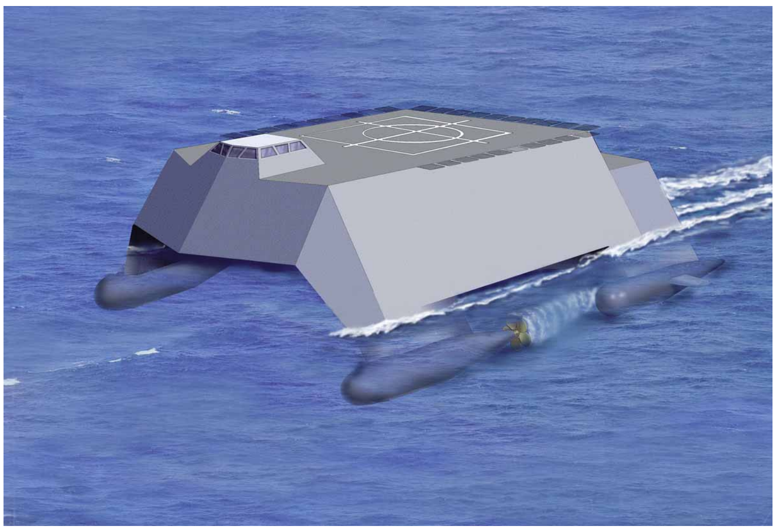
A FUTURE NAVAL CAPABILITY

Electric Warships & Combat Vehicles

Warships and combat vehicles are currently built with their propulsion systems separate from their auxiliary systems and weapons. The large amounts of power locked in the mechanical propulsion train are not available for other uses. Future all-electric warships and combat vehicles will break this paradigm, releasing large amounts of energy for pulsed power weapons and sensors. The move to integrated all-electric designs will significantly improve efficiency, effectiveness, and survivability while simultaneously increasing design flexibility, reducing costs, and enhancing Sailors' and Marines' quality of service.



Why is this Future Naval Capability Important?
The Electric Warships and Combat Vehicles Future Naval Capability (FNC) will develop and demonstrate critical technologies for Naval platforms to make the most effective and efficient use of their power plants, and to unlock propulsion power, making it available for other uses. Surface ships, submarines, and Marine Corps vehicles will be revolutionized by electrical power generation, propulsion, conditioning, and distribution technologies.

What's our investment strategy?
In developing the core investment program of this new FNC, the Electric Warships and Combat Vehicles FNC Integrated Product Team (IPT) will focus on identifying and filling capability gaps, fulfilling commitments to funded acquisition programs, and designing a strategy that would provide the wherewithal to execute the program. As a preliminary approach to this transformational family of technologies, we think three enabling capabilities will get us there:

· ***First priority.*** We need to improve tactical endurance. We can do so by increasing the power (and its quality) available to mission-critical systems. We can increase the overall tactical efficiency of our warships and combat vehicles as well as their payload fraction.

· ***Second priority.*** We need to support high-energy weapons and systems—providing power on demand for new pulsed power systems like the Electro-Mechanical Aircraft Launch System (EMALS), and future pulsed power weapons.

· ***Third priority.*** We need to enhance survivability by the reduced susceptibility to damage electrical systems provide, and we need to take advantage of the increased ability to fight-through damage they will afford.

How are we identifying and filling the gaps in these enabling capabilities?
The Electric Warships and Combat Vehicles FNC execution plan will concentrate on accelerated development and demonstration of technologies that will enable the filling of critical operational capability gaps in all-electric ships and vehicles. Each enabling capability will have a set of milestones and transition opportunities. In this newly established FNC, the enabling capabilities and their gaps are currently undergoing definition, but in general, these technological areas will yield the capabilities we're looking for:

Electric, reconfigurable ship technologies. These run throughout the warship and combat vehicle, from fueling, to electric power generation, to power distribution, to power conditioning, to power storage, to electrical motors that deliver mechanical energy, to propelling devices, and to the hull forms that give speed, silence, and efficiency.

Power generation. Reformers for fuel cells that would permit them to use lower-quality fuels are likely to prove a key enabling technology. This line of work would leverage the extensive work in fuel cells being supported by industry and other government programs by making those fuel cells compatible with marine logistics fuels.

