Naval Energy Forum

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Outline

- Mission Systems Requirements
- Today's Platforms
- Looking into the future

"OUR SHIPS – THE SYSTEMS THAT WE USE AND THE POWER REQUIREMENTS THAT THEY HAVE ARE GETTING BIGGER ALL THE TIME. EVERY SYSTEM WE'RE PUTTING ON A SHIP NOW OR IN AN AIRCRAFT IS IN SOME WAYS SORT OF A POWER HOG... WE HAVE TO FIND A DIFFERENT WAY TO POWER THE THINGS WE NEED TO POWER."

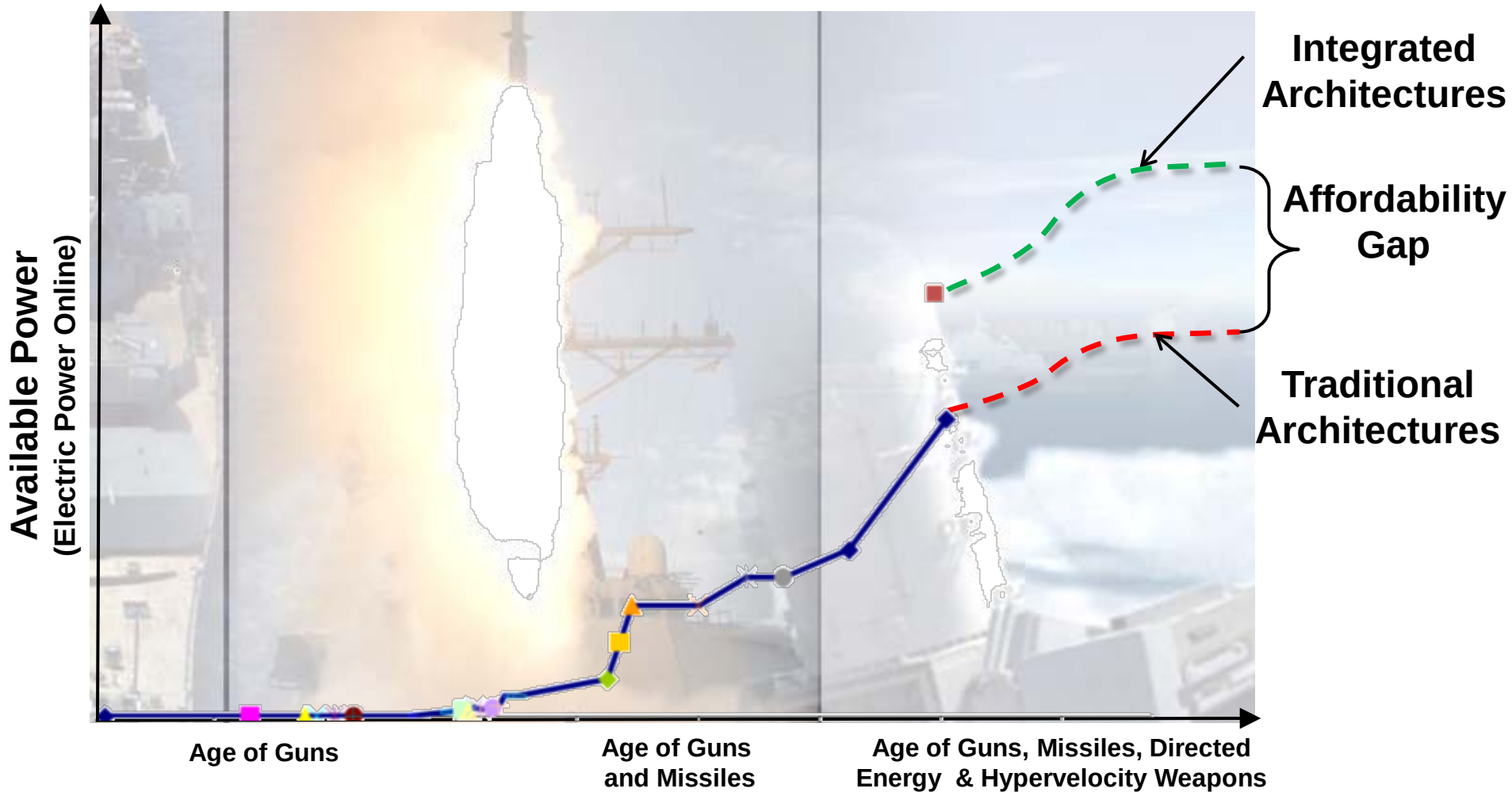
