software firm, DTSS Incorporated while at Dartmouth College where he was assistant professor of mathematics and associate director of the computation center. He graduated from Brown University (PhD Physics 1967) and Dartmouth College (AB Mathematics and Physics 1961). THORIUM: energy cheaper than coal, ISBN: 1478161299, purchased online at Amazon.com]

World water resources are stressed. UNESCO reports that 8% of worldwide electric power is used for water pumping, purification, and wastewater treatment. The World Bank says 2.6 billion people have no access to sanitation, leading to illness that reduces GDP by 6%. Over a billion people have no access to electricity. Agriculture uses 70% of world water withdrawals, and food production must increase 70% in the next 40 years to sustain the population. The withdrawal of groundwater has revolutionized agriculture, but replenishment is insufficient for sustainability. Shrinking glaciers have temporarily added to water flows, but due to global warming these sources will diminish along with their buffering effects. World energy production also competes for water resources. All thermal power plants require cooling, almost always accomplished with water by evaporative cooling or heating water in a river or ocean. Thermal power plants include nuclear, coal, natural gas, biomass, concentrated solar, and geothermal technologies. Even hydroelectric power consumes water by evaporation from reservoirs. LFTR power can reduce global water stress. High-temperature, air-cooled nuclear power plants such as LFTR will be especially valuable in water-stressed regions, because they do not compete for this scarce resource. With electrical power, sanitation systems can economically treat wastewater for reuse in agriculture. Treated waste water represents a growing fraction of total water withdrawals in Mideast countries Saudi Arabia (1%), Oman (3%), Jordan (9%), and Qatar (10%). Water desalination is becoming more efficient. Today most of the daily 70 million cubic meters of potable water by desalination is produced in plants that use petroleum fuels for energy, increasing CO2 emissions. The desalination plants are mostly in the wealthy countries of the arid Mideast. The older, common multi-stage flash (MSF) steam distillation processes use about 25 kWh(t) per cubic meter of water produced. Cogeneration improves this; when the MSF facility is an integral part of the power plant cooling system the power requirements can be halved to roughly 10 kWh/m3. Reverse osmosis (RO) is most commonly used in new desalination plants. Reverse osmosis requires up to 6 kWh(e)/m3, producing desalinated water at about $0.50/m3. The predominant cost for desalinated water is energy. Reducing the cost of energy with LFTR will reduce the cost of the water. Replacing petroleum fueled desalination plants with LFTRs will also reduce CO2 emissions. Multi-effect distillation (MED) is even more efficient, requiring only 1 kWh(t)/m3 of power. Siemens has developed an electrolysis based desalination technology that uses 1.5 kWh(e)/m3. For LFTR with its high 700°C temperature, the Brayton power conversion cycle is highly efficient, minimizing waste rejected heat. In this case an advanced multi effect distillation (AMED) process can cogenerate an additional 1 m3 of water for each 30 kWh of electric power produced. Since fuel costs are very small for LFTR (and most nuclear power plants) they operate at full power, continuously. Electric power peak demand is typically about twice minimum demand. Cogenerating LFTR electric power plants can be designed to use excess power to desalinate water during off-peak periods.

#### And, thorium is key—the impact is extinction

Ragheb, 8/21/12 [Magdi Ragheb, Associate Professor at University of Illinois, “FRESH WATER AUGMENTATION” https://netfiles.uiuc.edu/mragheb/www/NPRE%20402%20ME%20405%20Nuclear%20Power%20Engineering/Fresh%20Water%20Augmentation.pdf]

DEVELOPMENT PROJECTS Multiple designs for modular nuclear power units can be adapted for desalinating seawater. The Asea Brown Boveri-Siemens potato reactor, so named for its spherical fuel pebble bed design, uses a thorium fuel cycle. California-based General Atomics has proposed a modular, helium-cooled unit which is sited entirely underground. A portion of the energy from either type of unit at about 135 MWs, can be handily used for desalinating seawater, and units can be added as required. With four nuclear power units per installation, only 20 such complexes could desalinate 3,500 million cubic meters of water for the disputed Jordan River water basin, the equivalent of a second Jordan River. At Al Dabaa, Egypt, an area that receives just 6 inches of rainfall in a year, a plan for building a nuclear and desalting plant producing 150 MWe of electricity and 5 mgd of fresh water has been languishing since the early 1970s for lack of resolve and an expectation for an illusive promise of foreign aid financing that never materialized. Mexico is 60 percent arid. Tunisia is desperate for fresh water supplies. Yet both countries have areas along seashores that can be developed should fresh water supplies materialize. Southern Tunisia’s saline content varies from 1.5-1.7 gm/liter, and in some places it reaches 24 grams per liter. Even though 2.5 gm/liter is usually not considered unpalatable, the USA Public Health Service suggests that drinking water should not contain more than 0.5 gm/liter. DISCUSSION An issue facing humanity in the 21st century is how to share the 1/2 percent of usable freshwater to feed its increasing population. A predicted 40 percent shortfall is predicted in the freshwater supply. By 2050, according to United Nations, UN, 9 billion people, compared with the present 7 billion would need to be fed using far less fresh water than we have available today. According to Marc Bierkens of the Utrecht University in Utrecht, the Netherlands: “If you let the population grow by extending the irrigated areas using groundwater that is not being recharged, then you will run into a wall at a certain point in time, and you will have hunger and social unrest to go with it. That is something that you can see coming for miles.” The advances in technology, innovation, and best practices/conservation are clashing with finite water resources, relentless population growth, changing diets, a lack of investment in water infrastructure and increased urban, agricultural and industrial water usage. Investment in water management as a percentage of GDP has dropped by 1/2 in most countries since the late 1990s. Current estimates indicate that we will not have enough water to feed ourselves in a 25 years’ time-span, according to the International Water Management Institute, IWMI. The central issue over the next few decades will be whether humanity can achieve and sustain the food harvest needed to feed the world population. To ensure a reliable water supply in the USA will require a significant infrastructure upgrade. Upgrading pipelines to accommodate the needed new supply is estimated to require $300 billion over a 30 years period or $10 billion/year. In his book “Future of Life on Earth,” John Cairns Jr. states: “One lesson from the great global extinctions is that species and ecosystems come and go, but the evolutionary process continues. In short, life forms have a future on Earth, but humankind’s future depends on its stewardship of ecosystems that favor Homo Sapiens.” The gap between human demand of fresh water supplies and its available supply has reached the critical threshold of an unsustainable “ecological overshoot.” Fresh water is in short supply in most parts of the world, even more than electrical energy, and the future will certainly witness a role for nuclear, solar and wind energy in alleviating the shortage. Over the next few decades, fresh water shortages, in addition to climate change will determine whether humanity can sustainably feed its masses.

