NAVY

A NAVY ENERGY VISION
FOR THE 21ST CENTURY






NAVY ENERGY

OCTOBER 2010

The U.S. produces 10% *of all petroleum yet consumes* 23%.

26% *of U.S. petroleum comes from OPEC member countries.*

Navy energy use is 30% *of DOD energy use.*

Navy petroleum use represents 0.4% *of U.S. petroleum use.*

Navy uses 75% *of its energy afloat and* 25% *ashore.*

"Energy security for the Department [of Defense] means having assured access to reliable supplies of energy and the ability to protect and deliver sufficient energy to meet operational needs."

— 2010 Quadrennial Defense Review

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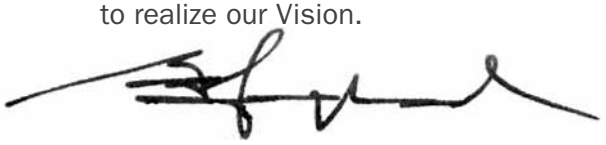
Our Energy Vision is a Navy that values energy as a strategic resource; a Navy that understands how energy security is fundamental to executing our mission afloat and ashore; and a Navy that is resilient to any potential energy future.

FOREWORD

The Energy Vision identifies ends, ways, and means for increasing energy security for the Navy. It is the product of broad and deep collaboration within our organization and our partners in the defense community, government, and the private sector.

Record oil prices in 2008 provided a glimpse of an energy future where business-as-usual might take us—a future of ever-rising costs and strategic vulnerability. In response, we created Task Force Energy. Members from across the Navy have worked to increase energy awareness and conservation, raise the visibility of energy in budgeting and acquisition, and identify the right initiatives to promote energy efficiency and alternative energy use afloat and ashore. A newly vectored approach toward energy use within the Navy will produce strategic and operational advantages that enhance combat capability and ensure resilience in any energy future.

This document conveys strategic imperatives that align with Department of the Navy energy targets announced at the 2009 Naval Energy Forum and in the Energy Awareness Message to the Fleet. It represents a commitment from the entire Navy to foster a culture in which energy awareness is part of everyday actions and decision-making. Energy is an issue of national importance and every Sailor has a role to play to realize our Vision.



ADM Gary Roughead
Chief of Naval Operations

INTRODUCTION

Every day, the Navy consumes approximately 80,000 barrels of oil afloat and 20,000 megawatt hours of electricity ashore. These rates of consumption represent strategic and operational vulnerabilities. The Navy has a long history of leading energy transformations—from sail to coal to oil to nuclear power. Today, through a long-term vision for energy security, the Navy will once again transform energy vulnerabilities into mission advantages.

STRATEGIC CONSIDERATIONS

Over-reliance on petroleum is a critical strategic vulnerability for the Navy. Almost 75 percent of the energy consumed by the Navy is used afloat in our ships, aircraft, and vehicles, and close to 60 percent can be attributed to liquid petroleum-based fuels. Nationally, the U.S. produces 10 percent of all petroleum yet consumes approximately 23 percent, importing more than half of its liquid fuel supply. Globally, demand for petroleum continues to rise. Competition for an ever more sought-after resource will almost certainly contribute to long-term price increases. Countries with large conventional oil reserves include nations in conflict-prone regions of the world and some not positively inclined to support free trade, open markets, or rule of law. The U.S. currently imports almost a quarter of its oil from these regions, leaving the Navy and the Nation vulnerable to petroleum markets where unforeseen events, both natural and man-made, often disrupt supply. For the Navy, high prices and price volatility pressurize budgets that could otherwise go to increased capability. For the Nation, dependence on foreign oil constrains foreign policy and threatens the stability of our economy. Non-petroleum fuels produced domestically, continued development of alternative power sources, and attention to increasing efficiency and managing total consumption will have a transformative impact on energy security for the Navy and the Nation.

Broadly speaking, the Navy plays an important role in maintaining global energy security. The world consumes 85 million barrels of oil per day, and 78 percent of this oil reaches refineries and end-users by sea. The Navy facilitates this flow of petroleum products around the world by providing and ensuring a stable zone of commerce. Issues of National and global energy security will continue to shape mission requirements for the Navy, as resource competition expands in the Arctic and other regions.

Finally, U.S. officials acknowledge a link between greenhouse gas emissions from the combustion of fossil fuels and global climate change. The Navy is committed to continue a strong legacy of environmental stewardship while leading DOD efforts to assess, adapt to, and mitigate the impacts of climate change. Virtually all investments the Navy makes in energy efficiency and alternative energy for the primary purpose of energy security and enhanced combat capability will also serve to reduce greenhouse gas emissions.

"Competition for energy resources must figure into our thinking, not just in our strategic view outside of the Navy but how we as a Navy develop alternative forms of energy."

— ADM Gary Roughead, Chief of Naval Operations

OPERATIONAL CONSIDERATIONS

Beyond the strategic significance of energy, the energy demands of individual Navy systems create constraints at the operational and tactical levels. Being wedded to liquid fuel is a concern for every Sailor whose options in the battlespace are limited by the range and endurance of his or her ship, aircraft, or tactical vehicle. Moreover, the need to provide fuel to tactical forces requires a long and often vulnerable logistics tail, which draws forces from the fight and exposes support units to hostile action. These additional requirements of securing and transporting fuel to tactical forces effectively increase the overall cost of fuel. This true, delivered price is now called the "fully-burdened cost of fuel." Although fuel constraints will not be eliminated entirely, targeted investments in energy efficiency lengthen the fuel tether, enhance combat capability, and provide more options to Navy and Joint Force commanders. Efficient tactical power management will also be critical to accommodate next-generation weapons systems with increased power requirements.

