# Military Hydrogen Refueling

# FYI

## How Hydrogen Power Works

<http://www.dtic.mil/dtic/tr/fulltext/u2/a520503.pdf> : Tech Solutions

Hydrogen Hydrogen in its elemental state, protium, is composed of a single proton and a single electron, while its isotopes deuterium and tritium contain an additional one and two neutrons, respectively. It is the most abundant element in the universe and is the lightest (i.e., smallest atomic mass). It is estimated that three quarters of the mass in the universe is composed of hydrogen atoms.[36] Hydrogen is very chemically reactive and readily combines with many other elements, particularly carbon and oxygen; on its own hydrogen is found in its relatively stable, diatomic gaseous form H2.[36] Hydrogen gas, H2, is highly flammable and when undergoing combustion (i.e., reaction with oxygen) it produces water and heat, as shown in the combustion equation: 2H2(g) + O2(g) → 2H2O(l) + 572 kJ[37] Since the only product is water and heat, hydrogen is a very clean burning fuel. Hydrogen is not considered an energy source, but rather, an energy carrier like a spring, because it is not abundantly occurring on its own in nature and therefore must be produced from other compounds. Hydrogen can be produced by leveraging other renewable energy sources, such as wind, solar, and hydroelectric power, and therefore it can be supplied from a variety of geographical regions. Once produced, most commonly by steam methane reforming, hydrogen as a fuel can be used in internal combustion engines and fuel cells. Liquid hydrogen is also used as a propellant, and is well known for its use to launch the Space Shuttle. Selected physical and thermodynamic properties of hydrogen are given in Table 5. Energy density is the amount of energy contained in matter per unit mass or unit volume, and is often used to compare different types of fuels. The mass-based energy density of hydrogen is very high but the volume-based energy density is low compared to other fuels. One pound of H2 has 44.4% of the energy contained in one gallon of gasoline.[42] The energy densities of hydrogen gas and liquid at several pressures are given in Table 6. Hydrogen Production Hydrogen as a resource is mostly contained in water (H2O) and organic matter (i.e., hydrocarbons), and therefore must be extracted to be useable as a fuel. The following are some of the common processes used for hydrogen production. Steam Methane Reforming. About 95% of the hydrogen produced today in the United States is made via steam-methane reforming, a process in which high-temperature steam (700°C1000°C) is used to produce hydrogen from a methane source, such as natural gas which is mostly methane gas. In steammethane reforming, methane reacts with steam under 3-25 bar pressure (1 bar = 14.5 psi) in the presence of a catalyst to produce hydrogen, carbon monoxide, and a relatively small amount of carbon dioxide.[44] Electrolysis. Electrolysis involves decomposing water into its base components of hydrogen and oxygen. This is accomplished by applying an electrical current through water via electrodes. Gasification. Hydrogen can be produced by other organic feedstocks, such as coal and biomass. Using high temperature and pressure to gasify coal or biomass, the gasified organic product is then converted to synthetic gas, which is then reacted with steam under temperature and pressure to produce hydrogen. Syngas is primarily carbon monoxide and hydrogen (more than 85 percent by volume) and smaller quantities of carbon dioxide and methane. Syngas can be used as a fuel to generate electricity or steam, or as a basic chemical building block for a multitude of uses. When mixed with air, syngas can be used in gasoline or diesel engines with few modifications to the engine.[45] Other Production Processes. Other processes used to produce hydrogen include renewable liquid reforming, nuclear high-temperature electrolysis, high-temperature thermochemical water splitting, and photobiological and photoelectrochemical processes. Hydrogen Storage In addition to its production, another technical challenge for hydrogen revolves around its storage. Even though hydrogen has a high energy density by mass, its energy density by volume is low. Therefore, storage of hydrogen fuel requires a sizable container that is also safe and reliable, since hydrogen is highly flammable. Hydrogen can be stored in tanks as a compressed gas or cryogenic liquid or can be stored on the surface or within other materials, such as metal hydrides and carbon-based materials.

## How Fuel Cells Work

<http://www.dtic.mil/dtic/tr/fulltext/u2/a520503.pdf> : Tech Solutions

FUEL CELLS A fuel cell (FC) is a device that converts chemical energy from a fuel source to electrical energy via electrochemical reactions in the presence of a catalyst. An electric current is generated as electrons are freed in a half-cell reaction at one electrode, conducted through an external circuit from which electric power is drawn, and finally combined at the opposing electrode in the other halfcell reaction. In the meantime, ions are migrating across an electrolyte to participate in the reactions. Much like batteries, with no moving parts fuel cells can silently and without vibration provide power. Since there is no mechanical wear, the expected life of a fuel cell is long. The primary difference between a fuel cell and a battery is the battery is a closed electrochemical system in which the reactants can be completely consumed and thus the output power eventually can be depleted. FCs have a continuous supply of reactants, and thus can operate without being recharged. While the fuel source can vary, the typical reactants are hydrogen and an oxidant, which is most often oxygen.While a hydrogen source must be provided, in most cases oxygen can be drawn from the air. The cellular aspect which is most often oxygen.While a hydrogen source must be provided, in most cases oxygen can be drawn from the air. The cellular aspect of these power devices is derived from their modular nature.

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## Energy Wars

#### Contention One is Energy Wars

#### Current DOD systems are heavily dependent on oil – this is unsustainable

Parthemore 10

[Christine Parthemore, Fellow at the Center for a New American Security, September 2010, “Fueling the Future Force Preparing the Department of Defense for a Post-Petroleum Era,” <http://www.cnas.org/files/documents/publications/CNAS_Fueling%20the%20Future%20Force_NaglParthemore.pdf>, accessed on 7/11/12, Kfo]

The U.S. Department of Defense (DOD) must prepare now to transition smoothly to a future in which it does not depend on petroleum. This is no small task: up to 77 percent of DOD’s massive energy needs – and most of the aircraft, ground vehicles, ships and weapons systems that DOD is purchasing today – depend on petroleum for fuel.1 Yet, while many of today’s weapons and transportation systems are unlikely to change dramatically or be replaced for decades, the petroleum needed to operate DOD assets may not remain affordable, or even reliably available, for the lifespans of these systems. To ready America’s armed forces for tomorrow’s challenges, DOD should ensure that it can operate all of its systems on non-petroleum fuels by 2040. This 30-year timeframe reflects market indicators pointing toward both higher demand for petroleum and increasing international competition to acquire it. Moreover, the geology and economics of producing petroleum will ensure that the market grows tight long before petroleum reserves are depleted. Some estimates indicate that the current global reserve-to-production (R/P) ratio – how fast the world will produce all currently known recoverable petroleum reserves at the current rate of production – is less than 50 years.2 Thus, given projected supply and demand, we cannot assume that oil will remain affordable or that supplies will be available to the United States reliably three decades hence. Ensuring that DOD can operate on non-petroleum fuels 30 years from today is a conservative hedge against prevailing economic, political and environmental trends, conditions and constraints.

#### DOD oil dependence will cause four scenarios for conflict: China, Straight of Hormuz, Terrorism, and Mexico collapse

Parthemore 10

[Christine Parthemore, Fellow at the Center for a New American Security, September 2010, “Fueling the Future Force Preparing the Department of Defense for a Post-Petroleum Era,” <http://www.cnas.org/files/documents/publications/CNAS_Fueling%20the%20Future%20Force_NaglParthemore.pdf>, accessed on 7/11/12, Kfo]

The Risks of Petroleum Dependence The growing world demand for petroleum presents major geostrategic risks. High prices and rising demand are a boon to major suppliers and reserve holders such as Iran and Venezuela, which are unfriendly to the United States. It also affects the international behavior of rising powers such as China, which is on a quest to secure access to natural resources that is in turn expanding its influence around the globe. In Mexico, one of the top suppliers of petroleum to the United States, pipelines serve as an increasingly attractive target for dangerous cartels to fund activities that could undermine the Mexican government, destabilize the region and decrease U.S. homeland security.4 American foreign policy itself has been colored by its growing petroleum demands since the 1970s oil crises and subsequent declaration of the Carter doctrine, which stipulated that the United States would consider threats to the Persian Gulf region threats to its “vital interests” due to the strategic importance of its petroleum reserves.5 Dependence on petroleum for 94 percent of transportation fuel is also a dangerous strategic risk for the United States given the leverage oil can provide to supplier countries. Many European allies have experienced such leverage in action with Russia periodically threatening to reduce or cut off natural gas exports to countries highly reliant on their supplies (and in some cases carrying through with these threats). Similarly, national oil companies and OPEC can choose to increase or decrease their production rates to drive changes in the market. The more the United States reduces its dependence on petroleum, the better it can hedge against petroleum suppliers exerting political leverage over U.S. interests, including in times of crisis. At the operational level, heavy reliance on liquid fuels also constitutes a force protection challenge for DOD. Fuel supply convoys have been vulnerable to attack in both Iraq and Afghanistan, where the services have struggled to adapt to the challenges of terrorism, insurgency and violent extremism. In addition to minimizing these risks in the current wars, DOD must also conceptualize and plan for what the future will likely hold for America’s security. The Navy’s battle against pirates off the coast of the Horn of Africa foreshadows the littoral and unconventional challenges that await the United States in the coming decades, as populations continue to migrate toward the world’s coastal area. These types of problems often manifest at major shipping chokepoints (including petroleum transit chokepoints), and addressing them will include distinctive fueling requirements. The Air Force, likewise, confronts dramatic changes in manned and unmanned flight, in addition to the proliferation of space technologies, all of which could dramatically alter fuel needs. In another example, one recently published AirSea battle concept focused on China notes that the type of conflict it outlines could require hardening fueling infrastructure, improving aerial refueling, “stockpiling petrol, oil, and lubricants” and potentially “running undersea fuel pipelines between Guam, Tinian and Saipan.”6 As the character of warfare changes, DOD will have to continue to consider the attraction of fuel supply lines to opponents.

#### Conflict with China goes nuclear

Glaser 2011 (Professor of Political Science and International Affairs and Director of the Institute for Security and Conflict Studies at the Elliott School of International Affairs at George Washington University, Will China's Rise Lead to War? Subtitle: Why Realism Does Not Mean Pessimism, Foreign Affairs, March/April, lexis)

ACCOMMODATION ON TAIWAN? The prospects for avoiding intense military competition and war may be good, but growth in China's power may nevertheless require some changes in U.S. foreign policy that Washington will find disagreeable -- particularly regarding Taiwan. Although it lost control of Taiwan during the Chinese Civil War more than six decades ago, China still considers Taiwan to be part of its homeland, and unification remains a key political goal for Beijing. China has made clear that it will use force if Taiwan declares independence, and much of China's conventional military buildup has been dedicated to increasing its ability to coerce Taiwan and reducing the United States' ability to intervene. Because China places such high value on Taiwan and because the United States and China -- whatever they might formally agree to -- have such different attitudes regarding the legitimacy of the status quo, the issue poses special dangers and challenges for the U.S.-Chinese relationship, placing it in a different category than Japan or South Korea. A crisis over Taiwan could fairly easily escalate to nuclear war, because each step along the way might well seem rational to the actors involved. Current U.S. policy is designed to reduce the probability that Taiwan will declare independence and to make clear that the United States will not come to Taiwan's aid if it does. Nevertheless, the United States would find itself under pressure to protect Taiwan against any sort of attack, no matter how it originated. Given the different interests and perceptions of the various parties and the limited control Washington has over Taipei's behavior, a crisis could unfold in wh

ich the United States found itself following events rather than leading them. Such dangers have been around for decades, but ongoing improvements in China's military capabilities may make Beijing more willing to escalate a Taiwan crisis. In addition to its improved conventional capabilities, China is modernizing its nuclear forces to increase their ability to survive and retaliate following a large-scale U.S. attack. Standard deterrence theory holds that Washington's current ability to destroy most or all of China's nuclear force enhances its bargaining position. China's nuclear modernization might remove that check on Chinese action, leading Beijing to behave more boldly in future crises than it has in past ones. A U.S. attempt to preserve its ability to defend Taiwan, meanwhile, could fuel a conventional and nuclear arms race. Enhancements to U.S. offensive targeting capabilities and strategic ballistic missile defenses might be interpreted by China as a signal of malign U.S. motives, leading to further Chinese military efforts and a general poisoning of U.S.-Chinese relations.

#### Strait of Hormuz conflict escalates and destroys the economy

Klare 12

[Michael T. Klare is a professor of peace and world security studies at Hampshire College, January 31, 2012, <http://obrag.org/?p=53517>, accessed 7/17/12, Kfo]

Ever since December 27th, war clouds have been gathering over the Strait of Hormuz, the narrow body of water connecting the Persian Gulf with the Indian Ocean and the seas beyond. On that day, Iranian Vice President Mohammad Reza Rahimi warned that Tehran would block the strait and create havoc in international oil markets if the West placed new economic sanctions on his country. “If they impose sanctions on Iran’s oil exports,” Rahimi declared, “then even one drop of oil cannot flow from the Strait of Hormuz.” Claiming that such a move would constitute an assault on America’s vital interests, President Obama reportedly informed Iran’s supreme leader Ayatollah Ali Khamenei that Washington would use force to keep the strait open. To back up their threats, both sides have been bolstering their forces in the area and each has conducted a series of provocative military exercises. All of a sudden, the Strait of Hormuz has become the most combustible spot on the planet, the most likely place to witness a major conflict between well-armed adversaries. Why, of all locales, has it become so explosive? Oil, of course, is a major part of the answer, but — and this may surprise you — only a part. Petroleum remains the world’s most crucial source of energy, and about one-fifth of the planet’s oil supply travels by tanker through the strait. “Hormuz is the world’s most important oil chokepoint due to its daily oil flow of almost 17 million barrels in 2011,” the U.S. Department of Energy noted as last year ended. Because no other area is capable of replacing these 17 million barrels, any extended closure would produce a global shortage of oil, a price spike, and undoubtedly attendant economic panic and disorder. No one knows just how high oil prices would go under such circumstances, but many energy analysts believe that the price of a barrel might immediately leap by $50 or more. “You would get an international reaction that would not only be high, but irrationally high,” says Lawrence J. Goldstein, a director of the Energy Policy Research Foundation. Even though military experts assume the U.S. will use its overwhelming might to clear the strait of Iranian mines and obstructions in a few days or weeks, the chaos to follow in the region might not end quickly, keeping oil prices elevated for a long time. Indeed, some analysts fear that oil prices, already hovering around $100 per barrel, would quickly double to more than $200, erasing any prospect of economic recovery in the United States and Western Europe, and possibly plunging the planet into a renewed Great Recession. The Iranians are well aware of all this, and it is with such a nightmare scenario that they seek to deter Western leaders from further economic sanctions and other more covert acts when they threaten to close the strait. To calm such fears, U.S. officials have been equally adamant in stressing their determination to keep the strait open. In such circumstances of heightened tension, one misstep by either side might prove calamitous and turn mutual rhetorical belligerence into actual conflict. Military Overlord of the Persian Gulf In other words, oil, which makes the global economy hum, is the most obvious factor in the eruption of war talk, if not war. Of at least equal significance are allied political factors, which may have their roots in the geopolitics of oil but have acquired a life of their own. Because so much of the world’s most accessible oil is concentrated in the Persian Gulf region, and because a steady stream of oil is absolutely essential to the well-being of the U.S. and the global economy, it has long been American policy to prevent potentially hostile powers from acquiring the capacity to dominate the Gulf or block the Strait of Hormuz. President Jimmy Carter first articulated this position in January 1980, following the Islamic Revolution in Iran and the Soviet invasion of Afghanistan. “Any attempt by an outside force to gain control of the Persian Gulf region will be regarded as an assault on the vital interests of the United States of America,” he told a joint session of Congress, “and such an assault will be repelled by any means necessary, including military force.” In accordance with this precept, Washington designated itself the military overlord of the Persian Gulf, equipped with the military might to overpower any potential challenger. At the time, however, the U.S. military was not well organized to implement the president’s initiative, known ever since as the Carter Doctrine. In response, the Pentagon created a new organization, the U.S. Central Command (CENTCOM), and quickly endowed it with the wherewithal to crush any rival power or powers in the region and keep the sea lanes under American control. CENTCOM first went into action in 1987-1988, when Iranian forces attacked Kuwaiti and Saudi oil tankers during the Iran-Iraq War, threatening the flow of oil supplies through the strait. To protect the tankers, President Reagan ordered that they be “reflagged” as American vessels and escorted by U.S. warships, putting the Navy into potential conflict with the Iranians for the first time. Out of this action came the disaster of Iran Air Flight 655, a civilian airliner carrying 290 passengers and crew members, all of whom died when the plane was hit by a missile from the USS Vincennes, which mistook it for a hostile fighter plane — a tragedy long forgotten in the United States, but still deeply resented in Iran. Iraq was America’s de facto ally in the Iran-Iraq war, but when Saddam Hussein invaded Kuwait in 1990 — posing a direct threat to Washington’s dominance of the Gulf — the first President Bush ordered CENTCOM to protect Saudi Arabia and drive Iraqi forces out of Kuwait. And when Saddam rebuilt his forces, and his very existence again came to pose a latent threat to America’s dominance in the region, the second President Bush ordered CENTCOM to invade Iraq and eliminate his regime altogether (which, as no one is likely to forget, resulted in a string of disasters). If oil lay at the root of Washington’s domineering role in the Gulf, over time that role evolved into something else: a powerful expression of America’s status as a global superpower. By becoming the military overlord of the Gulf and the self-appointed guardian of oil traffic through the Strait of Hormuz, Washington said to the world: “We, and we alone, are the ones who can ensure the safety of your daily oil supply and thereby prevent global economic collapse.” Indeed, when the Cold War ended — and with it an American sense of pride and identity as a bulwark against Soviet expansionism in Europe and Asia — protection of the flow of Persian Gulf oil became America’s greatest claim to superpowerdom, and it remains so today. Every Option on Every Table With the ouster of Saddam Hussein in 2003, the one potential threat to U.S. domination of the Persian Gulf was, of course, Iran. Even under the U.S.-backed Shah, long Washington’s man in the Gulf, the Iranians had sought to be the paramount power in the region. Now, under a militant Shiite Islamic regime, they have proven no less determined and — call it irony — thanks to Saddam’s overthrow and the rise of a Shiite-dominated government in Baghdad, they have managed to extend their political reach in the region. With Saddam’s fate in mind, they have also built up their defensive military capabilities and — in the view of many Western analysts — embarked on a uranium-enrichment program with the potential to supply fissile material for a nuclear weapon, should the Iranian leadership choose someday to take such a fateful step. Iran thus poses a double challenge to Washington’s professed status in the Gulf. It is not only a reasonably well-armed country with significant influence in Iraq and elsewhere, but by promoting its nuclear program, it threatens to vastly complicate America’s future capacity to pull off punishing attacks like those launched against Iraqi forces in 1991 and 2003. While Iran’s military budget is modest-sized at best and its conventional military capabilities will never come close to matching CENTCOM’s superior forces in a direct confrontation, its potential pursuit of nuclear-arms capabilities greatly complicates the strategic calculus in the region. Even without taking the final steps of manufacturing actual bomb components — and no evidence has yet surfaced that the Iranians have proceeded to this critical stage — the Iranian nuclear effort has greatly alarmed other countries in the Middle East and called into question the continued robustness of America’s regional dominance. From Washington’s perspective, an Iranian bomb — whether real or not — poses an existential threat to America’s continued superpower status. How to prevent Iran not just from going nuclear but from maintaining the threat to go nuclear has, in recent years, become an obsessional focus of American foreign and military policy. Over and over again, U.S. leaders have considered plans for using military force to cripple the Iranian program though air and missile strikes on known and suspected nuclear facilities. Presidents Bush and Obama have both refused to take such action “off the table,” as Obama made clear most recently in his State of the Union address. (The Israelis have also repeatedly indicated their desire to take such action, possibly as a prod to Washington to get the job done.) Most serious analysts have concluded that military action would prove extremely risky, probably causing numerous civilian casualties and inviting fierce Iranian retaliation. It might not even achieve the intended goal of halting the Iranian nuclear program, much of which is now being conducted deep underground. Hence, the consensus view among American and European leaders has been that economic sanctions should instead be employed to force the Iranians to the negotiating table, where they could be induced to abandon their nuclear ambitions in return for various economic benefits. But those escalating sanctions, which appear to be causing increasing economic pain for ordinary Iranians, have been described by that country’s leaders as an “act of war,” justifying their threats to block the Strait of Hormuz. To add to tensions, the leaders of both countries are under extreme pressure to vigorously counter the threats of the opposing side. President Obama, up for re-election, has come under fierce, even hair-raising, attack from the contending Republican presidential candidates (except, of course, Ron Paul) for failing to halt the Iranian nuclear program, though none of them have a credible plan to do so. He, in turn, has been taking an ever-harsher stance on the issue. Iranian leaders, for their part, appear increasingly concerned over the deteriorating economic conditions in their country and, no doubt fearing an Arab Spring-like popular upheaval, are becoming more bellicose in their rhetoric. So oil, the prestige of global dominance, Iran’s urge to be a regional power, and domestic political factors are all converging in a combustible mix to make the Strait of Hormuz the most dangerous place on the planet. For both Tehran and Washington, events seem to be moving inexorably toward a situation in which mistakes and miscalculations could become inevitable. Neither side can appear to give ground without losing prestige and possibly even their jobs. In other words, an existential test of wills is now under way over geopolitical dominance in a critical part of the globe, and on both sides there seem to be ever fewer doors marked “EXIT.” As a result, the Strait of Hormuz will undoubtedly remain the ground zero of potential global conflict in the months ahead.