#### This development path stabilizes global population and averts resource conflict

Hargraves, 12 [July, Robert, Robert Hargraves has written articles and made presentations about the liquid fluoride thorium reactor and energy cheaper than from coal – the only realistic way to dissuade nations from burning fossil fuels. His presentation “Aim High” about the technology and social benefits of the liquid fluoride thorium reactor has been presented to audiences at Dartmouth ILEAD, Thayer School of Engineering, Brown University, Columbia Earth Institute, Williams College, Royal Institution, the Thorium Energy Alliance, the International Thorium Energy Association, Google, the American Nuclear Society, and the Presidents Blue Ribbon Commission of America’s Nuclear Future. With coauthor Ralph Moir he has written articles for the American Physical Society Forum on Physics and Society: Liquid Fuel Nuclear Reactors (Jan 2011) and American Scientist: Liquid Fluoride Thorium Reactors (July 2010). Robert Hargraves is a study leader for energy policy at Dartmouth ILEAD. He was chief information officer at Boston Scientific Corporation and previously a senior consultant with Arthur D. Little. He founded a computer software firm, DTSS Incorporated while at Dartmouth College where he was assistant professor of mathematics and associate director of the computation center. He graduated from Brown University (PhD Physics 1967) and Dartmouth College (AB Mathematics and Physics 1961). THORIUM: energy cheaper than coal, ISBN: 1478161299, purchased online at Amazon.com]

Resource depletion may be more severe than climate change.

Global warming is indeed a severe threat to our environment and human civilization. But resource depletion may be an even more immediate threat. Physicist Tom Murphy writes the blog, Do the Math, encouraging people to quantify the problems and envisioned solutions. In a 2012 interview with OilPrice.com he says: “I see climate change as a serious threat to natural services and species survival, perhaps ultimately having a very negative impact on humanity. But resource depletion trumps climate change for me, because I think this has the potential to effect far more people on a far shorter timescale with far greater certainty. Our economic model is based on growth, setting us on a collision course with nature. When it becomes clear that growth cannot continue, the ramifications can be sudden and severe. So my focus is more on averting the chaos of economic/resource/agriculture/distribution collapse, which stands to wipe out much of what we have accomplished in the fossil fuel age. To the extent that climate change and resource limits are both served by a deliberate and aggressive transition away from fossil fuels, I see a natural alliance.” Population is stable in developed nations. World population is projected to grow from 7 billion to over 9 billion people. Most of this growth is in the developing nations. The US and other economically strong OECD nations have little population growth, attributable to immigration from the developing nations. Increasing population will increase the demand for resources of food and energy. Increased demand leads to increased competion and possible conflict. Impoverished countries birth the most children. This scatter plot uses data from the 2008 CIA world fact book. Each point corresponds to one nation, relating average number of children born to each woman and GDP per capita - closely related to income. It demonstrates that countries with high GDP per capita have birthrates that lead to a sustainable population. All the countries to the left of the vertical bar would have diminishing populations, except for immigration. With increased income, there is less need to have children to work in agriculture, or to care for aging parents. There is less need to give birth to extra children to compensate for childhood deaths. With work saving technologies such as water pumps, efficient cook stoves, and washing machines, women are freed from constant labor. They are able to have time for education and to earn money. With more independence and access to contraceptives, women can choose to have fewer children, as evidenced above. Prosperity stabilizes population. In this same plot is added a horizontal bar at $7,500 GDP per capita, arbitrarily chosen and labeled “Prosperity”. The poor nations, below $7,500, are those that have the highest birthrates. This strongly implies that improving the economic status of poor nations will lower birthrates, leading to a stable or shrinking world population. This plot cries out for a need to increase world prosperity to $7,500 GDP per capita, only 16% of the US number. With a stable or shrinking global population, world civilization can be sustainable. At the Wall Street Journal ECOmomics forum in March 2012 Microsoft founder and philanthropist Bill Gates remarked: "If you want to improve the situation of the poorest two billion on the planet, having the price of energy go down substantially is about the best thing you could do for them. ... Energy is the thing that allowed civilization over the last 220 years to dramatically change everything." This plot, also with CIA data, shows the relationship between GDP and energy - specifically electric energy, measured in kilowatt- hours per capita per year. For our civilization, electric energy is the most valuable and useful form of energy. Unlike heat from fire, or power from falling water, electric power can be used for many purposes essential to economic development. Applications include water sanitizing and distribution, sewage processing, lighting, heating, refrigeration, air conditioning, cooking, communications, computing, transportation, food processing, medical care, manufacturing, industry, and commerce. These are all hallmarks of emerging prosperity. Adequate electric power alone cannot guarantee a prosperous economy and civilization without education, basic health care, rule of law, property rights, financial system, and good government. But electricity is essential for economic progress. Over 1.3 billion people, 20% of the world population, have no access to electricity. Even rapidly developing nations such as India and South Africa can not provide full time electricity. over 10 million. Electricity can power sewage processing systems, necessary to assure clean water. The World Bank says 2.6 billion people have no access to sanitation, leading to illness that reduces GDP by 6%. Diarrhea is responsible for more child deaths than AIDS, TB, and malaria combined. UNESCO reports that 8% of worldwide electric power is used for water pumping, purification, and wastewater treatment. Clean water distribution is one example of how affordable, reliable power can free women from hauling water, helping to lead to a standard of living with time for education, gainful work, women’s independence, and choices about reproduction. The previous plot suggests an annual 2,000 kWh per capita supply leads to the $7,500 GDP per capita level that leads to sustainable birthrates and population. This minimum electric energy supply rate is 230 watts per person, about 16% of the US rate. In summary, an economy with minimum electric power availability of 230 W per person is needed to achieve the modest prosperity level of $7,500 per person leading to a sustainable population. In India today, average electric power consumption per capita is 85 W; 40% of the people have no access to electricity, and another 40% have access only a few hours per day. The long term goal of India’s government ministers is 570 W per capita, compared to 1400 W in the US.