Energy is of similar operational concern ashore, where vulnerabilities associated with the commercial electric grid present a growing risk to shore support for operational forces, particularly during the same emergencies that would call on the full capabilities of the Navy. Energy security is a foundation for the scalable, agile, and adaptive joint-integrated shore capabilities essential to support a mobile force. The Navy is dedicated to ensuring that mission critical assets ashore remain resilient to outages, whether natural or man-made. Energy efficiency, viable alternative energy sources, and smart grid technology for use on-base are key to securing critical infrastructure from an energy standpoint. Long-term cost avoidance and reduced reliance on fossil fuels through alignment, standardization, and more efficient operations ashore represent an investment in protection and warfighting capability.

Navy leadership in World War II saw clearly the importance of fuel.

PAST SUCCESSES

The Navy has long been an early adopter of new energy practices and technologies. In its earliest days, the light and swift hulls of American frigates contributed to stunning victories against British naval forces in the Revolutionary War. A century ago, the Great White Fleet traveled around the world on steam generated by the combustion of coal, which released the Navy from the vagaries of wind. In the following decades, the Navy found a superior and, with technology application, inexpensive energy source in oil, enabling underway replenishment, more efficient boilers, and smaller crews. Such advances proved critical as the Navy fought and won World War II. During the Cold War, the Navy adopted nuclear power in submarines and large surface ships, producing clear operational and strategic advantages.

The Navy continues this tradition of energy transformation today. The Shore Energy Office was established in the early 1980's to administer efficiency and conservation efforts on installations in response to Federal and DOD mandates. Since then, energy intensity ashore (energy consumed per square foot) has been reduced significantly. With respect to alternative energy, the Navy is the largest producer in the federal government. Notably, the Navy's Geothermal Program Office has been a DOD leader since geothermal power production commenced at Naval Air Weapons Station China Lake in 1987. The geothermal plants at China Lake, with a full capacity of 270 megawatts, provide reliable, renewable power to over 300,000 households in California. Afloat, the Fleet has benefited from the Incentivized Energy Conservation (i-ENCON) program since 1999, contributing to a 10 percent reduction in average maritime fuel burn rates. In the same period, stern flaps installed on more than 60 percent of all surface ships have produced a strong return on investment for the Navy. Meanwhile, simulators have become increasingly central to surface and naval aviation training and readiness, reducing fuel consumption and maintenance costs.

In 2009, the Navy commissioned its first amphibious assault ship with an electric auxiliary propulsion system, the USS Makin Island. In 2010, the Navy tested the full envelope of an F/A-18 Super Hornet, including supersonic flight, on a jet fuel blend of petroleum-based fuel and "drop-in" biofuel. Both events are key steps for the Navy Energy Vision, which provides a line of sight for energy transformation to 2020 and beyond.

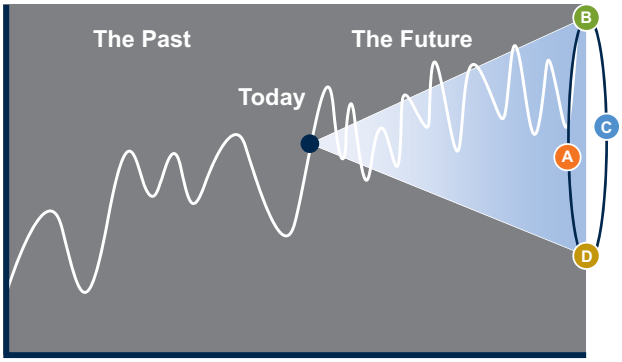
VISION

UNDERSTANDING ENERGY SECURITY

Energy security is having assured access to reliable supplies of energy and the ability to protect and deliver sufficient energy to meet operational needs afloat and ashore. Energy security is a critical component of National security.

Tactical energy security for the Navy is mitigation of vulnerabilities related to the energy requirements of tactical platforms, including the length of the logistics tail and the volatility of petroleum prices. The Navy increases tactical energy security by decreasing overall fuel consumption, increasing the fuel efficiency of tactical systems, and using alternative fuels.

Shore energy security for the Navy is mitigation of vulnerabilities related to the electrical grid, including outages from natural disaster, accident, and physical and cyber attack. The Navy increases shore energy security by decreasing overall energy consumption, increasing the energy efficiency of shore systems, increasing the use of viable alternative energy sources, and increasing the reliability of energy for critical assets.



Decisions made today will have a lasting impact on the energy posture of the Navy. The Navy considered a range of potential scenarios to "bound the future" and inform the development of the Energy Vision.

THE NAVY ENERGY VISION

Our Energy Vision is a Navy that values energy as a strategic resource; a Navy that understands how energy security is fundamental to executing our mission afloat and ashore; and a Navy that is resilient to any potential energy future.

In achieving this vision, the Navy will:

- Protect access to energy sources for our Nation and our Allies
- Consider energy requirements in strategic planning
- Incorporate energy requirements in all phases of systems development and acquisition
- Employ energy efficiency as a force multiplier for enhanced combat capability and a reduced logistics tail
- Spearhead early testing and adoption of viable alternative energy sources
- Rapidly adopt energy efficient technology and operating procedures
- Partner closely with other Services, government, industry, and academia to strengthen energy security at Navy, Joint, and National levels
- Receive wide recognition for energy leadership
- Lead Federal efforts to reduce greenhouse gas emissions
- Maintain a long-term perspective regarding energy security

STRATEGY AND STRATEGIC IMPERATIVES

Realizing the Energy Vision will require a comprehensive Strategy comprising strategic imperatives and goals that align with the Department of Defense and Federal government approach to energy and climate issues. The Navy Energy Strategy will guide a strong portfolio of investments in people, technology, and programs across Navy enterprises. In the near-term, the Navy will make significant gains by adjusting policies to enable more energy efficient operations, encouraging awareness and energy-conscious behavior in every Navy setting, optimizing existing technologies to reduce energy consumption, and speeding the implementation of new technologies, all with the intent of enhancing or enabling greater combat readiness.