Economic decline causes war – statistically proven

Royal 10 — Jedidiah Royal, Director of Cooperative Threat Reduction at the U.S. Department of Defense, M.Phil. Candidate at the University of New South Wales, 2010 (“Economic Integration, Economic Signalling and the Problem of Economic Crises,” *Economics of War and Peace: Economic, Legal and Political Perspectives*, Edited by Ben Goldsmith and Jurgen Brauer, Published by Emerald Group Publishing, ISBN 0857240048, p. 213-215)

Less intuitive is how periods of economic decline may increase the likelihood of external conflict. Political science literature has contributed a moderate degree of attention to the impact of economic decline and the security and defence behaviour of interdependent states. Research in this vein has been considered at systemic, dyadic and national levels. Several notable contributions follow.

First, on the systemic level, Pollins (2008) advances Modelski and Thompson's (1996) work on leadership cycle theory, finding that rhythms in the global economy are associated with the rise and fall of a pre-eminent power and the often bloody transition from one pre-eminent leader to the next. As such, exogenous shocks such as economic crises could usher in a redistribution of relative power (see also Gilpin. 1981) that leads to uncertainty about power balances, increasing the risk of miscalculation (Feaver, 1995). Alternatively, even a relatively certain redistribution of power could lead to a permissive environment for conflict as a rising power may seek to challenge a declining power (Werner. 1999). Separately, Pollins (1996) also shows that global economic cycles combined with parallel leadership cycles impact the likelihood of conflict among major, medium and small powers, although he suggests that the causes and connections between global economic conditions and security conditions remain unknown.

Second, on a dyadic level, Copeland's (1996, 2000) theory of trade expectations suggests that 'future expectation of trade' is a significant variable in understanding economic conditions and security behaviour of states. He argues that interdependent states are likely to gain pacific benefits from trade so long as they have an optimistic view of future trade relations. However, if the expectations of future trade decline, particularly for difficult [end page 213] to replace items such as energy resources, the likelihood for conflict increases, as states will be inclined to use force to gain access to those resources. Crises could potentially be the trigger for decreased trade expectations either on its own or because it triggers protectionist moves by interdependent states.4

Third, others have considered the link between economic decline and external armed conflict at a national level. Blomberg and Hess (2002) find a strong correlation between internal conflict and external conflict, particularly during periods of economic downturn. They write,

The linkages between internal and external conflict and prosperity are strong and mutually reinforcing. Economic conflict tends to spawn internal conflict, which in turn returns the favour. Moreover, the presence of a recession tends to amplify the extent to which international and external conflicts self-reinforce each other. (Blomberg & Hess, 2002. p. 89)

Economic decline has also been linked with an increase in the likelihood of terrorism (Blomberg, Hess, & Weerapana, 2004), which has the capacity to spill across borders and lead to external tensions.

Furthermore, crises generally reduce the popularity of a sitting government. “Diversionary theory" suggests that, when facing unpopularity arising from economic decline, sitting governments have increased incentives to fabricate external military conflicts to create a 'rally around the flag' effect. Wang (1996), DeRouen (1995). and Blomberg, Hess, and Thacker (2006) find supporting evidence showing that economic decline and use of force are at least indirectly correlated. Gelpi (1997), Miller (1999), and Kisangani and Pickering (2009) suggest that the tendency towards diversionary tactics are greater for democratic states than autocratic states, due to the fact that democratic leaders are generally more susceptible to being removed from office due to lack of domestic support. DeRouen (2000) has provided evidence showing that periods of weak economic performance in the United States, and thus weak Presidential popularity, are statistically linked to an increase in the use of force.

In summary, recent economic scholarship positively correlates economic integration with an increase in the frequency of economic crises, whereas political science scholarship links economic decline with external conflict at systemic, dyadic and national levels.5 This implied connection between integration, crises and armed conflict has not featured prominently in the economic-security debate and deserves more attention.

This observation is not contradictory to other perspectives that link economic interdependence with a decrease in the likelihood of external conflict, such as those mentioned in the first paragraph of this chapter. [end page 214] Those studies tend to focus on dyadic interdependence instead of global interdependence and do not specifically consider the occurrence of and conditions created by economic crises. As such, the view presented here should be considered ancillary to those

#### Nuclear terrorism is an existential threat—it escalates to nuclear war with Russia and China

**Ayson 10** (Robert Ayson, Professor of Strategic Studies and Director of the Centre for Strategic Studies: New Zealand at the Victoria University of Wellington, 2010 (“After a Terrorist Nuclear Attack: Envisaging Catalytic Effects,” Studies in Conflict & Terrorism, Volume 33, Issue 7, July, Available Online to Subscribing Institutions via InformaWorld)

A terrorist nuclear attack, and even the use of nuclear weapons in response by the country attacked in the first place, would not necessarily represent the worst of the nuclear worlds imaginable. Indeed, there are reasons to wonder whether nuclear terrorism should ever be regarded as belonging in the category of truly existential threats. A contrast can be drawn here with the global catastrophe that would come from a massive nuclear exchange between two or more of the sovereign states that possess these weapons in significant numbers. Even the worst terrorism that the twenty-first century might bring would fade into insignificance alongside considerations of what a general nuclear war would have wrought in the Cold War period. And it must be admitted that as long as the major nuclear weapons states have hundreds and even thousands of nuclear weapons at their disposal, there is always the possibility of a truly awful nuclear exchange taking place precipitated entirely by state possessors themselves. But these two nuclear worlds—a non-state actor nuclear attack and a catastrophic interstate nuclear exchange—are not necessarily separable. It is just possible that some sort of terrorist attack, and especially an act of nuclear terrorism, could precipitate a chain of events leading to a massive exchange of nuclear weaponsbetween two or more of the states that possess them. In this context, today’s and tomorrow’s terrorist groups might assume the place allotted during the early Cold War years to new state possessors of small nuclear arsenals who were seen as raising the risks of a catalytic nuclear war between the superpowers started by third parties. These risks were considered in the late 1950s and early 1960s as concerns grew about nuclear proliferation, the so-called n+1 problem. It may require a considerable amount of imagination to depict an especially plausible situation where an act of nuclear terrorism could lead to such a massive inter-state nuclear war. For example, in the event of a terrorist nuclear attack on the United States, it might well be wondered just how Russia and/or China could plausibly be brought into the picture, not least because they seem unlikely to be fingered as the most obvious state sponsors or encouragers of terrorist groups. They would seem far too responsible to be involved in supporting that sort of terrorist behavior that could just as easily threaten them as well. Some possibilities, however remote, do suggest themselves. For example, how might the United States react if it was thought or discovered that the fissile material used in the act of nuclear terrorism had come from Russian stocks,40 and if for some reason Moscow denied any responsibility for nuclear laxity? The correct attribution of that nuclear material to a particular country might not be a case of science fiction given the observation by Michael May et al. that while the debris resulting from a nuclear explosion would be “spread over a wide area in tiny fragments, its radioactivity makes it detectable, identifiable and collectable, and a wealth of information can be obtained from its analysis: the efficiency of the explosion, the materials used and, most important … some indication of where the nuclear material came from.”41 Alternatively, if the act of nuclear terrorism came as a complete surprise, and American officials refused to believe that a terrorist group was fully responsible (or responsible at all) suspicion would shift immediately to state possessors. Ruling out Western ally countries like the United Kingdom and France, and probably Israel and India as well, authorities in Washington would be left with a very short list consisting of North Korea, perhaps Iran if its program continues, and possibly Pakistan. But at what stage would Russia and China be definitely ruled out in this high stakes game of nuclear Cluedo? In particular, if the act of nuclear terrorism occurred against a backdrop of existing tension in Washington’s relations with Russia and/or China, and at a time when threats had already been traded between these major powers, would officials and political leaders not be tempted to assume the worst? Of course, the chances of this occurring would only seem to increase if the United States was already involved in some sort of limited armed conflict with Russia and/or China, or if they were confronting each other from a distance in a proxy war, as unlikely as these developments may seem at the present time. The reverse might well apply too: should a nuclear terrorist attack occur in Russia or China during a period of heightened tension or even limited conflict with the United States, could Moscow and Beijing resist the pressures that might rise domestically to consider the United States as a possible perpetrator or encourager of the attack? Washington’s early response to a terrorist nuclear attack on its own soil might also raise the possibility of an unwanted (and nuclear aided) confrontation with Russia and/or China. For example, in the noise and confusion during the immediate aftermath of the terrorist nuclear attack, the U.S. president might be expected to place the country’s armed forces, including its nuclear arsenal, on a higher stage of alert. In such a tense environment, when careful planning runs up against the friction of reality, it is just possible that Moscow and/or China might mistakenly read this as a sign of U.S. intentions to use force (and possibly nuclear force) against them. In that situation, the temptations to preempt such actions might grow, although it must be admitted that **any** preemption would probably still meet with a devastating response. As part of its initial response to the act of nuclear terrorism (as discussed earlier)Washington might decide to order a significant conventional (or nuclear) retaliatory or disarming attack against the leadership of the terrorist group and/or states seen to support that group. Depending on the identity and especially the location of these targets, Russia and/or China might interpret such action as being far too close for their comfort, and potentially as an infringement on their spheres of influence and even on their sovereignty. One far-fetched but perhaps not impossible scenario might stem from a judgment in Washington that some of the main aiders and abetters of the terrorist action resided somewhere such as Chechnya, perhaps in connection with what Allison claims is the “Chechen insurgents’ … long-standing interest in all things nuclear.”42 American pressure on that part of the world would almost certainly raise alarms in Moscow that might require a degree of advanced consultation from Washington that the latter found itself unable or unwilling to provide. There is also the question of how other nuclear-armed states respond to the act of nuclear terrorism on another member of that special club. It could reasonably be expected that following a nuclear terrorist attack on the United States, both Russia and China would extend immediate sympathy and support to Washington and would work alongside the United States in the Security Council. But there is just a chance, albeit a slim one, where the support of Russia and/or China is less automatic in some cases than in others. For example, what would happen if the United States wished to discuss its right to retaliate against groups based in their territory? If, for some reason, Washington found the responses of Russia and China deeply underwhelming, (neither “for us or against us”) might it also suspect that they secretly were in cahoots with the group, increasing (again perhaps ever so slightly) the chances of a major exchange. If the terrorist group had some connections to groups in Russia and China, or existed in areas of the world over which Russia and China held sway, and if Washington felt that Moscow or Beijing were placing a curiously modest level of pressure on them, what conclusions might it then draw about their culpability? If Washington decided to use, or decided to threaten the use of, nuclear weapons, the responses of Russia and China would be crucial to the chances of avoiding a more serious nuclear exchange. They might surmise, for example, that while the act of nuclear terrorism was especially heinous and demanded a strong response, the response simply had to remain below the nuclear threshold. It would be one thing for a non-state actor to have broken the nuclear use taboo, but an entirely different thing for a state actor, and indeed the leading state in the international system, to do so. If Russia and China felt sufficiently strongly about that prospect, there is then the question of what options would lie open to them to dissuade the United States from such action: and as has been seen over the last several decades, the central dissuader of the use of nuclear weapons by states has been the threat of nuclear retaliation. If some readers find this simply too fanciful, and perhaps even offensive to contemplate, it may be informative to reverse the tables. Russia, which possesses an arsenal of thousands of nuclear warheads and that has been one of the two most important trustees of the non-use taboo, is subjected to an attack of nuclear terrorism. In response, Moscow places its nuclear forces very visibly on a higher state of alert and declares that it is considering the use of nuclear retaliation against the group and any of its state supporters. How would Washington view such a possibility? Would it really be keen to support Russia’s use of nuclear weapons, including outside Russia’s traditional sphere of influence? And if not, which seems quite plausible, what options would Washington have to communicate that displeasure? If China had been the victim of the nuclear terrorism and seemed likely to retaliate in kind, would the United States and Russia be happy to sit back and let this occur? In the charged atmosphere immediately after a nuclear terrorist attack, how would the attacked country respond to pressure from other major nuclear powers not to respond in kind? The phrase “how dare they tell us what to do” immediately springs to mind. Some might even go so far as to interpret this concern as a tacit form of sympathy or support for the terrorists. This might not help the chances of nuclear restraint.