\* World

1950 1960 1970 1980 1990 2000 2010 2020 2030 2040 2050

OECD

US

#### Water shortages cause war

Lee, 12 [Matthew Lee, Huffington Post, “Water War Could Erupt In Coming Decades, Says U.S. Intel Report”, http://www.huffingtonpost.com/2012/03/22/water-war-intel-report-hillary-clinton\_n\_1372496.html]

The report is based on a classified National Intelligence Estimate on water security, which was requested by Secretary of State Hillary Rodham Clinton and completed last fall. It says floods, scarce and poor quality water, combined with poverty, social tension, poor leadership and weak governments will contribute to instability that could lead the failure of numerous states. Those elements "will likely increase the risk of instability and state failure, exacerbate regional tensions and distract countries from working with the United States on important policy objectives," said the report, which was released at a State Department event commemorating World Water Day. Clinton, who unveiled a new U.S. Water Partnership that aims to share American water management expertise with the rest of the world, called the findings "sobering." "These threats are real and they do raise serious security concerns," she said. The report noted that countries have in the past tried to resolve water issues through negotiation but said that could change as water shortages become more severe. "We judge that as water shortages become more acute beyond the next 10 years, water in shared basins will increasingly be used as leverage; the use of water as a weapon or to further terrorist objectives, also will become more likely beyond 10 years," it said. The report predicts that upstream nations – more powerful than their downstream neighbors due to geography – will limit access to water for political reasons and that countries will regulate internal supplies to suppress separatist movements and dissident populations. At the same time, terrorists and rogue states may target or threaten to target water-related infrastructure like dams and reservoirs more frequently. Even if attacks do not occur or are only partially successful, the report said "the fear of massive floods or loss of water resources would alarm the public and cause governments to take costly measures to protect the water infrastructure." The unclassified summary of the intelligence estimate does not identify the specific countries most at risk. But it notes that the study focused on several specific rivers and water basins. Those included the Nile in Egypt, Sudan and nations farther south, the Tigris and Euphrates in Iraq and the greater Middle East, the Mekong in China and Southeast Asia, the Jordan that separates Israel from the Palestinian territories, the Indus and the Brahmaputra in India and South Asia as well as the Amu Darya in Central Asia. At a U.N. news conference in New York marking World Water Day, Ania Grobicki, executive secretary of the Global Water Partnership, which includes government, private sector, academic and nongovernmental groups, said, "Water is a global issue and is increasingly seen as a global risk." She pointed to the World Economic Forum's 2011 Global Risk Report which for the first time included water as one of the top five global risks. The report said the rapidly rising global population and growing prosperity are putting "unsustainable pressure" on resources and demand for water, food and energy is expected to rise by 30 percent to 50 percent in the next two decades. "Shortages could cause social and political instability, geopolitical conflict and irreparable environmental damage," the report warned.

#### And, those conflicts escalate globally

**Rasmussen 11** – CEO, Monday Morning; Founder, Green Growth Leaders, founder of the Copenhagen Climate Council (Erik, 04/12, “Prepare for the Next Conflict: Water Wars,” http://www.huffingtonpost.com/erik-rasmussen/water-wars\_b\_844101.html)

For years experts have set out warnings of how the earth will be affected by the water crises, with millions dying and **increasing conflicts** over dwindling resources. They have proclaimed -- in line with the report from the US Senate -- that the water scarcity is a security issue, and that it will yield political stress with a risk of **international water wars**. This has been reflected in the oft-repeated observation that water will likely replace oil as a future cause of war between nations. Today the first glimpses of the coming water wars are emerging. Many countries in the Middle East, Africa, Central and South Asia -- e.g. Afghanistan, Pakistan, China, Kenya, Egypt, and India -- are already feeling the direct consequences of the water scarcity -- with the competition for water leading to social unrest, conflict and migration. This month the escalating concerns about the possibility of water wars triggered calls by Zafar Adeel, chair of UN-Water, for the UN to promote "hydro-diplomacy" in the Middle East and North Africa in order to avoid or at least manage emerging tensions over access to water. The gloomy outlook of our global fresh water resources points in the direction that the current conflicts and instability in these countries are **only glimpses** of the water wars expected to unfold in the future. Thus we need to address the water crisis that can **quickly escalate** and become a great humanitarian crisis and also a **global safety problem**.