The mission of the Navy is to maintain, train and equip combat-ready forces capable of winning wars, deterring aggression, and maintaining freedom of the seas. The following strategic imperatives convey the importance of energy to maintain and enhance the core capabilities needed to execute this mission. These strategic imperatives are guided in part by energy targets announced by the Secretary of the Navy, with the support of Navy Task Force Energy, at the 2009 Naval Energy Forum and later in the Energy Awareness Message to the Fleet.

ASSURE MOBILITY AND PROTECT CRITICAL INFRASTRUCTURE

The Navy requires mobility to project force, and the majority of Navy platforms—ships, aircraft, tactical vehicles, and non-tactical vehicles—have long run on petroleum-based fuels. In turn, operational and tactical forces rely on continuous support from critical assets at Navy installations around the world, most of which depend on electrical grids outside the fence for power. The movement of people, weapons, munitions, supplies, information, and command must be protected against disruption for the Navy to maintain its core capabilities. The following targets aim for energy security through energy alternatives afloat and ashore without compromising operational readiness.

Alternative Energy Afloat: By 2020, half of the Navy's total energy consumption afloat will come from alternative sources

The Navy already draws more than a quarter of its energy afloat from nuclear reactors on aircraft carriers and submarines. Although the Navy pursues research into next-generation nuclear reactors, this game-changing alternative energy source has limitations in size, weight, and manpower requirements that are not easily inserted into existing platforms. There are other potential game-changing technologies, but in the short-term, the next energy transformation to assure mobility across the Fleet is likely to be found in alternative liquid fuels that match the characteristics and performance of conventional petroleum-based fuels. Alternatives to petroleum will provide the clear strategic advantage of a sustainable fuel supply for the Navy.

Navy fuel consumption alone is not large enough to establish a new market. However, by testing and certifying alternatives for use with tactical platforms, the Navy can spur the development of the industry by providing a clear demand signal. Serving as an early adopter with a stable demand, while partnering with other large individual users, can influence capital influx and development within an emerging market and help move the Nation away from its reliance on foreign sources of fossil fuel.

Navy investments are aligned and synchronized into a lean, targeted program to identify and approve alternative fuels whose introduction will be invisible to operators across the Fleet. Alternatives for tactical platforms will be drop-in replacements having equivalent performance to petroleum-based fuels that have propelled ships and aircraft for decades. These fuels will require no change to weapons systems, logistics infrastructure, or distribution, and be able to be seamlessly interchanged with petroleum based fuel.

The first alternatives currently under evaluation are derived from hydroprocessed renewable non-food plant and algal feedstocks which could be supplied domestically, bolstering energy security for the Navy and the Nation and producing lower greenhouse gas emissions.

Non-petroleum based liquid fuels are not the only alternative fuel source under development. A Navy prototype Unmanned Aerial Vehicle (UAV) provides 24-hour mission endurance, high functionality, and low heat and noise signatures using zero-emission hydrogen fuel cell technology. Sailors in the expeditionary environment, and their Marine Corps counterparts, will benefit from emerging technologies for portable, renewable power generation.

Achieving 50 percent alternatives afloat depends on a robust industry to provide an economical supply, an agile approval process to enable Navy procurement, and basic research into promising technologies. A sustainable non-petroleum based fuel supply is a foundation for energy security for the Navy and the Nation.

Great Green Fleet: By 2016, the Navy will sail the Great Green Fleet, a carrier strike group composed of nuclear ships, hybrid electric ships running biofuel, and aircraft flying on biofuel

At the turn of the 20th century, the Great White Fleet served as a clear demonstration of U.S. naval and national power. Today, the Navy envisions a 21st century demonstration of leading-edge technologies for assuring mobility. This demonstration will be a carrier strike group of ships and aircraft setting sail as a "Great Green Fleet." Foremost among the featured technologies will be biofuels and shipboard hybrid-electric propulsion.

In 2009, Navy conducted the first test of an F/A-18 engine running on a 50/50 blend of petroleum-based and camelina-based naval aviation fuel (JP-5). Engine performance was equivalent to that of petroleum-based JP-5, setting the stage for the successful operational test of an F/A-18 Super Hornet, the "Flight of the Green Hornet," in spring 2010. Test and certification of alternative fuels for maritime applications is also underway. The first fuel to be tested will be a 50/50 blend of petroleum-based and algal-based naval ship propulsion fuel (F-76). Land-based engine testing and small craft at-sea demonstrations are planned for 2010 and 2011, and a shipboard demonstration is planned for 2012.

In addition to biofuels, the "Great Green Fleet" will showcase electric ship technologies and other initiatives that support energy efficient platforms and operations. In 2009, the USS Makin Island set sail from a Gulf Coast shipyard for her homeport of San Diego. The amphibious assault ship features an auxiliary electric-drive system that enables more efficient operation at speeds up to 12 knots. Systems based on the same principle—using the shipboard gas turbine generator for propulsion—are under development for DDG-51 class ships. Current designs for a hybrid electric drive for DDG-51 could provide fuel savings on the order of 10 percent over baseline models at low speeds. A shipboard prototype is planned for 2012 on USS Truxtun. Beyond electric drive, the Office of Naval Research is sponsoring research by the Electric Ship Office into advanced energy storage and other systems for efficient power management afloat. These systems will ultimately accommodate the vastly increased power requirements of next-generation weapons systems—and the great leaps in capability they provide.

