## Plan

#### The United States Federal Government should reduce restrictions on airborne wind energy systems in the United States.

## Advantage 1: Heg

#### Hegemony precludes multiple scenarios for nuclear war – decline causes violent transitions

Brooks, Ikenberry, and Wohlforth ’13 (Stephen, Associate Professor of Government at Dartmouth College, John Ikenberry is the Albert G. Milbank Professor of Politics and International Affairs at Princeton University in the Department of Politics and the Woodrow Wilson School of Public and International Affairs, William C. Wohlforth is the Daniel Webster Professor in the Department of Government at Dartmouth College “Don’t Come Home America: The Case Against Retrenchment,” International Security, Vol. 37, No. 3 (Winter 2012/13), pp. 7–51)

A core premise of deep engagement is that it prevents the emergence of a far more dangerous global security environment. For one thing, as noted above, the United States’ overseas presence gives it the leverage to restrain partners from taking provocative action. Perhaps more important, its core alliance commitments also deter states with aspirations to regional hegemony from contemplating expansion and make its partners more secure, reducing their incentive to adopt solutions to their security problems that threaten others and thus stoke security dilemmas. The contention that engaged U.S. power dampens the baleful effects of anarchy is consistent with influential variants of realist theory. Indeed, arguably the scariest portrayal of the war-prone world that would emerge absent the “American Pacifier” is provided in the works of John Mearsheimer, who forecasts dangerous multipolar regions replete with security competition, arms races, nuclear proliferation and associated preventive war temptations, regional rivalries, and even runs at regional hegemony and full-scale great power war. 72 How do retrenchment advocates, the bulk of whom are realists, discount this benefit? Their arguments are complicated, but two capture most of the variation: (1) U.S. security guarantees are not necessary to prevent dangerous rivalries and conflict in Eurasia; or (2) prevention of rivalry and conflict in Eurasia is not a U.S. interest. Each response is connected to a different theory or set of theories, which makes sense given that the whole debate hinges on a complex future counterfactual (what would happen to Eurasia’s security setting if the United States truly disengaged?). Although a certain answer is impossible, each of these responses is nonetheless a weaker argument for retrenchment than advocates acknowledge. The first response flows from defensive realism as well as other international relations theories that discount the conflict-generating potential of anarchy under contemporary conditions. 73 Defensive realists maintain that the high expected costs of territorial conquest, defense dominance, and an array of policies and practices that can be used credibly to signal benign intent, mean that Eurasia’s major states could manage regional multipolarity peacefully without the American pacifier. Retrenchment would be a bet on this scholarship, particularly in regions where the kinds of stabilizers that nonrealist theories point to—such as democratic governance or dense institutional linkages—are either absent or weakly present. There are three other major bodies of scholarship, however, that might give decisionmakers pause before making this bet. First is regional expertise. Needless to say, there is no consensus on the net security effects of U.S. withdrawal. Regarding each region, there are optimists and pessimists. Few experts expect a return of intense great power competition in a post-American Europe, but many doubt European governments will pay the political costs of increased EU defense cooperation and the budgetary costs of increasing military outlays. 74 The result might be a Europe that is incapable of securing itself from various threats that could be destabilizing within the region and beyond (e.g., a regional conflict akin to the 1990s Balkan wars), lacks capacity for global security missions in which U.S. leaders might want European participation, and is vulnerable to the influence of outside rising powers. What about the other parts of Eurasia where the United States has a substantial military presence? Regarding the Middle East, the balance begins to swing toward pessimists concerned that states currently backed by Washington— notably Israel, Egypt, and Saudi Arabia—might take actions upon U.S. retrenchment that would intensify security dilemmas. And concerning East Asia, pessimism regarding the region’s prospects without the American pacifier is pronounced. Arguably the principal concern expressed by area experts is that Japan and South Korea are likely to obtain a nuclear capacity and increase their military commitments, which could stoke a destabilizing reaction from China. It is notable that during the Cold War, both South Korea and Taiwan moved to obtain a nuclear weapons capacity and were only constrained from doing so by a still-engaged United States. 75 The second body of scholarship casting doubt on the bet on defensive realism’s sanguine portrayal is all of the research that undermines its conception of state preferences. Defensive realism’s optimism about what would happen if the United States retrenched is very much dependent on its particular—and highly restrictive—assumption about state preferences; once we relax this assumption, then much of its basis for optimism vanishes. Specifically, the prediction of post-American tranquility throughout Eurasia rests on the assumption that security is the only relevant state preference, with security defined narrowly in terms of protection from violent external attacks on the homeland. Under that assumption, the security problem is largely solved as soon as offense and defense are clearly distinguishable, and offense is extremely expensive relative to defense. Burgeoning research across the social and other sciences, however, undermines that core assumption: states have preferences not only for security but also for prestige, status, and other aims, and they engage in trade-offs among the various objectives. 76 In addition, they define security not just in terms of territorial protection but in view of many and varied milieu goals. It follows that even states that are relatively secure may nevertheless engage in highly competitive behavior. Empirical studies show that this is indeed sometimes the case. 77 In sum, a bet on a benign postretrenchment Eurasia is a bet that leaders of major countries will never allow these nonsecurity preferences to influence their strategic choices. To the degree that these bodies of scholarly knowledge have predictive leverage, U.S. retrenchment would result in a significant deterioration in the security environment in at least some of the world’s key regions. We have already mentioned the third, even more alarming body of scholarship. Offensive realism predicts that the withdrawal of the American pacifier will yield either a competitive regional multipolarity complete with associated insecurity, arms racing, crisis instability, nuclear proliferation, and the like, or bids for regional hegemony, which may be beyond the capacity of local great powers to contain (and which in any case would generate intensely competitive behavior, possibly including regional great power war). Hence it is unsurprising that retrenchment advocates are prone to focus on the second argument noted above: that avoiding wars and security dilemmas in the world’s core regions is not a U.S. national interest. Few doubt that the United States could survive the return of insecurity and conflict among Eurasian powers, but at what cost? Much of the work in this area has focused on the economic externalities of a renewed threat of insecurity and war, which we discuss below. Focusing on the pure security ramifications, there are two main reasons why decisionmakers may be rationally reluctant to run the retrenchment experiment. First, overall higher levels of conflict make the world a more dangerous place. Were Eurasia to return to higher levels of interstate military competition, one would see overall higher levels of military spending and innovation and a higher likelihood of competitive regional proxy wars and arming of client states—all of which would be concerning, in part because it would promote a faster diffusion of military power away from the United States. Greater regional insecurity could well feed proliferation cascades, as states such as Egypt, Japan, South Korea, Taiwan, and Saudi Arabia all might choose to create nuclear forces. 78 It is unlikely that proliferation decisions by any of these actors would be the end of the game: they would likely generate pressure locally for more proliferation. Following Kenneth Waltz, many retrenchment advocates are proliferation optimists, assuming that nuclear deterrence solves the security problem. 79 Usually carried out in dyadic terms, the debate over the stability of proliferation changes as the numbers go up. Proliferation optimism rests on assumptions of rationality and narrow security preferences. In social science, however, such assumptions are inevitably probabilistic. Optimists assume that most states are led by rational leaders, most will overcome organizational problems and resist the temptation to preempt before feared neighbors nuclearize, and most pursue only security and are risk averse. Confidence in such probabilistic assumptions declines if the world were to move from nine to twenty, thirty, or forty nuclear states. In addition, many of the other dangers noted by analysts who are concerned about the destabilizing effects of nuclear proliferation—including the risk of accidents and the prospects that some new nuclear powers will not have truly survivable forces—seem prone to go up as the number of nuclear powers grows. 80 Moreover, the risk of “unforeseen crisis dynamics” that could spin out of control is also higher as the number of nuclear powers increases. Finally, add to these concerns the enhanced danger of nuclear leakage, and a world with overall higher levels of security competition becomes yet more worrisome. The argument that maintaining Eurasian peace is not a U.S. interest faces a second problem. On widely accepted realist assumptions, acknowledging that U.S. engagement preserves peace dramatically narrows the difference between retrenchment and deep engagement. For many supporters of retrenchment, the optimal strategy for a power such as the United States, which has attained regional hegemony and is separated from other great powers by oceans, is offshore balancing: stay over the horizon and “pass the buck” to local powers to do the dangerous work of counterbalancing any local rising power. The United States should commit to onshore balancing only when local balancing is likely to fail and a great power appears to be a credible contender for regional hegemony, as in the cases of Germany, Japan, and the Soviet Union in the midtwentieth century. The problem is that China’s rise puts the possibility of its attaining regional hegemony on the table, at least in the medium to long term. As Mearsheimer notes, “The United States will have to play a key role in countering China, because its Asian neighbors are not strong enough to do it by themselves.” 81 Therefore, unless China’s rise stalls, “the United States is likely to act toward China similar to the way it behaved toward the Soviet Union during the Cold War.” 82 It follows that the United States should take no action that would compromise its capacity to move to onshore balancing in the future. It will need to maintain key alliance relationships in Asia as well as the formidably expensive military capacity to intervene there. The implication is to get out of Iraq and Afghanistan, reduce the presence in Europe, and pivot to Asia— just what the United States is doing. 83 In sum, the argument that U.S. **security** commitments are unnecessary **for peace** is countered by a lot of scholarship, including highly influential realist scholarship. In addition, the argument that Eurasian peace is unnecessary for U.S. security is weakened by the potential for a large number of nasty security consequences as well as the need to retain a latent onshore balancing capacity that dramatically reduces the savings retrenchment might bring. Moreover, switching between offshore and onshore balancing could well be difªcult. Bringing together the thrust of many of the arguments discussed so far underlines the degree to which the case for retrenchment misses the underlying logic of the deep engagement strategy. By supplying reassurance, deterrence, and active management, the United States lowers security competition in the world’s key regions, thereby preventing the emergence of a hothouse atmosphere for growing new military capabilities. Alliance ties dissuade partners from ramping up and also provide leverage to prevent military transfers to potential rivals. On top of all this, the United States’ formidable military machine may deter entry by potential rivals. Current great power military expenditures as a percentage of GDP are at historical lows, and thus far other major powers have shied away from seeking to match top-end U.S. military capabilities. In addition, they have so far been careful to avoid attracting the “focused enmity” of the United States. 84 All of the world’s most modern militaries are U.S. allies (America’s alliance system of more than sixty countries now accounts for some 80 percent of global military spending), and the gap between the U.S. military capability and that of potential rivals is by many measures growing rather than shrinking. 85

**Social science proves unipolarity generates stability**

Wohlforth 9 (Professor of government at Dartmouth (William, “Unipolarity, Status Competition, and Great Power War,” World Affairs, January, project muse)

The upshot is a near scholarly consensus that unpolarity’s consequences for great power conﬂict are indeterminate and that a power shift resulting in a return to bipolarity or multipolarity will not raise the specter of great power war. This article questions the consensus on two counts. First, I show that it depends crucially on a **dubious** assumption about human motivation. Prominent theories of war are based on the assumption that people are mainly motivated by the instrumental pursuit of tangible ends such as physical security and material prosperity. This is why such theories seem irrelevant to interactions among great powers in an international environment that diminishes the utility of war for the pursuit of such ends. Yet we know that people are motivated by a great many noninstrumental motives, not least by concerns regarding their social status. 3 As John Harsanyi noted, “Apart from economic payoffs, social status (social rank) seems to be the most important incentive and motivating force of social behavior.” 4 This proposition rests on much ﬁrmer scientiﬁc ground now than when Harsanyi expressed it a generation ago, as cumulating research shows that humans appear to be hardwired for sensitivity to status and that relative standing is a powerful and independent motivator of behavior. 5 Second, I question the dominant view that status quo evaluations are relatively independent of the distribution of capabilities. If the status of states depends in some measure on their relative capabilities, and if states derive utility from status, then different distributions of capabilities may affect levels of satisfaction, just as different income distributions may affect levels of status competition in domestic settings. 6 Building on research in psychology and sociology, I argue that even capabilities distributions among major powers foster **ambiguous status hierarchies**, which generate more dissatisfaction and clashes over the status quo. And the more stratiﬁed the distribution of capabilities, the less likely such status competition is. **Unipolarity** thus **generates far fewer incentives** than either bipolarity or multipolarity for direct great power positional competition over status. Elites in the other major powers continue to prefer higher status, but in a unipolar system they face comparatively weak incentives to translate that preference into costly action. And the absence of such incentives matters because social status is a positional good—something whose value depends on how much one has in relation to others. 7 “If everyone has high status,” Randall Schweller notes, “no one does.” 8 While one actor might increase its status, all cannot simultaneously do so. High status is thus inherently scarce, and competitions for status tend to be zero sum. 9 I begin by describing the puzzles facing predominant theories that status competition might solve. Building on recent research on social identity and status seeking, I then show that under certain conditions the ways decision makers identify with the states they represent may prompt them to frame issues as positional disputes over status in a social hierarchy. I develop hypotheses that tailor this scholarship to the domain of great power politics, showing how the probability of status competition is likely to be linked to polarity. The rest of the article investigates whether there is sufﬁcient evidence for these hypotheses to warrant further reﬁnement and testing. I pursue this in three ways: by showing that the theory advanced here is consistent with what we know about large-scale patterns of great power conﬂict through history; by demonstrating that the causal mechanisms it identiﬁes did drive relatively secure major powers to military conﬂict in the past (and therefore that they might do so again if the world were bipolar or multipolar); and by showing that observable evidence concerning the major powers’ identity politics and grand strategies under unipolarity are consistent with the theory’s expectations.