#### Academic data proves

**Jawan, 12** [S Naji, Faculty of Human Ecology, Universiti Putra Malaysia, ‘Resource Wars’ in the Post-Cold War Era: The Persian Gulf Oil, US, and the Iraq War Arts and Social Sciences Journal, Vol. 2012: ASSJ-49, <http://astonjournals.com/manuscripts/Vol2012/ASSJ-49_Vol2012.pdf>]

\*\*\*Cites **Yergin**, Pulitzer Prize winning economic researcher. and chairman of Cambridge Energy Research Associates and Billon (MBA Paris, PhD Oxford) is Associate Professor at the University of British Columbia with the Department of Geography and Klare [professor](http://en.wikipedia.org/wiki/Professor) of Peace and World Security Studies, at [Hampshire College](http://en.wikipedia.org/wiki/Hampshire_College), author of *Resource Wars* and *Blood and Oil: The Dangers and Consequences of America's Growing Petroleum Dependency* (Metropolitan) and Dr. Susanne Peters the Academic Director of the Kent State University and teaches International Relations and European Politics\*\*\*

2. ‘Resource Wars’ and Conflict for Oil Natural resources have always played a key role in conflicts and wars taking place. These struggles are often caused by the scarcity and immense value resources such as diamonds, copper, gold, water, timber, arable land, and oil [1]. Among them, the role of petroleum as a vital commodity for the industrial world, and due to its global influences has been most remarkable, and as Yergin [8] noted, the history of petroleum has always been associated with the history of struggle and war. Indeed, “petroleum is unique among the world’s resources” [1]. There is this view that, the 21st century, similar to the previous century will be a “century of oil” and from this view, access to oil as a global resource has always included those issues that have formed battles [9]. In fact, the new resource wars in the world will be a significant problem in the future. It will be because of the oil supply crisis as a natural resource. It will occur because of the declining oil reservoirs as well as the unbalanced distribution of these resources in particular along the North-South axis [4]. Billon [3] believes that the natural resources have always been introduced as a crucial motive of conflicts and wars. He refers to the more important role of these resources in creating wars in the 1990s and argues that some interventions take place because of the lust for valuable resources. He also believes that, on the other hand, the political and economic vulnerabilities of dependent countries on resources are the main reason for the importance of resources in creating wars. In this respect, the geopolitical thinking in the west, concerning resources, has been established over an equally strong relationship amongst power, trade, and war which has been tied strongly to maritime navigation and overseas resources too. In the past, this geopolitical thought had been reflected in the view that “whoever commands the oceans commands the trade of the world, and whoever commands the trade of the world commands the riches of the world, and whoever is master of that commands the world itself.” With growing dependence of the western countries on imported materials during the 19th century, indeed, great western countries expanded their command over raw materials throughout the world. In this commentary, some classic geopolitical concepts such as “vital space” or Lebensraum for accessing further resources and Mackinder’s “Heartland” in warning about the role of railways in control of resources are very important [3]. Oil is the most significant overseas resource, and Billon [3], showed the key role it played during World War I and World War II. The vulnerability of those resources at that time was also revealed so that during the Cold War, ultimately, it was focused “on the vulnerability of rising resource supply dependence” which required various strategies to secure the needed resources in the forms of military deployments, accumulation of resources, diplomatic activities, coup d’état, etc. [3]. In this respect, four important events have also been mentioned by Billon, which have influenced the oil strategies and history; the decolonization process, Suez crisis in 1956, the 1973 Arab oil embargo, and the Islamic revolution of Iran in 1979. He also mentioned two important events, the end of the Cold War and the Iraqi invasion of Kuwait, as events that increased the importance of energy security and vulnerability of these resources. Billon, on the other hand, indicates the necessity of energy security for the oil producer countries. For him, always one of the strategic http://astonjournals.com/assj 3 Arts and Social Sciences Journal, Vol. 2012: ASSJ-49 concerns for importing and exporting countries relates to geopolitics of energy security. In that regard, he also considers the natural resources revenues as a strong instrument to create wars in the post-Cold War era. This view is similar to Huntington’s idea that oil-rich countries in the Persian Gulf became money-rich and then weapons-rich, and then, several wars finally occurred between Arab and Israel [10]. Peters [4], however, in his work “Coercive Western Energy Security Strategies: ‘Resource Wars’ as a New Threat to Global Security,” explains the conditions of the Cold War era concerning resource wars and believes that, in 1986, a list of 12 wars and skirmishes in the 20th century was presented indicating that all were started by clashes over access to resources, renewable or non-renewable. For him, the 1991 Gulf War was the first interstate war on a major scale in the post-Cold War era, which was fought to control the oil of the region. From his view, oil is the most important non-renewable resources. In particular, it is a vital commodity in the industrial countries, with industrialized economies, particularly in agriculture and transportation sectors. As evidence, he refers to demand rates of consumer countries and indicates that demand is growing significantly and will continue to do so especially in the forthcoming decades such that in accordance with the international energy agency’s (IEA) request for oil between 1997 and 2020 which is anticipated to rise with a growth rate of 1.9% per year [4]. In this respect and according to an international group of petroleum specialists (Association for the Study of Peak Oil, ASPO), researchers will witness the peak of world supply of oil in early 2010, and as a consequence, the energy prices will grow, and ultimately the world will face economic upheaval. Peters examines in fact, the resources conflict from the South–North perspectives and argues that 67.3% of all proven oil reservoirs has been covered by the G-77 and OPEC, and Arab league covers nearly 60% of world oil reservoirs. On the other hand, the demands of the developing countries are growing too. It is expected to rise almost three-fold as fast as in the developed world. It is estimated that from 43% for today to 55% of total global consumption by 2020. Therefore, conflict between South and North will be built over the distribution of energy resources among the energy-producing states and the energy-consuming states. There is, indeed, this view that, wars are generally the result of a multifaceted combination of motives, and the most important motivation is the concerns that are related to access and control of resources [4]. It is interesting that Peters refers to two wars in the post-Cold War as “resource wars,” which were the result of the US coercive strategy in order to protect energy supplies. In this respect, however, Singh refers to three wars in the Persian Gulf; two Iraq wars and the Afghanistan war that took place between two Iraq wars. He, in reference to the Afghanistan war, presents this question: “Is the NATO military presence in South-West Asia only to fight terrorism and introduce democracy or is there a hidden agenda like dominating the energy sources for the use of the west? Are they spending billions of dollars to maintain a large number of troops not only in Iraq but also in the neighborhood for political philanthropy, like establishing democracy, or is it an investment for energy security in the future?” [11]. Singh, with reference to some studies emphasizes that bypassing the National Oil Company of Iraq in support of free market of oil was the aim of neo-conservatives, as it would reduce the domination of OPEC and other oil producers over the international oil market. He refers to production and consumption of oil for the period 1970–2003, and emphasizes the US dependency on foreign oil. He also stresses three significant issues: a continuous decrease in oil production, growing oil consumption, and as a result constantly rising dependence upon foreign imported oil. This increasing dependence has been shown to grow from 12.15% in 1970 to 43.7% in 1990 and to 65.1% in 2003. From this point of view, as the oil reserves of the US, South-East Asia and North Sea are declining; all the major consumers’ dependence is increasing, especially on the Persian Gulf oil because of their future needs. This increase for the US is from 2.3 million barrels per day (mbd) in 2003 to 4.2 mbd by 2020. He also refers to declining oil production in the US from 9.5 mbd in 1970 to 6.72 mbd in 1994 and to 5.72 mbd in 2003. There is also decline in Norway, UK, and Indonesia. Clearly, the oil reservoirs and productions of the Persian Gulf area will increasingly be vital for global energy security because the decreasing oil production and limited reservoirs in the OECD states [11]. Another commentator, Klare [12] discusses three main resources in his work: energy resources (oil and natural gas), water, and valuable timber and minerals, and refers to the importance of these vital materials in the outbreak of conflicts across the world. Klare reveals his own worry about these conflicts and believes that it is a necessary issue to find and plan ways to resolve the issue of the competition over natural resources, because controlling specific natural resources is a national security theme of many countries and “something worth fighting for.” In this respect, he divides the reasons of conflicts after the Cold War to two periods and says that fighting in Central Africa, Kashmir, and the former Yugoslavia focused the global community on preventing ethnic conflict in the early 1990s, while in the next few years, violence in Africa occurred in the fight to control the copper mines, diamond fields, and farmlands. Concerning oil and gas, however, Klare pointed out the mechanism of supply and demand as the starting point of the pressure on http://astonjournals.com/assj 4 Research Article energy reserves. He believes that increasing the populations and expanding the economic activities caused increasing need for vital materials, and demands for these materials, especially oil and gas, has always risen. Based on this viewpoint, “as shortages of critical materials rise in frequency and severity, the competition for access to the remaining supplies of these commodities will grow more intense” [12]. He refers to a report of the US Department of Energy and declares that the world oil consumption will increase from about 77 mbd in 2000 to 110 mbd in 2020 (about 43%). In this condition, the world consumption will rise to approximately 670 billion barrels of oil only from 2000 till 2020. It means that it will include nearly two-thirds of the proven oil reservoirs of the world. In this respect, it seems that the production of petroleum will not be able to keep up with global demands and as a result the world will face an unbalanced global supply and demand [12].

