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The Great Green Fleet

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THE GREAT GREEN FLEET

The U.S. Navy and Fossil-Fuel Alternatives

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On 16 December 1907 President Teddy Roosevelt launched the deployment of sixteen brand-new, glistening white, steam-powered battleships on a fourteen-month circumnavigation of the globe.[1] Later known as the "Great White Fleet," the armada demonstrated America's new ability to project its power abroad and represented a turning point in global power politics. The cruise is still widely recognized as an important achievement for the U.S. Navy. In the century since then, in which the United States has emerged as the world's sole superpower, its navy has made some strides in transforming itself for the purpose of dealing with new and emerging global threats. It continues to face such challenges, and it remains to be seen how effective it will be with its ongoing transformation.

The complexities of projecting American power abroad have been compounded by an array of costs that are increasingly associated with the use of fossil fuels. The American public and peoples around the world are gradually recognizing that oil dependence is a major problem and that it is crucial to develop a serious, long-term approach for dealing with it. The key concerns related to oil use are now commonly expressed—among them, that American oil dependence enriches and empowers some of its adversaries, including terrorists who use oil-related monies and states, such as Iran, that fund their defense programs with oil money;[2] that reliance upon oil makes the United

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States vulnerable to the vagaries of Middle East politics; and that oil consumption contributes fundamentally to climate change.[3] The use of alternative energies would also pose costs, but not the full array of these costs.

The American government as a whole and specifically the Department of Defense increasingly view fossil-fuel dependence as a national and international security vulnerability. Their concerns not only revolve around the obvious issues of the costs of transportation and the protection of oil resources and infrastructure but extend to broader problems as well.[4] Thus, in 2007 the CNA Military Advisory Board, made up of retired admirals and generals from across the military services, issued a report that defined climate change as a key threat to national security and world stability, a matter that required immediate attention.[5] Expressing frustration with public reluctance to accept scientific findings on climate change, a former Army Chief of Staff, General Gordon R. Sullivan, addresses a core aspect of military decision making: "We never have 100 percent certainty. . . . If you wait until you have 100 percent certainty, something bad is going to happen on the battlefield. That's something we know. You have to act with incomplete information. You have to act based on the trend line. You have to act based on your intuition sometimes."[6]

From a different perspective, the U.S. Joint Forces Command's *Joint Operating Environment, 2010* describes various threats posed by developing countries like China, which is racing to acquire oil resources around the world as its demand for oil rockets.[7] The document, which speculates on global trends that could impact future joint military forces, addresses significant concerns about the destabilizing effects of American oil dependence. After all, future violent conflicts and humanitarian disasters will be directly in the purview of the U.S. military, whether caused by the stresses of climate change or an "arms race" over natural resources.[8]

Meanwhile, the Pentagon is struggling to identify the true cost of its 300,000 barrel-per-day consumption, factoring in the logistical costs of supplying deployed units in Iraq, Afghanistan, and elsewhere.[9] Estimates range from a hundred to six hundred dollars per gallon, depending on whether the fuel is transported in peaceful or hostile areas and by truck, aircraft, or helicopter.[10] Delivery to a ship at sea can cost from five to fifty times the market price.[11] The cost of transporting fuel in convoys to remote forward operating bases in hostile-fire zones includes the loss of lives to roadside bombs or enemy attacks. Would transporting alternative liquid fuels present similar logistical challenges? At least one difference is that where electricity can replace fossil-fuel use through innovative technologies (for example, in electric vehicles), it can be delivered in safer ways and even be generated closer to the area of need. In any case, determining the "fully burdened cost of oil," though not a hard science, takes into account all of these realities and is a fundamental force behind the military's push for alternative energy.

Though its 300,000 barrels per day represents less than 2 percent of total American oil consumption, the Defense Department is the single largest consumer in the country.[12] Of the services, at least 25 percent is allocated to the Navy, the second-largest service consumer.[13] The Army and Air Force have their own "green" energy initiatives, but this article focuses on the Navy's diverse and important measures to tackle the problem of fossil-fuel dependence. Secretary of the Navy Ray Mabus's October 2009 energy vision addresses the Navy's mission areas at sea, ashore, and in the air. In the transformative spirit of the Great White Fleet, it envisions a "Great Green Fleet," made up of nuclear carriers, hybrid electric biofueled surface ships, and biofueled aircraft, supported by shore-based installations that run largely off renewable electricity.[14] In spite of budget efficiency reviews and realignments in 2010, the Navy is pressing ahead with energy projects.