**The threat of cyber warfare is real – countries are increasing attacks against the US risking great power war
Habiger ‘10** (Eugene, Retired Air Force General, “ CYBERWARFARE AND CYBERTERRORISM: THE NEED FOR A NEW U.S. STRATEGIC APPROACH,” The Cyber Security Institute, February 1)

However, there are reasons to believe that what is going on now amounts to a fundamental shift as opposed to business as usual. Today’s network exploitation or information operation trespasses possess a number of characteristics that suggest that the line between espionage and conflict has been, or is close to being, crossed. (What that suggests for the proper response is a different matter.) First, the number of cyberattacks we are facing is growing significantly. Andrew Palowitch, a former CIA official now consulting with the US Strategic Command (STRATCOM), which oversees the Defense Department’s Joint Task Force‐Global Network Operations, recently told a meeting of experts that the Defense Department has experienced almost 80,000 computer attacks, and some number of these assaults have actually “reduced” the military’s “operational capabilities.”20 Second, the nature of these attacks is starting to shift from penetration attempts aimed at gathering intelligence (cyber spying) to offensive efforts aimed at taking down systems (cyberattacks). Palowitch put this in stark terms last November, “We are currently in a cyberwar and war is going on today.”21 Third, these recent attacks need to be taken in a broader strategic context. Both Russia and China have stepped up their offensive efforts and taken a much more aggressive cyberwarfare posture. The Chinese have developed an openly discussed cyberwar strategy aimed at achieving electronic dominance over the U.S. and its allies by 2050. In 2007 the Department of Defense reported that for the first time China has developed first strike viruses, marking a major shift from prior investments in defensive measures.22 And in the intervening period China has launched a series of offensive cyber operations against U.S. government and private sector networks and infrastructure. In 2007, Gen. James Cartwright, the former head of STRATCOM and now the Vice Chairman of the Joint Chiefs of Staff, told the US‐China Economic and Security Review Commission that China’s ability to launch “denial of service” attacks to overwhelm an IT system is of particular concern. 23 Russia also has already begun to wage offensive cyberwar. At the outset of the recent hostilities with Georgia, Russian assets launched a series of cyberattacks against the Georgian government and its critical infrastructure systems, including media, banking and transportation sites.24 In 2007, cyberattacks that many experts attribute, directly or indirectly, to Russia shut down the Estonia government’s IT systems. Fourth, the current geopolitical context must also be factored into any effort to gauge the degree of threat of cyberwar. The start of the new Obama Administration has begun to help reduce tensions between the United States and other nations. And, the new administration has taken initial steps to improve bilateral relations specifically with both China and Russia. However, it must be said that over the last few years the posture of both the Chinese and Russian governments toward America has clearly become more assertive, and at times even aggressive. Some commentators have talked about the prospects of a cyber Pearl Harbor, and the pattern of Chinese and Russian behavior to date gives reason for concern along these lines: both nations have offensive cyberwarfare strategies in place; both nations have taken the cyber equivalent of building up their forces; both nations now regularly probe our cyber defenses looking for gaps to be exploited; both nations have begun taking actions that cross the line from cyberespionage to cyberaggression; and, our bilateral relations with both nations are increasingly fractious and complicated by areas of marked, direct competition. Clearly, there a sharp differences between current U.S. relations with these two nations and relations between the US and Japan just prior to World War II. However, from a strategic defense perspective, there are enough warning signs to warrant preparation. In addition to the threat of cyberwar, the limited resources required to carry out even a large scale cyberattack also makes likely the potential for a significant cyberterror attack against the United States. However, the lack of a long list of specific incidences of cyberterrorism should provide no comfort. There is strong evidence to suggest that al Qaeda has the ability to conduct cyberterror attacks against the United States and its allies. Al Qaeda and other terrorist organizations are extremely active in cyberspace, using these technologies to communicate among themselves and others, carry out logistics, recruit members, and wage information warfare. For example, al Qaeda leaders used email to communicate with the 9‐11 terrorists and the 9‐11 terrorists used the Internet to make travel plans and book flights. Osama bin Laden and other al Qaeda members routinely post videos and other messages to online sites to communicate. Moreover, there is evidence of efforts that al Qaeda and other terrorist organizations are actively developing cyberterrorism capabilities and seeking to carry out cyberterrorist attacks. For example, the Washington Post has reported that “U.S. investigators have found evidence in the logs that mark a browser's path through the Internet that al Qaeda operators spent time on sites that offer software and programming instructions for the digital switches that run power, water, transport and communications grids. In some interrogations . . . al Qaeda prisoners have described intentions, in general terms, to use those tools.”25 Similarly, a 2002 CIA report on the cyberterror threat to a member of the Senate stated that al Qaeda and Hezbollah have become "more adept at using the internet and computer technologies.”26 The FBI has issued bulletins stating that, “U. S. law enforcement and intelligence agencies have received indications that Al Qaeda members have sought information on Supervisory Control And Data Acquisition (SCADA) systems available on multiple SCADA‐related web sites.”27 In addition a number of jihadist websites, such as 7hj.7hj.com, teach computer attack and hacking skills in the service of Islam.28 While al Qaeda may lack the cyber‐attack capability of nations like Russia and China, there is every reason to believe its operatives, and those of its ilk, are as capable as the cyber criminals and hackers who routinely effect great harm on the world’s digital infrastructure generally and American assets specifically. In fact, perhaps, the most troubling indication of the level of the cyberterrorist threat is the countless, serious non‐terrorist cyberattacks routinely carried out by criminals, hackers, disgruntled insiders, crime syndicates and the like. If run‐of‐the‐mill criminals and hackers can threaten powergrids, hack vital military networks, steal vast sums of money, take down a city’s of traffic lights, compromise the Federal Aviation Administration’s air traffic control systems, among other attacks, it is overwhelmingly likely that terrorists can carry out similar, if not more malicious attacks. Moreover, even if the world’s terrorists are unable to breed these skills, they can certainly buy them. There are untold numbers of cybermercenaries around the world—sophisticated hackers with advanced training who would be willing to offer their services for the right price. Finally, given the nature of our understanding of cyber threats, there is always the possibility that we have already been the victim or a cyberterrorist attack, or such an attack has already been set but not yet effectuated, and we don’t know it yet. Instead, a well‐designed cyberattack has the capacity cause widespread chaos, sow societal unrest, undermine national governments, spread paralyzing fear and anxiety, and create a state of utter turmoil, all without taking a single life. A sophisticated cyberattack could throw a nation’s banking and finance system into chaos causing markets to crash, prompting runs on banks, degrading confidence in markets, perhaps even putting the nation’s currency in play and making the government look helpless and hapless. In today’s difficult economy, imagine how Americans would react if vast sums of money were taken from their accounts and their supporting financial records were destroyed. A truly nefarious cyberattacker could carry out an attack in such a way (akin to Robin Hood) as to engender populist support and deepen rifts within our society, thereby making efforts to restore the system all the more difficult. A modestly advanced enemy could use a cyberattack to shut down (if not physically damage) one or more regional power grids. An entire region could be cast into total darkness, power‐dependent systems could be shutdown. An attack on one or more regional power grids could also cause cascading effects that could jeopardize our entire national grid. When word leaks that the blackout was caused by a cyberattack, the specter of a foreign enemy capable of sending the entire nation into darkness would only increase the fear, turmoil and unrest. While the finance and energy sectors are considered prime targets for a cyberattack, an attack on any of the 17 delineated critical infrastructure sectors could have a major impact on the United States. For example, our healthcare system is already technologically driven and the Obama Administration’s e‐health efforts will only increase that dependency. A cyberattack on the U.S. e‐health infrastructure could send our healthcare system into chaos and put countless of lives at risk. Imagine if emergency room physicians and surgeons were suddenly no longer able to access vital patient information. A cyberattack on our nation’s water systems could likewise cause widespread disruption. An attack on the control systems for one or more dams could put entire communities at risk of being inundated, and could create ripple effects across the water, agriculture, and energy sectors. Similar water control system attacks could be used to at least temporarily deny water to otherwise arid regions, impacting everything from the quality of life in these areas to agriculture. In 2007, the U.S. Cyber Consequences Unit determined that the destruction from a single wave of cyberattacks on critical infrastructures could exceed $700 billion, which would be the rough equivalent of 50 Katrina‐esque hurricanes hitting the United States all at the same time.29 Similarly, one IT security source has estimated that the impact of a single day cyberwar attack that focused on and disrupted U.S. credit and debit card transactions would be approximately $35 billion.30 Another way to gauge the potential for harm is in comparison to other similar noncyberattack infrastructure failures. For example, the August 2003 regional power grid blackout is estimated to have cost the U.S. economy up to $10 billion, or roughly .1 percent of the nation’s GDP. 31 That said, a cyberattack of the exact same magnitude would most certainly have a much larger impact. The origin of the 2003 blackout was almost immediately disclosed as an atypical system failure having nothing to do with terrorism. This made the event both less threatening and likely a single time occurrence. Had it been disclosed that the event was the result of an attack that could readily be repeated the impacts would likely have grown substantially, if not exponentially. Additionally, a cyberattack could also be used to disrupt our nation’s defenses or distract our national leaders in advance of a more traditional conventional or strategic attack. Many military leaders actually believe that such a disruptive cyber pre‐offensive is the most effective use of offensive cyber capabilities. This is, in fact, the way Russia utilized cyberattackers—whether government assets, governmentdirected/ coordinated assets, or allied cyber irregulars—in advance of the invasion of Georgia. Widespread distributed denial of service (DDOS) attacks were launched on the Georgian governments IT systems. Roughly a day later Russian armor rolled into Georgian territory. The cyberattacks were used to prepare the battlefield; they denied the Georgian government a critical communications tool isolating it from its citizens and degrading its command and control capabilities precisely at the time of attack. In this way, these attacks were the functional equivalent of conventional air and/or missile strikes on a nation’s communications infrastructure.32 One interesting element of the Georgian cyberattacks has been generally overlooked: On July 20th, weeks before the August cyberattack, the website of Georgian President Mikheil Saakashvili was overwhelmed by a more narrowly focused, but technologically similar DDOS attack.33 This should be particularly chilling to American national security experts as our systems undergo the same sorts of focused, probing attacks on a constant basis. The ability of an enemy to use a cyberattack to counter our offensive capabilities or soften our defenses for a wider offensive against the United States is much more than mere speculation. In fact, in Iraq it is already happening. Iraq insurgents are now using off‐the‐shelf software (costing just $26) to hack U.S. drones (costing $4.5 million each), allowing them to intercept the video feed from these drones.34 By hacking these drones the insurgents have succeeded in greatly reducing one of our most valuable sources of real‐time intelligence and situational awareness. If our enemies in Iraq are capable of such an effective cyberattack against one of our more sophisticated systems, consider what a more technologically advanced enemy could do. At the strategic level, in 2008, as the United States Central Command was leading wars in both Iraq and Afghanistan, a cyber intruder compromised the security of the Command and sat within its IT systems, monitoring everything the Command was doing. 35 This time the attacker simply gathered vast amounts of intelligence. However, it is clear that the attacker could have used this access to wage cyberwar—altering information, disrupting the flow of information, destroying information, taking down systems—against the United States forces already at war. Similarly, during 2003 as the United States prepared for and began the War in Iraq, the IT networks of the Department of Defense were hacked 294 times.36 By August of 2004, with America at war, these ongoing attacks compelled then‐Deputy Secretary of Defense Paul Wolfowitz to write in a memo that, "Recent exploits have reduced operational capabilities on our networks."37 This wasn’t the first time that our national security IT infrastructure was penetrated immediately in advance of a U.S. military option.38 In February of 1998 the Solar Sunrise attacks systematically compromised a series of Department of Defense networks. What is often overlooked is that these attacks occurred during the ramp up period ahead of potential military action against Iraq. The attackers were able to obtain vast amounts of sensitive information—information that would have certainly been of value to an enemy’s military leaders. There is no way to prove that these actions were purposefully launched with the specific intent to distract American military assets or degrade our capabilities. However, such ambiguities—the inability to specifically attribute actions and motives to actors—are the very nature of cyberspace. Perhaps, these repeated patterns of behavior were mere coincidence, or perhaps they weren’t. The potential that an enemy might use a cyberattack to soften physical defenses, increase the gravity of harms from kinetic attacks, or both, significantly increases the potential harms from a cyberattack. Consider the gravity of the threat and risk if an enemy, rightly or wrongly, believed that it could use a cyberattack to degrade our strategic weapons capabilities. Such an enemy might be convinced that it could win a war—conventional or even nuclear—against the United States. The effect of this would be to undermine our deterrence‐based defenses, making us significantly more at risk of a **major** **war**.