The "Great Green Fleet" will demonstrate key Navy energy technologies to the Nation and represent a major step forward in realizing the Energy Vision.

Alternative Energy Ashore: By 2020, half of the Navy's total energy consumption ashore will come from alternative sources; the Navy will make half of its installations net-zero energy consumers, using solar, wind, ocean, and geothermal power generated on base



Federal and DOD mandates require a significant increase in the use of alternative energy sources. To meet these mandates, the Navy will first focus on a dramatic reduction in energy consumption.

The Navy shore community has already made notable achievements in renewable energy, such as the geothermal power plants at Naval Air Weapons Station China Lake. Other investments include wind turbines and solar arrays at Navy bases across the country. The shore community continues to invest in solar, wind, and geothermal energy, as well as leading-edge technologies such as ocean thermal energy conversion (OTEC) and other ocean energy technologies. Energy efficiency, combined with the right alternative energy technologies at the right time and place, will enable some bases to eliminate reliance on grid power—that is, become net-zero energy consumers. Such investments, along with advanced grid and energy storage technologies, will reduce reliance on the commercial grid and increase resilience of supply, reduce greenhouse gas emissions, and spur national energy innovation.

In pursuing distributed renewable generation opportunities, the Navy faces many of the same challenges that all organizations face, including transmission capacity limits, utility regulatory structure limits, local economic impacts, environmental compatibility, power storage technology, and high unit material costs. Investment in advanced monitoring ashore is a significant down payment on microgrid or smart grid technology that will enable greater energy efficiency and wider adoption of alternative energy. Efforts in these areas must ultimately be measured against the strategic imperative of improving critical infrastructure protection.

Critical Infrastructure: By 2020, all of the Navy's critical infrastructure will have reliable backup power systems and redundant power systems where viable

Navy forces afloat require constant support from shore installations. The loss of critical assets ashore, even temporarily, would seriously hinder Navy operations. Many Navy critical assets and shore installations face vulnerabilities related to the commercial electrical grid, which may experience outages from natural disaster, accident, and physical and cyber attack. Navy installations must develop sufficient backup power systems and redundant power capacity to maintain mission effectiveness in the event of an outage. The Navy will work to ensure maximum resiliency with comprehensive contingency planning and sensible partnering. Navy cyber forces will be employed to protect Navy energy infrastructure from attack. In addition, the Navy will explore viable alternative energy solutions for backup and base power generation systems to protect critical infrastructure assets.

Petroleum in Non-Tactical Vehicles: By 2015, the Navy will cut in half the amount of petroleum used in its commercial vehicle fleet through phased adoption of hybrid, electric, and flex fuel vehicles

As the Navy looks to alternative liquid fuels for tactical platforms, the Department of the Navy is also dramatically reducing the consumption of fossil fuels by the non-tactical vehicle fleet by reducing the number of vehicles, purchasing or leasing more efficient vehicles, and converting the majority of the fleet to alternative fuel vehicles. Alternative fuel vehicles encompass neighborhood electric, plug-in electric, and hybrid-electric systems, as well as vehicles capable of running on high ethanol blends, biodiesel blends or compressed natural gas. In addition to procuring alternative fuel vehicles, the Navy is committed to developing infrastructure and distribution systems to support them and adapting policies which minimize barriers to using alternative fuel in the non-tactical vehicle fleet.

"To address energy security while simultaneously enhancing mission assurance at domestic facilities, the Department is focusing on making them more resilient."

— 2010 Quadrennial Defense Review

LIGHTEN THE LOAD AND EXPAND TACTICAL REACH

While alternative fuels provide a strategic advantage over petroleum-based fuels, they are ideally invisible to the warfighter. To provide operational advantages that resonate across sea, air, and land, the Navy will "lighten the load," physically and in terms of power consumption, through weight-reducing advances to airframes, vehicles, and weapon casings, energy efficient technologies, or changes to policy. Expanding tactical reach—gaining capacity to go further, longer, or even faster on the same load fuel, or save fuel for the next mission—is a strategic imperative that emphasizes the contribution of energy security to combat capability.

Efficiency and Conservation Afloat: By 2020, the Navy will increase efficiency and reduce overall fuel consumption afloat by 15 percent

The Navy target for increasing alternatives afloat will not be achieved only by increasing the use of alternative fuels. The Navy must take a two-pronged approach by aggressively pursuing initiatives that increase fuel efficiency and reduce overall fuel consumption afloat while maintaining or enhancing our ability to fight. The following sections describe Navy initiatives for efficiency and conservation in the maritime, aviation, and expeditionary environments.

Maritime

Over the last half-century, the aircraft carrier and submarine fleets have been completely converted to nuclear propulsion. However, more than 200 Navy ships remain dependent on fuel that must be resupplied every few days. Ships are most vulnerable to enemy attack and collision at sea while alongside an oiler during underway replenishment. Additional time on station provided by fuel efficiencies could prove decisive in tomorrow's war. To lighten the load and expand tactical reach, the maritime community will expand successful technology and operational initiatives, complete testing and evaluation of quick win solutions, and cultivate game-changing technologies for a Next Navy with substantially increased energy efficiency and improved energy security.