#### A Mexico failed state would escalate

Webster 9

[Michael Webster, Syndicated Author, January 25,2009, <http://www.canadafreepress.com/index.php/article/7883>, accessed 7/18/12, Kfo]

The US Department of Defense considers Mexico one of the two governments in the world most likely to suffer a “rapid and sudden collapse” that could require military intervention. A section on “weak and failing countries,” of a report recently released by the US Joint Forces Command says that narcotraffic and organized crime could generate a chaotic scene and the army would be obligated to respond for reasons of national security. At the end of 2008, the US government declared the Mexican drug cartels to be the greatest threat to its territory. In their meeting Monday, President-elect Obama and President Calderon agreed to establish an alliance to work bilaterally in combating drug and arms traffic, commerce and migration. This is Obama’s first meeting with a president of another country since his election. He also promised to collaborate with the Mexican government in matters of security. President elect Obama met with Mexican President Felipe Calderon, continuing a longstanding tradition by which new American presidents meet with their Mexican counterparts. Emerging from a private lunch at the Mexican Cultural Institute that lasted over an hour, President-elect Obama expressed his commitment to advance cooperation on a range of issues, including security, the economy and immigration. “On security, President-elect Obama underscored his interest in finding ways to work together to reduce drug-related violence. He applauded the steps that President Calderón has taken to improve security in Mexico and expressed his on-going support for the valuable work being done under the Mérida Initiative. Obama said he believes the cooperation under the Mérida Initiative can be a building block for a deeper relationship. Obama expressed support for President Calderón’s pet project for the United States and Mexico to eradicate drug-related violence and stop the flow of guns and cash into Mexico. He told President Calderón that he intends to ask the Secretary of Homeland Security to lead an effort to increase information sharing to strengthen those efforts. Calderon, whom U.S. officials have praised for deploying troops to fight cartels and capturing top drug kingpins, helped him win a multimillion-dollar, anti-drug aid package from the Bush Administration late last year. Interestingly Obama supports that plan, known as the Merida Initiative. Obama further said he is an admirer of Calderon’s stewardship of Mexico’s economy, as well as his efforts to fight deadly drug violence. According to the U.S. Joint Forces Command there is one dynamic in the literature of weak and failing states that has received relatively little attention, namely the phenomenon of “rapid collapse.” For the most part, weak and failing states represent chronic, long-term problems that allow for management over sustained periods. The collapse of a state usually comes as a surprise, has a rapid onset, and poses acute problems. The collapse of Yugoslavia into a chaotic tangle of warring nationalities in 1990 suggests how suddenly and catastrophically state collapse can happen - in this case, a state which had hosted the 1984 Winter Olympics at Sarajevo, and which then quickly became the epicenter of the ensuing civil war. In terms of worst-case scenarios for the Joint Force and indeed the world is Mexico a large and important country bordering the United States and could be facing a rapid and sudden collapse. The Mexican possibility of a failed state may seem less likely to many, but the Government, its politicians, police, and judicial infrastructure are all under sustained assault and pressure by criminal gangs and wealthy Mexican drug cartels. How that internal conflict of which many experts believe is actually a civil war turns out over the next several years will have a major impact on the stability of the Mexican state and therefore the U.S. Any descent by Mexico into chaos would demand an American response based on the serious implications for homeland security alone. Mexico poses a real threat to the national security interests of the Western Hemisphere. In particular, the growing assault by the warring Mexican drug cartels and their many gangs of thugs on the Mexican government over the past several years reminds one that an unstable Mexico represents a homeland security problem of immense proportions to the United States. U.S. Joint Forces Command (USJFCOM) is one of DoD’s nine combatant commands and has several key roles in transforming the U.S. military’s capabilities. Headquartered in Norfolk, Va., the command oversees a force of more than 1.16 million dedicated men and women, spanning USJFCOM’s service component commands and subordinate activities. The command is comprised of active and reserve personnel from each branch of the armed forces, civil servants and contract employees.

#### An energy transition solves the reasons why heg is bad – oil dependence forces the US into wars of imperialism and overextension

Clark 12

[Wesley Clark, US Army General, [Rhodes Scholarship](http://en.wikipedia.org/wiki/Rhodes_Scholarship) to the University of Oxford where he obtained a degree in [Philosophy, Politics and Economics](http://en.wikipedia.org/wiki/Philosophy,_Politics_and_Economics), and later graduated from the [Command and General Staff College](http://en.wikipedia.org/wiki/Command_and_General_Staff_College) with a master's degree in [military science](http://en.wikipedia.org/wiki/Military_science), May 23, 2012, “American Families Need American Fuel,” <http://energy.nationaljournal.com/2012/05/powering-our-military-whats-th.php#2212875>, accessed on 7/13/12, Kfo]

Our nation is dangerously dependent on foreign oil. We import some 9 million barrels per day, or over 3 billion barrels per year; the U.S. military itself comprises [two percent](http://thinkprogress.org/climate/2011/06/14/244716/military-renewables-efficiency-and-energy-security/?mobile=nc) of the nation’s total petroleum use, making it the world’s largest consumer of energy and oil imports. Of U.S. foreign oil imports, [one out of five barrels](http://thinkprogress.org/climate/2011/06/14/244716/military-renewables-efficiency-and-energy-security/?mobile=nc) comes from unfriendly nations and volatile areas, including [at least 20 percent](http://ac360.blogs.cnn.com/2010/04/01/fact-check-u-s-dependence-on-foreign-oil/) stemming from the Persian Gulf, including Bahrain, Iraq, Iran, Kuwait, Qatar, Saudi Arabia, and the United Arab Emirates. Further, our nation heavily relies on hot-beds of extremism, as [Saudi Arabia, Venezuela, Nigeria](http://www.globalpost.com/dispatch/100726/top-7-us-oil-importers) are our third, fourth, and fifth, respectively, largest exporters of oil. How dangerous is this? Very! Not only does America’s huge appetite for oil entangle us into complicated relationships with nations marred by unstable political, economic, and security situations, it also gravely impacts our military, who risk their lives daily to protect foreign energy supply routes. Because of our addiction to oil, we have been in almost constant military conflict, lost more than 6,500 soldiers and created a whole new class of wounded warriors, thousands of whom will need long-term care funded by our government. [One in eight soldiers](http://money.cnn.com/technology/storysupplement/cost_military_oil_addiction/?iid=EL) killed or wounded in Iraq from 2003-2007 were protecting fuel convoys, with a total of 3,000 Army casualties alone. We maintain extra military forces at an annual cost of about $150 billion annually, just to assure access to foreign oil - because we know that if that stream of 9 million barrels per day is seriously interrupted, our economy will crash. That's what I call dangerously dependent.

## Warming

#### **Private interest exists in establishing a national fueling infrastructure; however, lack of government support has deterred investment in a fueling infrastructure**

LeVine 12

[Giving Hydrogen Fuel-Cell Cars Another Chance By Steve LeVine, New America Foundation /KG

May 17, 2012 | Slate http://newamerica.net/node/67661]

When the first cars come out, they will cost more than electrics, whose price tag is currently substantially greater than gasoline-fueled engines. To help give consumers the confidence to take the hydrogen plunge, there will have to be a coordinated rollout of refueling stations, said Charles Freese, who runs the Detroit-based fuel-cell unit for General Motors. That is where public policy comes in: Government, fuel providers, infrastructure contractors, and the carmakers will have to work together to get the stations up and running. The cost of operating each station drops with every car it services. But there’s a “chicken or the egg dilemma," he says. "You need to have a number of stations in place so the customers have easy access to the fuel and have to have a minimum number of vehicles that start to deploy in [the] same time window so [you] can keep the throughput of fuel up at the station." Fuel-cell vehicles will start out not with mass deployment, but in targeted regions—especially islands. The first places in the United States will be Los Angeles and Hawaii, Freese thinks—Los Angeles because there are high population concentrations that can be served by just 50 or 55 refueling stations; Hawaii because driving patterns are predictable: along set coastal routes and around self-contained islands, so drivers can’t go too far afield and find themselves stranded without fuel. GM and the U.S. Army launched a test fleet of 16 hydrogen fuel-cell cars in Hawaii earlier this year. In California, the state government is already behind the allocation of funds for building hydrogen fueling stations. Twenty-six are either in place or funded. An industry-government collaboration called the California Fuel Cell Partnership has established equipment standards and permitting processes, and organized the training of emergency personnel in the case of an accident. In Hawaii, GM is teamed up with 13 companies, government agencies and university bodies in order to organize the rollout of infrastructure there. Private supporters of fuel cells appear to be hedging their own bets. After the Obama administration withdrew support, companies pulled back their initial efforts in some markets. Hofmeister noted that Shell has closed hydrogen refueling stations it established during the Bush era in New York, Washington, D.C., and elsewhere. But companies have also built up investment in what they regard as more promising areas—particularly those countries offering government funding. Shell, for instance, has added investment in Germany and Japan, which have poured hundreds of millions of dollars in public funds into the construction of hydrogen fuel cell infrastructure. "Government," said Hofmeister, "has to be in there in being the fixer, the solution, and not the obstacle, and maybe that will be happening."

#### A DOD energy transition is key to catalyze an energy transition in the private sector

Pew Environment Group 11

[Pew Environment Group, “From Barracks to the Battlefield: Clean Energy Innovation and America’s Armed Forces,” September 21 2011, <http://www.pewenvironment.org/uploadedFiles/PEG/Publications/Report/DoD-Report_FINAL.pdf>, accessed on 7/14/12, Kfo]

In view of the new risks and challenges that have been identified over the past decade, DoD is moving aggressively to harness new energy technologies that can reduce fuel demand and enhance long-term energy security. In all these efforts, military needs are closely aligned with national imperatives and interests. Dependence on foreign oil is a concern of the military and civilian sectors alike. Power outages, which threaten the continuity of military operations, are of equal concern to America’s commercial interests and homeowners. Rising energy costs are a major factor for household budgets as well as military financial planning. Inefficient legacy infrastructure is as much of a challenge across the country as it is across DoD’s facilities. Further, both sectors are concerned about the environmental impact of current energy options. DoD’s History of Technology Innovation While the department is focused appropriately on its priority mission of protecting the American people, it has demonstrated that it can also help advance America’s technology development and commercial interests. The scale of its operations, its continuous need for improved technologies and its capacity for technology development and deployment have played a key role in a wide and important range of recent innovations such as semiconductors, computers, the GPS and the Internet. In all of these efforts, DoD helped new technologies reach commercial maturity. As illustrated in Figure 4 and documented by David Mowery of the Haas School of Business at the University of California, Berkeley, “the military applications of semiconductors and computers meant that defense-related research and development funding and procurement were important to their early development. The R&D infrastructure created in U.S. universities by defense-related and other federal R&D expenditures contributed to technical developments in semiconductors, computer hardware, and computer software, in addition to training a large cadre of scientists and engineers.”53 In its pursuit of advanced technologies such as semiconductors, the basis of modern electronics including transistors, computers and telephones, DoD aligned its considerable research and development capabilities with the expertise of other federal agencies and the dynamism of the private sector. In doing so, the department reflected an understanding of the links between economic and military security. A vibrant, innovative American economy is crucial to a strong, technologically superior U.S. defense posture. Encouragingly, DoDs energy innovation efforts are taking a similar approach. The inaugural Operational Energy Strategy, released in June 2011, notes that “the department has an interest in long-term national security and should take steps to work with other federal agencies and the private sector to diversify and secure fuel supplies.”54 The 2010 Quadrennial Defense Review (QDR) notes that the department’s Environmental Security and Technology Certification Program is actively engaged in using “military installations as a test bed to demonstrate and create a market for innovative energy efficiency and renewable energy technologies coming out of the private sector and DoD and Department of Energy laboratories.”55 In fact, the department has created a far-reaching memorandum of understanding (MOU) with the Department of Energy (DoE) to help accelerate the energy innovation process in service of the nation’s energy and national security goals. DoD and DoE are working cooperatively on advanced batteries, energy efficiency, microgrids and “smart” technology.56 Similarly, DoD has initiated an MOU with the Department of Agriculture to help accelerate development of advanced biofuels that can be produced in the United States at cost-competitive prices and without negatively affecting food producton. DoD is also working cooperatively with the private sector by engaging scientists and corporations, as well as the defense industrial base. While the department is depending in large part on the private sector to provide energy technologies, it is actively engaged in preparing its infrastructure and vehicles to accept new products. DoD’s Technology Innovation Assets Whether on fixed installations or on the battlefield, DoD brings a variety of strengths to the major stages of energy innovation: research and development, proof of concept, pilot testing, diffusion, and commercial maturity.In all of these efforts, the department brings a broad range of expertise and institutional capacity to bear, including: An Established R&D System—DoD has a mature research and development system, giving the department an understanding and structure for managing far-reaching technology development processes, from research to procurement. For example, the Defense Advanced Research Products Agency (DARPA) has a 50-year tradition of accelerating technology development, and DoD’s military construction and logistics capabilities are world renowned. DoD research and development spending, mostly on weapons and platforms, has averaged more than $80 billion annually over the past decade.57 The department also has longestablished relationships with the defense industrial base, which can aid the technology development process. Scale—DoD conducts operations across the United States and around the world, in all regions, climates and geographic settings, making it an apt proving ground for new technologies and applications. The various branches of the military also bring a wide range of expertise

**Establishing a fueling infrastructure will make Hydrogen Fuel cells economically competitive in the auto industry – it’s the key sector**

**Burns 12**

[Stuart Burns, Bachelor of Science degree from Kingston University and “Metal Miner” expert author, February 23, 2012, <http://oilprice.com/Alternative-Energy/Fuel-Cells/Hydrogen-Fuel-Cells-Not-Long-to-Wait-Now.html>, accessed on 7/5/12, Kfo]

Fuel cells are one of those technologies we have covered before, usually citing some manufacturer who is fan-faring a new technology purported to be game-changing for the cost structure of the hydrogen fuel cell market. So far, fuel cells are used predominantly in specialist applications such as submarines and space vehicles, or in remote areas where power requirements are low yet refuelling is expensive or difficult — or both. **The breakthrough application would be an economically viable application in automobiles**, but according to the [FT](http://www.ft.com/cms/s/0/0b9aafc2-4123-11e1-b521-00144feab49a.html#axzz1mvOvBWl3), **carmakers have sunk large amounts of money into hydrogen research programs with little to show for it so far, in terms of cars on the road.** **General Motors says** **it has** invested $2 billion in the technology to date. But **although** it says it has a test fleet of 100 fuel-cell **vehicles** on the road in Europe and the US, **which will be ready for market introduction by 2016**, **there is not a viable business model for providing a refuelling infrastructure** or firm details of what models will be powered by fuel cells. The reality is as attractive as zero-carbon-emission vehicles are: **if** the vehicles are prohibitively expensive in the first place and **there is not a robust, widespread refuelling infrastructure in place, the public will not buy**. Just witness sales of all electric vehicles — barely 1,000 plug-in vehicles were registered in Britain last year out of a market for some 2 million cars. So the British government’s launch of two initiatives (backed, it must be said, by hard cash) sounds like something of a leap of faith if it wasn’t for the parties involved and some interesting technological developments. The first is a bringing-together of industry firms, including Air Liquide, Johnson Matthey, Daimler, GM, Shell, Total and others in a program called H2 Mobility, as part of a US and European-wide drive to map out the steps necessary to make the technology commercially viable by 2015. In itself this could be yet another taxpayer-funded talking shop, but **one hopes the presence of the oil companies may ensure that any resulting road map has sufficient critical thinking into the refuelling infrastructure, which is seen as a make-or-break issue in widespread adoption**. Oil firms cannot be said to have embraced the re-charging requirements of electric cars to date, probably because the technology still requires lengthy re-charging times incompatible with current gasoline forecourt layouts or power supply options. The second initiative follows on neatly from this issue: **the UK government is backing two firms in a joint effort to develop self-contained hydrogen refuelling stations that could be introduced to just about any contemporary gas station, along with a liquid catalyst fuel cell that would bring down the up-front cost of the fuel cell, so that jointly, the power cost would drop to $37 per kW generated, making it competitive with conventional engines**, say backers of the project, the Carbon Trust.