#### Two Internal links – First,

#### Grid collapse is inevitable – qualified studies indicate multiple credible threats

Slavo ’12 (Mac Slavo, SHTFplan.com, quoting qualified people, “Report: Chance of a Catastrophic Solar Storm Is 1 in 8; Would Take Down Power Grid, Food Transportation, Water Utilities, Financial Systems”, <http://www.shtfplan.com/headline-news/report-chance-of-a-catastrophic-solar-storm-is-1-in-8-would-take-down-power-grid-food-transportation-water-utilities-financial-systems_03062012>, March 6, 2012)

According to a recent study published by Space Weather: The International Journal of Research and Applications, we have roughly a 12% chance of getting hit with a solar storm so powerful that it could take down the national power grid and yield catastrophic consequences for the general population. Pete Riley, a senior scientist at Predictive Science in San Diego, is the author of the study which looks at the probability of the occurrence of extreme weather events: Via: On the probability of occurrence of extreme space weather events Key Points Probability of a Carrington event occurring over next decade is ~12% Space physics datasets often display a power-law distribution Power-law distribution can be exploited to predict extreme events By virtue of their rarity, extreme space weather events, such as the Carrington event of 1859, are difficult to study, their rates of occurrence are difficult to estimate, and prediction of a specific future event is virtually impossible. Additionally, events may be extreme relative to one parameter but normal relative to others. In this study, we analyze several measures of the severity of space weather events (flare intensity, coronal mass ejection speeds)… … By showing that the frequency of occurrence scales as an inverse power of the severity of the event, and assuming that this relationship holds at higher magnitudes, we are able to estimate the probability that an event larger than some criteria will occur within a certain interval of time in the future. For example, the probability of another Carrington event occurring within the next decade is ∼12%. The 1859 Carrington Event, as described by Wired Science, may have been a marvel to observers and caused some setbacks in the developing telegraph infrastructure at the time, but a similar occurrence today could be a global game changer: At the time of the Carrington Event, telegraph stations caught on fire, their networks experienced major outages and magnetic observatories recorded disturbances in the Earth’s field that were literally off the scale. In today’s electrically dependent modern world, a similar scale solar storm could have catastrophic consequences. Auroras damage electrical power grids and may contribute to the erosion of oil and gas pipelines. They can disrupt GPS satellites and disturb or even completely black out radio communication on Earth. During a geomagnetic storm in 1989, for instance, Canada’s Hydro-Quebec power grid collapsed within 90 seconds, leaving millions without power for up to nine hours. The potential collateral damage in the U.S. of a Carrington-type solar storm might be between $1 trillion and $2 trillion in the first year alone, with full recovery taking an estimated four to 10 years, according to a 2008 report from the National Research Council. The post-storm effects of such an event are underestimated by the majority of the world’s population, including our political leadership. Like an electro magentic pulse attack, according to the National Research Council a massive enough solar storm could have long term effects that ”would likely include, for example, disruption of the transportation, communication, banking, and finance systems, and government services; the breakdown of the distribution of potable water owing to pump failure; and the loss of perishable foods and medications because of lack of refrigeration.” The worst case scenario has been outlined by the Center for Security Policy, which suggests that an EMP, or a solar storm that results in similar magnetic discharge across the United States, could potentially leave 90% of Americans dead within the first year: “Within a year of that attack, nine out of 10 Americans would be dead, because we can’t support a population of the present size in urban centers and the like without electricity,” said Frank Gaffney, president of the Center for Security Policy. “And that is exactly what I believe the Iranians are working towards.” In the documentary Urban Danger, Congressman Roscoe Bartlett warns of the threat posed by a downed power grid and urges his fellow citizens to take action to protect themselves for the inevitable results that would follow: We could have events in the future where the power grid will go down and it’s not, in any reasonable time, coming back up. For instance, if when the power grid went down some of our large transformers were destroyed, damaged beyond use, we don’t make any of those in this country. They’re made overseas and you order one and 18 months to two years later they will deliver it. Our power grid is very vulnerable. It’s very much on edge. Our military knows that. … There are a number of events that could create a situation in the cities where civil unrest would be a very high probability. And, I think that those who can, and those who understand, need to take advantage of the opportunity when these winds of strife are not blowing to move their families out of the city. Source: Congressman Warns: “Those Who Can, Should Move Their Families Out Of the City” For many, a 1 in 8 chance of a catastrophic event occurring in a decade’s time may be nothing to worry about. For the emergency, disaster and preparedness minded individual, however, a massive solar storm with the potential to take out our modern day power grid and utility infrastructure is just one in a variety of potentially catastrophic natural and man-made scenarios that could lead to the collapse of life in America as we know it today. Though any given event on its own may have a low probability of occurrence, when combined with other potentialities like economic collapse, currency collapse, global or regional military conflict, Super EMP, political destabilization, massive earthquakes (such as on the New Madrid fault), Tsunamis, asteroids, pandemic, and cyber attacks the odds of a game changing paradigm shift in our lifetime’s rise significantly.

#### Cyber-attacks against the grid are uniquely likely

Reed ‘12 (John, FP contributor on cyber war and military technology, "U.S. energy companies victims of potentially destructive cyber intrusions", 10/11/12, killerapps.foreignpolicy.com/posts/2012/10/11/us\_energy\_companies\_victims\_of\_potentially\_destructive\_cyber\_attacks)

Foreign actors are probing the networks of key American companies in an attempt to gain control of industrial facilities and transportation systems, Defense Secretary Leon Panetta revealed tonight.¶ "We know that foreign cyber actors are probing America's critical infrastructure networks," said Panetta, disclosing previously classified information during a speech in New York laying out the Pentagon's role in protecting the U.S. from cyber attacks. "They are targeting the computer control systems that operate chemical, electricity and water plants, and those that guide transportation thorough the country."¶ He went on to say that the U.S. government knows of "specific instances where intruders have gained access" to these systems -- frequently known as Supervisory Control and Data Acquisition (or SCADA) systems -- and that "they are seeking to create advanced tools to attack these systems and cause panic, destruction and even the loss of life," according to an advance copy of his prepared remarks.¶ The secretary said that a coordinated attack on enough critical infrastructure could be a "cyber Pearl Harbor" that would "cause physical destruction and loss of life, paralyze and shock the nation, and create a profound new sense of vulnerability."¶ While there have been reports of criminals using 'spear phishing' email attacks aimed at stealing information about American utilties, Panetta's remarks seemed to suggest more sophisticated, nation-state backed attempts to actually gain control of and damage power-generating equipment. ¶ Panetta's comments regarding the penetration of American utilities echo those of a private sector cyber security expert Killer Apps spoke with last week who said that the networks of American electric companies were penetrated, perhaps in preparation for a Stuxnet-style attack.¶ Stuxnet is the famous cyber weapon that infected Iran's uranium-enrichment centrifuges in 2009 and 2010. Stuxnet is believed to have caused some of the machines to spin erratically, thereby destroying them.¶ "There is hard evidence that there has been penetration of our power companies, and given Stuxnet, that is a staging step before destruction" of electricity-generating equipment, the expert told Killer Apps. Because uranium centrifuges and power turbines are both spinning machines, "the attack is identical -- the one to take out the centrifuges and the one to take out our power systems is the same attack."¶ "If a centrifuge running at the wrong speed can blow apart" so can a power generator, said the expert. "If you do, in fact, spin them at the wrong speeds, you can blow up any rotating device."¶ Cyber security expert Eugene Kaspersky said two weeks ago that one of his greatest fears is someone reverse-engineering a sophisticated cyber weapon like Stuxnet -- a relatively easy task -- and he noted that Stuxnet itself passed through power plants on its way to Iran. "Stuxnet infected thousands of computer systems all around the globe, I know there were power plants infected by Stuxnet very far away from Iran," Kaspersky said.

#### That shuts down US military operations

Stockton ’11 (Paul, assistant secretary of defense for Homeland Defense and Americas’ Security Affairs, “Ten Years After 9/11: Challenges for the Decade to Come”, <http://www.hsaj.org/?fullarticle=7.2.11>)

The cyber threat to the DIB is only part of a much larger challenge to DoD. Potential adversaries are seeking asymmetric means to cripple our force projection, warfighting, and sustainment capabilities, by targeting the critical civilian and defense supporting assets (within the United States and abroad) on which our forces depend. This challenge is not limited to man-made threats; DoD must also execute its mission-essential functions in the face of disruptions caused by naturally occurring hazards.20 Threats and hazards to DoD mission execution include incidents such as earthquakes, naturally occurring pandemics, solar weather events, and industrial accidents, as well as kinetic or virtual attacks by state or non-state actors. Threats can also emanate from insiders with ties to foreign counterintelligence organizations, homegrown terrorists, or individuals with a malicious agenda. From a DoD perspective, this global convergence of unprecedented threats and hazards, and vulnerabilities and consequences, is a particularly problematic reality of the post-Cold War world. Successfully deploying and sustaining our military forces are increasingly a function of interdependent supply chains and privately owned infrastructure within the United States and abroad, including transportation networks, cyber systems, commercial corridors, communications pathways, and energy grids. This infrastructure largely falls outside DoD direct control. Adversary actions to destroy, disrupt, or manipulate this highly vulnerable homeland- and foreign-based infrastructure may be relatively easy to achieve and extremely tough to counter. Attacking such “soft,” diffuse infrastructure systems could significantly affect our military forces globally – potentially blinding them, neutering their command and control, degrading their mobility, and isolating them from their principal sources of logistics support. The Defense Critical Infrastructure Program (DCIP) under Mission Assurance seeks to improve execution of DoD assigned missions to make them more resilient. This is accomplished through the assessment of the supporting commercial infrastructure relied upon by key nodes during execution. By building resilience into the system and ensuring this support is well maintained, DoD aims to ensure it can "take a punch as well as deliver one."21 It also provides the department the means to prioritize investments across all DoD components and assigned missions to the most critical issues faced by the department through the use of risk decision packages (RDP).22 The commercial power supply on which DoD depends exemplifies both the novel challenges we face and the great progress we are making with other federal agencies and the private sector. Today’s commercial electric power grid has a great deal of resilience against the sort of disruptive events that have traditionally been factored into the grid’s design. Yet, the grid will increasingly confront threats beyond that traditional design basis. This complex risk environment includes: disruptive or deliberate attacks, either physical or cyber in nature; severe natural hazards such as geomagnetic storms and natural disasters with cascading regional and national impacts (as in NLE 11); long supply chain lead times for key replacement electric power equipment; transition to automated control systems and other smart grid technologies without robust security; and more frequent interruptions in fuel supplies to electricity-generating plants. These risks are magnified by globalization, urbanization, and the highly interconnected nature of people, economies, information, and infrastructure systems. The department is highly dependent on commercial power grids and energy sources. As the largest consumer of energy in the United States, DoD is dependent on commercial electricity sources outside its ownership and control for secure, uninterrupted power to support critical missions. In fact, approximately 99 percent of the electricity consumed by DoD facilities originates offsite, while approximately 85 percent of critical electricity infrastructure itself is commercially owned. This situation only underscores the importance of our partnership with DHS and its work to protect the nation’s critical infrastructure – a mission that serves not only the national defense but also the larger national purpose of sustaining our economic health and competitiveness. DoD has traditionally assumed that the commercial grid will be subject only to infrequent, weather-related, and short-term disruptions, and that available backup power is sufficient to meet critical mission needs. As noted in the February 2008 Report of the Defense Science Board Task Force on DoD Energy Strategy, “In most cases, neither the grid nor on-base backup power provides sufficient reliability to ensure continuity of critical national priority functions and oversight of strategic missions in the face of a long term (several months) outage.”23 Similarly, a 2009 GAO Report on Actions Needed to Improve the Identification and Management of Electrical Power Risks and Vulnerabilities to DoD Critical Assets stated that DoD mission-critical assets rely primarily on commercial electric power and are vulnerable to disruptions in electric power supplies.24 Moreover, these vulnerabilities may cascade into other critical infrastructure that uses the grid – communications, water, transportation, and pipelines – that, in turn, is needed for the normal operation of the grid, as well as its quick recovery in emergency situations. To remedy this situation, the Defense Science Board (DSB) Task Force recommended that DoD take a broad-based approach, including a focused analysis of critical functions and supporting assets, a more realistic assessment of electricity outage cause and duration, and an integrated approach to risk management that includes greater efficiency, renewable resources, distributed generation, and increased reliability. DoD Mission Assurance is designed to carry forward the DSB recommendations. Yet, for a variety of reasons – technical, financial, regulatory, and legal – DoD has limited ability to manage electrical power demand and supply on its installations. As noted above, DHS is the lead agency for critical infrastructure protection by law and pursuant to Homeland Security Presidential Directive 7. The Department of Energy (DOE) is the lead agency on energy matters. And within DoD, energy and energy security roles and responsibilities are distributed and shared, with different entities managing security against physical, nuclear, and cyber threats; cost and regulatory compliance; and the response to natural disasters. And of course, production and delivery of electric power to most DoD installations are controlled by commercial entities that are regulated by state and local utility commissions. The resulting paradox: DoD is dependent on a commercial power system over which it does not – and never will – exercise control.

#### **Second, oil dependence wrecks DOD budgeting and operations**

Gardner 12 (Robert, Adjunct Junior Fellow at the American Security Project, 6/21/12, Budgeting for Biofuels:The Military’s Dependence on Petroleum Must be Mitigated, http://americansecurityproject.org/blog/2012/budgeting-for-biofuelsthe-militarys-dependence-on-petroleum-must-be-mitigated/, JD)

Petroleum is currently used to satisfy 80% of the US military’s energy needs and is relied upon as the single source of liquid fuel for transportation, operations, and training. The volatile price of oil has incurred huge unbudgeted costs for the military, causing national security risks for the military’s operations. In light of national security risks it has become widely agreed upon that the Department of Defense should be hedging its bets against petroleum use. The Navy is seeking to move away from petroleum dependence by investing in biofuels, the primary alternative to petroleum fuels. However, both the House and Senate Armed Services Committees have moved to block the Navy’s plans to purchase biofuels for testing and to directly invest in domestic biofuels producers. This action undermines the military’s efforts to mitigate the long term strategic risks posed by its dependence on petroleum. Biofuel research and development needs to be on the table as the military reduces its dependence on petroleum. Why does the military need to shift away from petroleum fuel? Currently the military is dependent upon volatile petroleum prices set on the global market. These prices are largely determined by the unpredictable politics of foreign countries. Even if the military dose not import oil directly from Iran or the Middle East, the price paid for petroleum is largely set by market conditions in the region. Price instability has caused budgeting dilemmas for the military in recent years. A June 2012 Congressional Research Service report found that the cost of buying fuel has increased faster than any other major DoD budget category. Despite the DoD’s cutting back 4% on petroleum use from FY2005 to FY2011, its spending on petroleum ballooned 381% in real (i.e., inflation-adjusted) terms during this time period. Along with rising prices, the short term volatility of oil prices poses substantial risks for DoD budgeting and operations. Secretary of the Navy Ray Mabus has stated that every dollar increase in the price of a barrel of petroleum costs the Navy about $31 million of unbudgeted funding annually . DoD reports have found that a 10% increase from the FY2011 price of fuel would cost the DoD as a whole an additional $1.7 billion a year . Former Defense Secretary Robert Gates asserted that unbudgeted fuel costs could force operational cuts in Air Force flying hours, Navy steaming days, and training for home-stationed Army troops. These cuts pose serious security risks for military operations. While testifying on military budgeting for 2013 Secretary Mabus stated that “we would be irresponsible if we did not reduce our dependence on foreign oil.” Steps Forward Steep increases and fluctuations in petroleum spending emphasize the need for the DoD to hedge its bets against rising petroleum prices. The Navy and Air Force have set forth 2020 goals to reduce their oil usage by 50%, by using alternative fuels. Secretary Mabus and others have stated that efforts toward biofuel development will increase the security of the energy supplies and reduce the service’s vulnerability to price shocks. In the short-term, biofuels will do nothing to help the budget – this year’s investments in biofuels will do nothing to rectify the budget – but over the longer term, developing an alternative to oil will be an important way to break oil’s monopoly. The military must be willing to take significant steps today to reach its goals of mitigating the security risks of its current dependence on oil. As will be expanded upon in further posts, biofuels should be on the table as part of the military’s comprehensive plan for hedging its bets against petroleum use.