The maritime i-ENCON program has successfully introduced the fundamentals of maritime energy conservation to the Fleet, contributing to decreased fuel consumption rates for many surface combatants. Going forward, the maritime i-ENCON program will continue to aggressively pursue increased fuel efficiency afloat and target energy efficiency initiatives for ships in-port. Sister programs will spearhead conservation for support ships and naval aircraft. The introduction of an "energy dashboard" on maritime platforms to monitor power and fuel consumption will provide commanding officers and Sailors with the information they need to make real-time operating decisions and change energy usage behaviors as the tactical situation permits. Among the other initiatives that could enable a more effective maritime force and produce decreases in overall fleet fuel consumption are smart voyage planning software, optimized supply routes for oilers and other support craft, and expanded use of fleet synthetic training for maritime platforms.

However, many operational adjustments to improve maritime energy conservation may be untenable in combat situations. The key to expanding tactical reach in these cases is efficient systems. The Fleet Readiness Research and Development Program identifies technology candidates for rapid transition from research and development to implementation. Initiatives that produce efficiencies across the spectrum of operations include modifications for improved hydrodynamics, improved maintenance procedures, efficient shipboard systems, power management systems, and electric-drive systems. Some initiatives, such as solid state lighting, reduce maintenance requirements in addition to using less power and fuel thus reducing total ownership costs across the entire lifecycle of the Navy asset or platform. Although many initiatives produce a relatively small-percentage efficiency, those small contributions are significant both in combat, as additional capability, and over the decades of the ship's life, as savings.

The maritime community is continually searching for new technology solutions for both in-service ships and new designs. Game-changing technologies, such as advanced cycle engines, may shape the future of maritime energy security.

Aviation

Naval Aviation operates more than 3,700 aircraft that consume over 600 million gallons of petroleum-based fuels each year. Resource constraints and mission requirements demand increased operational capability be extracted from each gallon of fuel. To achieve near, mid and long term efficiency objectives, the aviation community manages a balanced investment portfolio targeting four key areas: simulation; operational policy and doctrine; legacy system technology integration; and next-generation technology solutions.

The most prominent aviation initiative is the use of training simulators. Simulator technology has steadily advanced over the last decade, allowing more training and readiness (T&R) to be achieved through simulation than ever before. Distributed mission training capabilities offered by modern simulators allow fleet air, surface, and subsurface trainees to interact in robust synthetic environments, often providing superior training to that achievable with actual Fleet assets at reduced risk and cost. As Naval Aviation transitions from a sortie-based to a capability-based T&R model, aircrews are already achieving greater T&R credit from simulation. Facility capacity and technology upgrades offer further flight hour and fuel reduction savings. In 2008, simulators operated by the Chief of Naval Air Training (CNATRA) covered more than one third of the training syllabus and accounted for $45 million in fuel cost avoidance. Additional savings, including reduced aircraft operating costs and airframe fatigue life expenditures, can significantly exceed those obtained from reduced fuel usage.

Naval Aviation is building a culture of conservation through operational policy, doctrine, and fleet engagement. In 2009, Naval Air Stations achieved over 2 million gallons in fuel savings by utilizing fuel trucks instead of "hot" skids during aircraft refueling. The F/A-18 Super Hornet community realized an additional $250,000 in annual fuel savings per squadron by achieving certification to operate at higher, more efficient altitudes normally reserved for commercial airliners. An Energy Conservation program is under development to encourage operational fuel conservation, increase fleet energy awareness, and disseminate validated energy best practices within the fleet without impacting operational performance or mission capabilities.

In addition, Naval Aviation is evaluating proven technology solutions to improve the energy efficiency of currently fielded systems. Improved compressor and turbine designs, performance-seeking controls, and advanced materials are under development to reduce the specific fuel consumption of legacy propulsion systems up to 8 percent. Ongoing mission planning database updates and onboard flight performance modules offer an additional 1 to 3 percent reduction in sortie fuel consumption. Drag-resistant aircraft coatings are being evaluated for military applications after demonstrating up to 6 percent fuel savings in commercial aviation. Advanced materials may similarly lighten the load of future munitions, enabling aircraft to go farther and carry more weapons—a striking example of the "more tooth, less tail" philosophy cited in the 2008 Defense Science Board report.

Looking to the future, the Navy is investing in potentially game-changing energy conservation technologies for the next generation of Naval Aviation platforms. Variable cycle engine technology could decrease aircraft fuel consumption rates up to 25 percent. Unmanned Aerial Vehicles could see 20 percent fuel efficiency improvement from small heavy fuel technology, or in some cases, eliminate the need for petroleum fuel altogether.

Expeditionary

One of the most critical vulnerabilities of expeditionary forces is reliance on regular supplies of fuel. In Iraq and Afghanistan, Navy and Marine Corps forces are scattered across hundreds of miles, necessitating extensive logistical support. Many U.S. and coalition casualties are the result of improvised explosive devices and other insurgent attacks on convoys carrying the most basic supplies—fuel and water. To minimize these

"Operate, fight, and win more effectively and more efficiently, making the most of our precious resources."

— Naval Aviation Vision 2020

vulnerabilities, commanders must dedicate scarce equipment and personnel to protect these supply lines. Addressing this deficit in energy security comes with an economic cost as well; estimates of the fully burdened cost of fuel in expeditionary settings can be exceptionally high. Increasing the fuel efficiency of all expeditionary systems and fielding portable, renewable power generation systems will lighten the load for expeditionary forces, saving lives, equipment, and money, and potentially enabling the Navy to further expand its own reach in brown water and on the battlefield.