This article makes two basic arguments. First, the U.S. Navy is engaged in what appears to be a serious move away from oil dependence. The American military is not generally viewed as a bastion of environmentally conscious innovation —quite the contrary. The popular idea is that the military tends to be conservative and not progressive; for their part, specialists in national security and world affairs tend not to think of the U.S. Navy as seeking novel ways to decrease oil dependence. They are more likely to view it as expending oil copiously and without great concern for the implications of doing so.

In fact, however, like some other sectors of the military, the Navy is transforming itself in an attempt to break away from the conventional, fossil fuel–driven energy market. Its developments in this arena should challenge perceptions of the military as conservative and behind the times. Secretary Mabus freely acknowledges that the politically controversial topics of climate change, "peak oil" (projections of when global petroleum extraction will reach a maximum and begin an inevitable decline), and green investment are the driving forces behind his strategic plan. He and other Defense leaders have expressed deep concern over the implications that reliance on fossil fuels could have on national security. The 2010 Quadrennial Defense Review declares, "Climate change, energy security, and economic stability are inextricably linked."[15] The report stresses that the effects of climate change are already being felt and that they demand proactive engagement and collaboration.[16] Among other effects, rising sea levels, intensifying weather patterns, and the shrinking of arctic ice caps all potentially affect the operating patterns of Navy maritime and expeditionary forces.

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Second, this article makes the argument that the Navy's approach to the question of oil dependence merits attention. The U.S. government as a whole, as well as international governments and companies, should be interested in the Navy's approaches, and increased cooperation among these actors would make eminent sense.

THE MABUS VISION

As we will see, the U.S. military has over decades taken steps to cut its dependence on foreign oil and move toward cleaner technology, but the low cost of oil has heretofore limited incentives for doing so in a consistent and sustained manner. However, the high oil prices of 2008, which reached around $147 per barrel, spurred greater interest in this regard, as did the election of President Barack Obama, who has put energy and the creation of "green jobs" at the top of his agenda.[17] His Secretary of the Navy, the Honorable Ray Mabus, assuming the role in June 2009, immediately accelerated the service's shift to alternative energy. The Navy's plan is highly ambitious.

The Navy appears to be moving in the right direction so far. In October 2009, USS *Makin Island* (LHD 8), aptly nicknamed the "Prius of the Seas," was commissioned as the first amphibious assault ship equipped with gas-turbine engines and all-electric auxiliary machinery.[18] On 22 April 2010, Earth Day, the Navy publicly demonstrated a test "Green Hornet" variant of its most capable fighter jet, the F/A-18 Super Hornet, powered by a fifty/fifty blend of biofuel and conventional jet fuel.[19] These technologies had been in development before Secretary Mabus's appointment, but they represented major steps toward his goals.

Secretary Mabus's naval energy plan comprises five key targets to be reached in the next decade. First, half of all Department of the Navy (DoN) energy consumption ashore and afloat is to come from alternative sources by 2020. Second, by 2020 half of all naval installations are to be "net zero" energy consumers, producing electricity from renewable sources, such as solar, wind, ocean, and geothermal power, even supplying excess energy to the civilian grid. Third, by 2012 the Navy is to have developed a "green" strike group, made up of nuclear-powered carriers, hybrid-electric-driven surface ships (their oil supplemented by biofuel), and biofuel aircraft. By 2016, the force will begin an out-of-area deployment as the first strike group of a future "green fleet." Fourth, by 2015 the Navy is to cut by half the use of petroleum in its fifty-thousand-vehicle fleet of cars, trucks, etc., by incorporating hybrid and electric vehicles.

Finally, the Navy is reforming its acquisition process. This initiative, which addresses the Navy's challenge of rising contracting costs generally, is to incorporate the lifetime cost of fuel in the consideration of new contracts.[20] The acquisition process underwent intense scrutiny in 2010, especially the shipbuilding programs. While the fiscal year 2011 Defense Department budget increased, some high-profile programs were cut due to increasing costs, including the projected next class of guided-missile destroyers, the DDG-1000.[21] The Defense Department is now thoroughly reviewing budget efficiency and reallocating money away from certain costly programs. Nonetheless, energy security and climate change remain key priorities. According to Secretary Mabus, the DDG-1000's hybrid-electric propulsion system will be backfitted into the existing *Arleigh Burke* (DDG 51) class.[22]

Though some may question whether the acquisition-reform initiative could damage its predictability as a customer, the Navy will still be attractive to potential contractors. Its current budget allots about $200 million to energy projects and research and development.[23] Secretary Mabus has stated that DoN has "4.4 million acres of land, 72,500 buildings, 50,000 commercial vehicles, 3,800 aircraft, 286 ships, and more than 900,000 employees."[24] Each ship requires about ninety thousand barrels of fuel annually.