#### Specifically, it causes Indo-Pak war

**Bokhari 10** – assistant editor at Dawn (Ashfak, 01/18, “Water dispute and war risk,” http://archives.dawn.com/archives/24980)

In March last year, a group of more than 20 different UN bodies warned that, since water has become the latest cause to stoke tensions between India and Pakistan, the world may be **perilously close** to its first water war. “Water is linked to the crises of climate change, energy and food supplies and prices, and troubled financial markets,” said their report. “Unless their links with water are addressed and water crises around the world are resolved, other crises may **intensify** and local water crises may worsen, converging into a global water crisis and leading to political insecurity and conflict at various levels.” The first attempt to use water as a military tool was made in 1503 when Leonardo da Vinci and Machiavelli planned to divert Amo River away from Pisa during the conflict between Pisa and Florence. On January 28, 2009, President Asif Ali Zardari in an article in Washington Post warned “The water crisis in Pakistan is directly linked to relations with India. Its resolution could prevent an environmental catastrophe in South Asia, but failure to do so could fuel the fires of discontent that may lead to extremism and terrorism.” In early 2009, Pakistan was seen being on the brink of a water disaster, as the availability of water which was 5,000 cubic meters per capita 60 years ago has declined to 1,200 cubic meters. By 2020, it may fall to about 800 cubic meters per capita. In recent weeks water shortage has worsened from 30 to 40 per cent because of the drought that may reduce the Rabi crops produce by 20 per cent. In case the drought continues, the country may get 21- 22 million tonnes of wheat against the target of 25 million tonnes. The first phase of the Baglihar dam, a 450-MW hydroelectric power project initiated in the 1990s, was completed on October 10, 2008. Inaugurating the project, Indian Prime Minister Manmohan Singh noted “It is a matter of satisfaction that the reconstruction programme… [entailing] 67 projects is well under way with 19 projects completed, one of which is the Baglihar project that I inaugurate today.” Zardari reacted angrily saying India`s move to block Pakistan`s water supply from the Chenab River could harm their relations. “Manmohan Singh had assured me in our meeting in New York that his country is seriously committed to our (Indus) water sharing treaty,” he said, referring to their meeting on the sidelines of the UN General Assembly a month before. “We expect him to stand by his commitment.” India didn`t take steps to abide by Singh`s commitment or provisions of the Indus treaty. Meanwhile, talk about water war had been gaining currency. On November 3, 2008, PML-Q chief and former premier Chaudhry Shujaat Hussain said the water crisis between Pakistan and India could become more serious than terrorism and can result in a war. Mr Majid Nizami, chief editor of a group of newspapers, observed in June last that the water dispute with India could trigger a war. “Pakistan can become a desert within the next 10 to 15 years. We should show upright posture or otherwise prepare for a **nuclear war**,” he said.