Power distribution. Finding the best power distribution scheme for a reconfigurable electric ship will prove the most critical challenge. Meeting it involves choosing intelligently among many technical trade-offs: voltage, AC or DC, superconductivity, bus design, damage control, zonal power management, etc. Work is going on to leverage existing investments to create the means of making these choices intelligently.

Energy storage. We would like to be able to store electrical energy, not only for surge needs like aircraft launch and recovery or discharge of high energy weapons, but most fundamentally to provide system stability under rapidly changing conditions of damage, casualty, environment, and mission.

Virtual ship and electric device prototyping. Very successful on-line computer design of electrical systems and devices is bringing industry and academia into constant close and fruitful collaboration on new warship and combat vehicle design.

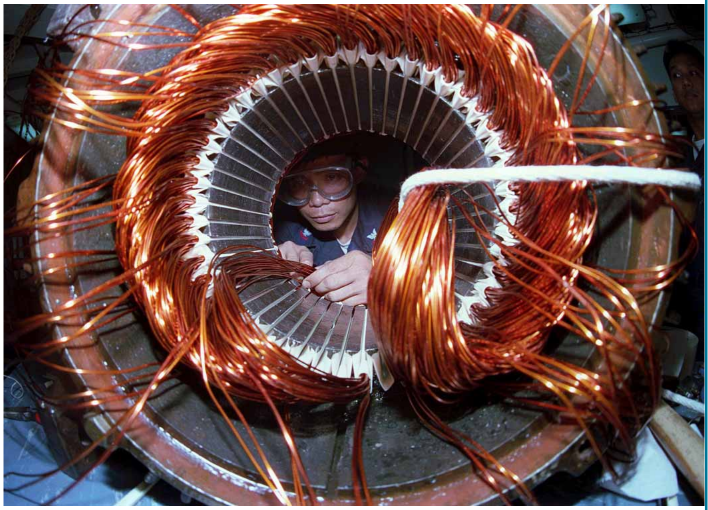
Power control and conditioning. A core science and technology program to create power electronic building blocks is transitioning to industry. The next step is demonstration of these technologies in shipboard environments.

Electric motors. Novel electric motors, systems, and subcomponents are being pursued: permanent magnet motors, superconducting synchronous motors, and homopolar motors.

Propulsors. Commercial ship propulsors now in production point the way to podded propulsors for warships. Waterjet technology also offers important opportunities. Such propulsors and standard shafted propellers will be integrated into new hull forms.

Demonstrator vessel. Equally important to developing discrete technologies is their insertion into a real advanced ship—a demonstrator. ONR is currently developing a demonstrator ship strategy which will include not only demonstration of electrical technologies, but new operational concepts. In the electrical arena, a significant challenge will be to achieve the power density needed to make the all-electric approach a viable option for small, fast ships.

Transition opportunities. Several core science and technology programs that relate to advanced electric ship technology are



aimed at DD-21 and its subsequent flights. The technologies that emerge from these programs will also be useful in other ships or ship concepts. As a strategy three independent paths are being pursued—development of individual reconfigurable ship technologies, development of a demonstrator ship program, and technology insertion into combat vehicle systems. We anticipate transition opportunities in areas like these:

- Quiet Electric Drive for Submarines.
- 625kW Fuel Cell and Reformer Demonstration.
- Podded Propulsor Development and Evaluation.
- Advanced Power Electronics Technology for EMALS.
- Aircraft Electrical Servicing Station.
- Virginia-class submarine non-propulsion electrification.
- Superconducting or high-speed generators.
- Electromagnetic weapons and sensors.
- Energy Storage.

What's some of the sustaining discovery and invention science and technology?

Exploitation and delivery depend upon discovery and invention. In ONR's vertically integrated program, we will continue to exploit basic work that proves relevant to future all-electric warships and combat vehicles:

- ***Material science***—including work in ***wide bandgap semiconductors and devices*** that will continue to increase available solid state power, efficiency, and linearity.
- Work in ***high-temperature superconductivity*** and ***magnetic materials*** will enable the development of advanced electric motors and power distribution grids.
- Work in ***energy-dense capacitors*** and ***advanced energy storage devices*** will enable miniaturization of pulsed power systems.
- ***Integrated hydrodynamic and propulsion system design*** will enable tactically significant performance improvements, especially in littoral operations.