The Navy expeditionary energy strategy focus centers on data collection, mobility platforms, and base systems. To move forward on energy in the expeditionary environment, the Navy Expeditionary Combat Command requires a consistent ability to measure tactical vehicle fuel consumption in the theater of operations, where fuel consumption is spread across thousands of pieces of equipment in hundreds of locations. This capability does not exist in the current vehicle fleet and there is no clear method for collecting tactical fuel usage at advance bases, particularly during contingency operations. Initiatives are being explored to integrate data on gallons of fuel consumed, miles driven, and hours operated, while investment in power management and distribution will enable more efficient generator use.

The Navy operates a wide range of tactical ground vehicles, patrol craft, and construction equipment. Fuel efficiency upgrades to mobility platforms will have an immediate impact on combat capability. For example, upgrades to the Landing Craft Air Cushion (LCAC) will result in fuel savings of up to 10 percent.

The Navy will also produce and consume power more efficiently at forward operating bases and combat outposts, where diesel fuel generators support electronics and other hardware. Power generation systems scale from portable systems for two-man teams to large generators supporting tent camps for the Marine Expeditionary Force. One of the most energy-intensive tasks in the field today is tent heating and cooling. On the supply side, the Navy has begun procuring more efficient and generator-integrated environmental control units for both the Navy Expeditionary Combat Command and the Marine Corps. On the demand side, the Navy is working with DOD partners to determine cross-service solutions for improving the insulation of temporary structures, which significantly lowers requirements for generating capacity, leaving more fuel for the fight.

Also under development are alternative power generation systems, including on-board vehicle power generation and renewable energy systems, such as roll-out solar panels and solar lighting. Beyond reducing fuel requirements, these technologies could literally lighten the packs of Navy and Marine Corps personnel by reducing the large number of batteries necessary to support communications and weapons systems. Such requirements demonstrate that in the expeditionary environment every gallon and kilowatt hour counts.

Efficiency and Conservation Ashore: By 2020, the Navy will increase efficiency and reduce overall energy consumption ashore by 50 percent

The shore community has decreased the energy consumption of its facilities over the past three decades in accordance with Federal and DOD mandates by utilizing efficient building technologies, investing in repairs and modernization of facilities, and applying sustainable design principles. Reducing energy requirements, along with adding more reliable data and control systems, allows for reduced pressure on aging infrastructure and reduced backup generation requirements for critical infrastructure. The Navy will build on past successes in energy management and continue to adopt leading-edge technologies at the right time, balancing maturity risk.

Efficiency and conservation investments ashore will focus on energy awareness programs; advanced metering of electricity, natural gas, and steam; annual facility energy audits of increasing breadth and depth; re-commissioning of existing energy systems; direct energy efficiency improvements; modernization of facilities and utility systems; and

"It will be extraordinarily important that what we put in play today my successors many times removed will have to be able to operate at a cost that's reasonable and gives them the best advantage in the future." *— ADM Gary Roughead, Chief of Naval Operations*

sustainable design for new construction and major renovations. Advanced metering, integrated with digital controls (DDC) and supervisory control and data acquisition (SCADA), will provide the required data and accountability foundation for an eventual "smart grid" with near real-time knowledge of energy consumption, providing accountability and the ability to reduce consumption directly. Current efforts will lead to the implementation of a pilot location for an installation smart grid with the long-range vision of full integration into a national smart grid.

Finally, efficiency and conservation are essential for the shore community to meet alternative or renewable energy goals. As past successes have shown, dramatic increases in the impact of alternative energy sources can be obtained by decreasing overall energy requirements. The Navy will increase efficiency to reduce requirements while transforming culture and behavior at the individual, command, and functional levels.

Energy Efficient Acquisition: Evaluation of energy factors will be mandatory when awarding contracts for systems and buildings; industry will be held contractually accountable for meeting energy efficiency targets

The acquisition process is a foundation of the Navy's fighting force. Ships commissioned this year will be in the Fleet for the next 25 to 50 years; likewise, aircraft and tactical vehicles are maintained for many years. Shore infrastructure is designed to last for decades. Therefore a broad energy transformation of the Navy requires driving energy considerations to the forefront of acquisition decisions. Expanding tactical reach and lightening the load must be prominent aims of reforming how the Navy and DOD do business.