The required technology for becoming less dependent on oil exists but is not fully developed. Some of this technology is designed for increasing the ability of electricity to offset the use of fossil fuels, which, at present, is not significant. Increasing this ability translates chiefly into replacing oil with electricity where most of the world's oil is used—in transportation. Moving to a fleet of electric and hybrid vehicles could accomplish this goal.

Also, if history is any indication, the "technological curve" should produce higher-quality, lower-cost technologies over time. That has certainly been the case with semiconductor-based consumer products and with internet routers and switches. That is important because as long as oil remains relatively cheap, such technologies may not be feasible to pursue without government subsidies or market "triggers," such as higher taxes on fossil fuels. This is where a customer like DoN could play a role, serving as a predictable customer of green technologies, with a long-term demand.[25] Even a comparatively small amount of money could help stimulate a growing industry, especially with other branches of the military following suit. Gradually larger military orders could drive innovation and foster economies of scale. Once capable of filling bulk orders at competitive cost, these burgeoning industries would be in a position to bid for private-sector fuel contracts.

The Defense Energy Support Center (DESC) is the organization responsible for acquiring and providing various types of fuel to the services, at standard prices intended to provide some degree of protection against wild swings in the market.[26] The standard price, however, is subject to some fluctuation; from 2004 to 2005, it was adjusted ten times.[27] In fiscal year 2008, when oil hit $147 per barrel, the Navy and Marine Corps consumed about 38.5 million barrels, with 38 percent going to aviation, 25.5 percent to maritime forces, 31 percent to expeditionary forces, and 5.5 percent to shore-based services.[28] DoN's fuel cost increased from $1.2 billion to five billion per year, in one year.[29] With further instability in global oil markets looming, the pursuit of alternatives grows more imperative for the Navy.

REVOLUTIONIZING ENERGY TECHNOLOGY TO POWER TACTICAL VEHICLES

"Tactical vehicles" are air, land, and sea-based "vehicles"—including, that is, aircraft, ships, and craft—that directly conduct or support military operations. They represent the overwhelming majority of Navy and Marine Corps fuel consumption and present special challenges in terms of finding reliable alternative fuels. Biofuels represent one of DoN's most promising sources, but with current technology they require extensive land and water resources to produce. For this reason, Secretary Mabus is adamant that DoN sources of biofuel are not to compete with food crops, as has corn-based ethanol. This policy puts the Navy on stronger political footing in developing biofuels.

Naval assets rely heavily on three types of fuel oil: JP-8 jet fuel, for shore-based aircraft; JP-5, which has a higher flash point, for carrier-based aircraft; and F-76, a maritime distillate fuel oil, for ships. Contracts have been let to pursue camelina, a weedlike plant related to mustard, as an alternative to JP-5.[30] Algae-based fuels have proved promising as alternatives to JP-8 and, especially, F-76.[31]

Unlike oxygenated fuels like ethanol, vegetable-based fuels, such as those derived from camelina, behave exactly like traditional jet fuel but cut "cradle to grave" carbon emissions by 84 percent.[32] The Green Hornet test flight on Earth Day in 2010, burning a fifty/fifty mix of vegetable-based and traditional fuel, demonstrated how far the technology has come—the Hornet "hardly knew the difference."[33] Camelina-based fuel now costs about sixty-seven dollars per gallon, but with enough demand the cost could eventually be comparable to that of fossil fuel.[34] In 2009 DESC awarded the Sustainable Oils Company a $2.7 million contract for forty thousand gallons, with the option to acquire an additional 150,000.[35] This is a small amount of the Navy's overall oil consumption but a huge production goal for the infant industry. Camelina requires a fraction of the water and fertilizer needed by other crops. It can be grown in marginal lands or produced as a rotation crop with wheat, to prevent overexpansion of cultivated land.[36]

