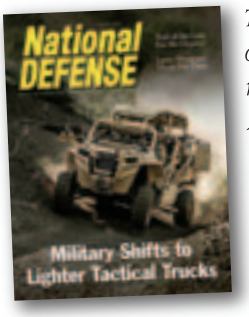
Being Energy Smart Creates More Combat Capability

Vice Admiral Philip H. Cullom Shares His Perspectives with *National Defense* Magazine



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ENERGY IS AT the core of U.S. Navy capabilities. Without nuclear power or liquid fuels, Navy ships cannot operate. Without charged batteries, SEALs' radios and night vision goggles are useless. Without quality fuel, aviators are grounded.

Conversely, secure energy supplies with a robust logistics train enables an enduring Navy presence around the globe.

Across the service, from operational planning to educational programs to procurement decision making, this simple truth is becoming more embedded in our thinking and actions.

Established by former Chief of Naval Operations Admiral Gary Roughead five years ago and reinvigorated by the current chief, Admiral Jonathan Greenert, Task Force Energy works to find the most cost-effective paths to improve energy security, which is the ability to assure that warfighters have the necessary energy resources when and how they require them.

While we all know that energy—in all forms—is critical for naval operations, only in the last five years have we begun to truly comprehend the significance of moving to an energy smart Navy.

Even before my days at the Naval Academy, I knew from reading history that energy mattered for military forces. In Operation Paukenschlag (Drumbeat), German U-boats targeted tankers off the East Coast in 1942.

But it wasn't just reading. As a young boy, I was riveted by my uncle's personal recollections of North Atlantic convoy duty in the early years of World War II, with ships afire at night as his destroyer escort raced to screen the rest of the convoy, dropping depth charges and hedge hogs along the way. Of course, toward the end of the war the tables were turned. Convoy duty became routine,

Vice Admiral Philip H. Cullom

The guided missile destroyer USS Mitscher (DDG 57).
MC2 Brian M. Brooks

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and in the Pacific, U.S. submarines had crippled the Japanese navy by cutting off fuel supplies from conquered territories.

As with all surface warfare officers, I spent a good deal of my formative time at-sea below the waterline, focused on understanding the complex engineering behind what made our surface combatants able to fight robustly. Energy—from monitoring the quality of fuel in the tanks to making sure that the electrons moved around the ship—was part and parcel of my daily life. For a long time, however, energy efficiency remained somewhat of an afterthought. The Navy's supply officers are top-notch in managing the flow of logistics and our tankers keep the ships topped off.

Like so many others, perhaps I simply assumed that this arena didn't require that much attention. I always had the fuel that I required. Energy was like air—always there and seemingly without cost to the warrior. Even as I learned how to measure fuel inventory and quality and conduct at-sea refueling evolutions, my real concern was on mastering the weapons systems and learning how to fight.

In the spring of 1998, U.S. forces stood on alert for potential military operations against Serbia to protect Kosovo civilians. My ship, the Aegis-guided missile destroyer USS Mitscher (DDG 57), was in the Adriatic Sea. Our load of Tomahawk missiles was the most rapid strike option available in theater. To refuel, we had to leave our patrol station, sometimes for eight to 12 hours, at least once a week. Refueling left the combatant commander without this capability. Not a single Sailor aboard Mitscher wanted to miss our opportunity to launch a strike due to refueling. The challenge was to minimize the risk that we wouldn't be there when the president called.

The incentivized Energy Conservation (i-ENCON) program began as a pilot program in the early 1990s. Ships that reduced fuel demand would share in the savings. The Navy did not want efforts to shave off energy demands to interfere with combat capabilities, thus the i-ENCON program didn't apply to operational environments. Many took this as a subtle signal that those energy efficiency measures weren't meant for combat environments.

With our eyes on potential combat threats in the Persian Gulf and elsewhere, the tricks to shave out fuel demand often fell by the wayside.

USS Mitscher (DDG 57).
Paul Farley

For my Mitscher Sailors in the Adriatic, we realized that i-ENCON wasn't a challenge for when we weren't worrying about combat operations but was actually a combat capability enabler.

Taking a page from the i-ENCON playbook, we began to sprint and drift when operationally feasible—a tactic adapted from an old fishing trick. We took a good look at the currents within our operating box. The navigator then charted courses so that we would steam to the edge of our operating box and ride a current down to the other end of our box.

During that drift time and depending on the tactical situation, we could manage our fuel burn by shutting down some engines. As prudent mariners, we watched traffic density and patterns; our engineers practiced rapid, reliable engine starts; and our combat systems teams drilled incessantly with the engineers in carrying out rapid responses to perceived or real air and surface threats.