**Only a transition to hydrogen fuel cells can eliminate petroleum use**

**Greene et al 8**

[David Greene, Expert at Oak Ridge National Laboratory, March 2008, <http://cta.ornl.gov/cta/Publications/Reports/ORNL_TM_2008_30.pdf>, accessed on 7/6/12, Kfo]

The scenarios also show that **hydrogen powered light-duty vehicles can dramatically reduce petroleum use and significantly decreases overall energy use** by light-duty vehicles. By 2050, in Scenario 3, **petroleum use by lightduty vehicles would be reduced to less than 30 billion gallons per year (a savings of 15 million barrels per day), on its way towards zero** (see Figure 26). **Without a successful move to hydrogen fuel cell vehicles, gasoline consumption would be held fairly steady** in the 2030-2050 timeframe, **at about 140 billion gallons of gasoline a year, due to the higher efficiency of hybrid-electric vehicles** (Greene and Leiby, 2007).5

#### Transitioning away from fossil fuels is key to reduce emissions and solve warming – the status quo is insufficient

**Moomaw 11**

William Moomwaw, Professor of International Environmental Policy at the Fletcher School of Law and Diplomacy, Tufts University, 2011, “IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation”, IPCC Chapter 1 , <http://srren.ipcc-wg3.de/report/IPCC_SRREN_Ch01.pdf>, accessed on 7/8/12, Kfo]

All societies require energy services to meet basic human needs (e.g., lighting, cooking, space comfort, mobility, communication) and to serve productive processes. For development to be sustainable, delivery of energy services needs to be secure and have low environmental impacts. Sustainable social and economic development requires assured and affordable access to the energy resources necessary to provide essential and sustainable energy services. This may mean the application of different strategies at different stages of economic development. **To be environmentally benign, energy services must be provided with low environmental impacts and low greenhouse gas (GHG) emissions**. However, **85% of current primary energy driving global economies comes from the combustion of fossil fuels and consumption of fossil fuels accounts for 56.6% of all anthropogenic GHG emissions**. Re**newable energy sources play a role in providing energy services in a sustainable manner and**, in particular**, in mitigating climate change**. This Special Report on Renewable Energy Sources and Climate Change Mitigation explores the current contribution and potential of renewable energy (RE) sources to provide energy services for a sustainable social and economic development path. It includes assessments of available RE resources and technologies, costs and co-benefi ts, barriers to up-scaling and integration requirements, future scenarios and policy options. **GHG emissions associated with the provision of energy services are a major cause of climate change**. The IPCC Fourth Assessment Report (AR4) concluded that “**Most of the observed increase in global average temperature since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations**.” **Concentrations of CO2 have continued to grow and by the end of 2010 had reached 390 ppm CO2 or 39% above preindustrial levels**. The long-term baseline scenarios reviewed for the AR4 show that **the expected decrease in the energy intensity will not be able to compensate for the effects of the projected increase in the [GDP] global gross domestic product**. As a result, **most of the scenarios exhibit a strong increase in primary energy supply throughout this century**. **In the absence of any climate policy, the overwhelming majority of the baseline scenarios exhibit considerably higher emissions in 2100 compared to 2000, implying rising CO2 concentrations and, in turn, enhanced global warming**. Depending on the underlying socioeconomic scenarios and taking into account additional uncertainties, **global mean temperature is expected to rise and to approach** a level between 1.1°C and **6.4°C over the 1980 to 1999 average** **by the end of this century.** To avoid adverse impacts of such climate change on water resources, ecosystems, food security, human health and coastal settlements with potentially irreversible abrupt changes in the climate system, the Cancun Agreements call for limiting global average temperature rises to no more than 2°C above preindustrial values, and agreed to consider limiting this rise to 1.5°C. In order to be confi dent of achieving an equilibrium temperature increase of only 2°C to 2.4°C, **GHG concentrations would need to be stabilized in the range of 445 to 490 ppm CO2eq in the atmosphere.**

**Warming’s anthropogenic and accelerating**

**Rahmstorf 8** (Richard, Professor of Physics of the Oceans – Potsdam University, “Anthopogenic Climate Change?”, Global Warming: Looking Beyond Kyoto, Ed. Zedillo, p. 42-49)

It is time to turn to statement B: human activities are altering the climate. This can be broken into two parts. The first is as follows: global climate is warming. This is by now a generally undisputed point (except by novelist Michael Crichton), so we deal with it only briefly. The two **leading compilations of data measured with thermometers** are shown in figure 3-3, that of the National Aeronautics and Space Administration (NASA) and that of the British Hadley Centre for Climate Change. Although they differ in the details, due to the inclusion of different data sets and use of different spatial averaging and quality control procedures, they both show a consistent picture, with a global mean warming of 0.8°C since the late nineteenth century. Temperatures over the past ten years clearly were the warmest since measured records have been available. The year 1998 sticks out well above the longterm trend due to the occurrence of a major El Nino event that year (the last El Nino so far and one of the strongest on record). These events are examples of the largest natural climate variations on multiyear time scales and, by releasing heat from the ocean, generally cause positive anomalies in global mean temperature. It is remarkable that the year 2005 rivaled the heat of 1998 even though no El Nino event occurred that year. (A bizarre curiosity, perhaps worth mentioning, is that several prominent "climate skeptics" recently used the extreme year 1998 to claim in the media that global warming had ended. In Lindzen's words, "Indeed, the absence of any record breakers during the past seven years is statistical evidence that temperatures are not increasing.")33 In addition to the surface measurements, the more recent portion of the global warming trend (since 1979) is also documented by satellite data. It is not straightforward to derive a reliable surface temperature trend from satellites, as they measure radiation coming from throughout the atmosphere (not just near the surface), including the stratosphere, which has strongly cooled, and the records are not homogeneous' due to the short life span of individual satellites, the problem of orbital decay, observations at different times of day, and drifts in instrument calibration.' Current analyses of these satellite data show trends that are fully consistent with surface measurements and model simulations." If no reliable temperature measurements existed, could we be sure that the climate is warming? The "canaries in the coal mine" of climate change (as glaciologist Lonnie Thompson puts it) ~are mountain glaciers. We know, both from old photographs and from the position of the terminal moraines heaped up by the flowing ice, that mountain glaciers have been in retreat all over the world during the past century. There are precious few exceptions, and they are associated with a strong increase in precipitation or local cooling.36 I have inspected examples of shrinking glaciers myself in field trips to Switzerland, Norway, and New Zealand. As glaciers respond sensitively to temperature changes, data on the extent of glaciers have been used to reconstruct a history of Northern Hemisphere temperature over the past four centuries (see figure 3-4). Cores drilled in tropical glaciers show signs of recent melting that is unprecedented at least throughout the Holocene-the past 10,000 years. Another powerful sign of warming, visible clearly from satellites, is the shrinking Arctic sea ice cover (figure 3-5), which has declined 20 percent since satellite observations began in 1979. While climate clearly became warmer in the twentieth century, much discussion particularly in the popular media has focused on the question of how "unusual" this warming is in a longer-term context. While this is an interesting question, it has often been mixed incorrectly with the question of causation. Scientifically, how unusual recent warming is-say, compared to the past millennium-in itself contains little information about its cause. Even a highly unusual warming could have a natural cause (for example, an exceptional increase in solar activity). And even a warming within the bounds of past natural variations could have a predominantly anthropogenic cause. I come to the question of causation shortly, after briefly visiting the evidence for past natural climate variations. Records from the time before systematic temperature measurements were collected are based on "proxy data," coming from tree rings, ice cores, corals, and other sources. These proxy data are generally linked to local temperatures in some way, but they may be influenced by other parameters as well (for example, precipitation), they may have a seasonal bias (for example, the growth season for tree rings), and high-quality long records are difficult to obtain and therefore few in number and geographic coverage. Therefore, there is still substantial uncertainty in the evolution of past global or hemispheric temperatures. (Comparing only local or regional temperature; as in Europe, is of limited value for our purposes,' as regional variations can be much larger than global ones and can have many regional causes, unrelated to global-scale forcing and climate change.) The first quantitative reconstruction for the Northern Hemisphere temperature of the past millennium, including an error estimation, was presented by Mann, Bradley, and Hughes and rightly highlighted in the 2001 IPCC report as one of the major new findings since its 1995 report; it is shown in figure 3\_6.39 The analysis suggests that, despite the large error bars, twentieth-century warming is indeed highly unusual and probably was unprecedented during the past millennium. This result, presumably because of its symbolic power, has attracted much criticism, to some extent in scientific journals, but even more so in the popular media. The hockey stick-shaped curve became a symbol for the IPCC, .and criticizing this particular data analysis became an avenue for some to question the credibility of the IPCC. Three important things have been overlooked in much of the media coverage. First, even if the scientific critics had been right, this would not have called into question the very cautious conclusion drawn by the IPCC from the reconstruction by Mann, Bradley, and Hughes: "New analyses of proxy data for the Northern Hemisphere indicate that the increase in temperature in the twentieth century is likely to have been the largest of any century during the past 1,000 years." This conclusion has since been supported further by every single one of close to a dozen new reconstructions (two of which are shown in figure 3-6). Second, by far the most serious scientific criticism raised against Mann, Hughes, and Bradley was simply based on a mistake. 40 The prominent paper of von Storch and others, which claimed (based on a model test) that the method of Mann, Bradley, and Hughes systematically underestimated variability, "was [itself] based on incorrect implementation of the reconstruction procedure."41 With correct implementation, climate field reconstruction procedures such as the one used by Mann, Bradley, and Hughes have been shown to perform well in similar model tests. Third, whether their reconstruction is accurate or not has no bearing on policy. If their analysis underestimated past natural climate variability, this would certainly not argue for a smaller climate sensitivity and thus a lesser concern about the consequences of our emissions. Some have argued that, in contrast, it would point to a larger climate sensitivity. While this is a valid point in principle, it does not apply in practice to the climate sensitivity estimates discussed herein or to the range given by IPCC, since these did not use the reconstruction of Mann, Hughes, and Bradley or any other proxy records of the past millennium. Media claims that "a pillar of the Kyoto Protocol" had been called into question were therefore misinformed. As an aside, the protocol was agreed in 1997, before the reconstruction in question even existed. The overheated public debate on this topic has, at least, helped to attract more researchers and funding to this area of paleoclimatology; its methodology has advanced significantly, and a number of new reconstructions have been presented in recent years. While the science has moved forward, the first seminal reconstruction by Mann, Hughes, and Bradley has held up remarkably well, with its main features reproduced by more recent work. Further progress probably will require substantial amounts of new proxy data, rather than further refinement of the statistical techniques pioneered by Mann, Hughes, and Bradley. Developing these data sets will require time and substantial effort. It is time to address the final statement: most of the observed warming over the past fifty years is anthropogenic. A large number of studies exist that have taken different approaches to analyze this issue, which is generally called the "attribution problem." I do not discuss the exact share of the anthropogenic contribution (although this is an interesting question). By "most" I imply mean "more than 50 percent.” The first and crucial piece of evidence is, of course, that the magnitude of the warming is what is expected from the anthropogenic perturbation of the radiation balance, so anthropogenic forcing is able to explain all of the temperature rise. As discussed here, the rise in greenhouse gases alone corresponds to 2.6 W/tn2 of forcing. This by itself, after subtraction of the observed 0'.6 W/m2 of ocean heat uptake, would Cause 1.6°C of warming since preindustrial times for medium climate sensitivity (3"C). With a current "best guess'; aerosol forcing of 1 W/m2, the expected warming is O.8°c. The point here is not that it is possible to obtain the 'exact observed number-this is fortuitous because the amount of aerosol' forcing is still very' uncertain-but that the expected magnitude is roughly right. There can be little doubt that the anthropogenic forcing is large enough to explain most of the warming. Depending on aerosol forcing and climate sensitivity, it could explain a large fraction of the warming, or all of it, or even more warming than has been observed (leaving room for natural processes to counteract some of the warming). The second important piece of evidence is clear: there is no viable alternative explanation. In the scientific literature, no serious alternative hypothesis has been proposed to explain the observed global warming. Other possible causes, such as solar activity, volcanic activity, cosmic rays, or orbital cycles, are well observed, but they do not show trends capable of explaining the observed warming. Since 1978, solar irradiance has been measured directly from satellites and shows the well-known eleven-year solar cycle, but no trend. There are various estimates of solar variability before this time, based on sunspot numbers, solar cycle length, the geomagnetic AA index, neutron monitor data, and, carbon-14 data. These indicate that solar activity probably increased somewhat up to 1940. While there is disagreement about the variation in previous centuries, different authors agree that solar activity did not significantly increase during the last sixty-five years. Therefore, this cannot explain the warming, and neither can any of the other factors mentioned. Models driven by natural factors only, leaving the anthropogenic forcing aside, show a cooling in the second half of the twentieth century (for an example, See figure 2-2, panel a, in chapter 2 of this volume). The trend in the sum of natural forcings is downward. The only way out would be either some as yet undiscovered unknown forcing or a warming trend that arises by chance from an unforced internal variability in the climate system. The latter cannot be completely ruled out, but has to be considered highly unlikely. No evidence in the observed record, proxy data, or current models **suggest that** such internal variability could cause a sustained trend of global warming of the observed magnitude. As discussed, twentieth century warming is unprecedented over the past 1,000 years (or even 2,000 years, as the few longer reconstructions available now suggest), which does not 'support the idea of large internal fluctuations. Also, those past variations correlate well with past forcing (solar variability, volcanic activity) and thus appear to be largely forced rather than due to unforced internal variability." And indeed, it would be difficult for a large and sustained unforced variability to satisfy the fundamental physical law of energy conservation. Natural internal variability generally shifts heat around different parts of the climate system-for example, the large El Nino event of 1998, which warmed, the atmosphere by releasing heat stored in the ocean. This mechanism implies that the ocean heat content drops as the atmosphere warms. For past decades, as discussed, we observed the atmosphere warming and the ocean heat content increasing, which rules out heat release from the ocean as a cause of surface warming. The heat content of the whole climate system is increasing, and there is no plausible source of this heat other than the heat trapped by greenhouse gases. ' A completely different approach to attribution is to analyze the spatial patterns of climate change. This is done in so-called fingerprint studies, which associate particular patterns or "fingerprints" with different forcings. It is plausible that the pattern of a solar-forced climate change differs from the pattern of a change caused by greenhouse gases. For example, a characteristic of greenhouse gases is that heat is trapped closer to the Earth's surface and that, unlike solar variability, greenhouse gases tend to warm more in winter, and at night. Such studies have used different data sets and have been performed by different groups of researchers with different statistical methods. They consistently conclude that the observed spatial pattern of warming can only be explained by greenhouse gases.49 Overall, it has to be considered, highly likely' that the observed warming is indeed predominantly due to the human-caused increase in greenhouse gases. ' This paper discussed the evidence for the anthropogenic increase in atmospheric CO2 concentration and the effect of CO2 on climate, finding that this anthropogenic increase is proven beyond reasonable doubt and that a mass of evidence points to a CO2 effect on climate of 3C ± 1.59C global-warming for a doubling of concentration. (This is, the classic IPCC range; my personal assessment is that, in-the light of new studies since the IPCC Third Assessment Report, the uncertainty range can now be narrowed somewhat to 3°C ± 1.0C) This is based on consistent results from theory, models, and data analysis, and, even in the absence-of any computer models, the same result would still hold based on physics and on data from climate history alone. Considering the plethora of consistent evidence, the chance that these conclusions are wrong has to be considered minute. If the preceding is accepted, then it follows logically and incontrovertibly that a further increase in CO2 concentration will lead to further warming. The magnitude of our emissions depends on human behavior, but the climatic response to various emissions scenarios can be computed from the information presented here. The result is the famous range of future global temperature scenarios shown in figure 3\_6.50 Two additional steps are involved in these computations: the consideration of anthropogenic forcings other than CO2 (for example, other greenhouse gases and aerosols) and the computation of concentrations from the emissions. Other gases are not discussed here, although they are important to get quantitatively accurate results. CO2 is the largest and most important forcing. Concerning concentrations, the scenarios shown basically assume that ocean and biosphere take up a similar share of our emitted CO2 as in the past. This could turn out to be an optimistic assumption; some models indicate the possibility of a positive feedback, with the biosphere turning into a carbon source rather than a sink under growing climatic stress. It is clear that even in the more optimistic of the shown (non-mitigation) scenarios, global temperature would rise by 2-3°C above its preindustrial level by the end of this century. Even for a paleoclimatologist like myself, this is an extraordinarily high temperature, which is very likely unprecedented in at least the past 100,000 years. As far as the data show, we would have to go back about 3 million years, to the Pliocene, for comparable temperatures. The rate of this warming (which is important for the ability of ecosystems to cope) is also highly unusual and unprecedented probably for an even longer time. The last major global warming trend occurred when the last great Ice Age ended between 15,000 and 10,000 years ago: this was a warming of about 5°C over 5,000 years, that is, a rate of only 0.1 °C per century. 52 The expected magnitude and rate of planetary warming is highly likely to come with major risk and impacts in terms of sea level rise (Pliocene sea level was 25-35 meters higher than now due to smaller Greenland and Antarctic ice sheets), extreme events (for example, hurricane activity is expected to increase in a warmer climate), and ecosystem loss. The second part of this paper examined the evidence for the current warming of the planet and discussed what is known about its causes. This part showed that global warming is already a measured and-well-established fact, not a theory. Many different lines of evidence consistently show that most of the observed warming of the past fifty years was caused by human activity. Above all, this warming is exactly what would be expected given the anthropogenic rise in greenhouse gases, and no viable alternative explanation for this warming has been proposed in the scientific literature. Taken together., the very strong evidence accumulated from thousands of independent studies, has over the past decades convinced virtually every climatologist around the **world (many of whom were initially quite skeptical**, including myself) that anthropogenic global warming is a reality with which we need to deal.

**Extinction**

**Cummins 10** (Ronnie, International Director – Organic Consumers Association and Will Allen, Advisor – Organic Consumers Association, “Climate Catastrophe: Surviving the 21st Century”, 2-14, http://www.commondreams.org/view/2010/02/14-6)

The hour is late. Leading climate scientists such as James Hansen are literally shouting at the top of their lungs that **the world needs to reduce emissions** by 20-40% as soon as possible, and 80-90% by the year 2050, if we **are to avoid climate chaos, crop failures, endless wars, melting of** the **polar icecaps, and a disastrous rise in ocean levels**. **Either we** radically **reduce CO2** and carbon dioxide equivalent (CO2e, which includes all GHGs, not just CO2) pollutants (currently at 390 parts per million and rising 2 ppm per year) to 350 ppm, including agriculture-derived methane and nitrous oxide pollution, **or** else **survival** for the present and future generations **is in jeopardy**. As scientists warned at Copenhagen, business as usual and a corresponding 7-8.6 degree Fahrenheit rise in global temperatures means that the carrying capacity of the Earth in 2100 will be reduced to one billion people. Under this hellish scenario, **billions will die of thirst, cold, heat, disease, war, and starvation. If the U.S.** significantly **reduces** greenhouse gas **emissions, other countries will follow**. One hopeful sign is the recent EPA announcement that it intends to regulate greenhouse gases as pollutants under the Clean Air Act. Unfortunately we are going to have to put tremendous pressure on elected public officials to force the EPA to crack down on GHG polluters (including industrial farms and food processors). Public pressure is especially critical since "just say no" Congressmen-both Democrats and Republicans-along with agribusiness, real estate developers, the construction industry, and the fossil fuel lobby appear determined to maintain "business as usual."

