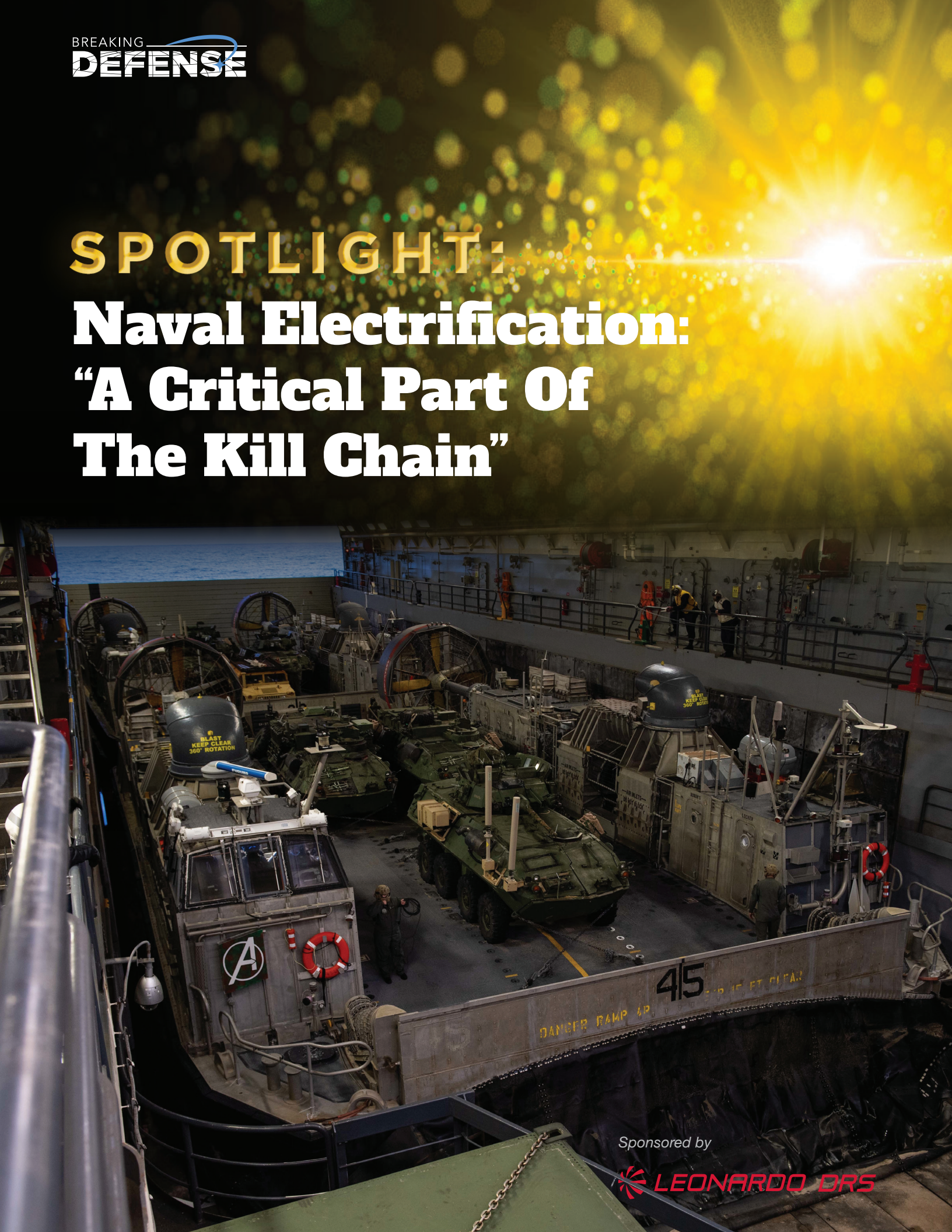
BREAKING DEFENSE

SPOTLIGHT:

Naval Electrification: "A Critical Part Of The Kill Chain"



Sponsored by

LEONARDO DRS

BREAKING DEFENSE

NAVAL ELECTRIFICATION:

"A Critical Part Of The Kill Chain"

BY BARRY ROSENBERG, Contributing Editor, Technology & Special Projects

Driving naval electrical power needs are directed energy weapons, high-power radars, escalating fuel costs, and the Navy's desire to expand operations without increasing its environmental footprint.



The Columbia-class ballistic missile submarine, shown in an artist's conception, will have an electric-drive power-propulsion system developed by Leonardo DRS.