My crew got so good at this that the fleet staff would radio us—"It's been four days, time to go unrep and get refueled." We would tell them that it wasn't necessary, that our tanks were still healthy in the green range. On several occasions, their incredulity required resounding tanks to convince them that we didn't need to leave station just yet.

In the end, due to this and other measures to minimize fuel use, we cut our refueling from every four-to-five days to well less than once a week. My crew's ingenuity and determination increased our operational availability, in a potential war zone, by perhaps 50 percent—while reducing demands on the strike group's logistics train and reducing fuel costs.

This was an epiphany deployment for me—the moment that light-emitting diode (LED) light bulb truly went off. Paying serious attention to energy in the operational environment is a path to reduce risks while delivering more combat capability. Part of that realization also involved a window on the networked complexity of the Navy's energy system. Aboard Mitscher, we played the hand we were dealt. As her captain, I couldn't modify her hull, change her engines or install more efficient heating and cooling systems to reduce fuel demand and increase endurance. That great warship resulted from decades of experience, technical development, and procurement decisions. But we did have a choice in operating that same equipment in a deliberately innovative manner.

In reality, however, choices in the operational environment can only go so far.

This requires a Navy-wide strategic focus on energy, as pursued by Task Force Energy, in collaboration with U.S. Fleet Forces and Pacific Fleet. Starting with targeted research and development by the Office of Naval Research (ONR), detailed engineering analysis at systems commands and then evaluation on our ranges, these promising energy projects reveal their expected lifecycle cost and a

Sailors aboard the USS Mitscher (DDG 57) line up after an underway replenishment and refueling at sea.
MC2 Anthony R. Martinez

combat edge. Our training and education programs benefit from them as well.

We have several initiatives under way. The Naval Air Systems Command is working on the "intelligent engine demonstrator" which has an objective not just to squeeze more power out of every drop of fuel but to deliver and manage electricity more effectively to the aircraft's systems, which could include directed energy weapons.

A critical energy enabler is finding more energy dense battery options to support unmanned underwater vehicles. Battery power is a key limiter to operational endurance. This effort—spanning across the Department of Defense, the Department of Energy and private industry—has had solid results that will enable far more capable unmanned undersea vehicles by the end of the decade than many thought possible even a few years ago.

The Defense Production Act (DPA) assists developing drop-in biofuel plants and refineries, capable of producing advanced second-generation biofuels at cost-competitive prices for the Navy-Marine Corps team. DPA funds capital investment of companies that will drive down the price of military-grade biofuel. Three companies—Emerald Biofuels, Fulcrum BioEnergy and Red Rock Biofuels—were awarded phase two contracts in September 2014 to construct commercial-scale, integrated bio-refineries to produce alternative military specification fuels that are cost-competitive with conventional petroleum. Production begins in 2016 at an estimated cost of $3.45 per gallon, below the current price of $3.61 per gallon for F-76 and $3.64 per gallon for JP-5.

Many think this move is just about being green. Green it may be, but more powerfully it diversifies our energy portfolio and provides liquid aviation and maritime fuel that is consistently at, or cheaper than, the price of conventionally derived petroleum. That may allow us to train more to become better warriors or facilitate use of this resource for other readiness needs for the Navy.

Off in the far distant future, ONR is working on a program to make fuel from seawater. If this seems like fantasy, an unmanned aircraft has already flown with the fuel. We know it works, at least on a very small scale. The challenge is to develop a cost-effective path so that someday every strike group is making its own fuel and we can finally cut the fuel umbilical cord. This won't be the Navy of 2025 but could be a reality in a few decades.

And most recently, several energy companies have publicly announced the pursuit of fusion with plans to field a compact fusion reactor prototype within three years and potential initial production in a decade. If these initiatives are successful, it's possible that the Navy will not only have installations but ships powered by compact fusion reactors. Energy may then become the resource for propulsion and sensors as well as the weapon itself.

It is our Sailors who will unlock and unleash the ideas of this energy culture change and marry them with new efficient technologies.

The research, development, testing and evaluation program spans from these large-scale game changers to specific technology advances that are being leveraged now. For decades, Navy researchers have been involved with solid-state lighting and LEDs. Uncertainty about performance in the maritime environment, combined with steep upfront costs, has limited the applicability to our acquisition programs. However, we now understand these systems far better, and the purchase costs have plummeted. With each passing day, LEDs are providing high-quality lighting to ever more Sailors operating at the tip of the spear.