Navy contracts are being extended for algae-based biofuel as well. While camelina has been more rapidly deployed, algae could be an able competitor. Through a contract with Solazyme, in southern California, the Navy will allocate $8.5 million toward 1,500 gallons for aircraft testing and twenty thousand for maritime use, significantly more money per gallon than it will spend on the camelina option.[37] DoN accepted a delivery of twenty thousand gallons from Solazyme in 2010 and extended a new order for 150,000 gallons.[38] Like camelina, algae do not compete with traditional food crops. Algae can be grown on brackish, saltwater, or nonarable desert land, reducing the need to divert freshwater.[39]

A skeptic might point to the sheer scale of the Navy's biofuel goals. In order to supply the Navy's entire current demand for aviation fuel with algae, an estimated five hundred square miles of land would be required to grow the plants. To bring the cost down to two dollars a gallon, carbon dioxide would have to be transported from nearby conventional power plants;[40] otherwise the cost jumps to forty-four dollars.[41] Similarly, without a program to manage land and infrastructure for biofuels, camelina grown in the amounts necessary to meet DoN demand would require an area equivalent to between a quarter and a third of the state of Montana.[42] At present, these obstacles are prohibitive, as they are for other forms of green energy. However, they could be surmounted as technology progresses and economies of scale emerge. Advances, for instance, in battery technology have allowed for a variety of electric and hybrid vehicles to gain traction in the market—a development that would not have been possible a decade ago.

The Department of the Navy is not alone in its attempts to develop and test algae- and camelina-based fuels and bring down the costs of production. As jet fuel accounts for half of the Defense Department's fuel consumption, the Air Force is testing similar technology to develop a JP-8 equivalent.[43] Both services could benefit from the other's success, as could the aviation industry. Additionally, the Defense Advanced Research Projects Agency has awarded a $34.8 million contract to two companies to find ways to reduce the cost of algae-based fuel to three dollars per gallon.[44] This effort has been met with skepticism, but the agency's methods have proved successful in the past—notably with the computer mouse, the Global Positioning System, and the internet.[45]

Biofuel development, however, is only a part of the Navy's strategy to transform its tactical vehicle fuel consumption; new technology for the weapons systems themselves represents another initiative. *Makin Island* is the first amphibious assault ship to employ more efficient gas turbines instead of the traditional steam boilers.[46] Additionally, it can shift to full-electric propulsion at low speeds, perhaps up to 75 percent of the time it is under way.[47] The new, comprehensive machinery-control system also allows the ship to switch readily between gas-turbine and auxiliary power.[48] While it still must burn fuel to generate electricity, the ship represents a leap forward in efficiency and fuel consumption in comparison to its predecessors in the *Wasp* (LHD 1) class.

Among U.S. warships, the *Wasp*s are second in size only to nuclear aircraft carriers and provide a vital capability to transport Marines, equipment, and aircraft and send them ashore. They are tremendously capable platforms and workhorses in today's global environment, which increasingly presents needs for littoral capabilities, from disaster relief to command and control for forces ashore. With growing missions and deployments comes concern over cost. On its first voyage, from the outfitting yard in Mississippi to its home port in San Diego, *Makin Island* saved nearly two million dollars in fuel costs.[49] If fuel prices remained constant, the ship could save $250 million over its lifetime.[50] Here is a potential for tremendous fuel savings, especially as the technology proliferates —to, for instance, USS *America* (LHA 6), the first of a new class of slightly smaller but similarly equipped amphibious assault ships.[51]

As mentioned above, hybrid electric drive is being developed for incorporation into new and existing *Arleigh Burke* guided-missile destroyers. These Aegis-fitted ships are also fleet workhorses and thus present real opportunities for fuel-cost savings; refitting the older units with these more efficient engines is expected to save 8,500 barrels per ship per year. However, the technology still has a long way to go.[52] The contract must be finalized with General Atomics before the prototype propulsion system is expected in 2012 and a full production unit is installed in an *Arleigh Burke* to be launched in 2014, in time to meet the green-strike-group goal of 2016.[53]

Another important energy alternative is nuclear power, which the Navy already successfully employs in the eleven aircraft carriers and seventy-seven submarines (at this writing) of its 286-ship fleet.[54] The department assesses that 16 percent of its energy use is supplied by nuclear fuel.[55] The nuclear navy represents the core of the Navy's strategic power projection capability. For over fifty-five years, DoN has maintained an excellent safety record through its high standardization and quality education and training.[56]