On the surface, a Navy amphibious transport dock ship and an Arleigh Burke-class guided-missile destroyer (DDG) have little in common. Both, however, are now playing important roles in Navy experiments to bring electrification to the fleet.

To test the viability of electric propulsion, battery power for directed energy weapons, and energy management for shipboard applications, the Navy has partially electrified several of those ships with these systems:

- An Energy Storage Module on the USS Portland amphibious dock ship (LPD 27) to support the Solid State Laser;
- The High Energy Laser with Integrated Optical-dazzler and Surveillance (HELIOS) on the USS Preble (DDG 88); and
- The Air and the Missile Defense Radar (AMDR) Power Conversion Module on the first DDG 51 Flight III Arleigh Burke-class destroyer launched in June—the future Jack H. Lucas (DDG 125). The Flight III configuration is centered around AN/SPY-6(V)1 Air and Missile Defense Radar and incorporates upgrades to the electrical power and cooling capacity

The Navy's 2019-2037 technology development roadmap for Naval Power and Energy Systems (NPES) calls naval electrification "a critical part of the kill chain" based on its electrification needs for high-power radars and networks, directed-energy weapons for counter-unmanned systems and missiles, and prime mover propulsion for silent running and the severing of the logistical chain for refueling.

ON THE COVER: The Navy installed an Energy Storage Module on the USS Portland (LPD 27) to support the Solid State Laser. Shown are sailors and marines preparing to launch two landing craft from the well deck of the USS Portland. (US Navy photo).

"The Navy expects more out of its future fleet." states the NPES report. "Electricity allows moving large amounts of energy from one place to another, controllably and quickly, making the energy resource (power generated by prime movers) extremely fungible. The trend towards electrification of warfighting capability takes advantage of, and relies upon, the fungible nature of electricity.

"An integrated energy system involves converting energy to the electric weapon or sensor's needs. The vision of integrated power and energy systems carries this further, with the end-goal of linking all energy consumers with all energy sources in a single electrical network to maximize flexibility in affecting the ship's functions, namely a total and complete solution for Tactical Energy Management that provides capability optimization."

ELECTRIFICATION FOR WHAT SPECIFICALLY?

There are a number of drivers for increased U.S. naval electrical power needs, including new and more advanced weapons systems and radars, escalating fuel costs, and the Navy's stated desire to expand operations without increasing its environmental footprint. These drivers include:

- ***Advanced Payloads:*** Arriving in the near future are power-hungry next-generation technologies like higher-power radar systems and offensive/defensive directed energy lasers that the Navy wants to incorporate onto a range of ships. High bursts of energy by pulse-power weapons along with advanced air and missile defense radar sensors demand more power—which is power that can't always be met by mechanical systems.

- ***Advanced Propulsion:*** This provides significant warfighting capability in the areas of enhanced survivability, deployment of unmanned platforms, flexible design and upgradeability throughout vessel interiors, and increased platform endurance for distributed maritime operations.

- ***Cost:*** Operations and maintenance costs for the Navy far exceed shipbuilding costs. Included in that is the on-the-rise price of gas and diesel fuel along with the logistical-support costs to deliver it to ships at sea. Electric and hybrid-electric drives can address many naval power and propulsion needs with reduced fuel and fuel-transportation costs, while also enabling use of simpler and less expensive fixed-pitch propellers.

- ***Environmental:*** Ships operating with or transporting fuel generate carbon dioxide that contributes to global warming. The environmental benefit of electric drives is significant and directly proportional to the operational cost savings.

Naval ships that are less dependent on their supply chain for fuel and also better equipped with high-powered radar systems and directed-energy weapons will also be more suited to the Navy's new warfighting concept known as Distributed Maritime Operations targeted at China and Russia in the Great Power competition.

"China is basically doing all they can to push our Navy ships further away from the mainland and the South China Sea," said Jonathan Miller, senior vice president and general manager for Naval Power Systems at Leonardo DRS. "That increases the amount of radar and sensing power you need to operate defense and tactical systems and potentially deliver naval weapons at a standoff distance. Electric power systems can make more efficient use of existing power and deliver that energy on an intermittent basis as needed."

In broad terms, DMO marks a shift away from increasingly vulnerable large platforms operating as a group and toward a widely dispersed but highly networked fleet of mostly smaller vessels and intelligence/surveillance/reconnaissance aerial platforms, both manned and unmanned, integrated closely with a broad array of sensor and weapon systems for maximum domain awareness, survivability, and lethality.