## Air Power

#### Contention three is Air Power

#### Adversaries are catching up to US air power – they are utilizing asymmetric advantages

Bartels 9

[Clay Bartels, April 2009, Major, USAF, “How The USAF Can Lose The Next War Losing Air Superiority,” <http://www.dtic.mil/dtic/tr/fulltext/u2/a540193.pdf>, accessed on 7/14/12, Kfo]

The current direction of our defense posture is setting the United States along a path that could lead to defeat in a future conflict. Airpower has been the asymmetric advantage of the U.S. military since Operation Desert Storm. In particular, no western-led joint or coalition operation in the future would even begin to get off the ground without air superiority. Joint publications, military doctrine, and American thought are all based on the fundamental premise that we will have air superiority. Future planning at this very instant assumes this as a fact. Unfortunately, this may not be the case in the future. No American solider has been attacked by enemy aircraft since 1953. Only a concerted, conscious effort over the years made this protection possible. It is easy to assume air superiority, but potential outcomes without it can yield potentially dire results. While the U.S. has shifted focus towards fighting the Global War on Terror, potential enemies have adapted. Iran, China, and Russia have had the advantage of observing our operations and gathering intelligence from Operation Allied Force in the former Yugoslavia to current actions in Iraq and Afghanistan. They clearly recognize the importance of American airpower and the fact that we count on it as our decisive force multiplier. With this viewpoint, they have been working to counter this threat for over a decade. Meanwhile, the USAF and the DOD have deemphasized air superiority. They have not replaced the F-4G, EF-111, F-117, or F15C. In some cases, the capability these aircraft brought to the fight simply no longer exists. In others, the Air Force does not possess aircraft in enough numbers to yield the desired effect. Comprehensively, very little has been achieved in the last 20 years to guarantee air superiority. The only exception is the F-22 Raptor, which currently has a contract for only 183 aircraft. Meanwhile, the adaptations of our foes have resulted in capabilities that can match or counter what the U.S. has right now. Advanced SAMs such as S-300 and S-400 (NATO SA-10 and SA-20) can effectively deny access to the battle space to our Non-LO (Low Observable) platforms. The Russian Flanker variants such as the SU-30 and SU-35, the French Rafale, and others are equal to or exceed the capabilities of all our fighter aircraft except the F-22. Though it is not likely we will fight a war against any country with these assets in the immediate future, you go to war with the Air Force you have. In the United States, the acquisition cycle requires well over ten years of lead-time. Thus, the U.S. needs to be following a line of procurement and focus that is thinking 20 years in the future. American history is rife with supporting countries that later turned into to adversaries such as Iraq, Iran and others. Furthermore, it is extraordinarily difficult to predict geopolitics in general and determine who could become potential adversaries. From a realist, self-preservationist perspective, the United States must maintain the ability to defeat any future competitor. To analyze this situation, this paper begins with defining air superiority and its importance and how the USAF has historically viewed the mission. Next, the level of unprecedented advantage by the U.S. in the 1990s is examined, as well as how potential enemies have countered this advantage. The trend in the USAF is next, which compared to the existing and future threat shows the potential capabilities gap. Lastly, the impact of losing air superiority in potential future encounters is analyzed demonstrating the value of controlling the air. The current trajectory could end with the U.S. military in the position of being unable to accomplish national strategic objectives. The USAF in particular has a checkered history of discounting air superiority. Strategic Air Command’s (SAC) dominance over Tactical Air Command (TAC) after World War II and the predictable results in Korea and Vietnam are the most striking examples. Several compromise solutions exist concerning the F-22, but many of them are invalid upon closer examination. The problem, however, ranges well beyond any particular airframe. The USAF needs to refocus on air superiority because it is the center of the true identity of the independent Air Force. If you cannot provide air superiority, what is the purpose of having an Air Force at all?

operations.21

#### Hydrogen fuel allows for a variety of key combat technologies that are key to maintain air superiority and can overcome asymmetry

Reiman 9

[Adam Reiman, BS, MBA Major, USAF, June 2009, <http://www.dtic.mil/dtic/tr/fulltext/u2/a505106.pdf>, accessed on 7/14/12, Kfo]

The use of a cryogenic fuel source opens up a wide array of military applications. The cryogen enables superconducting applications. Superconductors can be used in antenna filters to improve the signal to noise ratio. This would enable superior data link performance against an adversary. With information superiority becoming more decisive in future combat, this capability enhancement could prove important. In addition to improved information exchange and increased electrical generating efficiency, superconductors have energy storage and electronic component advantages. There are superconducting magnetic energy storage devices that could increase power output for takeoff or enable large energy bursts for a solid state laser or a rail gun. From a short field takeoff perspective, this could provide added capability. The weight of these energy storage devices is currently problematic for aerospace applications. Electronic components such as fault limiters and transformers can have increased power capacity and improved response times. This allows for smaller components or added capability. Processing power will be critical for advanced military aerospace applications. Superconducting microchips can achieve an order of magnitude improvement over current designs. In addition to improved processing power, intelligence gathering capabilities will be enhanced by superconducting applications. Superconducting Quantum Interference Devices (SQUIDs) have the capability to detect mines and submarines. Superconducting X-ray and light detectors have demonstrated amazing sensitivity. The enhanced resolution could enable improved analysis. Another asset to intelligence gathering is advanced superconducting radar applications. Superconducting radars offer an order of magnitude improvement over current radars (Ryan, 1997). Throughout the electromagnetic spectrum, superconductors enable information collection superiority. The combination of improved processing with more advanced data gathering could enable advanced onboard intelligence analysis. At the heart of the advanced military applications, is the concept of superconducting motors. With infrared missiles being of primary concern to military aircraft, superconducting motors could eliminate the heat plume from the back of the aircraft engine. In addition, superconducting motors have a vastly reduced noise signature. A silent motor with no heat signature could reduce the enemy capability to target and destroy a superconducting motor aircraft. The cryogenic fuel can also be used to hide any other heat sources that an infrared missile might lock on to. The SOFC concept discussed before could be used to enable silent motor operation. Without the SOFC concept, noise reduction of 75% of JP-8 turbine levels is possible with a hydrogen turbine (Guynn, 2002). 61 In addition to capability enhancing superconducting applications, there are offensive weapon superconducting applications. Electro-Magnetic Pulse (EMP) weaponry is possible with superconductors. An EMP pulse could disable an enemy’s electronic equipment. The use of such a weapon would require EMP hardening or removal of all coalition equipment within the effective radius of the blast. An alternative to the EMP is the use of superconductors in rail gun applications. The Superconducting Augmented Rail Gun (SARG) can increase launch velocities by 50% and double the efficiency of non superconducting rail guns (Homan, 1986). Magnetic levitation technology might also be used in the distant future to enable extremely short field takeoff and landing capabilities. Currently, the use of superconductors to accelerate and decelerate an aircraft has not been thoroughly analyzed or proven feasible. Yet, one day this might become an extremely attractive solution. When the Air Force focuses on switching to scramjet technology in the distant future, liquid hydrogen will become a leading fuel candidate. Hydrogen is the only fuel capable of sustaining combustion above 7 Mach. Scramjet designs beyond this speed will require the use of hydrogen unless other technological advances enable the use of alternative fuels..

#### Air superiority deters conflicts in the South China Sea and India-Pakistan

Tellis 98

[Ashley, Ashley J., Senior Political Scientist at RAND specializing in South Asian Security, Chung Min Lee, James Mulvenon, Courtney Purrington, and Michael D. Swaine, <http://www.rand.org/pubs/monograph_reports/MR897/MR897.chap3.pdf>, accessed on 7/19/12, Kfo]

REGIONAL CONCLUSIONS AND IMPLICATIONS FOR THE UNITED STATES AIR FORCE This subsection attempts to synthesize some of the key operational implications distilled from the analyses relating to the rise of Asia and the potential for conflict in each of its constituent regions. The first key implication derived from the analysis of trends in Asia suggests that American air and space power will continue to remain critical for conventional and unconventional deterrence in Asia. This argument is justified by the fact that several subregions of the continent still harbor the potential for full-scale conventional war. This potential is most conspicuous on the Korean peninsula and, to a lesser degree, in South Asia, the Persian Gulf, and the South China Sea. In some of these areas, such as Korea and the Persian Gulf, the United States has clear treaty obligations and, therefore, has preplanned the use of air power should contingencies arise. U.S. Air Force assets could also be called upon for operations in some of these other areas. In almost all these cases, U.S. air power would be at the forefront of an American politico-military response because (a) of the vast distances on the Asian continent; (b) the diverse range of operational platforms available to the U.S. Air Force, a capability unmatched by any other country or service; (c) the possible unavailability of naval assets in close proximity, particularly in the context of surprise contingencies; and (d) the heavy payload that can be carried by U.S. Air Force platforms. These platforms can exploit speed, reach, and high operating tempos to sustain continual operations until the political objectives are secured. The entire range of warfighting capability—fighters, bombers, electronic warfare (EW), suppression of enemy air defense (SEAD), combat support platforms such as AWACS and J-STARS, and tankers—are relevant in the Asia-Pacific region, because many of the regional contingencies will involve armed operations against large, fairly modern, conventional forces, most of which are built around large land armies, as is the case in Korea, China-Taiwan, India-Pakistan, and the Persian Gulf. In addition to conventional combat, the demands of unconventional deterrence will increasingly confront the U.S. Air Force in Asia. The Korean peninsula, China, and the Indian subcontinent are already arenas of WMD proliferation. While emergent nuclear capabilities continue to receive the most public attention, chemical and biological warfare threats will progressively become future problems. The delivery systems in the region are increasing in range and diversity. China already targets the continental United States with ballistic missiles. North Korea can threaten northeast Asia with existing Scud-class theater ballistic missiles. India will acquire the capability to produce ICBM-class delivery vehicles, and both China and India will acquire long-range cruise missiles during the time frames examined in this report. The second key implication derived from the analysis of trends in Asia suggests that air and space power will function as a vital rapid reaction force in a breaking crisis. Current guidance tasks the Air Force to prepare for two major regional conflicts that could break out in the Persian Gulf and on the Korean peninsula. In other areas of Asia, however, such as the Indian subcontinent, the South China Sea, Southeast Asia, and Myanmar, the United States has no treaty obligations requiring it to commit the use of its military forces. But as past experience has shown, American policymakers have regularly displayed the disconcerting habit of discovering strategic interests in parts of the world previously neglected after conflicts have already broken out. Mindful of this trend, it would behoove U.S. Air Force planners to prudently plan for regional contingencies in nontraditional areas of interest, because naval and air power will of necessity be the primary instruments constituting the American response. Such responses would be necessitated by three general classes of contingencies. The first involves the politico-military collapse of a key regional actor, as might occur in the case of North Korea, Myanmar, Indonesia, or Pakistan. The second involves acute politicalmilitary crises that have a potential for rapid escalation, as may occur in the Taiwan Strait, the Spratlys, the Indian subcontinent, or on the Korean peninsula. The third involves cases of prolonged domestic instability that may have either spillover or contagion effects, as in China, Indonesia, Myanmar, or North Korea. In each of these cases, U.S. responses may vary from simply being a concerned onlooker to prosecuting the whole range of military operations to providing post-conflict assistance in a permissive environment. Depending on the political choices made, Air Force contributions would obviously vary. If the first response is selected, contributions would consist predominantly of vital, specialized, airbreathing platforms such as AWACS, JSTARS, and Rivet Joint—in tandem with controlled space assets—that would be necessary for assessment of political crises erupting in the region. The second response, in contrast, would burden the entire range of U.S. Air Force capabilities, in the manner witnessed in Operation Desert Storm. The third response, like the first, would call for specialized capabilities, mostly in the areas of strategic lift and airborne tanker support. The third key implication derived from the analysis of trends in Asia suggests that despite increasing regional air capabilities, U.S. Air Force assets will be required to fill gaps in critical warfighting areas. The capabilities of the Asian states, including those of U.S. allies and neutral states, have been steadily increasing in the last two decades. These increases have occurred largely through the acquisition of late-generation, advanced combat aircraft such as the MiG-29, and the F-15, F-16, and F/A-18 together with short-range infrared and medium-range semi-active air-to-air missiles. Despite such acquisitions, however, the states that possess these aircraft have not become truly effective users of air power, in part because acquiring advanced combat aircraft and their associated technologies is a small part of ensuring overall proficiency in the exploitation of air power. The latter includes incorporating effective training regimes, maintaining large and diverse logistics networks, developing an indigenous industrial infrastructure capable of supporting the variegated air assets, and integrating specific subspecialties such as air-to-air refueling, electronic warfare, suppression of enemy air defenses, airspace surveillance and battle management capabilities in a hostile environment, and night and adverse weather operations. Most of the Asian air forces lack full air-power capabilities of the sort described above. The Japanese and South Korean air forces are, as a rule, optimized mostly for air defense operations. Both air forces are generally proficient in all-weather defensive counterair operations, and they possess relatively modest day ground-attack capabilities as well. Because of their specific operating environments, however, the Japanese air force is particularly proficient in maritime air operations, whereas the South Korean air force has some close air support (CAS) experience as well. The Chinese air force (People’s Liberation Army Air Force, [PLAAF]) is still a predominantly daylight defensive counterair force with limited daylight attack capabilities, as are most of the Southeast Asian air forces, but the PLAAF has recently demonstrated an impressive ability to integrate its new weapon systems (e.g., the Su-27) much faster than most observers expected. The air forces of the Indian subcontinent have somewhat greater capabilities. Most squadrons of the Indian and Pakistani air forces are capable of daylight defensive counterair, a few are capable of all-weather defensive counterair, and several Indian units are capable of battlefield air interdiction and deep penetration-interdiction strike. None of these air forces, however, is particularly proficient at night and all-weather ground attack, especially at operational ranges. They lack advanced munitions, especially in the air-to-surface regime. With the exception of Japan and Singapore, they lack battle management command, control and communications (BMC3) platforms as well as the logistics and training levels required for successful, extended, high-tempo operations. The brittle quality of Asian air forces implies that U.S. Air Force assets will be required to fill critical gaps in allied air capabilities as well as to counter both the growing capabilities of potential adversaries such as China and the new nontraditional threats emerging in the form of ballistic and cruise missiles, information warfare, WMD, and possibly even the revolution in military affairs.