## Advantage 2: Climate Change

Warming is real, anthropogenic, and by far the largest risk of extinction

Deibel ‘7 (Terry L. Deibel, professor of IR at National War College, Foreign Affairs Strategy, “Conclusion: American Foreign Affairs Strategy Today Anthropogenic – caused by CO2”)

Finally, **there is one major existential threat** to American security (as well as prosperity) of a nonviolent nature, which, though far in the future, demands urgent action. **It is the threat of global warming to the stability of the climate upon which all earthly life depends**. Scientists worldwide have been observing the gathering of this threat for three decades now, **and what was once a mere possibility has passed through probability to near certainty.** Indeed **not one of more than 900 articles** **on climate change published in refereed scientific journals** from 1993 to 2003 doubted that anthropogenic warming is occurring. “In legitimate scientific circles,” writes Elizabeth Kolbert, “it is virtually **impossible to find evidence of disagreement** over the fundamentals of global warming.” Evidence from a vast international scientific monitoring effort accumulates almost weekly, as this sample of newspaper reports shows: an international panel predicts “brutal droughts, floods and violent storms across the planet over the next century”; climate change could “literally alter ocean currents, wipe away huge portions of Alpine Snowcaps and aid the spread of cholera and malaria”; “glaciers in the Antarctic and in Greenland are melting much faster than expected, and…worldwide, plants are blooming several days earlier than a decade ago”; “rising sea temperatures have been accompanied by a significant global increase in the most destructive hurricanes”; “NASA scientists have concluded from direct temperature measurements that 2005 was the hottest year on record, with 1998 a close second”; “Earth’s warming climate is estimated to contribute to more than 150,000 deaths and 5 million illnesses each year” as disease spreads; “widespread bleaching from Texas to Trinidad…killed broad swaths of corals” due to a 2-degree rise in sea temperatures. “The world is slowly disintegrating,” concluded Inuit hunter Noah Metuq, who lives 30 miles from the Arctic Circle. “They call it climate change…but we just call it breaking up.” From the founding of the first cities some 6,000 years ago until the beginning of the industrial revolution, carbon dioxide levels in the atmosphere remained relatively constant at about 280 parts per million (ppm). At present they are accelerating toward 400 ppm, and by 2050 they will reach 500 ppm, about double pre-industrial levels. Unfortunately, atmospheric CO2 lasts about a century, so there is no way immediately to reduce levels, only to slow their increase, we are thus in for significant global warming; the only debate is how much and how serous the effects will be. As the newspaper stories quoted above show, we are already experiencing the effects of 1-2 degree warming in more violent storms, spread of disease, mass die offs of plants and animals, species extinction, and threatened inundation of low-lying countries like the Pacific nation of Kiribati and the Netherlands at a warming of 5 degrees or less the Greenland and West Antarctic ice sheets could disintegrate, leading to a sea level of rise of 20 feet that would cover North Carolina’s outer banks, swamp the southern third of Florida, and inundate Manhattan up to the middle of Greenwich Village. Another catastrophic effect would be the collapse of the Atlantic thermohaline circulation that keeps the winter weather in Europe far warmer than its latitude would otherwise allow. Economist William Cline once estimated the damage to the United States alone from moderate levels of warming at 1-6 percent of GDP annually; severe warming could cost 13-26 percent of GDP. But **the most frightening scenario is runaway greenhouse warming, based on positive feedback from the buildup of water** **vapor** in the atmosphere that is both caused by and causes hotter surface temperatures. Past ice age transitions, associated with only 5-10 degree changes in average global temperatures, took place in just decades, even though no one was then pouring ever-increasing amounts of carbon into the atmosphere. Faced with this specter, the best one can conclude is that “humankind’s continuing enhancement of the natural greenhouse effect is akin to playing Russian roulette with the earth’s climate and humanity’s life support system. At worst, says physics professor Marty Hoffert of New York University, “we’re just going to burn everything up; we’re going to het the atmosphere to the temperature it was in the Cretaceous when there were crocodiles at the poles, and then everything will collapse.” During the Cold War, astronomer Carl Sagan popularized a theory of nuclear winter to describe how a thermonuclear war between the Untied States and the Soviet Union would not only destroy both countries but possible end life on this planet. **Global warming is the post-Cold War era’s equivalent of nuclear winter at least as serious and considerably better supported scientifically. Over the long run it puts dangers form terrorism and traditional military challenges to shame**. It is a threat not only to the security and prosperity to the United States, but potentially to the continued existence of life on this planet.

#### CO2 kills ocean biodiversity – causes acidification and mass dieoff

Joe Romm is a Fellow at American Progress and is the editor of Climate Progress, “Science: Ocean Acidifying So Fast It Threatens Humanity’s Ability to Feed Itself,” 3/2/2012, http://thinkprogress.org/romm/2012/03/02/436193/science-ocean-acidifying-so-fast-it-threatens-humanity-ability-to-feed-itself/?utm\_source=feedburner&utm\_medium=email&utm\_campaign=Feed%3A+climateprogre

The world’s oceans may be turning acidic faster today from human carbon emissions than they did during four major extinctions in the last 300 million years, when natural pulses of carbon sent global temperatures soaring, says a new study in Science. The study is the first of its kind to survey the geologic record for evidence of ocean acidification over this vast time period. “What we’re doing today really stands out,” said lead author Bärbel Hönisch, a paleoceanographer at Columbia University’s Lamont-Doherty Earth Observatory. “We know that life during past ocean acidification events was not wiped out—new species evolved to replace those that died off. But if industrial carbon emissions continue at the current pace, we may lose organisms we care about—coral reefs, oysters, salmon.” That’s the news release from a major 21-author Science paper, “The Geological Record of Ocean Acidification” (subs. req’d). We knew from a 2010 Nature Geoscience study that the oceans are now acidifying 10 times faster today than 55 million years ago when a mass extinction of marine species occurred. But this study looked back over 300 million and found that “the unprecedented rapidity of CO2 release currently taking place” has put marine life at risk in a frighteningly unique way: … the current rate of (mainly fossil fuel) CO2 release stands out as capable of driving a combination and magnitude of ocean geochemical changes potentially unparalleled in at least the last ~300 My of Earth history, raising the possibility that we are entering an unknown territory of marine ecosystem change. That is to say, it’s not just that acidifying oceans spell marine biological meltdown “by end of century” as a 2010 Geological Society study put it. We are also warming the ocean and decreasing dissolved oxygen concentration. That is a recipe for mass extinction. A 2009 Nature Geoscience study found that ocean dead zones “devoid of fish and seafood” are poised to expand and “remain for thousands of years.“ And remember, we just learned from a 2012 new Nature Climate Change study that carbon dioxide is “driving fish crazy” and threatening their survival. Here’s more on the new study: The oceans act like a sponge to draw down excess carbon dioxide from the air; the gas reacts with seawater to form carbonic acid, which over time is neutralized by fossil carbonate shells on the seafloor. But if CO2 goes into the oceans too quickly, it can deplete the carbonate ions that corals, mollusks and some plankton need for reef and shell-building.

**Extinction**

Romm ‘10 (Dr. Joseph Romm is the editor of Climate Progress and a Senior Fellow at the American Progress, Acting Assistant Secretary of Energy for Energy Efficiency and Renewable Energy during the Clinton Administration, PhD in Physics from MIT, “Nature Geoscience study: Oceans are acidifying 10 times faster today than 55 million years ago when a mass extinction of marine species occurred” <http://climateprogress.org/2010/02/18/ocean-acidification-study-mass-extinction-of-marine-life-nature-geoscience/#more-19529>)