The expansion of nuclear propulsion into other naval platforms has also been considered. For instance, it was recommended for the "Next Generation Cruiser," or CG(X), program as a way of offsetting the ship's immense procurement costs while meeting the demands of its advanced systems.[57] Retrofiting of large-deck amphibious ships with nuclear energy has also been suggested.[58] If oil prices remain above eighty dollars per barrel, the improvements would pay for themselves over the life of the ship.[59] Nuclear technology, however, is still extremely expensive. The CG(X) program was cut from the proposed fiscal year 2011 budget as too costly.[60] Further, the high cost of manpower must be accounted for in nuclear power programs. Senior leaders have also expressed concern that further development of the civilian nuclear-power-generation sector as public fears ease could make it more difficult, and expensive, to retain highly skilled specialists in the service.[61]

THE TRANSITION TO ALTERNATIVE-FUEL NONTACTICAL VEHICLES

The Navy's plan to reduce petroleum consumption in its "nontactical" vehicle fleet seems much less advanced than in the maritime and aviation areas. Nontactical vehicles are commercial-type cars, trucks, and other automobiles for travel or transport on and off military installations. They number upward of fifty thousand vehicles but account for less than 25 percent of DoN energy use.[62] Commercial vehicles, classed according to size, are acquired independently or through the U.S. General Services Administration (GSA), which supplies fleet vehicles to government agencies.[63]

The Energy Policy Act of 1992 mandated that federal agencies make "alternative fuel vehicles" (AFVs) 75 percent of their light-duty acquisitions. In 2008 the definition of AFVs was expanded to include fuel-cell and hybrid-electric-powered vehicles, among others.[64] In compliance with this guidance, GSA has led a consistent effort to shift to AFVs, but much of its focus is on "flex fuel" vehicles, capable of running on an ethanol mix. Advances in hybrid electric and hydrogen fuel-cell technology have opened new opportunities for these vehicles, but Navy acquisition complications remain. For instance, until recently the majority of manufacturers that produced these vehicles were not eligible for GSA contracts.[65]

The Navy's 2007 AFV strategy highlighted some of the difficulties of the department's transition. Many of the issues are still being addressed: organizational alignment, communication of energy goals and successes, infrastructure to support AFVs, availability of alternative-energy vehicles through GSA lease, and efficient employment of vehicles.[66] Organizational alignment seems to be a particular difficulty; there is no single effort spearheading the way toward rapid transition to AFVs and only an uncertain strategy as to which alternative technology should be employed.

However, large commands are making significant strides toward meeting the secretary's energy goal. Navy Recruiting Command, one of the highest-mileage users of the nontactical vehicle fleet, has ordered 297 Ford Fusion hybrid cars, with the intention of converting 75 percent of its 5,100 vehicles to hybrids by 2020.[67] Naval Facilities Engineering Command began a massive effort to employ clean "Neighborhood Electric Vehicles" (NEVs) and solar-powered, slow-moving vehicles in place of conventional vehicles for flight lines, ports, material handling, public-works maintenances, and base security on installations

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worldwide.[68] NEVs are smaller than conventional vehicles and not necessarily a direct replacement for them, but they are significantly cheaper, available through the GSA, require no infrastructure changes, and generate large reductions in fuel costs.[69] According to DoN, San Diego bases were able to cut about fourteen thousand gallons of petroleum per year by switching to NEVs in fiscal year 2005.[70] Smaller commands are introducing diesel-electric buses, capable of running on biodiesel, and performing initial small-scale tests with fuel-cell vehicles.[71]

SHORE-BASED RENEWABLE ENERGY GENERATION

DoN movement toward adopting renewable energy is not restricted to vehicle fuel. The department is innovatively pursuing ocean-centric renewable energy sources. These sources will contribute to DoN's target of half of its shore-based installations reaching net-zero consumption by 2020. One of these emerging technologies is the Kinetic Hydropower System (KHPS) in Puget Sound. The Navy plans to complete design, installation, test, and evaluation of the system in two phases.[72] The KHPS is made up of a small group of turbines, rigged to the seabed, that generate power as they are turned by the immense volumes of water moving regularly with the tide.[73] The technology is very similar to wind power but has much better predictability. Phase 1 of the project began in 2008, with the goal of selecting a site and studying its environmental suitability. Phase 2 of the project will involve actual design, production, and testing.[74] Similar tests are also exploring the potential of harnessing wave power for electricity generation.