#### An Indo-Pak war would escalate and cause extinction from nuclear winter – computer models prove

GSN 10

[GSN, “Regional Nuclear War Could Devastate World Population, Report Warns,” March 16, 2010, <http://www.nti.org/gsn/article/regional-nuclear-war-could-devastate-world-population-report-warns/>, accessed on 7/19/12, Kfo]

Computer modeling suggests a nuclear exchange between India and Pakistan would block out the sun with large amounts of airborne debris, disrupting global agriculture and leading to the starvation of around 1 billion people, Scientific American reported in its January issue (see [GSN](http://www.nti.org/gsn/article/pakistani-indian-leaders-could-meet-in-washington/), March 4). The nuclear winter scenario assumes that cities and industrial zones in each nation would be hit by 50 bombs the size of the atomic bomb dropped on Hiroshima, Japan, in World War II. Although some analysts have suggested a nuclear exchange would involve fewer weapons, researchers who created the computer models contended that the panic from an initial nuclear exchange could cause a conflict to quickly escalate. Pakistan, especially, might attempt to fire all of its nuclear weapons in case India's conventional forces overtake the country's military sites, according to Peter Lavoy, an analyst with the Naval Postgraduate School. The nuclear blasts and subsequent blazes and radiation could kill more than 20 million people in India and Pakistan, according to the article. Assuming that each of the 100 bombs would burn an area equivalent to that seen at Hiroshima, U.S. researchers determined that the weapons used against Pakistan would generate 3 million metric tons of smoke and the bombs dropped on India would produce 4 million metric tons of smoke. Winds would blow the material around the world, covering the atmosphere over all continents within two weeks. The reduction in sunlight would cause temperatures to drop by 2.3 degrees Fahrenheit for several years and precipitation to drop by one-tenth. The climate changes and other environmental effects of the nuclear war would have a devastating affect on crop yields unless farmers prepared for such an occurrence in advance. The observed effects of volcano eruptions, smoke from forest fires and other events support the findings of the computer modeling, the researchers said. "A nuclear war could trigger declines in yield nearly everywhere at once, and a worldwide panic could bring the global agricultural trading system to a halt, with severe shortages in many places. Around 1 billion people worldwide who now live on marginal food supplies would be directly threatened with starvation by a nuclear war between India and Pakistan or between other regional nuclear powers," wrote Alan Robock, a climatology professor at Rutgers University in New Jersey, and Owen Brian Toon, head of the Atmospheric and Oceanic Sciences Department at the University of Colorado at Boulder. "The combination of nuclear proliferation, political instability and urban demographics may constitute one of the greatest dangers to the stability of society since the dawn of humans," they added. "Only abolition of nuclear weapons will prevent a potential nightmare. Immediate reduction of U.S. and Russian arsenals to the same levels as other nuclear powers (a few hundred) would maintain their deterrence, reduce the possibility of nuclear winter and encourage the rest of the world to continue to work toward the goal of elimination"

#### A conflict in the South China Sea escalates and goes nuclear

Waldron 97

[Arthur, professor of Strategy and Policy at the Naval War College Commentary, <http://www.aei.org/publications/pubID.7442,filter.all/pub_detail.asp>, accessed on 7/19/12, Kfo]

Then there is Southeast Asia, which, having weathered the Vietnam War and a variety of domestic insurgencies, and having moved onto the track of prosperity, shows no desire to complicate matters with political headaches. Fault lines nevertheless remain, and not least between the numerous and disproportionately successful ethnic Chinese and other inhabitants. And here again China is a looming worry. Beijing's claim of "unquestionable sovereignty" over the Spratly Islands in the South China Sea and its recent seizure of one of them, Mischief Reef, also claimed by the Philippines, have alarmed Vietnam, the Philippines, Malaysia, and Brunei, and rattled Indonesia, which asserts its right to gas fields nearby. India and South Asia, long preoccupied with their own internal rivalries and content with their rates of growth, now look with envy and some concern as East Asia opens an ever-increasing lead in economics, military power, and general global clout. Indian and Chinese forces still face each other in the high mountains of their disputed border, as they have done since their war in 1962. Pakistan to the west is a key Chinese ally, and beyond, in the Middle East, China is reportedly supplying arms to Syria, Iraq, and Ir/an. To the north, Tibet (whose government-in-exile has been based in India since 1959) is currently the object of a vicious Chinese crackdown. And a new issue between India and China is Beijing's alliance with Rangoon and its reported military or intelligence-gathering presence on offshore Burmese territories near the Indian naval base in the Andaman Islands. Finally there is Russia, which has key interests in Asia. Sidelined by domestic problems, but only temporarily, Moscow has repeatedly faced China in this century, both in the northeast and along the Mongolian border. The break-up of the Soviet Union has added a potentially volatile factor in the newly independent states of Central Asia and Chinese-controlled Xinjiang (Sinkiang), where Beijing is currently fighting a low-level counterinsurgency. An Arms Race in Asia Making these flash-points all the more volatile has been a dramatic increase in the quantity and quality of China's weapons acquisitions. An Asian arms race of sorts was already gathering steam in the post-cold-war era, driven by national rivalries and the understandable desire of newly rich nation-states to upgrade their capacities; but the Chinese build-up has intensified it. In part a payoff to the military for its role at Tiananmen Square in 1989, China's current build-up is part and parcel of the regime's major shift since that time away from domestic liberalization and international openness toward repression and irredentism. Today China buys weapons from European states and Israel, but most importantly from Russia. The latest multibillion-dollar deal includes two Sovremenny-class destroyers equipped with the much-feared SS-N-22 cruise missile, capable of defeating the Aegis anti-missile defenses of the U.S. Navy and thus sinking American aircraft carriers. This is in addition to the Su-27 fighter aircraft, quiet Kilo-class submarines, and other force-projection and deterrent technologies. In turn, the Asian states are buying or developing their own advanced aircraft, missiles, and submarines--and considering nuclear options. The sort of unintended escalation which started two world wars could arise from any of the conflicts around China's periphery. It nearly did so in March 1996, when China, in a blatant act of intimidation, fired ballistic missiles in the Taiwan Straits. It could arise from a Chinese-Vietnamese confrontation, particularly if the Vietnamese should score some unexpected military successes against the Chinese, as they did in 1979, and if the Association of Southeast Asian Nations (ASEAN), of which they are now a member, should tip in the direction of Hanoi. It could flare up from the smoldering insurgencies among Tibetans, Muslims, or Mongolians living inside China. Chains of alliance or interest, perhaps not clearly understood until the moment of crisis itself, could easily draw in neighboring states--Russia, or India, or Japan--or the United States.

#### The plan is necessary to solve – air superiority is a prerequisite to other forms of deterrence

Bartels 9

[Clay Bartels, April 2009, Major, USAF, “How The USAF Can Lose The Next War Losing Air Superiority,” <http://www.dtic.mil/dtic/tr/fulltext/u2/a540193.pdf>, accessed on 7/14/12, Kfo]

Air superiority is defined by Joint Publication 3-30 as “That degree of dominance in the air battle of one force over another that permits the conduct of operations by the former and its related land, sea, and air forces at a given time and place without prohibitive interference by the opposing force. ”Simply put, it is freedom of maneuver in the air. Generally, air superiority is not an end to itself but is the first stepping stone towards other joint operations accomplished from the air, land, and sea. American doctrine explicitly states that air superiority is a vitally important prerequisite to the employment of military power. The first official air power document published in 1943 by the U.S. Army, FM 100-20, recognized the value of air superiority when it stated that “The gaining of air superiority is the first requirement for the success of any major land operation.”2 Joint Publication 3-01 quotes Field Marshall Bernard Montgomery “if we lose the war in the air, we lose the war and lose it quickly.”3 The same Joint Pub later states “historically, air superiority has proven to be a prerequisite to success for an operation/campaign.”4 The US Army also acknowledges in FM 100-5 the importance of control of the air. It is somewhat surprising, then, that in spite of the importance clearly given air superiority in American literature how little it is being emphasized in practice. The 2006 QDR states that one of its fundamental imperatives is to “Continue to reorient the Department’s capabilities and forces to be more agile in this time of war, to prepare for wider asymmetric challenges and to hedge against uncertainty over the next 20 years.”5 The Department of Defense is trying to emphasize the need for flexibility in this document and that the American military must be able to respond across the spectrum of conflict from Irregular Warfare (IW) to full spectrum conventional conflict. Although many feel that the military should place more emphasis on current IW conflicts, the need for air superiority is clearly implied. Controlling the air enables the rest of the fight. Air Force Doctrine Document 2-1.1 clearly identifies air superiority as a core competency, and that control of the air is necessary in today’s war.6 A key part of recent US Army and Marine success has been their immunity to attack from the air. Helicopter fires and air assault tactics would be ineffective without air superiority. Defensive measures would drastically hinder their maneuverability and ability to take the offensive to exploit enemy vulnerabilities. A carrier strike group would be much less efficient if it had to be moved 200 miles farther away from the AOR due to the loss of air superiority. In order to appreciate air superiority, you must be able to visualize what the battle would look like without it. It is imperative that all members of the joint force from the President of the United States to the average platoon leader understand the value of air superiority. There is no doubt that U.S. forces must have air superiority in order to accomplish the will of American leadership. Once a central strategy is decided upon that guarantees control of the skies, leadership can move on to assigning other tasks to accomplish the mission. The respected airpower author Robert Pape recognized this when he said, “The central question in air strategy is what to attack once air superiority has been achieved.”7 General Eisenhower also understood the concept well while discussing the packed roads in Normandy with his son after D-Day when he said, “If I didn’t have air supremacy, I wouldn’t be here.”8

## Plan

#### Thus the plan: The United States Federal Government should construct a hydrogen fueling infrastructure in military bases in the United States

#### We’ll Clarify

## Solvency

#### The plan is the best starting point for a DOD energy transition – a vehicle transition is key

Parthemore 10

[Christine Parthemore, Fellow at the Center for a New American Security, September 2010, “Fueling the Future Force Preparing the Department of Defense for a Post-Petroleum Era,” <http://www.cnas.org/files/documents/publications/CNAS_Fueling%20the%20Future%20Force_NaglParthemore.pdf>, accessed on 7/11/12, Kfo]

The best way to begin DOD’s energy transition will be to begin with fast-tracked efforts at bases in the continental United States. The services are already increasing renewable power generation at their installations, and leaders at several bases have even set goals of becoming net-zero energy consumers (in other words, producing as much energy as they consume) and developing resilient microgrids. In several conversations with energy managers at U.S. bases during the course of our research, there was a tangible sense that increasing efficiency and use of renewable energy domestically contributed to the broader goal of DOD improving its long-term energy security. To date, DOD has focused heavily on generating renewable electricity at domestic installations, but it should expand this focus to include reducing petroleum use in vehicle fleets. Moving to alternative fuels in ground vehicles will be easier than displacing aviation fuels, which require an array of additional specifications. At its installations, DOD also has more alternative fueling options that those designed for use in aviation (e.g., DOD cannot fly its aircraft with electricity today, but it can adopt electric ground vehicles if they meet the guiding principles outlined above). This added flexibility allows individual bases to invest in energy sources that make sense given regional renewable energy production capabilities and infrastructure.

#### Hydrogen is the best resource – easy production, zero-emissions, low cost, high storage potential, scalability, and high efficiency

Cooper 9

[Chris Cooper, April 27, 2009, Hydrogen Fuel Cells: Research Progress and Near Term Opportunities, <http://www.dtic.mil/dtic/tr/fulltext/u2/a519966.pdf>, accessed on 7/13/12, Kfo]

INTRODUCTION The United States faces some energy challenges that if not resolved will negatively affect our security, economy, and environment. The country depends on foreign oil for transportation, and greenhouse gases and other criteria pollutant emissions need to be reduced. There is no single solution to these critical problems; rather they require a multifaceted approach. Hydrogen, together with advanced biofuels, plug-in hybrids, and other energy efficient transportation technologies, can be an important part of a more comprehensive and balanced energy portfolio. Fuel cells are central to establishing this integrated solution. This article describes some of the benefits of hydrogen and fuel cells, as well as some of the obstacles to their implementation on a large scale. In addition, this article highlights achievements and partnerships that are moving the technology out of the lab and into practical, real-world use. Hydrogen, an energy carrier, can be derived from abundant and diverse energy resources, including natural gas and coal (with carbon sequestration), nuclear energy, and renewable energy resources such as wind, solar, geothermal, and biomass (including waste biogas). Hydrogen production from renewable and nuclear sources and from coal-based systems with carbon sequestration results in near-zero greenhouse gas emissions. Natural gas-derived hydrogen offers a cost-competitive near-term option that results in lower carbon emissions than the production and consumption of gasoline or the operation of hybrid-electric vehicles. Hydrogen also offers a way to “store” energy from variable renewable resources such as wind and solar power. Fuel cells are energy conversion devices that can efficiently use hydrogen to make electricity. Water and heat are the only byproducts of using a hydrogen fuel cell. In addition to producing zero carbon dioxide and near-zero greenhouse gas emissions at the point of use, fuel cells operate quietly and can be scaled to power a variety of applications including highway vehicles, specialty vehicles (e.g., forklifts and airport baggage tugs), stationary power generation units (for backup and primary power), and portable electronic equipment and auxiliary power units. They offer more than two times the efficiency of traditional combustion technologies. For vehicles, this efficiency results in a more than 50% reduction in fuel consumption when compared to a conventional vehicle that is powered by a gasoline-fueled internal combustion engine.[1] Efficiencies for stationary applications can be even greater in combined heat and power (or co-generation) applications. The expanded use of stationary fuel cells can also help to increase the reliability of the electricity grid by reducing system loads and bottlenecks. Fuel cells are an important enabling technology for the widespread use of hydrogen, and they represent a radically different approach to energy conversion that could replace conventional power generators like internal combustion engines, turbines, and batteries.

#### Technology barriers have been overcome by recent developments

Cooper 9

[Chris Cooper, April 27, 2009, Hydrogen Fuel Cells: Research Progress and Near Term Opportunities, <http://www.dtic.mil/dtic/tr/fulltext/u2/a519966.pdf>, accessed on 7/13/12, Kfo]

PROGRESS TOWARD COMMERCIALIZATION DOE-funded research and development (R&D) has made significant progress in overcoming technical challenges to hydrogen and fuel cell technology commercialization. Accomplishments over the last six years include: • Reduction in the projected cost of distributed hydrogen production using natural gas (assuming widespread deployment) from $5.00 to $3.00 per gallon gasoline equivalent (gge)\* – a 40% reduction.[2] • Reduction in the projected cost of hydrogen production using renewable-based technologies (assuming widespread deployment) from $5.15 to $4.80 per gge (e.g., electrolysis and distributed reforming† of bio-derived liquids – ethanol, sugars).[3] • Development of technologies for the production of hydrogen from coal that will enable increased efficiency, reduced cost, and improvements in hydrogen purity. • Reduction in the projected, high-volume manufacturing cost of automotive fuel cell systems from $275/kilowatt (kW) in 2002 to $73/kW in 2008[4]‡ and improvement in the projected durability of fuel cell systems in vehicles from 950 hours in 2006 to 1900 hours in 2008.[5] (The program’s targets are $30/kW and 5000-hour durability – approximately 150,000 miles of driving – which will enable fuel cells to be competitive with current gasoline internal combustion engine systems.) • Identification of new materials that have the potential to increase hydrogen storage capacity by more than 50%,[6] and the development and demonstration of a novel “cryocompressed” tank concept. • Improvement in the efficiency and durability of fuel cells for distributed energy generation.

#### A transition away from oil preserves solves for a perception of adaptation

Parthemore 10

[Christine Parthemore, Fellow at the Center for a New American Security, September 2010, “Fueling the Future Force Preparing the Department of Defense for a Post-Petroleum Era,” <http://www.cnas.org/files/documents/publications/CNAS_Fueling%20the%20Future%20Force_NaglParthemore.pdf>, accessed on 7/11/12, Kfo]

A successful transition away from petroleum will produce financial, operational and strategic gains. Reducing dependence on petroleum will help ensure the long-term ability of the military to carry out its assigned missions — and help ensure the security of the nation. Though adopting nonpetroleum fuels will require an initial investment, it will likely be recouped in budget savings over the long term. Finally, moving beyond petroleum will allow DOD to lead in the development of innovative technologies that can benefit the nation more broadly, while signaling to the world that the United States has as innovative and adaptable force. This transition should not compromise readiness and, indeed, DOD must always put mission first. However, DOD need not choose between accomplishing its mission and minimizing the strategic risks, price fluctuations and negative environmental effects of petroleum consumption. By providing the private sector with stable market signals and incentives to invest in scaling up the fuels that meet its unique energy needs, DOD will never need to sacrifice performance or national security for energy security. Rather, reducing reliance on petroleum will only help the armed services to accomplish their missions in the years and decades to come.

#### Hydrogen is uniquely key – on-site distribution eliminates supply lines

Reiman 9

[Adam Reiman, BS, MBA Major, USAF, June 2009, <http://www.dtic.mil/dtic/tr/fulltext/u2/a505106.pdf>, accessed on 7/14/12, Kfo]

Perhaps the one advantage of hydrogen that could enable a transformation of the military is distributed generation. Hydrogen can be made anywhere there is access to fresh water and electricity. JP-8 can have an extremely long logistics chain to get the fuel to the war-fighter. If the fuel could be created near its point of final use, then the logistics chain could be extremely reduced. This would also reduce the need to protect the resource in transit. Portable electrolyzers are currently in existence, but portable hydrogen liquefaction is not. Distributed generation of liquid hydrogen would require serious advances in liquefaction technology. If achieved, distributed generation could alter military concepts of energy logistics.

#### Existing energy strategies are not sufficient

Parthemore 10

[Christine Parthemore, Fellow at the Center for a New American Security, September 2010, “Fueling the Future Force Preparing the Department of Defense for a Post-Petroleum Era,” <http://www.cnas.org/files/documents/publications/CNAS_Fueling%20the%20Future%20Force_NaglParthemore.pdf>, accessed on 7/11/12, Kfo]

Though each of the services has admirably developed its own energy strategy to improve its near-term energy management, DOD must also develop a comprehensive long-term energy strategy. The strategies developed by individual services focus heavily on electricity usage at domestic installations, which accounts for a relatively small fraction of DOD’s energy needs, and most goals within these strategies do not look beyond 2015 or 2020 – a timeline that is too short to ensure DOD’s long-term energy security. Moreover, there is no single official who oversees DOD’s entire energy portfolio; authority within DOD is currently divided, which is likely to complicate implementation of the strategy. This report lays out the strategic necessity for DOD to find alternatives to petroleum over the next 30 years and then presents important steps in achieving that long-term goal.

# Case

## Military Readiness – Distributed Generation Solves

#### On-site generation capabilities solves readiness

Sklar 12

[Scott Sklar, President of the Stella Group, May 28,2012,

<http://energy.nationaljournal.com/2012/05/powering-our-military-whats-th.php#2214408>, accessed on 7/16/12, Kfo]

The US military's job is to protect the United States from its military bases and on the front lines "in theater of war". Energy is one of the critical determinants of how well DOD can fulfill it’s job. Just in 2012, we have had three military bases lose power due to unexpected electric grid outages. On the front lines, we lose a large portion of our soldiers and contractors, ferrying fuel to the front lines for electricity and transportation. Soldiers carry around from 20 – 60 pounds of batteries in the modern fighting force. Diesel engines make noise, leave a heat signature, and when they malfunction. Drop fuel. The integration of renewable energy and on-site distributed generation has spanned over four Administrations and supported by both political parties, with the first such conferences in the early 1990’s, and now embraced by all three services and the last three Secretaries of Defense. The concept is quite simple, just like portfolio theory in stock investing. The military needs to have the maximum options to reduce costs which including transporting and ferrying fuels, reducing het and noise signatures, insuring maximum operating times with the least amount of operations and maintenance, and most importantly, lightening the soldier’s equipment weight and increasing their agility. All new technologies and weapons systems cost more in the beginning and as they scale lower in cost – from the giant one room mainframe computers to the handheld microprocessors as stark examples. We can no longer afford outages at military bases due to squirrels and downed power lines, not our special forces troops being found by the noise and vibration of their diesel generators or have our mile long fuel convoys be sitting ducks for our enemies with the ensuing loss of life. Attempts by either party to make renewable energy a political football undercuts our Defense capabilities. The programs underway are sorting out and improving deployable systems for our Defense and Homeland Security and Emergency Preparedness Missions. Let the defense and security professionals do their jobs.