Marine life face some of the worst impacts. We now know that global warming is “capable of wrecking the marine ecosystem and depriving future generations of the harvest of the seas” (see 2009 Nature Geoscience study concludes ocean dead zones “devoid of fish and seafood” are poised to expand and “remain for thousands of years”). The acidification of the ocean in particular is a grave threat — for links to primary sources and recent studies, see “Imagine a World without Fish: Deadly ocean acidification — hard to deny, harder to geo-engineer, but not hard to stop” (and below). A new Nature Geoscience study, “Past constraints on the vulnerability of marine calcifiers to massive carbon dioxide release” (subs. req’d) provides a truly ominous warning. The release from the researchers at the University of Bristol is “Rate of ocean acidification the fastest in 65 million years.” I am reprinting below a piece by award-winning science journalist Carl Zimmer published this week by Yale environment360, which explains ocean acidification and what this important study says: The JOIDES Resolution looks like a bizarre hybrid of an oil rig and a cargo ship. It is, in fact, a research vessel that ocean scientists use to dig up sediment from the sea floor. In 2003, on a voyage to the southeastern Atlantic, scientists aboard the JOIDES Resolution brought up a particularly striking haul. They had drilled down into sediment that had formed on the sea floor over the course of millions of years. The oldest sediment in the drill was white. It had been formed by the calcium carbonate shells of single-celled organisms — the same kind of material that makes up the White Cliffs of Dover. But when the scientists examined the sediment that had formed 55 million years ago, the color changed in a geological blink of an eye. “In the middle of this white sediment, there’s this big plug of red clay,” says Andy Ridgwell, an earth scientist at the University of Bristol. In other words, the vast clouds of shelled creatures in the deep oceans had virtually disappeared. Many scientists now agree that this change was caused by a drastic drop of the ocean’s pH level. The seawater became so corrosive that it ate away at the shells, along with other species with calcium carbonate in their bodies. It took hundreds of thousands of years for the oceans to recover from this crisis, and for the sea floor to turn from red back to white. The clay that the crew of the JOIDES Resolution dredged up may be an ominous warning of what the future has in store. By spewing carbon dioxide into the air, we are now once again making the oceans more acidic. Today, Ridgwell and Daniela Schmidt, also of the University of Bristol, are publishing a study in the journal Nature Geoscience, comparing what happened in the oceans 55 million years ago to what the oceans are experiencing today. Their research supports what other researchers have long suspected: The acidification of the ocean today is bigger and faster than anything geologists can find in the fossil record over the past 65 million years. Indeed, its speed and strength — Ridgwell estimate that current ocean acidification is taking place at ten times the rate that preceded the mass extinction 55 million years ago — may spell doom for many marine species, particularly ones that live in the deep ocean. “This is an almost unprecedented geological event,” says Ridgwell. When we humans burn fossil fuels, we pump carbon dioxide into the atmosphere, where the gas traps heat. But much of that carbon dioxide does not stay in the air. Instead, it gets sucked into the oceans. If not for the oceans, climate scientists believe that the planet would be much warmer than it is today. Even with the oceans’ massive uptake of CO2, the past decade was still the warmest since modern record-keeping began. But storing carbon dioxide in the oceans may come at a steep cost: It changes the chemistry of seawater. At the ocean’s surface, seawater typically has a pH of about 8 to 8.3 pH units. For comparison, the pH of pure water is 7, and stomach acid is around 2. The pH level of a liquid is determined by how many positively charged hydrogen atoms are floating around in it. The more hydrogen ions, the lower the pH. When carbon dioxide enters the ocean, it lowers the pH by reacting with water. The carbon dioxide we have put into the atmosphere since the Industrial Revolution has lowered the ocean pH level by .1. That may seem tiny, but it’s not. The pH scale is logarithmic, meaning that there are 10 times more hydrogen ions in a pH 5 liquid than one at pH 6, and 100 times more than pH 7. As a result, a drop of just .1 pH units means that the concentration of hydrogen ions in the ocean has gone up by about 30 percent in the past two centuries. To see how ocean acidification is going to affect life in the ocean, scientists have run laboratory experiments in which they rear organisms at different pH levels. The results have been worrying — particularly for species that build skeletons out of calcium carbonate, such as corals and amoeba-like organisms called foraminifera. The extra hydrogen in low-pH seawater reacts with calcium carbonate, turning it into other compounds that animals can’t use to build their shells. These results are worrisome, not just for the particular species the scientists study, but for the ecosystems in which they live. Some of these vulnerable species are crucial for entire ecosystems in the ocean. Small shell-building organisms are food for invertebrates, such as mollusks and small fish, which in turn are food for larger predators. Coral reefs create an underwater rain forest, cradling a quarter of the ocean’s biodiversity. But on their own, lab experiments lasting for a few days or weeks may not tell scientists how ocean acidification will affect the entire planet. “It’s not obvious what these mean in the real world,” says Ridgwell. One way to get more information is to look at the history of the oceans themselves, which is what Ridgwell and Schmidt have done in their new study. At first glance, that history might suggest we have nothing to worry about. A hundred million years ago, there was over five times more carbon dioxide in the atmosphere and the ocean was .8 pH units lower. Yet there was plenty of calcium carbonate for foraminifera and other species. It was during this period, in fact, that shell-building marine organisms produced the limestone formations that would eventually become the White Cliffs of Dover. But there’s a crucial difference between the Earth 100 million years ago and today. Back then, carbon dioxide concentrations changed very slowly over millions of years. Those slow changes triggered other slow changes in the Earth’s chemistry. For example, as the planet warmed from more carbon dioxide, the increased rainfall carried more minerals from the mountains into the ocean, where they could alter the chemistry of the sea water. Even at low pH, the ocean contains enough dissolved calcium carbonate for corals and other species to survive. Today, however, we are flooding the atmosphere with carbon dioxide at a rate rarely seen in the history of our planet. The planet’s weathering feedbacks won’t be able to compensate for the sudden drop in pH for hundreds of thousands of years. Scientists have been scouring the fossil record for periods of history that might offer clues to how the planet will respond to the current carbon jolt. They’ve found that 55 million years ago, the Earth went through a similar change. Lee Kump of Penn State and his colleagues have estimated that roughly 6.8 trillion tons of carbon entered the Earth’s atmosphere over about 10,000 years. Nobody can say for sure what unleashed all that carbon, but it appeared to have had a drastic effect on the climate. Temperatures rose between 5 and 9 degrees Celsius (9 to 16 Fahrenheit). Many deep-water species became extinct, possibly as the pH of the deep ocean became too low for them to survive. But this ancient catastrophe (known as the Paleocene-Eocene thermal maximum, or PETM) was not a perfect prequel to what’s happening on Earth today. The temperature was warmer before the carbon bomb went off, and the pH of the oceans was lower. The arrangement of the continents was also different. The winds blew in different patterns as a result, driving the oceans in different directions. All these factors make a big difference on the effect of ocean acidification. For example, the effect that low pH has on skeleton-building organisms depends on the pressure and temperature of the ocean. Below a certain depth in the ocean, the water becomes so cold and the pressure so high that there’s no calcium carbonate left for shell-building organisms. That threshold is known as the saturation horizon. To make a meaningful comparison between the PETM and today, Ridgwell and Schmidt built large-scale simulations of the ocean at both points of time. They created a virtual version of the Earth 55 million years ago and let the simulation run until it reached a stable state. The pH level of their simulated ocean fell within the range of estimates of the pH of the actual ocean 55 millions years ago. They then built a version of the modern Earth, with today’s arrangements of continents, average temperature, and other variables. They let the modern world reach a stable state and then checked the pH of the ocean. Once again, it matched the real pH found in the oceans today. Ridgwell and Schmidt then jolted both of these simulated oceans with massive injections of carbon dioxide. They added 6.8 trillion tons of carbon over 10,000 years to their PETM world. Using conservative projections of future carbon emissions, they added 2.1 trillion tons of carbon over just a few centuries to their modern world. Ridgwell and Schmidt then used the model to estimate how easily carbonate would dissolve at different depths of the ocean. The results were strikingly different. Ridgwell and Schmidt found that ocean acidification is happening about ten times faster today than it did 55 million years ago. And while the saturation horizon rose to 1,500 meters 55 million years ago, it will lurch up to 550 meters on average by 2150, according to the model. The PETM was powerful enough to trigger widespread extinctions in the deep oceans. Today’s faster, bigger changes to the ocean may well bring a new wave of extinctions. Paleontologists haven’t found signs of major extinctions of corals or other carbonate-based species in surface waters around PETM. But since today’s ocean acidification is so much stronger, it may affect life in shallow water as well. “We can’t say things for sure about impacts on ecosystems, but there is a lot of cause for concern,” says Ridgwell. Ellen Thomas, a paleoceanographer at Yale University, says that the new paper “is highly significant to our ideas on ocean acidification.” But she points out that life in the ocean was buffeted by more than just a falling pH. “I’m not convinced it’s the whole answer,” she says. The ocean’s temperature rose and oxygen levels dropped. Together, all these changes had complex effects on the ocean’s biology 55 million years ago. Scientists now have to determine what sort of combined effect they will have on the ocean in the future. Our carbon-fueled civilization is affecting life everywhere on Earth, according to the work of scientists like Ridgwell — even life that dwells thousands of feet underwater. “The reach of our actions can really be quite global,” says Ridgwell. It’s entirely possible that the ocean sediments that form in the next few centuries will change from the white of calcium carbonate back to red clay, as ocean acidification wipes out deep-sea ecosystems. “It will give people hundreds of millions of years from now something to identify our civilization by,” says Ridgwell. And for completeness’ sake, here’s more background on ocean acidification (which regular CP readers can skip). You can watch NOAA administrator Lubchenco give a demonstration of the science of ocean acidification. Ocean acidification must be a core climate message, since it is hard to deny and impervious to the delusion that geoengineering is the silver bullet. Indeed, a major 2009 study GRL study, “Sensitivity of ocean acidification to geoengineered climate stabilization” (subs. req’d), concluded: The results of this paper support the view that climate engineering will not resolve the problem of ocean acidification, and that therefore deep and rapid cuts in CO2 emissions are likely to be the most effective strategy to avoid environmental damage from future ocean acidification. If you want to understand ocean acidification better, see this BBC story, which explains: Man-made pollution is raising ocean acidity at least 10 times faster than previously thought, a study says. Or see this Science magazine study, “Evidence for Upwelling of Corrosive “Acidified” Water onto the Continental Shelf” (subs. req’), which found Our results show for the first time that a large section of the North American continental shelf is impacted by ocean acidification. Other continental shelf regions may also be impacted where anthropogenic CO2-enriched water is being upwelled onto the shelf. Or listen to the Australia’s ARC Centre of Excellence for Coral Reef Studies, which warns: The world’s oceans are becoming more acid, with potentially devastating consequences for corals and the marine organisms that build reefs and provide much of the Earth’s breathable oxygen. The acidity is caused by the gradual buildup of carbon dioxide (CO2) in the atmosphere, dissolving into the oceans. Scientists fear it could be lethal for animals with chalky skeletons which make up more than a third of the planet’s marine life…. Corals and plankton with chalky skeletons are at the base of the marine food web. They rely on sea water saturated with calcium carbonate to form their skeletons. However, as acidity intensifies, the saturation declines, making it harder for the animals to form their skeletal structures (calcify). “Analysis of coral cores shows a steady drop in calcification over the last 20 years,” says Professor Ove Hoegh-Guldberg of CoECRS and the University of Queensland. “There’s not much debate about how it happens: put more CO2 into the air above and it dissolves into the oceans. “When CO2 levels in the atmosphere reach about 500 parts per million, you put calcification out of business in the oceans.” (Atmospheric CO2 levels are presently 385 ppm, up from 305 in 1960.) I’d like to see an analysis of what happens when you get to 850 to 1000+ ppm because that is where we’re headed (see U.S. media largely ignores latest warning from climate scientists: “Recent observations confirm … the worst-case IPCC scenario trajectories (or even worse) are being realised” — 1000 ppm). In June, dozens of Academies of Science, including ours and China’s, issued a joint statement on ocean acidification, warned “Marine food supplies are likely to be reduced with significant implications for food production and security in regions dependent on fish protein, and human health and wellbeing” and “Ocean acidification is irreversible on timescales of at least tens of thousands of years.” They conclude: Ocean acidification is a direct consequence of increasing atmospheric CO2 concentrations. To avoid substantial damage to ocean ecosystems, deep and rapid reductions of global CO2 emissions by at least 50% by 2050, and much more thereafter are needed. We, the academies of science working through the InterAcademy Panel on International Issues (IAP), call on world leaders to: • Acknowledge that ocean acidification is a direct and real consequence of increasing atmospheric CO2 concentrations, is already having an effect at current concentrations, and is likely to cause grave harm to important marine ecosystems as CO2 concentrations reach 450 ppm and above; • Recognise that reducing the build up of CO2 in the atmosphere is the only practicable solution to mitigating ocean acidification; • Within the context of the UNFCCC negotiations in the run up to Copenhagen 2009, recognise the direct threats posed by increasing atmospheric CO2 emissions to the oceans and therefore society, and take action to mitigate this threat; • Implement action to reduce global CO2 emissions by at least 50% of 1990 levels by 2050 and continue to reduce them thereafter. If we want to save life in the oceans — and save ourselves, since **we depend on that life** — the time to start slashing carbon dioxide emissions is now.

The science is settled - warming is real and anthropogenic - be highly skeptical of negative evidence

Costello et al ‘11(Anthony, Professor and Co-Director of the Institute for Global Health @ University College London, Mark Malsin, Professor in the Department of Geography @ UCL, Director of the UCL Institute for Human Health and Performance, Anne Johnson, Professor of Infectious Disease Epidemiology @ UCL, Paul Ekins, PhD in Economics from University of London and Professor of Energy and Environmental Policy @ UCL Energy Institute, "Global health and climate change: moving from denial and catastrophic fatalism to positive action," May, http://rsta.royalsocietypublishing.org/content/369/1942/1866.full)

Advocacy about the health consequences will ensure that climate change is a high priority. The United Nations Convention on Climate Change was set up in 1992 to ensure that nations worked together to minimize the adverse effects, but McMichael and Neira noted that, in preparation for the Copenhagen conference in December 2009, only four of 47 nations mentioned human health as a consideration [1]. With business as usual, global warming caused by rising greenhouse gas (GHG) emissions will threaten mass populations through increased transmission of some infections, heat stress, food and water insecurity, increased deaths from more frequent and extreme climate events, threats to shelter and security, and through population migration [2]. On the one hand it is necessary in the media to counter climate change sceptics and denialists, but on the other it is also important not to allow climate catastrophists, who tell us it is all too late, to deflect us from pragmatic and positive action. Catastrophic scenarios are possible in the longer term, and effective action will be formidably difficult, but evidence suggests that we do have the tools, the time and the resources to bring about the changes needed for climate stability. Previous Section Next Section 2. Climate change evidence and denial Given the current body of evidence, it is surprising that global warming and its causal relationship with atmospheric GHG pollution is disputed any more than the relationship between acquired immune deficiency syndrome (AIDS) and human immunodeficiency virus (HIV) infection, or lung cancer and cigarette smoking. The basic principles that determine the Earth’s temperature are, of course, relatively simple. Some of the short-wave solar radiation that strikes the Earth is reflected back into space and some is absorbed by the land and emitted as long-wave radiation (heat). Some of the long-wave radiation is trapped in the atmosphere by ‘greenhouse gases’, which include water vapour, carbon dioxide and methane. Without GHGs the Earth would be on average 33°C colder. Over the last 150 years, since the Industrial Revolution, humans have been adding more carbon dioxide and methane into the atmosphere. The result is that the Earth’s atmosphere, ocean and land are indeed warming—due to increased atmospheric ‘greenhouse gas’ concentrations [3]. Gleick et al. [4], from the US National Academy of Sciences, wrote a letter to Science stating ‘There is compelling, comprehensive, and consistent objective evidence that humans are changing the climate in ways that threaten our societies and the ecosystems on which we depend’. The most recent report by the Intergovernmental Panel on Climate Change (IPCC) [5], amounting to nearly 3000 pages of detailed review and analysis of published research, also declares that the scientific uncertainties of global warming are essentially resolved. This report states that there is clear evidence for a 0.75°C rise in global temperatures and 22 cm rise in sea level during the twentieth century. The IPCC synthesis also predicts that global temperatures could rise further by between 1.1°C and 6.4°C by 2100, and sea level could rise by between 28 and 79 cm, or more if the melting of Greenland and Antarctica accelerates. In addition, weather patterns will become less predictable and the occurrence of extreme climate events, such as storms, floods, heat waves and droughts, will increase. There is also strong evidence for ocean acidification driven by more carbon dioxide dissolving in the oceans [6]. Given the current failure of international negotiations to address carbon emission reductions, and that atmospheric warming lags behind rises in CO2 concentration, there is concern that global surface temperature will rise above the supposedly ‘safe limit’ of 2°C within this century. Each doubling of atmospheric carbon dioxide concentration alone is expected to produce 1.9–4.5°C of warming at equilibrium [7]. Of course, climate modelling is an extremely complex process, and uncertainty with projections relating to future emissions trajectories means that the time scale and magnitude of future climate change cannot be predicted with certainty [8]. These uncertainties are magnified when future climate predictions are used to estimate potential impacts. For example, the environmental impacts of climate change are also uncertain, but could underestimate such impacts because they detrimentally interact with habitat loss, pollution and loss of biodiversity due to other causes. There is also the additional problem that switching from biome to biome may not be directly reversible. For example, rainforest recycles a huge amount of water so it can survive a significant amount of aridification before it burns and is replaced by savannah. But the region then has to get much wetter before rainforest can return, as there is greatly reduced water cycling in savannah [9]. In the policy arena, further uncertainty surrounds the desire for international agreements on emission cuts, and the possible routes to such agreement and implementation. The feasible speed of technological innovation in carbon capture and provision of renewable/low-carbon energy resources is also uncertain. Denying the causes or the current weight of evidence for anthropogenic climate change is irrational, just as the existence of ‘uncertainties’ should not be used to deny the need for proportionate action, when such uncertainties could underestimate the risks and impact of climate change. There is no reason for inaction and there are many ways we can use our current knowledge of climate change to improve health provision for current and future generations. Previous Section Next Section 3. Catastrophism At the other end of the scale are doom-mongers who predict catastrophic population collapse and the end of civilization. In the early nineteenth century, the French palaeontologist Georges Cuvier first addressed catastrophism and explained patterns of extinction observed in the fossil record through catastrophic natural events [10]. We know now of five major extinctions: the Ordovician–Silurian extinction (439 million years ago), the Late Devonian extinction (about 364 million years ago), the Permian–Triassic extinction (about 251 million years ago), the End Triassic extinction (roughly 199 million to 214 million years ago) and the Cretaceous–Tertiary extinction (about 65 million years ago). These mass extinctions were caused by a combination of plate tectonics, supervolcanism and asteroid impacts. The understanding of the mass extinctions led Gould & Eldredge [11] to update Darwin’s theory of evolution with their own theory of punctuated equilibrium. Many scientists have suggested that the current human-induced extinction rates could be as fast as those during these mass extinctions [12,13]. For example, one study predicted that 58 per cent of species may be committed to extinction by 2050 due to climate change alone [14], though this paper has been criticized [15,16]. Some people have even suggested that human extinction may not be a remote risk [17–19]. Sherwood & Huber [7] point to continued heating effects that could make the world largely uninhabitable by humans and mammals within 300 years. Peak heat stress, quantified by the wet-bulb temperature (used because it reflects both the ambient temperature and relative humidity of the site), is surprisingly similar across diverse climates and never exceeds 31°C. They suggest that if it rose to 35°C, which never happens now but would at a warming of 7°C, hyperthermia in humans and other mammals would occur as dissipation of metabolic heat becomes impossible, therefore making many environments uninhabitable.