Scientists are grasping the incredible potential of harnessing the ocean for power generation, and this knowledge may now be meshing with the Navy's strategic plans. For instance, the Lockheed Martin Corporation received an $8.1 million contract from the Navy in 2009 to support development of an offshore power plant that uses the thermal energy trapped in the upper layers of tropical seas to generate electricity.[75] A subsequent $4.4 million contract was awarded in 2010 to advance the design; a pilot Ocean Thermal Energy Conversion (OTEC) plant is expected to begin operations in 2012. Conceptual designs of OTEC resemble offshore oil-drilling platforms, but in fact it is an "extremely large heat pump."[76] Warm ocean water on the surface would be used to heat a liquid, such as ammonia, causing it to evaporate; the vapor would turn turbine generators, producing electricity.[77] In the last step, the cooled water would be pumped back into the ocean at a depth with a comparable temperature, in order to prevent algae blooms and other environmentally damaging effects of tampering with the delicate temperature balance of the ocean.[78] Naval Station Pearl Harbor in Hawaii will host the first OTEC plant. Maturity of this technology could have far-reaching impacts, not only for power generation on the Pacific, Gulf of

Mexico, and southeastern Atlantic coasts but also for about eighty-five countries in tropical climate zones across the globe that are within reach of the coast.[79]

KHPS and OTEC are still years away from providing viable energy alternatives, but the Navy already runs installations that generate their own power based in whole or in part from renewable fuels. Naval Station Guantanamo Bay, Cuba, maintains wind turbines to supplement its power needs and is exploring the possibility of incinerating landfill as a power source.[80] Most notably, the Navy's geothermal facility at China Lake, California, has been supplying its own power and selling its excess power back into the regional commercial grid since 1987, generating a total of $197 million from royalties and conserved-power credit.[81] The Navy has put much of that money back into geothermal research, maintenance, and the preservation of "historic and natural resources."[82] From 1989 to 2003, China Lake spent about $125.7 million, two-thirds of its geothermal revenue, on twenty-seven irrigation and energy-conservation programs. Among other projects, these funds were used to install a solar-energy system at the Marine Corps Air Ground Combat Center, Twentynine Palms, California, eliminating its dependence on the electric grid.[83]

INCREASING EFFICIENCY

At least 220 of today's Navy's 286 ships will still be in service in 2020 as part of the "Great Green Fleet." In order to meet alternative-energy standards, they will have to be retrofited with new power-generating equipment and hull alterations. Upgrades to hull design—reducing wave resistance, altering water flow, and cutting drag—can be costly, but they can increase fuel efficiency tremendously, saving millions of dollars. Three of these technologies have been retrofited to various surface ships during dry-dock availabilities: bulbous bows, stern flaps, and propeller and hull coatings.[84] A bulbous bow, or forefoot, looks rather like a large finger extending from the bow of a vessel at the waterline. Bulbous bows are used widely in commercial shipping and can cut fuel consumption on surface ships like destroyers by 3.9 percent.[85] Stern flaps are small extensions above the screws and rudders that lengthen the hull and alter the flow of water, cutting fuel consumption by 6–7.5 percent.[86] New "antifouling" hull and propeller coatings prevent barnacle and marine growth that creates drag, potentially saving up to $180,000 per year per ship.[87]

The Navy has also reduced its energy use by implementing simple changes at the unit and operational levels, such as acquiring high-efficiency light bulbs, mandating electricity- and water-conservation measures, and raising general awareness among service members. Such measures could be extended to the public in general in many instances, saving significant amounts of energy.

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The Navy has also employed simulated, "virtual" training in lieu of live exercises, saving the cost of fuel. The Naval Sea Systems Command has spearheaded the Incentivized Energy Conservation (I-ENCON) program to help raise energy conservation awareness in the fleet.[88] The program sends representatives to meet with ship crew members about fuel saving and distributes monetary awards and cash incentives to commands achieving the best results.[89] The awards go to command discretionary funds, which can be used to acquire equipment for the ship or contribute to morale, welfare, and recreation programs.[90] In the first half of 2010 alone, I-ENCON conservation initiatives saved 386,000 barrels of fuel.[91]

BROADER LESSONS AND SYNERGIES

DoN's alternative-energy strategy has been criticized as overambitious. Some of these criticisms deserve consideration. After all, some of the new energy technologies discussed here are still in their infancy and face significant technological hurdles; others are prohibitively expensive at present and are many years away from being serious competitors to oil. Many of the alternatives, such as nuclear power, reduce carbon emissions but present environmental challenges of their own, such as waste disposal. These impediments will, in the short term, make a switch to alternative energies difficult without significant incentives and visionary leadership. In any case, careful, comparative cost-benefit analyses are necessary.