## Military Readiness - Heg

#### Military readiness is key to heg

Perry 06

(William J. “The US Military: Under Strain and at Risk”, January, <http://globalsecurity.org/military/library/report/2006/us-military_nsag-report_01252006.htm>)

**In the meantime, the United States has only limited ground force capability ready to respond to other contingencies. The absence of a credible strategic reserve in our ground forces increases the risk that potential adversaries will be tempted to challenge the United States. Since the end of World War II, a core element of U.S. strategy has been maintaining a military capable of deterring and, if necessary, defeating aggression in more than one theater at a time. As a global power with global interests, the United States must be able to deal with challenges to its interests in multiple regions of the world simultaneously. Today, however, the United States has only limited ground force capability ready to respond outside the Afghan and Iraqi theaters of operations. If the Army were ordered to send significant forces to another crisis today, its only option would be to deploy units at readiness levels far below what operational plans would require – increasing the risk to the men and women being sent into harm’s way and to the success of the mission. As stated rather blandly in one DoD presentation, the Army “continues to accept risk” in its ability to respond to crises on the Korean Peninsula and elsewhere. Although the United States can still deploy air, naval, and other more specialized assets to deter or respond to aggression, the visible overextension of our ground forces has the potential to significantly weaken our ability to deter and respond to some contingencies.**

## C4ISR Add-on

#### Alternative energies are critical to the development of C4ISR capabilities and our ground vehicle fleet

TARDEC 9

[US Army Tank Automotive Research, Development and Engineering Center, “TARDEC’s Power and Energy Vision,” January 1, 2009, <http://www.dtic.mil/dtic/tr/fulltext/u2/a520061.pdf>, accessed on 7/16/12, Kfo]

POWER MANAGEMENT Military vehicles increasingly rely on a suite of mission-critical electronic Command, Control, Communications, Computer, Intelligence, Surveillance and Reconnaissance equipment that, collectively, places an increased load on the electrical system, exceeding available electrical power generation capability for a variety of mission operational requirements. Traditional electrical generation methods, such as the standard engine-driven alternator, have practical limitations in output capacity that develop from the underlying physics, such as the ability to adequately cool the device in an engine compartment’s harsh operating conditions. Additionally, current initiatives to electrify vehicle subsystems promise to save fuel and extend missions but further burden electrical systems already at capacity. To address the need for additional electrical power, two fundamental approaches exist: use the available power more efficiently, and permit the safe incorporation of additional power sources when mission needs dictate. Power management, a concept that includes the hardware, software and algorithms to more intelligently control electrical power generation and usage, addresses both approaches. It is, therefore, a systems engineering approach to the efficient use of electrical power on vehicle platforms and is also an important area of research, development and engineering for current and future military vehicles. Power management is an integral component in developing our future vehicle fleet and furthering Army transformation in the area of ground vehicle technology. As a result, the TARDEC Power and Energy Integrated Product Team has identified power management as a critical technology area. Power management meets and/or enables many current and future military vehicle requirements

#### Reference the Drones Affirmative for C4ISR Impacts

## Air Superiority – Losing Dominance

Rivals are pursuing air dominance

Bartels 9

[Clay Bartels, April 2009, Major, USAF, “How The USAF Can Lose The Next War Losing Air Superiority,” <http://www.dtic.mil/dtic/tr/fulltext/u2/a540193.pdf>, accessed on 7/14/12, Kfo]

The United States is precariously close to giving away air superiority. Control of the air is arguably the most important enabler of modern combat, and is documented as such in American doctrine. From its inception, the USAF has tended to discount the air superiority mission. Over the last 15 years those with an interest in challenging the west have been adapting and finding ways to counter U.S. technology. In roughly this same time, the USAF has added only the F-22 while retiring the F-4G, EF-111, and F-117. In 2009, the threat of advanced SAMs like the SA-10 and SA-20 and aircraft like the SU-35, Rafale, and Typhoon are equal to or exceed our 4th generation aircraft. Allowing near parity to exist is not acceptable, because an adversary denying the U.S access to the battle space could win the conflict. These conditions are risk intensive, and air superiority is too important to risk losing.

## Air Superiority - Heg

#### Potential adversaries perceive air superiority as the lynchpin of US hegemony

Bartels 9

[Clay Bartels, April 2009, Major, USAF, “How The USAF Can Lose The Next War Losing Air Superiority,” <http://www.dtic.mil/dtic/tr/fulltext/u2/a540193.pdf>, accessed on 7/14/12, Kfo]

Potential enemies of the United States have learned from our recent successes and are

trying to catch up. General John Corley, commander of Air Combat Command, recently said:

“Everybody has figured out that airpower - specifically, from the U.S. Air Force - is America’s

asymmetric advantage. They want to take that away from us.”19 The overwhelming results and

effect of decisive air power in Operation Desert Storm was a significant event for the rest of the

world. Stealth technology was used for the first time as an important piece to a major operation,

and those opposed to the west felt extraordinarily threatened. The war served as a wake-up call,

and forced other countries to acknowledge American military hegemony. Maj Gen Vladimir

Slipchenko of the Russian general staff said “in Operation Desert Storm, air power was

responsible for victory because air superiority altered the complexion of war from outset.”20

Even in this highly successful conflict, however, nearly every major weapons system lost an

aircraft. Furthermore, even though the U.S. clearly dominated the air war, the dense surface

threat environment still posed a difficult threat for coalition aviators and negatively affected

# Solvency

## DOD Energy Spillsover

#### DOD energy efforts spill over to the private sector

McCain 12

[Steve McCain, retired Air Force Colonel who coordinates the national security and energy public policy practice at K&L Gates, May 22, 2012, <http://energy.nationaljournal.com/2012/05/powering-our-military-whats-th.php#2212572>, accessed on 7/16/12, Kfo]

No entity in government knows better than the Department of Defense (DoD) that the lack of energy security poses a national security threat to the United States. The geostrategic importance of energy has long been recognized. As the federal government's largest energy user, DoD also has a huge stake in reducing our dependence on unreliable supplies of energy and securing low-cost power. Clean energy can and should be an important element of any such national energy/security policy. Academia and the mainstream media exhort the populace to act now to develop alternatives to our current energy practices, and yet solutions seem slow to emerge. The DoD is well-positioned to be a leader on clean energy development, and has historically been an early adopter of new technologies. The Pentagon, for example, should seek to leverage smart microgrids, advanced biofuels, energy storage, solar, ocean, wind, geothermal, nuclear and other innovative technologies to reduce our vulnerability to foreign sources of power and energy. Although many suggest that Secretary Panetta should not be taking a lead role in alternative energy, DoD, in cooperation with the Departments of Agriculture and Energy, can catalyze market actions and accelerate the commercialization of viable, sustainable energy solutions (such as drop-in biofuels) for the warfighter and Americans more broadly. DoD should not withdraw from recent opposition to its alternative energy initiatives; a kite rises against the wind. Investment by the military in alternative energy technologies, even in times of constrained budgets, can produce needed return on investment over the coming years. DoD rightly seeks to improve its public-private financing processes and procedures. As defense budgets decline, efforts to improve energy efficiency and reduce the agency’s huge energy costs are ever more important. Among federal agencies, DoD has a proven track record of managing complex systems and supply chains, and working to apply the work of research laboratories toward real-world applications. Although it's tempting to play politics with the “energy issue” in an election year, we should not wait to overcome a challenge so pivotal to the future success of our nation. Private industry will provide the lion’s share of clean energy investment, but DoD can carefully augment these initiatives to resolve military requirements for lighter, more portable power sources, cleaner and more energy dense fuels, and reliable cost-effective energy solutions for our facilities at home and our forward operating locations abroad. Americans are starting to connect the dots between energy, security and our future, while other countries are seeking an edge in alternative energy production. A national energy policy that leverages U.S. innovation and our vast natural resources is vital to our continued economic prosperity and national security. If we can reach a unified vision, we are poised to lead the world's clean energy economy.

<http://www.dtic.mil/dtic/tr/fulltext/u2/a519966.pdf>

Grocers, banks, tire and hardware companies, logistics providers, and others in the private sector have begun to recognize the value of using fuel cells to support their operations. The DOE is working in partnership with other federal agencies to identify opportunities for incorporating fuel cells into government operations as well. Early federal adoption not only shows the public that hydrogen and fuel cells are real and no longer confined to the laboratory, but it also proves the government takes its leadership role seriously – that agencies are incorporating into their own operations clean, energy-efficient, advanced technologies (including fuel cells) that will reduce our nation’s dependence on oil as well as greenhouse gas emissions and criteria pollutants. In addition to achieving societal benefits, early federal adoption can support commercialization and industry growth by affecting fuel cell cost reduction. A recent study released by Oak Ridge National Laboratory found that implementing a government acquisition program focused on fuel cells for backup power and specialty vehicles/lift trucks would result in manufacturing economies of scale that could enable fuel cells to be cost competitive with conventional technologies, such as batteries and small combustion engines.[10]

<http://www.pewenvironment.org/uploadedFiles/PEG/Publications/Report/DoD-Report_FINAL-EXEC_SUMM.pdf>

How DoD Can Help Advance Energy Innovation In recent decades, DoD technology development efforts have supported commercial development of computers, the Internet, the Global Positioning System, semiconductors and many more innovations. DoD has a broad range of strengths that can help accelerate clean energy technology development and commercial maturity. These include an established research and development infrastructure, ability to grow demonstration projects to scale, significant purchasing power and the necessary culture and management infrastructure necessary to foster innovation. In recent years, DoD has begun to harness these capabilities in service of energy technology innovation. Its budget for energy security initiatives has risen from $400 million to $1.2 billion in the past four years,3 and market experts project steadily increased expenditures for energy innovation activities in the coming years. Pike Research estimates that DoD investments in advanced energy technologies will reach $10 billion a year by 2030.4

<http://energy.nationaljournal.com/2012/05/powering-our-military-whats-th.php>

This week the Senate Armed Services Committee voted to restrict efforts by the Department of Defense (DOD) to reduce its dependence on foreign oil. This will hurt the DOD’s efforts to protect its budget from oil price shocks, diversify its energy mix and ensure security of supply. This is a step backwards. The Department of Defense is one of the largest institutional energy users in the world, consuming more than 300,000 barrels of oil per day. Volatile global oil supply patterns create heightened exposure to price fluctuations. This instability was highlighted in a landmark report by the Defense Science Board entitled “More Fight–Less Fuel,” which recommended that the Pentagon initiate energy innovations to reduce risk to soldiers and enhance the military’s long-term energy security. True to form, DOD responded in forceful fashion. A recent Pew [report](http://www.pewenvironment.org/news-room/reports/from-barracks-to-battlefield-clean-energy-innovation-and-americas-armed-forces-85899364060) highlights the military’s investments and efforts in vehicle efficiency, energy efficiency, renewables and advanced biofuels as a way to diversify its energy sources and reduce demand and costs. A part of this strategy is the implementation of a Memorandum of Understanding (MOU) that was signed last August by the Departments of defense, energy and agriculture. The agencies committed to jointly invest $510 million to spur production of advanced aviation and marine biofuels to power military and commercial transportation. These investments – to be matched by the private sector - will be made through the Defense Production Act, which was enacted in 1950 to enable the federal government to partner with domestic industry to meet national security needs. This MOU is a core component of improving the military’s readiness capabilities and reducing fuel costs. DOD’s overall energy budget in 2012 was $16 billion. In fiscal years 2011 and 2012, DOD accrued $5.6 billion in unanticipated fuel costs (not budgeted) for military operations and maintenance. In early May, Rep. Conaway of Texas offered two amendments to the armed services authorization bill that set up a battle in the Senate Armed Services Committee this week over the military’s clean energy initiatives. The first amendment would have exempted DOD from Section 526 of the Energy Independence and Security Act of 2007 (EISA). Passed overwhelmingly by Congress, including many of the same members now opposing the measure, and signed into law by President Bush, Section 526 states that DOD and other federal agencies are not permitted to purchase fuels with higher life-cycle emissions than those of conventional petroleum fuels. Thankfully, Section 526 was protected today in the Senate Defense Authorization Bill. Conaway’s other amendment prohibits DOD from using funds to move forward on the advanced biofuels MOU. Sadly, by a slim majority, the Senate Armed Services Committee voted to restrict funds to be used for the purchase of alternative fuels. Meanwhile, U.S. advanced biofuel producers have made rapid progress toward cost-competitiveness. Per gallon cost of test quantities of advanced biofuels under Navy contracts have declined more than 90 percent over the past two years and will continue to decline as these technologies scale to commercial production. Bloomberg New Energy Finance, the premiere clean energy data and analysis firm, forecasts that advanced biofuels will be cost competitive by 2018. A key factor in that forecast is DOD’s continued commitment to reduce use of foreign oil and increase use of American advanced biofuels. Without the Pentagon's commitment --- signaled by Section 526 and the MOU--- it will be much harder and take much longer for the private sector to build these refineries on their own. With advanced biofuels or any other emerging sectors, investors want to make sure that there is a long-term demand signal before investing. Congress should support policies that will reduce our reliance on foreign oil not undermine them. There is too much at stake for the nation’s energy future to do anything less.

## Now Key

#### Now is the key time for an energy transition

Parthemore 10

[Christine Parthemore, Fellow at the Center for a New American Security, September 2010, “Fueling the Future Force Preparing the Department of Defense for a Post-Petroleum Era,” <http://www.cnas.org/files/documents/publications/CNAS_Fueling%20the%20Future%20Force_NaglParthemore.pdf>, accessed on 7/11/12, Kfo]

Now is an opportune time to make this transition. As the services redeploy from current wars, the Army (and to a lesser extent the other services) have years of reset ahead of them. Acquisition reforms and personnel restructuring initiatives launched by Secretary Robert Gates in 2009 and 2010 will continue through the Obama administration and likely beyond. Together, these developments will present opportunities to procure new, more energy-efficient systems.

## Experience/Coordination

#### The DOD as experience handling major energy transitions

Parthemore 10

[Christine Parthemore, Fellow at the Center for a New American Security, September 2010, “Fueling the Future Force Preparing the Department of Defense for a Post-Petroleum Era,” <http://www.cnas.org/files/documents/publications/CNAS_Fueling%20the%20Future%20Force_NaglParthemore.pdf>, accessed on 7/11/12, Kfo]

Transitioning away from petroleum dependence by 2040 will be enormously difficult, but fortunately the U.S. defense sector has made several energy transitions successfully in its history. In particular, it moved from coal to petroleum to nuclear power in its ships. In a similarly seismic shift, DOD rapidly increased its reliance on electronics, space assets and computer systems in modern warfare in ways that enhanced mission effectiveness. These experiences may offer lessons for DOD as it leverages an energy transition to maximize its strategic flexibility and freedom of maneuver.

## Hydrogen Solves

#### Technology barriers have been overcome by new developments

Cooper 9

[Chris Cooper, April 27, 2009, Hydrogen Fuel Cells: Research Progress and Near Term Opportunities, <http://www.dtic.mil/dtic/tr/fulltext/u2/a519966.pdf>, accessed on 7/13/12, Kfo]

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#### The technology Is ready and viable

Cooper 9

[Chris Cooper, April 27, 2009, Hydrogen Fuel Cells: Research Progress and Near Term Opportunities, <http://www.dtic.mil/dtic/tr/fulltext/u2/a519966.pdf>, accessed on 7/13/12, Kfo]

Technology Validation Complementing the program’s robust R&D effort is a technology validation component, the focal point of which is the National Hydrogen Learning Demonstration. This 50/50 government/ industry cost-shared effort brings together automobile and energy companies, as well as their suppliers and other stakeholders, to evaluate light-duty fuel cell vehicles and hydrogen infrastructure in real-world operating conditions. Data collected on fuel cell durability and efficiency, vehicle range, and hydrogen cost, among other performance parameters, feeds back to the R&D program and is measured against established technical targets. The data is published as “composite data products” that provide the public, R&D community, and other stakeholders a means for understanding progress and technology readiness. The demonstration includes 140 vehicles and 20 fueling stations to date; vehicle data has been analyzed over the course of approximately 346,000 trips, traveling nearly 2 million miles, with more than 88,000 kg of hydrogen produced or dispensed. Results have shown a vehicular fuel cell efficiency of 53-58%, vehicle range of up to 254 miles, and a projected system durability of 1977 hours (equivalent to about 59,000 miles).[7] In addition to the National Hydrogen Learning Demonstration, other technology validation projects are demonstrating fuel cells in distributed energy applications and examining the operation of integrated, renewable-based power generation and hydrogen production technologies. These efforts involve hydrogen generation from solar, wind, and geothermal energy and include techno-economic analysis of hydrogen as an energy storage medium for variable renewables and “peak shaving.”