#### Fulfilling domestic commitments to reduce emissions spills over internationally

Eilperin 2/6 (Juliety Eilperin, McGraw Professor of Journalism at Princeton University, magna cum laude from Princeton University, where she received a bachelor's in Politics, Reporter for the Washington Times, “U.S. could fall short of 2020 climate goal, new study says, but target remains in reach”, <http://www.washingtonpost.com/national/health-science/us-could-fall-short-of-2020-climate-goal-new-study-says-but-target-remains-in-reach/2013/02/06/128f8f82-6f08-11e2-ac36-3d8d9dcaa2e2_story_1.html>, February 6, 2013)

The United States is not on track to meet its international commitment to cut greenhouse gas emissions by 2020, according to an analysis released Wednesday by the World Resources Institute. The new findings examine the impact of the U.S. energy and transportation sectors as well as sources such as methane releases from landfills. The economic recession and a turn to natural gas for electricity production have caused a dip in greenhouse gas emissions, but the temporary decline isn’t enough for the United States to meet its pledged reduction of 17 percent by 2020, according to the World Resources Institute, which recommends an ambitious approach to tackling emissions. The economic recession and a turn to natural gas for electricity production have caused a dip in greenhouse gas emissions, but the temporary decline isn’t enough for the United States to meet its pledged reduction of 17 percent by 2020, according to the World Resources Institute, which recommends an ambitious approach to tackling emissions. The study gives a pessimistic view of the future even though carbon emissions have fallen in recent years because of the economic downturn and increased use of natural gas to produce electricity. While the Obama administration has taken several steps to curb greenhouse gas emissions, such as imposing the first carbon limits on vehicles and new power plants, the analysis suggests that non-carbon emissions from the U.S. natural gas boom and from chemicals used as refrigerants are on the rise. The U.S. target is to cut greenhouse gas emissions 17 percent by 2020 compared with 2005 levels. Energy-related carbon dioxide emissions have fallen 8.7 percent compared with 2005 levels and are projected to stay near that level through 2035. But greenhouse gas emissions from other sources are expected to increase 18 percent by 2020 compared with the 2005 baseline and 36 percent by 2035. Imposing greenhouse gas emission limits on existing power plants — a policy the White House is considering — could halve the gap between the current trajectory and the country’s 2020 climate target. Phasing out hydrofluorocarbons (HFCs), used in cooling equipment from soda machines to many car air conditioners, would make up 23 percent of the gap, according to the report, while stricter federal rules for natural-gas methane emissions and energy efficiency standards would make up 11 percent and 8 percent, respectively, of the difference. “The U.S. is not yet on track to hit its 17 percent target, but we have the tools to get there,” said Nicholas Bianco, a senior associate at World Resources Institute and the report’s lead author. Michael A. Levi, a senior fellow for energy and the environment at the Council on Foreign Relations, praised the report as “the first serious attempt to show what it would take to slash emissions over the next two decades without new legislation.” Facing stiff congressional opposition, President Obama has made clear that he plans to undertake more ambitious action on climate change in his second term by using existing regulatory authority. Durwood Zaelke, president of the Institute for Governance and Sustainable Development, noted that the car sector accounts for roughly half of U.S. HFC use, “making this the biggest opportunity for getting rid of this super greenhouse gas.” “The last time we changed the coolant in our cars, it only took three years to change the fleet in the U.S. and most of the world,” he added. Without setting these and other climate polices in motion, the WRI analysts warn, the United States will find itself falling short of the pledge it made in 2009 as part of U.N. climate negotiations. While the commitment is more modest than many scientists and other world leaders have called for, the United States’ ability to meet it could influence whether more than 190 nations can broker a new climate pact over the next three years that would take effect in 2020. Neil Morisetti, Britain’s climate and energy security envoy, said in a phone interview that the United States and other industrialized nations need to fulfill their climate pledges both to build trust among negotiators and to ensure that any global warming agreement delivers results. “It is important, having made that commitment, that you deliver against it,” Morisetti said of the current U.S. climate pledge. He added that when it comes to any future treaty, “it’s important not only that we sign bits of paper, but we have a plan to get there. It is that action by national governments that is the wind beneath the sails.” Jake Schmidt, international climate policy director for the Natural Resources Defense Council, an advocacy group, said that the rest of the world “will be looking to see what the U.S. does in the next few months,” given the signal that Obama has sent about tackling global warming. “It will show the U.S. can follow through, even after the climate bill demise” of 2010, Schmidt added. Still, Levi warned, the report “also emphasizes how unlikely we are to achieve deep emissions cuts without meaningful congressional action, particularly beyond 2020.” Ultimately, Levi said, the critical climate question is how the United States and the rest of the world will cut greenhouse gas emissions through 2030 and 2050, since that will have a much bigger impact on future warming. “Steps between now and 2020 should be evaluated primarily based on how they set the U.S. up for the longer term, not on the exact number of tons that get cut in the next eight years,” he said.

#### It’s not too late—emissions reductions can avoid and delay catastrophic impacts.

Chestney 1/13/13 (Nina, senior environmental correspondent, “Climate Change Study: Emissions Limits Could Avoid Damage By Two-Thirds,” <http://www.huffingtonpost.com/2013/01/13/climate-change-study-emissions-limits_n_2467995.html>)

The world could avoid much of the damaging effects of climate change this century if greenhouse gas emissions are curbed more sharply, research showed on Sunday. The study, published in the journal Nature Climate Change, is the first comprehensive assessment of the benefits of cutting emissions to keep the global temperature rise to within 2 degrees Celsius by 2100, a level which scientists say would avoid the worst effects of climate change. It found 20 to 65 percent of the adverse impacts by the end of this century could be avoided. "Our research clearly identifies the benefits of reducing greenhouse gas emissions - less severe impacts on flooding and crops are two areas of particular benefit," said Nigel Arnell, director of the University of Reading's Walker Institute, which led the study. In 2010, governments agreed to curb emissions to keep temperatures from rising above 2 degrees C, but current emissions reduction targets are on track to lead to a temperature rise of 4 degrees or more by 2100. The World Bank has warned more extreme weather will become the "new normal" if global temperature rises by 4 degrees. Extreme heatwaves could devastate areas from the Middle East to the United States, while sea levels could rise by up to 91 cm (3 feet), flooding cities in countries such as Vietnam and Bangladesh, the bank has said. The latest research involved scientists from British institutions including the University of Reading, the Met Office Hadley Centre and the Tyndall Centre for Climate Change, as well as Germany's Potsdam Institute for Climate Impact Research. It examined a range of emissions-cut scenarios and their impact on factors including flooding, drought, water availability and crop productivity. The strictest scenario kept global temperature rise to 2 degrees C with emissions peaking in 2016 and declining by 5 percent a year to 2050. FLOODING Adverse effects such as declining crop productivity and exposure to river flooding could be reduced by 40 to 65 percent by 2100 if warming is limited to 2 degrees, the study said. Global average sea level rise could be reduced to 30cm (12 inches) by 2100, compared to 47-55cm (18-22 inches) if no action to cut emissions is taken, it said. Some adverse climate impacts could also be delayed by many decades. The global productivity of spring wheat could drop by 20 percent by the 2050s, but the fall in yield could be delayed until 2100 if strict emissions curbs were enforced. "Reducing greenhouse gas emissions won't avoid the impacts of climate change altogether of course, but our research shows it will buy timeto make things like buildings, transport systems and agriculture more resilient to climate change," Arnell said.

#### Several internal links:

#### First – Airborne Wind revolutionizes energy production and goes global, squo renewables will fail

Fagiano ‘9 (Lorenzo, Marie Curie fellow at Politecnico di Torino and a visiting researcher at the University of California, Santa Barbara, co-author of 50 papers published in international journals, conference proceedings and book chapters. He is recipient of the ENI award "Debut in Research" prize 2010, of the Maffezzoni prize 2009 and of a Marie Curie International Outgoing Fellowship, “High-altitude wind power generation for renewable energy cheaper than oil,” http://ec.europa.eu/research/sd/conference/2009/papers/15/lorenzo\_fagiano,\_mario\_milanese\_and\_dario\_piga\_-\_high\_altitude\_wind\_power\_generation\_for\_renewable\_energy\_cheaper\_than\_oil.pdf)

The dependance of the global energy system on fossil sources owned by few producer countries leads to economical instability, prevents millions of people from having access to energy and gives rise to delicate geopolitical equilibria. Non–OECD countries growing at fast rates like China and India will account for a 50% increase of energy demand in the next two decades. Such an increment has to be covered by an increase of energy supply: considering the current situation, fossil sources are the ﬁrst candidates to fuel the growth of non–OECD world. As a consequence, the present problems of high concentration of fossil sources in few countries will be more acute, energy costs will continuously increase on average and pronounced short–term swings of oil price will remain the norm in the next 20 years.

The issue of climate change due to excessive concentration of greenhouse gases in the atmosphere, that is clearly related to the predominance of fossil sources in the global energy mix, may be even more serious than geopolitics. In fact, if no measure is undertaken to contain the emissions of carbon dioxide, a doubling of CO2 concentration is expected to be reached by 2100, with a consequent global average temperature increase of up to 6 ± C [1, 21, 22, 23]. Almost all of the increase of emissions in the next twenty years is accounted for by non–OECD countries. In [1], two alternative climate–policy scenarios are considered (in addition to the reference one), in which the undertaking of political measures and investments aimed at reducing CO2 emissions is assumed. Both scenarios lead to a long–term stabilization of carbon– dioxide emissions and they differ on the basis of the amount of efforts and investments employed to reach such a goal. Without entering into details (the interested reader is referred to [1]), the alternative scenarios clearly indicate two key points: ² power generation is a critical sector since it is the less expensive ﬁeld for CO2 reduction. As showed in Section 1.1, power generation accounts for 45% of energy– related CO2 emissions. A shift to carbon–free electricity and heat generation would signiﬁcantly contribute to reduce the emissions of greenhouse gases with relatively low costs and timings as compared to those needed to renew the transportation system, which is heavily oil dependent and would require expensive and slow transformation. Moreover, electricity is the most reﬁned form of energy and it can be used to replace the use of fossil sources in every sector.

Given the actual situation, policy intervention will be necessary, through appropriate ﬁnancial incentives and regulatory frameworks, to foster the development of renewable and carbon–free electricity generation. One of the key points to reduce the dependance on fossil fuels is the use of a suitable combination of alternative energy sources. Nuclear energy actually represents the fourth contribution to the world’s power generation sector (with a 15% share, see Section 1.1) and it avoids the problems related to carbon dioxide emissions. However, the issues related to safe nuclear waste management have not been solved yet, despite the employed strong efforts. Moreover, the cost of nuclear energy is likely to increase, due to massive investments of emerging countries [35, 36] and uranium shortage [37]. Renewable energy sources like hydropower, biomass, wind, solar and geothermal actually cover 19% of global electricity generation (with hydro alone accounting for 16%), but they could meet the whole global needs, without the issues related to pollution and global warming. However, the present cost of renewable energies is not competitive without incentives, mainly due to the high costs of the related technologies, their discontinuous and non–uniform availability and the low generated power density per km2 . The use of hydroelectric power is not likely to increase substantially in the future, because most major sites are already being exploited or are unavailable for technological and/or environmental reasons. Biomass and geothermal power have to be managed carefully to avoid local depletion, so they are not able to meet a high percentage of the global consumption. Solar energy has been growing fast during the last years (35% average growth in the U.S. in the last few years, [38]), however it has high costs and requires large land occupation.

Focusing the attention on wind energy, in Section 1.2 it has been noted that there is enough potential in global wind power to sustain the world needs [6]. However, the technical and economical limitations to build larger turbines and to deploy wind towers in “good” sites, that are often difﬁcult to reach, the low average power density per km2 and the environmental impact of large wind farms hinder the potential of the actual technology to increase its share of global electric energy generation above the actual 1%. The expected technological improvements in the next decade are not enough to make the cost of wind energy competitive against that of fossil energy, without the need of incentives. As is is stated in [7], “There is no “big breakthrough” on the horizon for wind technology”. The major contribution of Part I of this dissertation is to demonstrate that **a real revolution of wind energy can be achieved with the innovative KiteGen technology.** It will be showed that high–altitude wind power generation using controlled airfoils has the potential to overcome most of the main limits of the present wind energy technology, thus providing renewable energy, available in large quantities everywhere in the world, at lower costs with respect to fossil energy and without the need for ad–hoc policies and incentives. Moreover, it will be showed that such a breakthrough can be realized in a relatively short time, of the order of **few years**, with relatively small efforts in research and development. Indeed, the idea of harvesting high–altitude wind energy introduced in the early ’80s (see [8]) can be fully developed nowadays thanks to recent advances in several engineering ﬁelds like aerodynamics, materials, mechatronics and control theory. In particular, the advanced control techniques investigated in Part II of this dissertation play a role of fundamental importance, since they allow to control and maximize the performance of complex systems like KiteGen, while satisfying demanding operational constraints, at the relatively fast adopted sampling rate. In order to support these claims, the original results of the research activity performed in the last three years are organized in the next Chapters as follows.