- HONORABLE RAY MABUS
SECRETARY OF U.S. NAVY

"OVER THE NEXT 10 TO 15 YEARS, THE NAVY WILL EVOLVE AND REMAIN THE PREEMINENT MARITIME FORCE. THE REACH AND EFFECTIVENESS OF SHIPS AND AIRCRAFT WILL BE GREATLY EXPANDED THROUGH NEW AND UPDATED WEAPONS, UNMANNED SYSTEMS, SENSORS, AND INCREASED POWER."

- ADMIRAL JONATHAN GREENERT
CHIEF OF NAVAL OPERATIONS

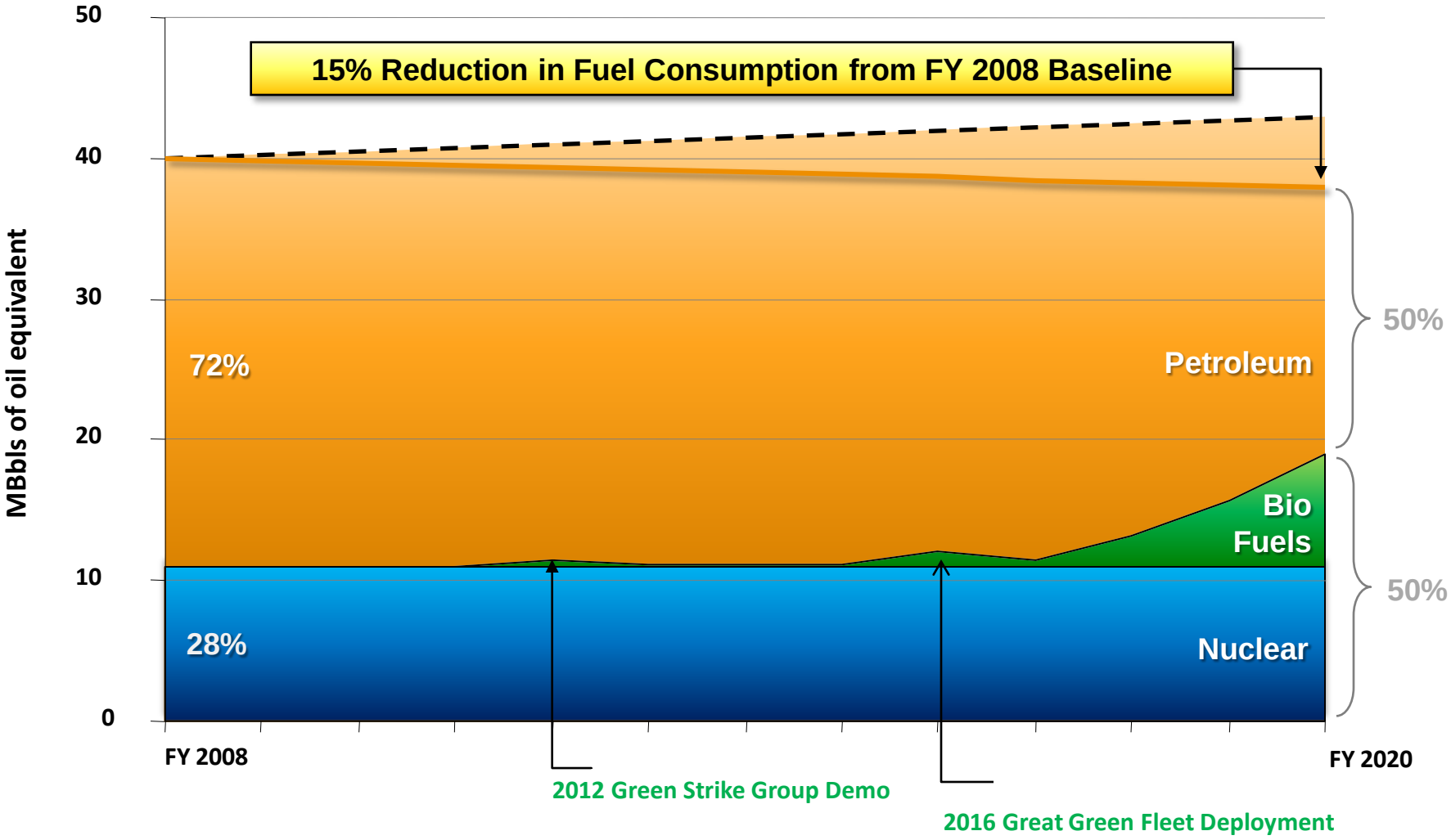
Fundamental Shift Required for Future Acquisition Programs