# Inherency

### 2AC

#### The DOD is constrained by lack of dedicated energy funding

Dickenson 12

[Bill Dickenson, May 22,2012, Managing Director at Navigant Consulting, <http://energy.nationaljournal.com/2012/05/powering-our-military-whats-th.php#2211719>, accessed on 7/14/12, Kfo]

The U.S. military uses almost every form of energy in a number of different ways in order to carry out its mission. Some applications are comparable to those in normal civilian life – such as heating or air conditioning for office buildings in downtown Washington, D.C., gasoline for on-base cars and trucks in Japan, or lighting for warehouses in Germany. Other applications are incredibly unique and certainly much less pedestrian – like fuel for high performance jets or tactical vehicles (we might call them tanks) in remote locations, electric power for communications equipment in mountain outposts, diesel fuel for Naval vessels on the Indian Ocean and uranium for vessels under it. The military applications that are more or less analogous to everyday civilian applications have similar constraints to those of their civilian counterparts. That is, what will be the cost of the renewable energy supply and how does it compare with the alternative – be it electric power from the grid or fuel oil from a regional refinery? In these situations, decisions become a balancing act between budgetary considerations (will the renewable alternative cost more than conventional sources and blow the budget? And, if so, where will the incremental funding come from?) and policy considerations (do renewables help or hinder the military’s mission? And, are there broader national policy objectives mandating renewables that need to be considered?). At a time when all military budgets are tight, and many military facility maintenance budgets are under-funded (never, however, in a way that affects mission readiness), it becomes difficult for the military to materially support renewables when the cost of renewable energy is substantially higher than the alternatives. Given the geographic variation in the availability of renewable resources, renewables are cost effective in some locations, but not in others. Where renewables are cost-effective, the military can (and does) use renewables as part of their regular course of doing business. In situations where renewable sources of energy are more expensive than conventional alternatives, it seems unfair to ask the military to shoulder extra costs at the expense of much needed maintenance or other activities, unless incremental funding is provided to support the extra costs associated with the renewable implementation decision.

# Offcase

## T

### 2AC – Transportation Infrastructure

#### Fueling stations are part of transportation infrastructure

Hartman, No Date Cited

Dennis Hartman, Syndicated Author, “His work covers a wide variety of topics and has been published nationally in print as well as online” –USA Today, <http://www.ehow.com/list_6292721_new-state-regulations-fueling-stations.html>, accessed on 7/25/12, Kfo]

Fueling stations are an important part of transportation infrastructure, providing fuel and other products and services for motorists and commercial drivers. Because of the danger posed by flammable fuel, strict [safety](http://www.ehow.com/list_6292721_new-state-regulations-fueling-stations.html) regulations govern the operation of gas stations. In the state of New Jersey, these regulations take some distinct forms

#### The plan is part of the defense transportation system, a subset of transportation infrastructure

Calvano 99

[Phillip Calvano, June 1999, <http://www.dtic.mil/cgi-bin/GetTRDoc?Location=U2&doc=GetTRDoc.pdf&AD=ADA372310>, accessed on 7/19/12, Kfo]

Defense Transportation System (DTS). That portion of the nation's transportation infrastructure which supports DoD transportation needs in peace and war. DTS consists of those military and commercial assets, services and systems organic to, contracted for, or controlled by the DoD.

### Other Definitions

#### The military transportation infrastructure is a collection of independent, specialized platforms, containers, and material handling equipment

<http://www.dsp.dla.mil/app_uil/content/newsletters/journal/DSPJ-04-11.pdf>

Problem/Opportunity The timely arrival of commodities and supplies to warfighters is critical to mission success. This is a constant challenge, however. The military transportation infrastructure is a collection of independent, specialized platforms, containers, and material handling equipment. Cargo flow is typically hampered by packing, loading, unloading, repacking, and reloading at various transshipment points. This contributes to major shipment delays and the delayed arrival of goods to the warfighter. Furthermore, the location, contents, and condition of each package’s items are not typically monitored or tracked accurately, if at all. In many cases, containers loaded with critical items arrive at forward logistics nodes, only to await distribution. In addition, each service uses disparate types and sizes of ISO containers and non-ISO containers and packaging. These differences require multiple means of material handling across the services and the commercial sector.

## States CP

#### The infrastructure must be dedicated to the military

Parthemore 10

[Christine Parthemore, Fellow at the Center for a New American Security, September 2010, “Fueling the Future Force Preparing the Department of Defense for a Post-Petroleum Era,” <http://www.cnas.org/files/documents/publications/CNAS_Fueling%20the%20Future%20Force_NaglParthemore.pdf>, accessed on 7/11/12, Kfo]

In setting these guidelines, first and foremost, DOD’s energy investments must meet military needs. Those that cannot be designed or adapted by their producers to meet military needs should not be considered worth DOD’s limited energy investment dollars. Otherwise, as the track record to date indicates, new fueling infrastructure, energy production technologies and vehicles will simply not be used. For example, a hydrogen vehicle and fueling station demonstration at Hickam Air Force Base in Hawaii marked a great sign that DOD bases can be used for testing new technologies, but the small scope of the demonstration – a single fueling station and limited range of the vehicles – significantly limited the utility of this investment to the airmen and civilians working at Hickam. DOD’s purchases should treat military utility as a mandatory constraint on any energy-related purchases.

## Privatization CP

#### The infrastructure must be dedicated to the military

Parthemore 10

[Christine Parthemore, Fellow at the Center for a New American Security, September 2010, “Fueling the Future Force Preparing the Department of Defense for a Post-Petroleum Era,” <http://www.cnas.org/files/documents/publications/CNAS_Fueling%20the%20Future%20Force_NaglParthemore.pdf>, accessed on 7/11/12, Kfo]

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## Spending DA

### No Link – Plan Saves Money

#### Plan saves money in the long term

Parthemore 10

[Christine Parthemore, Fellow at the Center for a New American Security, September 2010, “Fueling the Future Force Preparing the Department of Defense for a Post-Petroleum Era,” <http://www.cnas.org/files/documents/publications/CNAS_Fueling%20the%20Future%20Force_NaglParthemore.pdf>, accessed on 7/11/12, Kfo]

A successful transition away from petroleum will produce financial, operational and strategic gains. Reducing dependence on petroleum will help ensure the long-term ability of the military to carry out its assigned missions — and help ensure the security of the nation. Though adopting nonpetroleum fuels will require an initial investment, it will likely be recouped in budget savings over the long term. Finally, moving beyond petroleum will allow DOD to lead in the development of innovative technologies that can benefit the nation more broadly, while signaling to the world that the United States has as innovative and adaptable force.

## Platinum DA

#### No link – cheaper non-platinum cells will be used

Los Alamos National Laboratory 11

[Los Alamos National Laboratory, Aprill 22, 2011, <http://www.lanl.gov/news/releases/cheaper-hydrogen-fuel-cells.html>, accessed 7/20/12, Kfo]

LOS ALAMOS, New Mexico, April 22, 2011—Los Alamos National Laboratory scientists have developed a way to avoid the use of expensive platinum in hydrogen fuel cells, the environmentally friendly devices that might replace current power sources in everything from personal data devices to automobiles. In a paper published today in Science, Los Alamos researchers Gang Wu, Christina Johnston, and Piotr Zelenay, joined by researcher Karren More of Oak Ridge National Laboratory, describe the use of a platinum-free catalyst in the cathode of a hydrogen fuel cell. Eliminating platinum—a precious metal more expensive than gold—would solve a significant economic challenge that has thwarted widespread use of large-scale hydrogen fuel cell systems. Polymer-electrolyte hydrogen fuel cells convert hydrogen and oxygen into electricity. The cells can be enlarged and combined in series for high-power applications, including automobiles. Under optimal conditions, the hydrogen fuel cell produces water as a "waste" product and does not emit greenhouse gasses. However, because the use of platinum in catalysts is necessary to facilitate the reactions that produce electricity within a fuel cell, widespread use of fuel cells in common applications has been cost prohibitive. An increase in the demand for platinum-based catalysts could drive up the cost of platinum even higher than its current value of nearly $1,800 an ounce. The Los Alamos researchers developed non-precious-metal catalysts for the part of the fuel cell that reacts with oxygen. The catalysts—which use carbon (partially derived from polyaniline in a high-temperature process), and inexpensive iron and cobalt instead of platinum—yielded high power output, good efficiency, and promising longevity. The researchers found that fuel cells containing the carbon-iron-cobalt catalyst synthesized by Wu not only generated currents comparable to the output of precious-metal-catalyst fuel cells, but held up favorably when cycled on and off—a condition that can damage inferior catalysts relatively quickly. Moreover, the carbon-iron-cobalt catalyst fuel cells effectively completed the conversion of hydrogen and oxygen into water, rather than producing large amounts of undesirable hydrogen peroxide. Inefficient conversion of the fuels, which generates hydrogen peroxide, can reduce power output by up to 50 percent, and also has the potential to destroy fuel cell membranes. Fortunately, the carbon- iron-cobalt catalysts synthesized at Los Alamos create extremely small amounts of hydrogen peroxide, even when compared with state-of-the-art platinum-based oxygen-reduction catalysts. Because of the successful performance of the new catalyst, the Los Alamos researchers have filed a patent for it. "The encouraging point is that we have found a catalyst with a good durability and life cycle relative to platinum-based catalysts," said Zelenay, corresponding author for the paper. "For all intents and purposes, this is a zero-cost catalyst in comparison to platinum, so it directly addresses one of the main barriers to hydrogen fuel cells." The next step in the team’s research will be to better understand the mechanism underlying the carbon-iron-cobalt catalyst. Micrographic images of portions of the catalyst by researcher More have provided some insight into how it functions, but further work must be done to confirm theories by the research team. Such an understanding could lead to improvements in non-precious-metal catalysts, further increasing their efficiency and lifespan. Project funding for the Los Alamos research came from the U.S. Department of Energy's Energy Efficiency and Renewable Energy (EERE) Office as well as from Los Alamos National Laboratory’s Laboratory-Directed Research and Development program. Microscopy research was done at Oak Ridge National Laboratory’s SHaRE user facility with support from the DOE's Office of Basic Energy Sciences.

#### Platinum shortages are inevitable – demand will rise regardless of the plan

Yang 9(May 2009, Chi-Jen Yang, Research Scientist, Center on Global Change, Duke University, TA in Environmental Policy and Economics @ MIT 1998, MS in Technology and Policy from MIT 1999, MS in Civil and Environmental Engineering from MIT 1999, MS in Environmental Engineering. National Taiwan University. 1995, Doctor of Philosophy in Public Affairs., Volume 37, Issue 5, “An impending platinum crisis and its implications for the future of the automobile,” http://www.sciencedirect.com/science/article/pii/S0301421509000457, ngoetz)

2. Demand and supply of platinum

In recent years, the driver for platinum demand growth stemmed from the automotive catalyst. Several factors have contributed to this growing demand. First, automobile sales have been growing worldwide. In particular, many developing countries have seen a rapid expansion of automobile sales. Second, developing countries are becoming increasingly serious about mitigating their urban air pollution and are tightening their emission standards for automobiles. To meet stringent emission standards, automobiles must be equipped with advanced catalytic converters, which require higher loadings of platinum. Third, facing high oil prices and global warming, European countries are switching to diesel vehicles for their high fuel efficiency. In the past, diesel vehicles were considered dirty because of their high emissions. The problem is now resolved by equipping diesel vehicles with filters and two-way catalytic converters. Two-way catalytic converters require a higher loading of platinum than the three-way converters for gasoline vehicles. Therefore, increased demand for platinum is a side effect of improving fuel efficiency by promoting diesel (and bio-diesel) vehicles.

#### 4. Their impact evidence goes our way – resource wars will occur due to oil, not platinum – national economies are more reliant on oil

#### Non-Unique: Europe determines the direction of pricing, and we’re already using alternatives to platinum

Denning 12 Europe runs over platinum price By The Australian (originally posted in the WSG) · July 18, 2012 · 1:57 am · Leave a Comment Click here to read the whole story. By Liam Denning http://www.resourceintelligence.net/europe-runs-over-platinum-price/30679

Europe's inability to come together should at least make it easier for others to do so. Call it the platinum lining. General Motors is the latest auto maker to warn of mounting losses in Europe's moribund vehicle market. Morgan Stanley expects light-vehicle sales in Western Europe to fall 7% this year and 1% next. This is bad news for platinum prices. Auto catalysts, which reduce harmful tailpipe emissions, account for 45% of platinum demand, according to Citi. Of that, more than three-quarters is used in diesel vehicles, where Europe is the biggest market by far. With platinum averaging just $1,546 a troy ounce this year, mines should be shutting. Only a third can recover their all-in cost at that price, according to Thomson Reuters GFMS. Problem is 80% of the world's platinum comes from South Africa, where miners such as Anglo American Platinum must balance price signals against preserving jobs—and political goodwill. Platinum's cheaper cousin, palladium, trading at under $600 an ounce, looks relatively better positioned. Palladium auto catalysts are used more in gasoline vehicles, where demand is tied more to stronger markets like the U.S. and China. Palladium supply also is tighter. While Citi predicts an expanding palladium deficit, it expects excess platinum supply to persist for several years. This will cap platinum prices, which also will serve to continue deterring flows into exchange-traded funds. The bright side? All this should make platinum engagement rings and other jewelry, which account for 24% of demand, more affordable. That's great for brides-to-be. But it can't support a rally

## CP – Increase Efficiency/Reduce Consumption

#### Counterplan does not solve

Parthemore 10

[Christine Parthemore, Fellow at the Center for a New American Security, September 2010, “Fueling the Future Force Preparing the Department of Defense for a Post-Petroleum Era,” <http://www.cnas.org/files/documents/publications/CNAS_Fueling%20the%20Future%20Force_NaglParthemore.pdf>, accessed on 7/11/12, Kfo]

Other goals debated in recent years, including a goal of simply increasing the efficiency of petroleum use or a static reduction in overall fuel consumption, will be insufficient. Improving energy efficiency – in other words, getting more power per unit of energy consumed – must be part of a strategy to meet DOD’s energy needs without petroleum, but it is important that this not serve as the goal itself. Efficiency is one of the most important short-term operational energy objectives for DOD; for instance, any energy efficiency gains in Iraq and Afghanistan can immediately reduce vulnerable supply lines, save lives and free up manpower for other operations. However, efficiency does not mark a concrete end state over a multidecade time scale, and therefore cannot serve as an overarching goal. America’s energy efficiency has grown since the 1970s, yet its overall petroleum demand and corresponding vulnerabilities have also grown. For DOD, this means that its operational vulnerabilities and costs remain despite its efficiency gains. In other words, gains in efficiency are necessary and important, but there is a danger that too heavy a focus on efficiency over a longterm time scale will mask an increasing reliance onfuel that poses further risks to the Department of Defense. Efficiency should therefore be treated as a means and an operational enabler. It is also important that DOD’s energy goal does not amount solely to absolute reductions in energy consumption, devoid of consideration of how DOD uses energy in its efforts to protect and defend U.S. interests. DOD must always retain the flexibility to successfully conduct its missions. Demand reduction can be an important means of reducing vulnerabilities to supply lines abroad and reliance on a fragile grid at home. However, overall energy consumption should remain a function of DOD’s activities and global engagements. Total fuel demand must therefore remain flexible and should not serve as a fixed, long-term goal.

## Other Fuel PIC

#### Link to their fuel

#### [Their fuel] can’t solve readiness due to limited availability

Parthemore 10

[Christine Parthemore, Fellow at the Center for a New American Security, September 2010, “Fueling the Future Force Preparing the Department of Defense for a Post-Petroleum Era,” <http://www.cnas.org/files/documents/publications/CNAS_Fueling%20the%20Future%20Force_NaglParthemore.pdf>, accessed on 7/11/12, Kfo]

Third, new fuel sources must hold the potential to be available globally. DOD relies on international companies and other countries to provide fuel supplies for its use outside of the United States. Reliance on a single fuel that is commonly used in all countries and produced globally (petroleum) benefits DOD logistically, but this system will not survive indefinitely at a bearable cost. Many countries are already producing fuel alternatives to petroleum and increasing their capacity to do so, though there is a lack of information about where these supplies are, whether they can be formulated to fit DOD’s technical specifications, and to what scale they are likely to grow in supply availability. DOD must insist that its platforms can operate on fuels that it can procure abroad in order to ensure its ability to operate globally and to take advantage of the benefits that fuel source diversification can offer.

#### Link to performance

#### Performance deficit

Parthemore 10

[Christine Parthemore, Fellow at the Center for a New American Security, September 2010, “Fueling the Future Force Preparing the Department of Defense for a Post-Petroleum Era,” <http://www.cnas.org/files/documents/publications/CNAS_Fueling%20the%20Future%20Force_NaglParthemore.pdf>, accessed on 7/11/12, Kfo]

Fourth, performance is paramount. DOD cannot waver on its demand for fuels that perform properly. Its assets, particularly aircraft, require chemical consistency in the fuels used. This indicates special concern for reliability in formulating, refining and properly blending drop-in aviation biofuels that are mixed with petroleum.