#### Baseload power is the key source of emissions

AP ‘12 (DINA CAPPIELLO, “EPA: Power Plants Main Global Warming Culprits,” Associated Press, January 11, 2012)

**The most detailed data** yet on emissions of heat-trapping gases show that U.S. power plants are responsible for the bulk of the pollution blamed for global warming. Power plants released 72 percent of the **g**reen**h**ouse **g**ase**s** reported to the Environmental Protection Agency for 2010, according to information released Wednesday that was the first catalog of global warming pollution by facility. The data include more than 6,700 of the largest industrial sources of greenhouse gases, or about 80 percent of total U.S. emissions. According to an Associated Press analysis of the data, 20 mostly coal-fired power plants in 15 states account for the top-releasing facilities. Gina McCarthy, the top air official at the EPA, said the database marked "a major milestone" in the agency's work to address climate change. She said it would help industry, states and the federal government identify ways to reduce greenhouse gases.

#### Second – the plan spurs offshore wind, reduces costs and technical barriers

Hassan ’11 (GL Garrad Hassan, largest renewable energy consulting firm, “MARKET STATUS REPORT¶ HIGH ALTITUDE WIND ENERGY”, August 2011, http://www.gl-garradhassan.com/en/highaltitudewind.php/)

Also there are advantages in some of the high altitude wind technology concepts that could help to¶ overcome some of the main technology issues in conventional offshore wind energy technology. Most¶ high altitude wind energy technologies have lower structural forces (e.g. tower bottom bending¶ moments) when compared to conventional wind turbines, leading to lower material expenses for the¶ systems. Also the applicability on floating structures will be easier from a structural point as moment¶ resistance required by a floating platform for an airborne system. This advantage would help for¶ market regions where the site conditions (dominantly water depth) are to difficult or expensive for¶ normal fixed structure systems.¶ Looking into the market side the high altitude wind energy systems could participate in the boosting¶ offshore wind energy industry and market in which several of the challenges and barriers - especially¶ regulatory, safety and acceptance issues - are much easier to solve. Looking beyond identified project¶ sites, it is clear that significant high altitude wind resource exists. Most of these areas have deep¶ waters, much greater than that capable of being developed using fixed offshore foundations and so¶ might present suitable regions for economical floating solutions. This benefit could at the near future¶ been realised in parts of the market where the normal fixed structure systems are not applicable. Some¶ of the prospect regions include:¶ North America especially the Pacific West of Oregon and British Columbia and the Atlantic¶ east;¶ Northern Europe especially west of the UK and Ireland and the deep water areas of the¶ German Coast;¶ east of Japan costal areas.¶ Currently the first research projects appear on the horizon and also the airborne industry as a whole¶ becomes more visible in the policy and industry public. Thus maybe in the near future more¶ government research investment as well as commercial research and development investment will be¶ made into this emerging technology.¶ The development and success of the renewable energy industry including wind energy will benefit¶ from new technologies being introduced and getting more mature. From what is visible now of the¶ young airborne technology and industry the concepts seem to have a promising potential to play a vital¶ role in the renewable energy sector and should be seen as one of the available technical solutions.¶

#### Offshore wind is critical to boost marine ecosystems and reduce climate change

Casey ’12 (Zoe, Offshore wind farms benefit sealife, says study, 12/4/12, <http://www.ewea.org/blog/2012/12/offshore-wind-farms-benefit-sealife-says-study/>)

Offshore wind farms can create a host of benefits for the local marine environment, as well as combatting climate change, a new study by the Marine Institute at Plymouth University has found.¶ The Marine Institute found that wind farms provide shelter to fish species since sea bottom trawling is often forbidden inside a wind farm, and it found that turbine support structures can create artificial reefs for some species.¶ A separate study at the Nysted offshore wind farm in Denmark confirmed this finding by saying that artificial reefs provided favourable growth conditions for blue mussels and crab species. A study on the Thanet offshore wind farm in the UK found that some species like cod shelter inside the wind farm.¶ One high-profile issue covered by the Marine Institute study was that of organisms colliding with offshore wind turbines. The study, backed-up by a number of previous studies, found that many bird species fly low over the water, avoiding collision with wind turbine blades. It also found that some species, such as Eider ducks, do modify their courses slightly to avoid offshore turbines.¶ When it comes to noise, the study found “no significant impact on behaviour or populations.” It noted that a separate study in the Netherlands found more porpoise clicks inside a Dutch wind farm than outside it “perhaps exploiting the higher fish densities found”.¶ The study also said that offshore wind power and other marine renewable energies should be rolled out rapidly in order to combat the threats to marine biodiversity, food production and economies posed by climate change.¶ “It is necessary to rapidly deploy large quantities of marine renewable energy to reduce the carbon emissions from fossil fuel burning which are leading to ocean acidification, global warming and climatic changes,” the study published said.¶ EWEA forecasts that 40 GW of offshore wind capacity will be online in European seas by 2020 which will offset 102 million tonnes of CO2 every year. By 2030, the expected 150 GW of offshore capacity will offset 315 million tonnes of CO2 annually – that’s a significant contribution to the effort to cut carbon.¶ “It is clear that the marine environment is already being damaged by the increasingly apparent impacts of climate change; however it is not too late to make a difference to avoid more extreme impacts,” the study said.¶ “If you bring all these studies together they all point to a similar conclusion: offshore wind farms have a positive impact on the marine environment in several ways,” said Angeliki Koulouri, Research Officer at EWEA. “First they contribute to a reduction in CO2 emissions, the major threat to biodiversity, second, they provide regeneration areas for fish and benthic populations,” she added.¶ Koulouri and the studies noted in this blog suggest that further research is needed, in particular because impacts are season and site specific, and they note one proviso: offshore wind farms must be carefully planned and sited in order not to dramatically disturb sensitive marine environments.¶ “Developers and regulators should work closely with marine ecologists and conservation groups at an early stage to identify suitable locations for marine renewables,” the Marine Institute study recommended.

#### Spurs alternative fuel transitions

Mahan ’10 (Simon, Southern Alliance for Clean Energy (SACE) Renewable Energy Manager, Untapped Wealth:¶ Offshore Wind Can deliver Cleaner, More affordable ¶ energy and More Jobs than Offshore Oil, September 2010, http://oceana.org/sites/default/files/Offshore\_Wind\_Report\_-\_Final\_1.pdf)

Making a comparison between miles-per-gallon of gasoline ¶ (MPG), natural gas miles-per-gallon equivalent (MPGe) and ¶ miles per kilowatt hour (MPkWh), shows the potential for offshore ¶ wind to replace oil and natural gas in the transportation sector. ¶ Nearly 99 percent of all US cars and trucks use oil as an energy ¶ source.¶ 81¶ Vehicles that operate from natural gas are commercially ¶ available and currently in use, although in limited numbers. Plugin hybrid-electric vehicles, like Chevrolet’s Volt¶ 82¶ , and completely ¶ electric vehicles, like Nissan’s Leaf¶ 83¶ and THINK’s City¶ 84¶ , will ¶ begin to be sold commercially in the US within the next year. ¶ Tesla is already selling plug in electric cars, and the electrification ¶ of the fleet is a key component of the needed transition to ¶ clean energy. Therefore, it is reasonable to consider the role ¶ that offshore resources might play in the transportation sector ¶ in the next decade or two. Estimates of how many miles could ¶ be driven by fully utilizing each of the offshore energy resource ¶ available are provided in MPG, MPGe and MPkWh to compare ¶ the potential for each form of energy in terms of miles driven. ¶ With an electrified car fleet, 127 gigawatts of offshore wind could ¶ power nearly twice as many vehicles as new offshore oil and ¶ gas development combined. According to MMS estimates, East ¶ Coast offshore oil resource could fuel approximately 16 million ¶ gasoline vehicles annually for 20 years, while the natural gas ¶ resource could fuel an estimated 41.3 million compressed natural ¶ gas cars over the same time. In contrast, this analysis shows that ¶ the economically recoverable offshore wind resource on the East ¶ Coast could power approximately 112.5 million electric cars—¶ about twice as many vehicles than the East Coast’s offshore ¶ oil and natural gas resources combined. For comparison, DOE ¶ estimates that in 2010, there were about 227 million light-duty ¶ vehicles on the road in the United States.¶ Nissan, Chevrolet, Ford, Tesla and a variety of other companies ¶ are preparing to sell plug-in hybrid-electric vehicles (PHEV), ¶ or completely electric vehicles on an increasingly larger scale. ¶ According to a study by the National Renewable Energy Laboratory, ¶ if half of all light-duty vehicles are PHEV by 2050, gasoline ¶ consumption would decrease by between 35 billion and 53 billion ¶ gallons annually.¶ 86¶ If this scenario takes place by 2050, by 2055, the ¶ United States will have conserved more gasoline in just those five ¶ years than the entire oil resource available off the East Coast. This ¶ figure doesn’t even begin to assess the savings that would occur ¶ between now and 2050.¶ 87 ¶ As homes, heating and cars become more and more electrified, ¶ wind will become even better able to displace oil use. Ultimately, it ¶ is this shift to clean energy and away from fossil fuels that will turn back the clock on climate change.

## Solvency -- Restrictions

#### Despite technical progress restrictions undermine High Altitude Wind development

Leggett ’12 (Nickolaus E. Leggett, Masters degree in political science from Johns Hopkins, licensed pilot for hot-air balloons, gliders, and single-engine airplanes, certified electronics technician, testimony to the FAA, “To the Federal Aviation Administration: Formal Comments of Nickolaus E. Leggett” 1/29/12)

Near-Term Experimental Operation of AWES Prototypes

The first AWES prototypes should be operated in large but restricted airspace currently used for military practice work and/or for unmanned aircraft operations. The use of these areas is quite structured and disciplined which would be a useful starting point for learning to live with AWES installations.

**The** proposed **limit of testing to 499 feet** AGL is totally inadequate **for research and development**. This low height can be easily reached with a child’s classical hand-held kite. I have done it myself as a child. Such a low altitude does not represent the full physical situation of a commercial AWES installation. At this low altitude, the wind will often be too low to support a kite-type AWES installation.

A limit of near 2000 feet AGL is more appropriate for tests of actual deployed AWES installations. This would allow industrial-sized AWES to be tested in a realistic manner where a heavy structure is supported by the air and is exposed to the weather changes. Limiting AWES tests to daylight hours is also inadequate for realistic testing. An important part of any testing program is to expose the AWES to the variations of the weather over long periods of time (at least months). Any commercial AWES will have to survive and produce power continuously for long periods of time just as commercial terrestrial wind farms do. They will not be deploying these rather complex devices every morning. Think of an AWES as being more like a suspension bridge. You set it up and you leave it for long periods of time. Some mobile AWES installations will be used in the future. For example, specifically designed AWES could be used to provide electric power to ships at sea while they are in motion. This type of power could be used to recharge navy ships that are equipped with electric rail gun systems. Other mobile AWES could be used to resupply energy to fuel-cell propelled ships at sea via the electrolysis of water. Some mobile AWES will be used over land for large open-pit mining operations, prospecting efforts, and large agricultural properties. As a result of this, some controlled testing of mobile and portable AWES prototypes should be allowed by the FAA. Some testing of multiple-unit AWES is also needed to understand the aerodynamics of operating several units in close proximity to each other in various weather conditions and climates. It is important to realize that a whole new family of devices is being developed here and so a fairly liberal testing environment is needed.

#### **The plan is key to stimulate investment**

Kozubek ’11 (Jim, 11/4/11, Airborne Wind Energy Industry Struggles To Fly,

<http://idealab.talkingpointsmemo.com/2011/11/airborne-wind-energy-industry-struggles-to-take-off.php>)

To date Google.org has invested $15 million, and the Department of Energy’s the Advanced Research Projects Agency-Energy has invested $3 million. Over the summer, Makani Power made news with the maiden flight of its Wing 7 prototype, an airborne glider capable of generating 20 kW with a wingspan of eight meters, or just over 26 feet. The glider is designed to capture wind energy with its propeller at altitudes exceeding 1,000 feet and relay it by tether to the ground. “It is important to the overall U.S. airborne wind energy effort that Makani Power is successful in carrying out the work for the grant awarded” says PJ Shepard, secretary for industry group Airborne Wind Energy Consortium, and a spokesperson for California-based Sky WindPower, another company developing such a glider. One hurdle the nascent industry has to surmount, as most emerging technologies and industries do, is regulation. The Federal Aviation Administration is currently weighing a decision as to whether to allow such tethered gliders to operate. So far a ruling appears at least a year away, Shepard said. For its part, Makani to date has burned through most of its working capital, and is nearing completion of its 18-month ARPA-E grant-funded pilot project. And while the nascent industry awaits an FAA ruling, investors have been skittish of sinking capital into technology. Sky WindPower was named by TIME Magazine as one of the top 50 top inventions of 2008, but has yet to land investment capital; Dmitri Cherny, founder of energy glider developer Highest Wind, was the darling of New Hampshire’s Speed Venture Summit in 2009, only to come away empty-handed from scores of meetings in venture capital circuits in New Hampshire and South Carolina.

Our estimates are correct – AFF sufficiently solves

Fagiano ‘9 (Lorenzo, Marie Curie fellow at Politecnico di Torino and a visiting researcher at the University of California, Santa Barbara, co-author of 50 papers published in international journals, conference proceedings and book chapters. He is recipient of the ENI award "Debut in Research" prize 2010, of the Maffezzoni prize 2009 and of a Marie Curie International Outgoing Fellowship, “High-altitude wind power generation for renewable energy cheaper than oil,” http://ec.europa.eu/research/sd/conference/2009/papers/15/lorenzo\_fagiano,\_mario\_milanese\_and\_dario\_piga\_-\_high\_altitude\_wind\_power\_generation\_for\_renewable\_energy\_cheaper\_than\_oil.pdf)

A reliable estimate of the energy production costs of a KGfarm certainly requires more experimentations. However, for all the aspects discussed so far, a conservative estimate can be obtained by assuming that the overall costs are similar to those of an actual wind farm with the same nominal power. In a site with CF ≈ 0.3, a present wind farm has energy production costs of about 150 $/MWh. In the same location a KG-farm has CF ≈ 0.6, i.e. it can generate twice the energy with the same nominal power. Then, a conservative estimate of energy production cost of about 75 $/MWh is obtained. Note that the actual costs of energy production from fossil sources are in the range 60-90 $/MWh, according to the different types of source (coal, oil, gas). Moreover, the presented analyses show that a suitably designed KG-farm may generate an average power density from 7 to 13 times greater than that of an actual wind farm. Thus, scale factors may positively affect the production costs of KiteGen technology, leading to estimates of about **50 $/MWh** for a 100 MW KG-farm and **15 $/MWh** for a 500 MW KG-farm. In conclusion, from the results obtained so far, including numerical simulations, prototype experiments and wind data analyses, the KiteGen technology, capturing the wind power at significantly higher altitude over the ground than the actual wind towers, has the potential of generating renewable energy available in large quantities almost everywhere, with a cost even lower than that of fossil energy. Moreover, such a significant reduction of the dependence on fossil sources could be realized in a relatively short time. Indeed, the industrialization of KiteGen technology may require from 3 to 5 years, since no more basic research or technological innovations are needed, but only the fusion of advanced competencies already available in different engineering fields, such as modelling and control, aerodynamics and flight mechanics, materials and mechatronics.