However, with these caveats in mind, the move toward green energies and alternative technologies appears to be quite positive. The U.S. Navy is a sensible laboratory for testing and advancing these energies. Indeed, the American public is still divided on the subjects of climate change and fossil-fuel dependence, and that makes it harder for Congress or the president to implement effective market-stimulus measures. The U.S. military culture, though bedeviled by its own bureaucratic politics, is somewhat insulated from civilian political deadlock and the demands of public opinion; at least, its officials do not have to seek reelection.

The Navy is also known to be focused on preparing for national security threats. Polling data imply that the American public broadly trusts the U.S. military and its leadership to make decisions that will protect national security. It also expects the military to equip itself with the best, most innovative technology that money can buy. In the proposed fiscal year 2011 budget, the Department of Defense and Department of Veterans Affairs were two of only three departments to see increases in funding. By contrast, start-up energy companies are vulnerable to interest rates, limited cash flow, and other market factors. Many of them cannot sustain profitable operations long enough to reach important results.

One resounding message made by Navy and Defense Department leaders in arenas like last year's Quadrennial Defense Review process is that serious threats to national security are arising from dependence on fossil fuel, especially on foreign oil shipped through dangerous sea-lanes from some of the world's least stable regions. Although threats to the free flow of oil may have been exaggerated in the past three decades, a range of such threats could arise at any time under difficult circumstances—terrorist attacks on oil infrastructure, war in the Persian Gulf, and instability in key oil-producing states.[92] Recent uprisings in the Middle East, for instance, have generated fears that the Suez Canal might be affected by the turmoil or the spread of uprisings across North Africa and the Persian Gulf.

The Navy and other services are setting good examples by actively seeking energy solutions, in spite of skepticism and political controversy. Their programs can help spur similar efforts in other agencies and the private sector, but they still only represent a small percentage of the country's total consumption. Nonetheless, the Navy's experience offers some broader lessons and synergies, beyond oil dependence. For instance, as we have seen, DoN is innovatively pursuing renewable sources of electricity generation. Such power could produce needed electricity in the future when demand outstrips supply; simply pursuing alternative fuels, as such, is counterproductive if it means increased dependence on electricity generated by such sources as coal. The Navy's pursuit of multiple avenues for not only alternative fuels but renewable energy technology merits attention.

Electricity generated by sustainable methods could also help run a much larger fleet of electric vehicles. Indeed, creating more electricity does little to decrease oil dependence, because, as noted, Americans (and others around the world) put the bulk of their oil into their gas tanks. Electricity (whether solar, wind, nuclear, coal, or whatever) does not do much to decrease fuel consumption. We can't put electricity in a gas tank. However, studies show that a vehicle fleet of "plug-ins" could achieve mileages over eighty-four miles per gallon, compared to America's present average of twenty-three. In this way, used to run a national fleet of vehicles, electricity could in fact decrease oil consumption.

In terms of synergies, it may be that the Navy's research into alternative energies such as algae may dovetail with similar efforts under way in academic and business circles. Indeed, the Navy is a great laboratory for testing the value of algae-based approaches. One challenge of such approaches is to reduce costs relative to oil, partly by decreasing how much energy is used to operate them and partly by increasing their energy output. Progress in both areas might be achieved more effectively through greater cooperation among the Navy and academic and business actors.

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Clearly there are significant costs to transforming energy consumption, and ultimately, without a major shift in the total population's consumption behavior the effect of individual shifts to alternative energy and technology will be minimal. But the progress made by the Navy and other services offers promise that the obstacles are not impossible to overcome. In the long run, the benefits for the United States include boosting the economy and the job market through investments in new energy industries and gaining strategic advantage in the global energy market as resources become scarce. In the meantime, the U.S. military could maintain a globally deployable force, relatively isolated from fluctuations in the oil market—an advantage over potential adversaries still dependent on traditional fuels obtained from distant or unstable regions. Should those adversaries develop alternative power for their militaries first, the roles might be reversed.

NOTES

The opinions expressed are those of the authors and do not reflect the official policy or position of the U.S. Joint Forces Command, Department of the Navy, or Department of Defense.

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