Across our acquisition programs, from the major platforms to LED lighting, analysis is playing a key role. We want to understand trade-offs. Costs are not just monetary but include training time, implications for maintenance, inventory control and, most importantly, uncertain impacts on the operational environment. Benefits are also complex and not just financial.

We will only move forward if we have confidence that the benefits, especially in operational capability, outweigh any costs. This analytical effort ranges from including energy as a "key performance parameter" in major acquisition programs—seeking to assure that the program incorporates the most effective use of energy—to financial analysis of how fast an energy efficiency measure will provide a financial payback.

The reality is that, in a great number of cases, the returns are far better than what investors see from Wall Street. The Navy is adding stern flaps to an increasing number of platforms. The stern flap reduces drag and allows the ship to move more efficiently through the seas like a spoiler on a sports car. Financially, these stern flaps pay for themselves in less than two years. More importantly, the few percent of fuel savings translates to greater range.

One of Task Force Energy's great realizations is that our best payoffs don't always come from big silver bullets but from the cumulative value from a range of silver BBs. Stern flaps save a few percent of fuel demand. Putting an energy dashboard on the bridge, with detailed information on energy performance, enables more informed decisions and cuts another percent. The Navy is deploying a navigation aide that, when the operational environment allows, automatically leverages ocean currents to advantage for, again, a percent or two greater efficiency across the surface fleet. A percent here and a percent there begin to add up to serious numbers.

Some larger payoff opportunities do exist. These include the hybrid propul-

The amphibious assault ship USS Makin Island (LHD 8).

Sailors and Marines man the rails aboard the USS Makin Island (LHD 8).
MC2 Alan Gragg

sion system, which is moving into additional platforms after an extremely successful performance in the USS Makin Island (LHD 8) amphibious assault ship. Some nickname Makin Island the "Prius of the Seas." Simply put, at lower speeds and while in holding patterns, she uses an auxiliary engine to generate electricity efficiently for propulsion and reserves the gas turbines for higher speeds.

Too much of the discussion around Makin Island has focused on the fuel savings as a monetary payoff. While the ship is saving money by using far less fuel, far more important is that its fuel savings equate to 50 additional underway days a year, or 17 percent longer operational endurance without refueling. This same technology is available for smaller surface combatants like DDGs where they too, particularly in a ballistic missile defense role, spend significant time in a cruiser-destroyer holding pattern. The first retrofit of those DDGs will make its debut in 2016 and forward fits make an even more compelling case.

Opportunities exist to improve understanding of energy issues and become more effective in our use of energy. It is our Sailors who will unlock and unleash the ideas of this energy culture change and marry them with new efficient technologies. The Naval Postgraduate School's energy master's degree program develops officers with the detailed analytical skills to understand the complexity of energy issues and support internal Navy decision making to determine the best investments moving forward.

Throughout the Navy, energy awareness sessions provide education regarding energy smart measures—from turning off light bulbs to the importance of assuring that pumps are operating efficiently—that will both save money and strengthen the force. Whether the surface fleet's i-ENCON or the Aviation Energy Conservation Program, our operating forces are being incentivized to find paths toward more effective and efficient use of energy in ways that will not adversely affect mission performance or safety. In fact, in a surprisingly large number of situations, these measures actually improve mission performance and safety. And we've recently established the Energy Warrior digital app as a tool to communicate across the fleet, especially with young Sailors, about how everyone in the Navy enterprise—from the civilian engineer at a base to the Sailor deployed forward—can find ways to be ever more effective in the management and use of energy.

The Energy Warrior program, in part, seeks to recognize those across the Navy who have had their LED moments and who perhaps have discovered paths to reduce non-mission essential energy demands amid an operation and thus increased endurance and helped foster sharing of those lessons and methods across the Navy. They're figuring out how, just as we did on Mitscher, to more effectively play the energy hand they've been dealt.

My job as deputy chief of naval operations for fleet readiness and logistics is to stack the deck for today's and tomorrow's Sailors by providing platforms and systems with greater capabilities than our adversaries, across the entire conflict spectrum. Our training programs—from Top Gun to energy awareness classes—seek to create a team that can play that hand to the maximum.

Energy is one of the Navy's most critical enablers while potentially representing the most significant vulnerability to adversaries. Taking energy seriously in our research programs, acquisition, education and training reduces those vulnerabilities and enhances our strategic, operational and tactical advantages. It is time for all of us to positively disrupt our energy future for our 22nd century Sailors. ⚓