### Plan

#### The United States federal government should establish a matching funds programs, increase research and development funding and remove licensing restrictions for thorium power production in the United States.

### 1AC Solvency

#### Contention two is solvency --

#### The plan catalyzes effective investment in thorium based reactor technology

Martin, 12 [May 8th, Richard, A contributing editor for Wired since 2002, he has written about energy, for Time, Fortune, The Atlantic, and the Asian Wall Street Journal, editorial director for Pike Research, the leading cleantech research and analysis firm, former Technology Producer for ABCNews.com, Technology Editor for The Industry Standard (2000-2001), and Editor-at- Large for Information Week (2005-2008), recipient of the “Excellence in Feature Writing" Award from the Society for Professional Journalists and the White Award for Investigative Reporting, Educated at Yale and the University of Hong Kong, , “SuperFuel: Thorium, the Green Energy Source for the Future”, ISBN 978—0»230-116474]

WHILE A NEW MANHATTAN PROIECT is not going to happen, some¶ form of government support is necessary. Transforming the energy¶ sector is too large a project for the private sector alone. That’s the¶ fundamental dilemma that faces the thorium movement. However,¶ there is a middle way, involving higher levels of federal support, a¶ conscious industrial policy to foster advanced nuclear power, and¶ broad incentives to harness the entrepreneurial energy of the private¶ sector.¶ Congress and the White House should establish a matching funds¶ program**,** aimed exclusively at two or three technologies, including¶ thorium power, to drive the creation of a Generation IV reactor¶ industry that would swiftly within this decade—build prototypes and¶ then small commercial versions, first to supplement and later replace¶ the current collection of outmoded plants, then to replace existing coal¶ plants. The government should overhaul the NRC to streamline the¶ licensing process and favor Generation IV designs over incremental,¶ halfhearted advances. It should explicitly benefit start-ups, like¶ TerraPower and Flibe Energy, not just established vendors and¶ manufacturers like GE, and it should promote homegrown technologies¶ like the LFTR. And it should be conditional on not just submitting new¶ designs for licensing but bringing reactors into commercial production¶ in the shortest time possible. With matching investments coming from¶ the private sector, the program should provide at least $2 billion a year¶ and no more than $5 billion, for a total of $4 billion to $10 billion a¶ year.¶ Many conservatives and liberals alike scoff at the notion of¶ significant funding for new nuclear power—or, indeed, for renewable¶ energy projects such as wind farms and solar arrays. In September¶ 2011 Solyndra, the California-based maker of solar panels, filed for¶ bankruptcy protection after receiving a loan guarantee for more than¶ half a billion dollars from the federal government. Critics of¶ renewables funding, such as Robert Bryce, seized on the Solyndra¶ affair, which threatened to turn into a major political landmine for the¶ Obama administration, as evidence of why the federal government¶ should never “pick winners” in the energy sector.¶ Here it’s important to recall that, as of late 2011, investment by the¶ United States in new energy sources was paltry compared with that of¶ the countries of Western Europe, to say nothing of China. The Solyndra¶ debacle represented less than 3 percent of a loan program that had¶ delivered $19 billion in private capital for reshaping the energy¶ economy, creating thousands of jobs in the worst employment¶ environment since the Great Depression.¶ For further perspective, keep in mind that, according to the Nobel¶ Prize— winning economist ]oseph Stiglitz, in 2007 the Iraq War was¶ costing $720 million per day.“ Big Oil subsidies are also huge in¶ comparison with investment in alternative energy. In 2010 the¶ Government Accountability Office found that the oil industry’s waiver¶ for royalties for deep-water drilling in the Gulf of Mexico—originally¶ passed by Congress in 1995, when oil was selling for $18 a barrel¶ —“could cost the Treasury $55 billion or more in lost revenue over the¶ life of the leases.” The federal government is already picking winners—¶ it’s just backing the wrong horse. Simply requiring big oil companies¶ operating in the Gulf to pay half the usual royalties for extracting oil¶ from U.S. territorial waters would fully fund a nuclear power¶ transformation program through 2020, at no cost to U.S. taxpayers. The¶ tobacco industry has funded billions of dollars in health-care and¶ prevention programs to move toward a smoke-free society. Let the¶ fossil fuel industry take a large role in funding the movement toward a¶ carbon-free society based on thorium power.¶ ----¶ SO, LET US ASSUME THAT A NUCLEAR POWER transformation¶ program is fully funded. The goals are to:¶ - Build a prototype LFTR within five years¶ - Commercialize LFTRs starting in 2020¶ - Bring LFTRs on line at a rate sufficient to replace fossil fuel plants¶ with clean energy sources by 2050¶ How much power would that be? The United States consumed about¶ 3.8 million gigawatt-hours of electricity in 2010. Coal accounted for 44¶ percent of that, nuclear for 20 percent. Total U.S. electricity-generating¶ capacity is about 1,000 gigawatts. Under an optimistic scenario for¶ renewable energy production from wind, solar, biomass, geothermal,¶ and so on, let’s say that, to reduce carbon emissions enough to stave off¶ catastrophic climate change, by 2050 we must increase the portion of¶ our electricity generated by nuclear power to 50 percent. One half of¶ 1,000 gigawatts is 500 gigawatts, or 500,000 megawatts.¶ Electricity demand will grow in the next four decades, of course, by¶ as much as 50 to 60 percent in some forecasts. But I’m being optimistic.¶ So let us say that improved conservation technology and changing¶ consumer habits will limit the increase in demand, and we must build¶ enough new nuclear power plants to generate 500 gigawatts by 2050.¶ That’s the equivalent of 500 thousand-megawatt nuclear reactors.¶ Between 2020 and 2050 that means building about 17 LFTRs a year.¶ Let’s be ambitious and call it 20 new thousand-megawatt thorium¶ plants a year, for a total of 600.¶ One of the beauties of LFTRs is that they can be mass-produced.