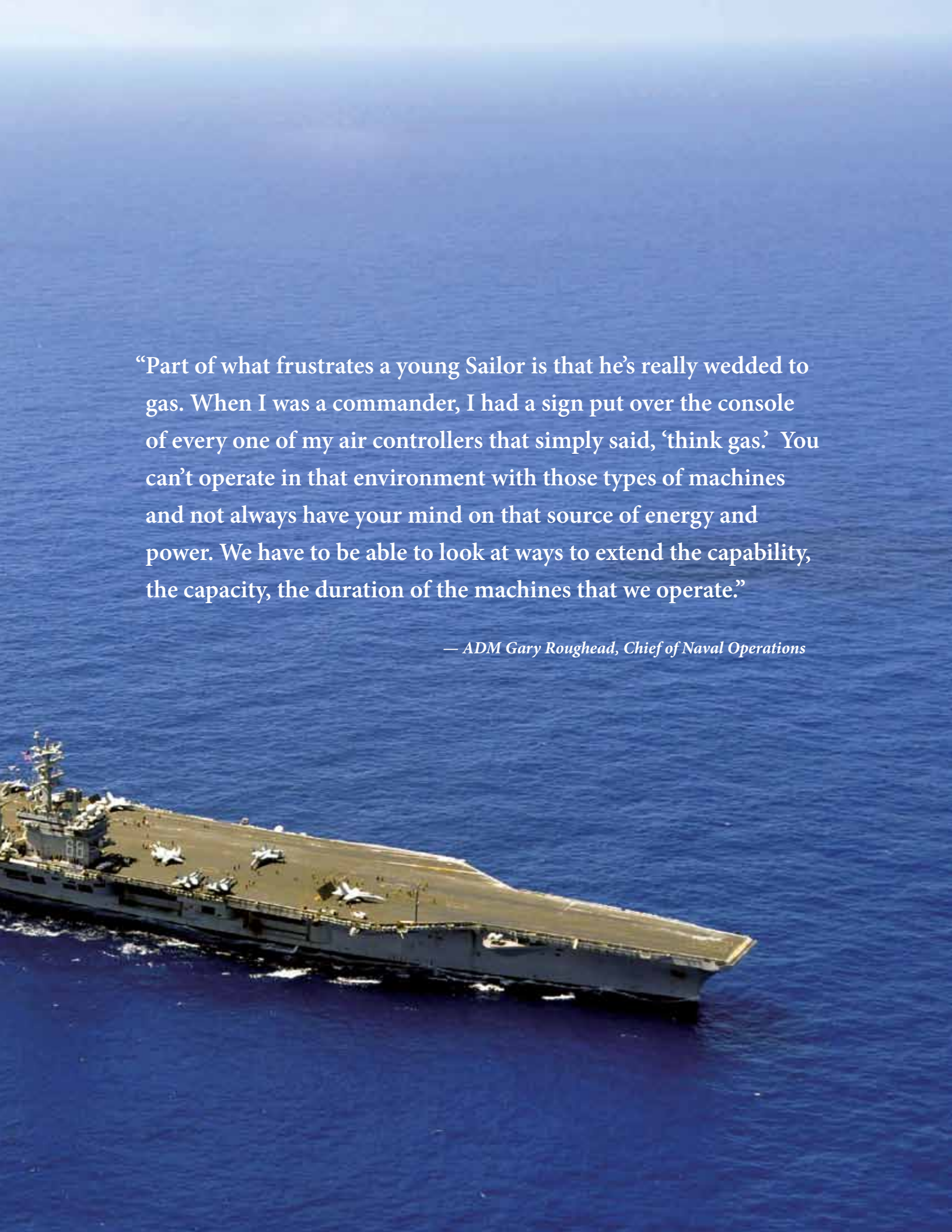
Federal, DOD, and Navy mandates now emphasize energy-related specifications in evaluating new systems afloat and ashore. The Navy will develop and implement an energy key performance parameter and energy figure of merit to guide these evaluations. In addition, the Navy has joined other Services and DOD in efforts to define and incorporate a fully burdened cost of fuel, which accounts for the total cost of purchasing and supplying fuel to different deployed platforms. With respect to installations, mandates already call for high-performance designs capable of achieving certification for sustainable building practices and energy efficiency for new construction.

Finally, the Department of the Navy will devise a mechanism for enforcing energy efficiency requirements for the defense industry. The Navy will demonstrate energy leadership in the public sector with a future Fleet that derives strategic and operational advantages from energy efficiency. At the same time, the naval industrial base can lead the private sector in methods to lighten the load and increase the energy security of the Nation, while lowering our dependence on fossil fuels.

GREEN THE FOOTPRINT

The Navy will continue to be a good steward of the environment, to include reducing emissions of heat-trapping gases that contribute to global climate change. The DOD recently announced the target of a 34 percent reduction in greenhouse gas emissions from a 2008 baseline by 2020. The Navy will pursue this target without compromising core capabilities. Investments in energy efficiency and alternative energy naturally reduce greenhouse gas emissions. The same investments that will provide the operational and strategic advantages of increased energy security will make a strong contribution to Navy and national environmental sustainability.

"Although they produce distinct types of challenges, climate change, energy security, and economic stability are inextricably linked." *— 2010 Quadrennial Defense Review*



"Part of what frustrates a young Sailor is that he's really wedded to gas. When I was a commander, I had a sign put over the console of every one of my air controllers that simply said, 'think gas.' You can't operate in that environment with those types of machines and not always have your mind on that source of energy and power. We have to be able to look at ways to extend the capability, the capacity, the duration of the machines that we operate."

— ADM Gary Roughead, Chief of Naval Operations

ENABLERS

The success of the Energy Vision and Strategy depends on key enablers: leadership, technology, policy, strategic partnerships, and culture change. Each of these enablers requires sustained commitment and resources.

LEADERSHIP

The decisions that indicate a cardinal heading for all energy efforts ultimately rest with Navy leadership. Just as the President will appoint a Director of Operational Energy Plans and Policy for DOD, the CNO will maintain a Navy Director of Operational Energy to lead the Navy Energy Coordination Office, responsible for overall leadership of Navy energy efforts afloat and ashore. The Director will continue to report to a Senior Energy Council with high-level representation from across the Navy, including the CNO and VCNO. The Director and operational energy staff will work with resource sponsors, system commands, and the Fleet to ensure that energy considerations are seamlessly incorporated in the decision-making process. Even as leadership changes, energy must remain a priority.

TECHNOLOGY

Realizing the Energy Vision will require sustained Navy investment at all levels of technology development: basic energy science; research and development; testing and evaluation; procurement; and maintenance and monitoring. Some initiatives will optimize existing systems; others will introduce or optimize new systems. Some will be evolutionary; others may be revolutionary. Together, they will power the Navy's next great energy transformation.