The DDG 51 Flight III development is specifically targeted at the DMO Concept of Operations that will permit the Navy's most advanced surface-attack vessel to operate offensively and defensively, independently, or as units of Carrier Strike Groups, Expeditionary Strike Groups, and Surface Action Groups in multi-threat environments that include air, surface and subsurface threats. These ships will provide or augment power projection, forward presence requirements, and escort operations at sea.

"Electrification and hybridization support a more powerful naval force with reduced logistics requirements," Navy spokesperson LT Lewis Aldridge at the US Navy Office of Information (CHINFO) at the Pentagon told Breaking Defense. "Increasing our lethality tooth while reducing our logistics tail means more bang for the American people's dollars—literally."

ELECTRIFICATION IS LIKE A MULTIVITAMIN FOR NAVAL SYSTEMS

At its essence, improved combat capability and lethality is at the heart of electrification by providing opportunities to expand the operational reach of platforms through improvements in energy efficiency and the sharing of power from stem to stern. And notably, from an environmental standpoint, the same technologies that support enhanced combat power and lethality also have positive impacts on climate change.

In addition to improving payloads, propulsion, cost, and the environment, electrification is like a military multivitamin that can provide essential elements to many areas of operations. For example:

Survivability: This offers improvement in susceptibility (ability to avoid detection, reduce the probability and number of hits, or store weapons in less vulnerable areas), vulnerability (ability to withstand damage, minimize casualties, and maximize the ability to recover), and recoverability (restoration of key capabilities such as mobility, seaworthiness, critical ship systems, and warfighting capabilities).

Unmanned Systems: Shipboard NPES can be developed to support rapid, simultaneous charging of multiple unmanned systems to improve the effectiveness of deployable assets in theater.

Communications and Information Security/Cybersecurity: Communications and information are vital to supporting situational awareness and coordinated decision making. The Navy is requiring that cybersecurity be built in and native to the design and development of new NPES products and systems.

Flexible Ship/Modularity/Standard Modular Interfaces: This will permit parallel development of payloads and platforms, just-in-time installation of payloads, more efficient and frequent modernization and technology refresh, and faster mission reconfiguration as needed.

RESOURCES TO LEVERAGE FOR ELECTRIFICATION

Generating electric power for propulsion, high-power radars, and directed-energy weapons is only half the challenge. Storing that energy and managing it in such a way that it can be doled out in an unlimited number of pulses for laser weapons, for example, or having the ability to shift it around a vessel to where it's needed most are the second half of the challenge.

"The Navy is developing safe, high-density, high-cycle-life energy storage systems and advanced power management controls to support Energy Magazine integration into ships as either a point of use capability (backfit) or in a future power system electrical architecture as part of an overall Integrated Power System ," explained Aldridge. "The Energy Magazine is a common, modular, scalable, intermediate energy storage system that could be used across multiple mission systems and ship installations, which can supplement typical ship service power to avoid putting stochastic, large pulsed loads directly on generators."

Additionally, as the Navy develops its DDG(X) future, large surface guided missile destroyer, it will incorporate an Integrated Power System to enable power generation capacity to be stored and directed where needed, i.e., propulsion and mission systems, according to Aldridge. In fact, stored energy was the original function of the Navy's Energy Magazine program to enable single-turbine-generator operations back in the 2019 timeframe.

Like stored energy, specifically designed power modules for use aboard Navy ships, using commercial technology where appropriate, can contribute to increased onboard power.

So can leveraging existing architectures to reduce both costs and risk. For example, the modular and scalable Columbia-class ballistic missile submarine electric power/propulsion architecture, developed by Leonardo DRS, was specifically designed for common use on both submarines and surface ships.

"The Navy clearly sees the demand for electrification of its ships.," said Miller. "They've taken several major steps in that direction, and have clearly signaled that they're planning to do that more with newer classes of ships.

"For the Navy to progress toward a future electric-drive fleet, while optimizing existing power aboard the current fleet, the service must leverage all of its resources," said Miller. "That includes: first, optimization of current ship architectural designs to increase power and facilitate use of intermittent power; second, more efficient use of existing power through energy storage and process adjustments like changing fan speeds rather than throttling airflow to waste heat recovery; and third, greater use of specifically designed power modules, using commercial technology where and when it makes sense."