¶ Small, modular LFTRs can be built as 250 megawatt machines and¶ assembled into larger plants. Boeing builds about one $200 million jet a¶ day. A modern airliner has many, many more moving parts and¶ greater overall complexity than a 250-megawatt LFTR. If we build, say,¶ four LFTR manufacturing plants a year with each plant producing 20¶ 250-megawatt reactors (five 1,000-megawatt plants) a year (think of the¶ jobs and spillover technological benefits each plant would bring to the¶ state in which it’s located), that would just about do it. And from 2050 to¶ 2100 we can build another 400 plants, until we have created 1,000¶ gigawatts of thorium power. By the end of the century, we will have¶ built a safe, clean energy infrastructure based on a mix of offshore and¶ land-based wind farms, big solar arrays in the West, geothermal, and¶ natural gas plants, layered on top of a baseload power-generating¶ sector of thorium reactors. Particularly in the Southwest, these plants¶ will use excess heat energy to desalinate seawater.¶ How much will this cost? Technology advances will bring the cost of¶ thorium reactors down rapidly after commercialization, potentially to¶ the cost of a new jet. Call it $1 billion per thousand-megawatt plant. The¶ cost of building 600 thousand-megawatt LFTRs (or twenty-four hundred¶ 250-megawatt machines) would come to $600 billion. Add 15 percent¶ for start-up costs and financing and round up: $700 billion. In¶ comparison, the 2010 budget for the U.S. Department of Defense was¶ $685 billion. In other words, for about what we spend in one year on¶ defense in wartime (which, by the way, is almost as much as all other¶ countries spend on defense combined), we can lay the foundation for a¶ thorium-based, carbon-free energy economy that could last a¶ millennium. And most of that construction cost will be borne by private¶ industry, which, thanks to the expedited licensing and speedy¶ construction of LFTRs, will generate profits from this construction¶ boom in a short timeframe. Consider the costs, direct and indirect, of¶ building any other thousand-megawatt power plant (coal, conventional¶ nuclear, solar, natural gas)—or of doing nothing and allowing climate¶ change to run rampant by midcentury. Building a couple dozen LFTRs¶ a year starts to sound like a bargain.¶ Alvin Weinberg’s vision of a nuclear-powered world running on¶ molten salt reactors will become a reality a couple of generations later¶ than he foresaw.¶ These are ambitious goals. What, then, must we do to pull them off?¶ To create a thorium energy economy in the next decade, three things¶ must happen at once: funding, licensing reform, and R&D. I have¶ already described the funding mechanism that must be put in place¶ quickly, by the end of 2013. Licensing reform and R&D—including the¶ development and procurement of the needed materials and fuel—must¶ occur in parallel. The president should order the NRC to expedite its¶ licensing process so that the period from application to final approval¶ is no more than five years. That means that by 2015, while a prototype¶ LFTR is being built (at the Savannah River Site, Idaho National¶ Laboratory, or Oak Ridge), companies will begin submitting¶ applications.¶ At the same time, you must have fuel to start up all those reactors.¶ Two kinds are required: fissile fuel to ignite the chain reaction and¶ transmute thorium into uranium-233, plus the thorium itself. Luckily¶ we have plenty of both. The Department of Energy (DOE) has more¶ than a ton of U-233, produced by past thorium reactor experiments, on¶ hand. Foolishly, the DOE is planning to spend half a billion dollars to¶ blend the U-233 with U-238 and throw it away in the desert. That plan¶ must be scrapped and the U-233 put to good use as starter fuel for¶ LFTRs.¶ As for thorium, the U.S. Geological Survey estimates that total¶ thorium reserves in the United States are about 440,000 tons, mostly in¶ Montana and Idaho. If we assume that future LFTRs will achieve an¶ energy efficiency of 50 percent (half the available energy in a given¶ unit of thorium is actually converted to electricity), then a single ton of¶ thorium would produce about 12.1 billion kilowatt-hours (or 12.1¶ million megawatt-hours) of electricity. About 1,650 tons of thorium¶ would satisfy all the electricity needs of the entire world for a single¶ year. Since LFTRs can he run as breeder reactors, producing more fuel¶ than they consume, 440,000 tons is effectively a limitless supply of¶ nuclear fuel.¶ ----¶ THE NEXT STEP, once a prototype reactor has been built and tested, is¶ to build a series of liquid fuel reactors to burn up the plutonium and¶ fission products from existing spent uranium fuel. Kirk Sorensen has¶ proposed a type of liquid chloride thorium reactor, a cousin to LFTRs,¶ that will consume transuranic fission products and use plutonium to¶ create uranium-233. The U-233 will be used to start up new LFTRs.¶ Next we must create the infrastructure to manufacture LFTRs. The¶ expertise to build these machines is dispersed among a cadre of startups¶ described in chapter 9, including Elibe Energy, DBI, and so on, as¶ well as among the big nuclear suppliers like GE and Westinghouse,¶ which already, in some cases, have R&D programs for liquid-core¶ reactors. As has happened in the electric vehicle market, the actual¶ manufacturers would likely include established companies (GE), startups¶ (Flibe), and joint ventures combining the two. States will compete¶ to host the new plants with tax incentives, university-based R&D¶ support, and training programs to provide the skilled workers. (Here¶ it’s worth noting that the Navy has for years been training recruits with¶ only high school educations to be shipboard nuclear engineers. The¶ new thorium power industry will create thousands of skilled, highpaying¶ jobs that do not require a Ph.D. in nuclear physics.)¶ It does no good to build carbon-free thorium reactors if you don’t get¶ rid of the existing nuclear and coal-fired plants. Decommissioning¶ nuclear reactors is a long, involved, and costly process. A typical decom¶ costs $300 million and takes a decade; an extreme case, like the¶ Hartford Weapons Reactor, can cost billions and take many decades.¶ Ways must be found to bring down that cost. One way would be to¶ build new LFTRs on the sites of old nuclear plants and use the new¶ thorium reactors to consume the fission products from the old¶ machines.¶ As for coal plants, new regulations from the Environmental¶ Protection Agency (EPA) will lead to the retirement of dozens of aging¶ facilities in the next few decades, regardless of what type of new plants¶ come on line. In July 2011 the consulting firm ICP released a report¶ saying that, while shutting down existing coal plants will take longer¶ than foreseen in the EPA deadlines, 30 to 50 gigawatts of coal-fired¶ electricity production will be retired in the coming decade.” Total coalfired¶ generating capacity in the United States is about 314 gigawatts.¶ Shutting down 50 gigawatts of that every decade, and replacing it with¶ safe, clean thorium power, will eliminate coal from the U.S. electrical¶ portfolio by 2070.¶ These are achievable goals. Remember: the obstacles to creating a¶ thorium power economy in the next 40 years are not technological or¶ even economic. They are political and perceptual. If we don’t do it, it ¶ will be because we chose not to—not because it was impossible.