Fuel and energy efficiencies achieved through technology investments may be used for additional capability; when that capability is not needed, these same efficiencies will produce energy savings. Although payback periods will vary, many investments will provide net savings to the Navy by lowering the total ownership cost of systems. Initiatives with immediate energy savings may be effectively self-funding. Proposed energy investments will be rigorously analyzed to provide the greatest possible return on investment—in capability and in savings—for the Navy. The assessment process will also ensure that proposed energy solutions would not simply replace existing vulnerabilites with new ones. The Nation may benefit from Navy's investment in energy technologies, such as energy storage solutions and biofuels, which are likely to have civilian applications.

POLICY

Some of the most cost-effective energy initiatives will combine advances in technology with forward-looking policies and old-fashioned incentives. The maritime i-ENCON program is a prominent example of such an approach. New technologies can inform everyday operations by monitoring energy consumption directly or providing data on factors that influence consumption, such as observed or forecast weather and ocean currents. These technologies enable the real-time decisions that define energy efficient operations. The Navy may also have to adapt policy to support effective use of new technologies and ensure the full realization of advantages derived from them. Where a policy change will enhance energy security without negatively impacting readiness, the Navy will favor energy efficient operations. Navy business processes will similarly reflect the high priority of energy.

STRATEGIC PARTNERSHIPS

In pursuing energy initiatives, the Navy will seek to leverage the knowledge and resources of inter-service, interagency, and international partners. Strong collaboration on energy issues is essential to minimize redundancy in the face of constrained budgets and maximize return for the Nation and Allies.

The Navy will continue to work closely with the Marine Corps and the Deputy Assistant Secretary of the Navy for Energy to ensure energy security for the Department of the Navy. Other government partners will include the Air Force, Army, DOD organizations, and Federal agencies. For example, the Navy will collaborate via memoranda of understanding with the Department of Agriculture on biofuels and with the Department of Energy on smart grid technology, renewable energy, and other issues. State and local energy offices will also be valuable partners, potentially providing incentives through third parties for energy initiatives ashore.

The Navy will pursue public-private partnerships where possible to support the best ideas of industry and drive an energy focus in the industrial base as DOD seeks to reform how it does business. Whether the solution is an efficient engine, an alternative fuel, or a solar panel, only industry can provide the final product for use in Navy operations. Partnerships with local utility providers will address common challenges in advancing the deployment of alternative energy and energy security strategies. The Navy will also engage with academic institutions and non-profits to inform the implementation of the Energy Vision and stimulate rigorous public debate on energy issues.

Finally, the Navy will reach out to friendly nations and coalition partners to identify solutions and develop new capabilities collaboratively. Some Allies have been addressing the high cost of fuel for many years and co-invest with industry in the development of energy technologies. Working jointly with foreign ministries of defense and energy has the potential to reduce costs and strengthen markets while challenging status quo approaches. With guidance from the Office of the Secretary of Defense and the State Department, the Navy will structure cooperative proposals that offer significant return on investment for all parties.

CULTURE CHANGE

Although Navy leadership sets the course, realizing the Energy Vision requires the dedication of all members of the Navy organization. Even the most efficient technologies and comprehensive policy support do not guarantee efficient operations. Whether uniformed or civilian, officer or enlisted, every individual must contribute to a culture that values energy as a strategic resource. Energy awareness training will ensure that every Sailor has the necessary knowledge to act, and incentives may be applied to promote energy-conscious behavior. The Navy has built capacity in energy management ashore for years, and Navy tactical communities increasingly demonstrate efficient operating procedures that save fuel and enhance readiness. Changing the culture means that everyone, down to the deck plate, understands how energy security is fundamental to executing our mission.

"Energy reform and the new energy economy are not just talking points. It's not a political game. It means lives of our troops. It means making our military better fighters. It means making our country more independent."

— The Honorable Ray Mabus, Secretary of the Navy

CONCLUSION

Successful implementation of the Energy Strategy and realization of the Energy Vision will depend on a variety of factors. Among the most difficult to predict are future mission requirements, fleet structure, and operating tempo. Introducing new technologies and operating procedures may require modifications to policy. While today's fight is ongoing, and the character of tomorrow's is uncertain, the Navy must maintain the long-term perspective required for investing in a new energy posture. Despite the challenges, the Navy is committed to an energy transformation that will provide strategic and operational advantages and serve as a model of energy security for the Nation.

EXECUTIVE SUMMARY

CNO Guidance: Provide a Navy Energy Strategy that treats energy as a strategic resource

Ends	Ways		Means
Vision	**Strategic Imperatives**	**Targets**	**Enablers**
▪ A Navy that values energy as a strategic resource ▪ A Navy that understands how energy security is fundamental to executing our mission afloat and ashore ▪ A Navy resilient to any potential energy future	▪ Assure Mobility ▪ Protect Critical Infrastructure ▪ Lighten the Load ▪ Expand Tactical Reach ▪ Green Our Footprint	▪ Increase Alternatives Afloat ▪ Sail the Great Green Fleet ▪ Increase Alternative Energy Ashore ▪ Reliable Power for Critical Infrastructure ▪ Reduce Non-Tactical Petroleum Use ▪ Increase Efficiency Afloat ▪ Increase Efficiency Ashore ▪ Energy Efficient Acquisition	▪ Leadership ▪ Technology ▪ Policy ▪ Strategic Partnerships ▪ Culture Change

Energy Security is having assured access to reliable and sustainable supplies of energy and the ability to protect and deliver sufficient energy to meet operational needs

PHOTO CREDITS

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