#### High Altitude Wind solves military operations, budgets, and remote deployment

Cahoon ’11 (Troy L. AIRBORNE WIND ENERGY: IMPLEMENTATION AND DESIGN FOR THE U.S. AIR FORCE THESIS, AIR UNIVERSITY AIR FORCE INSTITUTE OF TECHNOLOGY, March 2011, THESIS Presented to the Faculty, Department of Aeronautics and Astronautics, Graduate School of Engineering and Management, Air Force Institute of Technology, Air University)

However, now that ground-based wind power is reaching a peak and advancements are leveling off, it has become difficult to significantly improve the cost effectiveness of wind power unless someone makes a new leap in the technological approach used to harness wind energy. One innovative way to make a new leap in wind power technology would be to encourage the DoD to look into, and use, the winds at higher altitudes, where vastly more energy is available. Ground-based wind power has proven that it can be competitive with other energy sources when the price of energy is high. However, if the technology of AWE is advanced to the point where it is cost effective and competitive at any energy price, then this would greatly benefit the DoD, citizens, utilities, and the U.S. Thus, the future of the country is dependent on utilizing and enhancing such resources as AWE technology. Airborne Wind Energy has many interesting attributes that could lead to a potential solution for many of the energy issues that the U.S. faces. AWE is a means to have energy on demand at a remote location, without dependence upon a supply line. AWE is available almost everywhere in the entire world. The leap and potential for energy availability, and the consistency at which this energy can be tapped, is very far reaching. It is possible that continued development in technology for wind power could push this energy into being fully competitive with fossil fuels. Thissource of energy could do wonders for the U.S. economy and domestic energy security.AWE has the ability to supplant traditional energy sources on its own, without subsidy. And streamlined AWE could meet all of the DoD’s national security goals described.

#### **No disads – DOE just increased funding**

Max 12/3 (John, ARPA-E looks to seed breakthroughs in energy technology, http://www.hydrogenfuelnews.com/arpa-e-looks-to-seed-breakthroughs-in-energy-technology/857225/)

ARPA-E announces new grants

The Advanced Research Project Agency-Energy (ARPA-E) has announced a new round of grants that are meant to help encourage “transformational, breakthrough technologies” in the energy sector. ARPA-E is an offshoot of DARPA, an agency that is famously responsible for scientific and technological breakthroughs that have lead to phenomenon such as the Internet and cell phones. The U.S. Department of Energy oversees ARPA-E and is keen to see the agency’s latest round of grants produce some breakthroughs that could revolutionize the way energy is used and generated.

Agency chooses 66 groups to receive funding for their innovative energy projects¶ In March of this year, ARPA-E began accepting applications for its grant program. The agency received thousands of concept papers that it had reviewed extensively. This week, ARPA-E has chosen 66 applications that will receive a total of $130 million in grants. These applications cover a wide range of alternative energy projects, such as wind, solar, and even hydrogen fuel. The money awarded to the companies and organizations behind the applications is expected to help these innovative projects take form.¶ ¶ Makani Power chosen as a recipient for funding¶ Makani Power is one of the groups that will receive funding from ARPA-E. The company has been working on developing an airborne wind turbine, which is meant to take advantage of the strong wind streams that are found at high altitudes. This project received funding from ARPA-E in 2009 and has again won the agency’s support this year. The project is ambitious and innovative, representing the overarching goal of ARPA-E, according to the Department of Energy.¶

#### **Renewables boost military capabilities by transitioning away from diesel – but lack of development precludes wind power**

Boland ’12 (Rita, SIGNAL Magazine’s news editor. Before coming to AFCEA, she worked at Booz Allen Hamilton as a communications consultant, Marines Test Alternative Power in Afghanistan, March 2011, http://www.afcea.org/content/?q=node/2549)

The U.S. Marine Corps hopes a forward operating base that obtains its power from renewable energy sources will benefit the force in many ways—especially by saving lives. Eliminating the need for fuel deliveries lowers the number of convoys and exposed troops on treacherous roads in perilous places. The experimental base also could reduce the amount of equipment Marines take into theater, ensuring the Corps remains an expeditionary force. With the tools in the battlespace now, program officials are waiting to hear how the concept performs in combat. Warfighters in the 3rd Battalion, 5th Marine Regiment’s Company I volunteered to take the Expeditionary Forward Operating Base (ExFOB) with them on their seven-month deployment in Afghanistan to determine how the included technologies operate on the battlefield. The deployment follows field studies at Marine Corps Air Ground Combat Center Twentynine Palms, California. In that environment, Marines were able to maintain continuous power for 200 hours without any fossil fuels. Program officials decided the time was right to send it into combat operations based on the users’ assessments. “A 19-year-old Marine gave us the thumbs up,” says Col. Bob “Brutus” Charette Jr., USMC, director, Marine Corps Expeditionary Energy Office. Narrowing down which technologies to include in the ExFOB was an involved process for decision makers. They received almost 200 proposals to evaluate and eventually invited 26 vendors to showcase their capabilities at Marine Corps Base Quantico, Virginia. In the end, the Marines purchased seven technologies, six of which traveled to Afghanistan. The items sent into the theater are a solar field shelter to power lights and field communications; a portable hybrid photovoltaic/battery power system called the Ground Renewable Expeditionary ENergy System (GREENS); a ReGenerator that uses solar energy to power high-tech devices; a towable solar lighting system, a light-emitting diode (LED) lighting system; and the Solar Portable Alternative Communications Energy System that offers portable power to charge batteries, operate communications equipment and run electronic accessories. The generators power computers, radios, life-support equipment, shavers, iPods and the other various devices troops take onto the battlefield. Each produces approximately 300 watts of power and has battery storage. During the summer training at Twentynine Palms, these technologies kept all equipment up and running except the surveillance system. Col. Charette explains that traditional fuel still is necessary for that capability, though the military is working on a renewable energy source for it as well. During the field assessments, program officials monitored activities to ensure that none of the equipment was harmful. After handing it off to young troops, leaders watched how they operated. Col. Charette compares the process to cooking. After going to the grocery store to buy ingredients, the shopper still has to come home and turn them into dinner. In the same way, the Marines have to put together the components of the ExFOB and make war. As evidenced by the choices, the Marine Corps has particular interest in solar-energy technology. “The biggest point I like to leave with industry when I talk to them is we’ve got to harvest the sun,” Col. Charette says. He would like developers to obtain as many watts as possible from the center of the solar system, but he also wants to find methods to derive more energy out of diesel fuel. Experiments with wind power have proven unsuccessful at that tactical level because of the size of the necessary towers and because of the unknown conditions where Marines often operate. The colonel explains wind is difficult to harvest, and the Corps has found no wind solution with the potential to work in expeditionary operations. Marines also have researched nuclear power, which comes with issues of its own, and geothermal power. They have had some success with the latter, but Col. Charette explains that “it comes with a lot of drilling.” Desert conditions in Afghanistan with their high levels of solar radiation are a prime place to test solar-energy technologies. Marines also plan to examine the technologies in jungle conditions, sending them along with Marine Corps Forces Pacific personnel to the Cobra Gold exercise in Thailand. Troops there can experiment with how the energy gathering works in areas with a thick overhead plant canopy and determine if they have to put flexible panels up in trees. Maj. Sean M. Sadlier, USMC (l), of the Marine Corps Expeditionary Energy Office, explains the solar power element of the Expeditionary Forward Operating Base (ExFOB) concept to Col. Anthony Fernandez, USMC, during a testing phase of this sustainable energy initiative in Tan Tan, Morocco, at African Lion 2010, a month-long theater security cooperation exercise led by Marine Forces Africa. Photo by Maj. Paul Greenberg, USMC. The Marines pulled no punches when they decided to allow Company I to move out to Afghanistan with the experimental solution. The unit is engaged in the northern section of the Helmand Province, an area of the country with an extremely kinetic fight. Sadly, the unit has suffered heavy losses, including the deaths of more than a dozen Marines in less than two months in 2010. Conditions currently are so dangerous that not only were the Devil Dogs unable to accommodate an interview, but at the time of Col. Charette’s interview had not yet reported on their experiences. And the officer is in no hurry to receive any information if it means putting Marines in even more danger. In fact, keeping troops safe is the major goal in this impetus. His biggest test of success will be if the unit “comes back and says we didn’t have to have a Marine on the road because of this solution.” Col. Charette adds that if he learns one Marine was relieved from having to haul fuel, that fact will be worth the approximately $3.5 million spent on research, development and procurement. When the unit does return, the colonel explains, the plan is to write a report about what worked well and what needs improvement. Though the Corps hopes to replace fossil fuels, according to Col. Charette, it is not particularly focused on the issue. “Others will figure that out,” he says, explaining that the Marines maintain dialog with those groups, but “we don’t drive the fossil fuel equation.” What the Marine Corps would like is a drop in its need for liquid fuels from the current 200,000 gallons a day in Afghanistan to 100,000 gallons a day by 2025 when comparing forces of the same size and needs. Col. Charette emphasizes the term “liquid fuels,” which he expects will remain the norm. However, what makes up that fuel could vary. Another reason for the ExFOB is the Marines’ focus on the expeditionary edge. “Your Marine Corps is the expeditionary force in readiness,” the colonel says. This means they need small, lightweight equipment to move from sea to shore. The Army and Air Force have renewable-energy experiments for larger camps and systems. Col. Charette says the Corps’ capability is to provide resources to the expeditionary fighter. One huge consideration for remaining a lean, mean fighting force is the amount of equipment troops must carry with them. For Marines, this entails thinking about how their items fit on the ships that transport them. Col. Charette says that some of the solar technologies in the ExFOB might originally take up more space than their fossil-fuel counterparts. However, with these renewable-energy generators, the number of batteries needed per day for equipment drops from seven or eight down to one or two, resulting in less room needed overall. The colonel states that this drop in batteries pays off pretty quickly not just in money, but also in weight and space. In some cases, the benefits might be a little harder to find. GREENS can fit onto the back of a military vehicle, but the solar panels and batteries take up more space and cost more than similar gas systems. They also cost more. Col. Charette says one such system runs $50,000 to $70,000, while a same-level, traditional-fuel generator costs approximately $800 at a commercial hardware store. “But the thing is, you have to look at the holistic picture,” he explains. While the solar alternative is bulkier and more expensive up front, it results in fewer fuel trucks on the road, which comes with its own costs in money and lives. He urges people not to look at this capability myopically, but to stand back and consider overall effects. Being at the front edge of the fight was a major impetus for the ExFOB project. The commandant of the Marine Corps began the initiative in 2009, telling his personnel that Marines would take the lead in pushing expeditionary technology out to the battlefield. He also directed them to employ commercial off-the-shelf technology as quickly as possible to reduce risks and increase combat effectiveness. Col. Charette says the commandant has watched the exponential growth in power needs and power generators over the last decade or so. As those requirements grew, so did the risks to troops who have to haul the fuel. To get their arms around the problem, Marines stood up the Marine Corps Expeditionary Energy Office and then the ExFOB initiative. The moves also partly address the improvised explosive device threat—estimated to account for more than 70 percent of battlefield casualties—by reducing the number of Marines on the road for refueling purposes. Col. Charette says Marines have learned many lessons during the war in Afghanistan, explaining they can now perform tasks on the battlefield that were unimaginable even five years ago. “There’s no greater change agent than war,” he states. When Marines are spending less time on the roads, not only does it protect life and limb, it also increases the time they can spend on other facets of missions, such as helping allies and battling enemies. Another benefit of renewable energy is its potential to help local populaces in areas with minimal infrastructure. Many of the places where U.S. forces end up fighting are undergoverned at least. “They’re not hospitable places,” Col. Charette says, and the people living there often lack power and clean water. A less-discussed aspect of the ExFOB and similar initiatives is the effort to figure out how to take the technologies U.S. troops are using to help build renewable systems in these communities. Funding is one concern for such civilian-assistance projects, because Title X money is designated for other uses, but work already has started in some places. Col. Charette shares that Marines are in the early stages of looking at small projects in Helmand Province. Along with the many current and potential benefits of the ExFOB come several downsides, especially for those operating the systems in dangerous locations. For one, almost all the deployed solar technologies are commercial off the shelf; nothing is very hardened, and program officials are unsure how they will hold up to the elements. “We’re worried about consecutive days of bad weather,” Col. Charette says. The Company I warfighters also carry the concern that ExFOB is only an 80 percent solution and has never been tested in combat before. Decision makers know the capability is not the complete answer to Marine Corps issues, and Col. Charette is unsure how comfortable Marines will be with the technology in a shooting match. System officials tried to help mitigate risks through training, including with vendors, and by sending along traditional power sources on the deployment in case the renewable technologies fall short. Because whether on the road or in battle, saving lives is a top priority. “At the end of the day, we told them if it doesn’t work, to throw it in the Helmand River,” Col. Charette says.