#### Current support is insufficient—Congressional appropriations are key to fast-track reactor development

Cannarra, 5/5/11 [Engineering and Environmental Consultant Member: AAAS, IEEE, Sierra Club Supporter: EDF, Greenpeace, NAPF, Nature Conservancy, NRDC, RAN, UCS, WWF… Affiliated with the Thorium Energy Alliance Thorium – A Safe, Abundant and ‘Fertile’ Power Source Dr. Alexander Cannara,http://cybercemetery.unt.edu/archive/brc/20120627230324/http://brc.gov/sites/default/files/comments/attachments/thoriumarticle\_a\_cannara\_0.pdf]

Today, for example, we in the US have limited support for better reactor Designs. We even have little interest in utility-funded, standard reactor construction. It’s not that alternate nuclear-power paths were never opened. It’s that Cold War policies dampened our own research, leaving the world with few developed options now that they’re essential. There is no source of power as dense and environmentally friendly as properly-chosen nuclear power. There’s no fission source as cheap or as lasting as the Thorium breeder. Yet, we in the US also have a regulatory agency, the NRC, holding just a few basic LWR power-plant designs for prospective builders to choose from, with some mix and match of components. And, each of those designs requires about $10 billion and many years to complete. No utility can invest that, which is why our present administration has promoted loan guarantees to get new plants built. Yet, even that hasn’t worked. Furthermore, the US NRC reports to Congress and can do only what that body mandates and funds**.** No work on alternative reactor designs, fuel cycles and rules can be expected from the NRC itself without new appropriations. Even a 1977 EPRI report(8) on the usefulness of Thorium in LWRs gained no industry action. Some new work has been funded by DoE (7), but not yet near the level needed, even if it continued from the excellent decades of work funded by the AEC and DoD at ORNL(5). Similarly, private investors see no near-term return, but great risk, because nuclear reactors require extensive design for safety and regulation – the function of government agencies andresearch**.** The present situation is odd, yet with some hope, as will be explained. “Nowadays [1994] I often hear arguments about whether the decision to concentrate on the LWR was correct. I must say that at the time I did not think it was; and 40 years later we realize, more clearly than we did then, that safety must take precedence even over economics—that no reactor system can be accepted unless it is first of all safe. However, in those earliest days we almost never compared the intrinsic safety of the LWR with the intrinsic safety of its competitors. We used to say that every reactor would be made safe by engineering interventions. We never systematically compared the complexity and scale of the necessary interventions for [different] reactors. So in this respect I would say that [AEC head] Ken Davis’ insistence on a single line, the LWR, was premature.” (Weinberg (5)) In this light, consider the reality all peoples of the world now share, though disproportioned by wealth. To meet just the internationally-estimated need to reduce greenhouse-gas (GHG) emissions now (January 2011) by a modest 4% per year, 2050 must see our (then) 9 billion souls emitting just 1 ton of CO2 per capita per year(1). And, with sea acidification and rise (see Rignot)(1) soon threatening over 100 million people, we need to be building and running one new, 1GWe emissions-free power plant each week for decades. A city-bound New Yorker currently causes emissions of 10 tons/year. A car-using Denver-ite 5/6/2011 Page 7 causes twice that. And, an average California home causes 7 tons of CO2 per year to be emitted, just from its internal energy use (see CEC reports). Only in remote, poor communities in Africa does any person now cause just 1 ton of CO2 to be added to Earth’s atmosphere each year. Sustainability, even at 1-ton per capita per year, is far from our reach. Regardless of pro/con debates on climate change, we are collectively making a Pascal Wager against already evident climate change growing worse due to our emissions – we’re “betting the farm” despite good hints as early as Nobel Laureate S. Arrhenius’ 1896 and 1905 papers on possible effects of unnatural CO2 emissions(1). Later, we didn’t listen to post-WWII analytical reports to governments; and our governments didn’t even follow up on research we’d paid for that pointed the way to safe, non-emitting nuclear power -- 50 years before this writing. Some Generation IV (8) efforts are finally in motion, but another decade will pass before any demonstration system will run. The emissions-free power debt will then be 1GWe x 10 x 52 (a plant a week unbuilt) or more, just for US needs. Perhaps the new Chinese commitment(4) will be speedier, but the shortfall will remain stupendous, worldwide. We need serious efforts today, if we wish to leave a future to our descendants. This article will explain why what has long been known about Thorium as a fertile nuclear fuel leads us to a viable future for Earth’s power and water needs. And, it will use as example the complementary reactor architecture designed by the same people who gave us the LWR, but who knew better was needed. Thus, this article is dedicated to Alvin Weinberg, H. MacPherson and their ORNL teams, who were aware of global warming before Wikipedia and spent 20 years (1954-1974) designing and operating MSRs. They led the way to safely fuelling our future via Thorium (3,4).

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