Warfighting Needs Drive Power Systems



Increased demands for power will continue for the foreseeable future

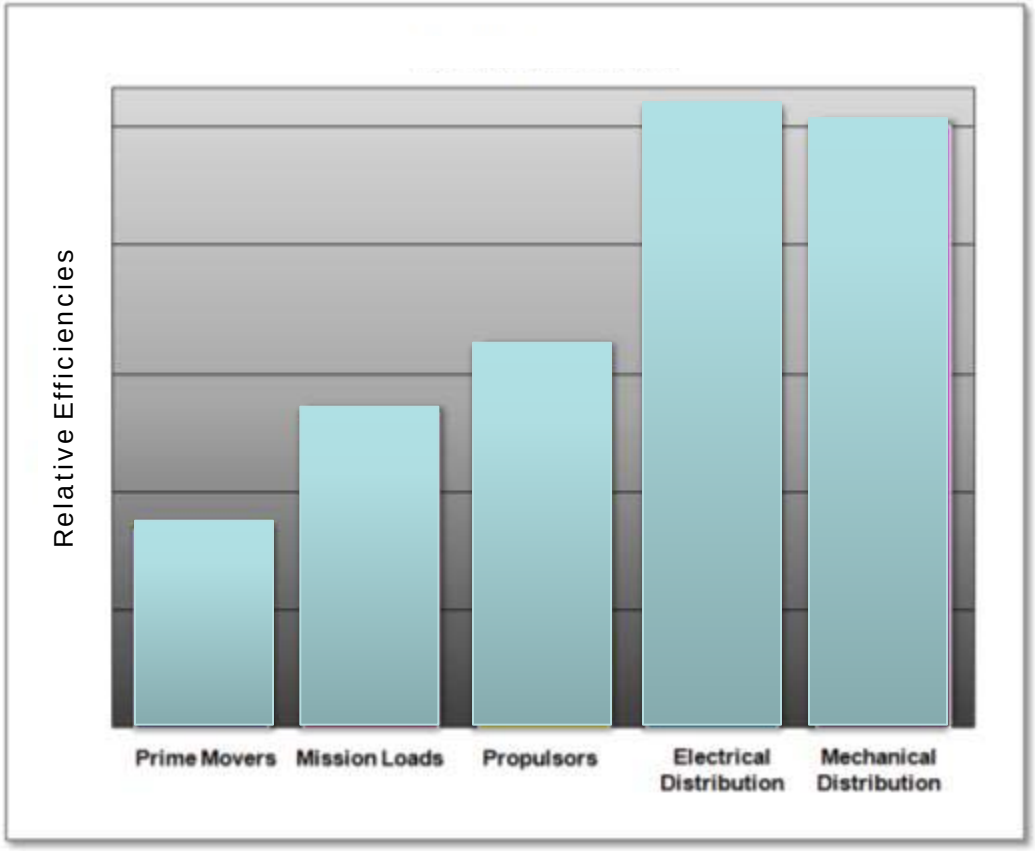
SECNAV Energy Goals



Reduce Consumption Through Conservation and Efficiency

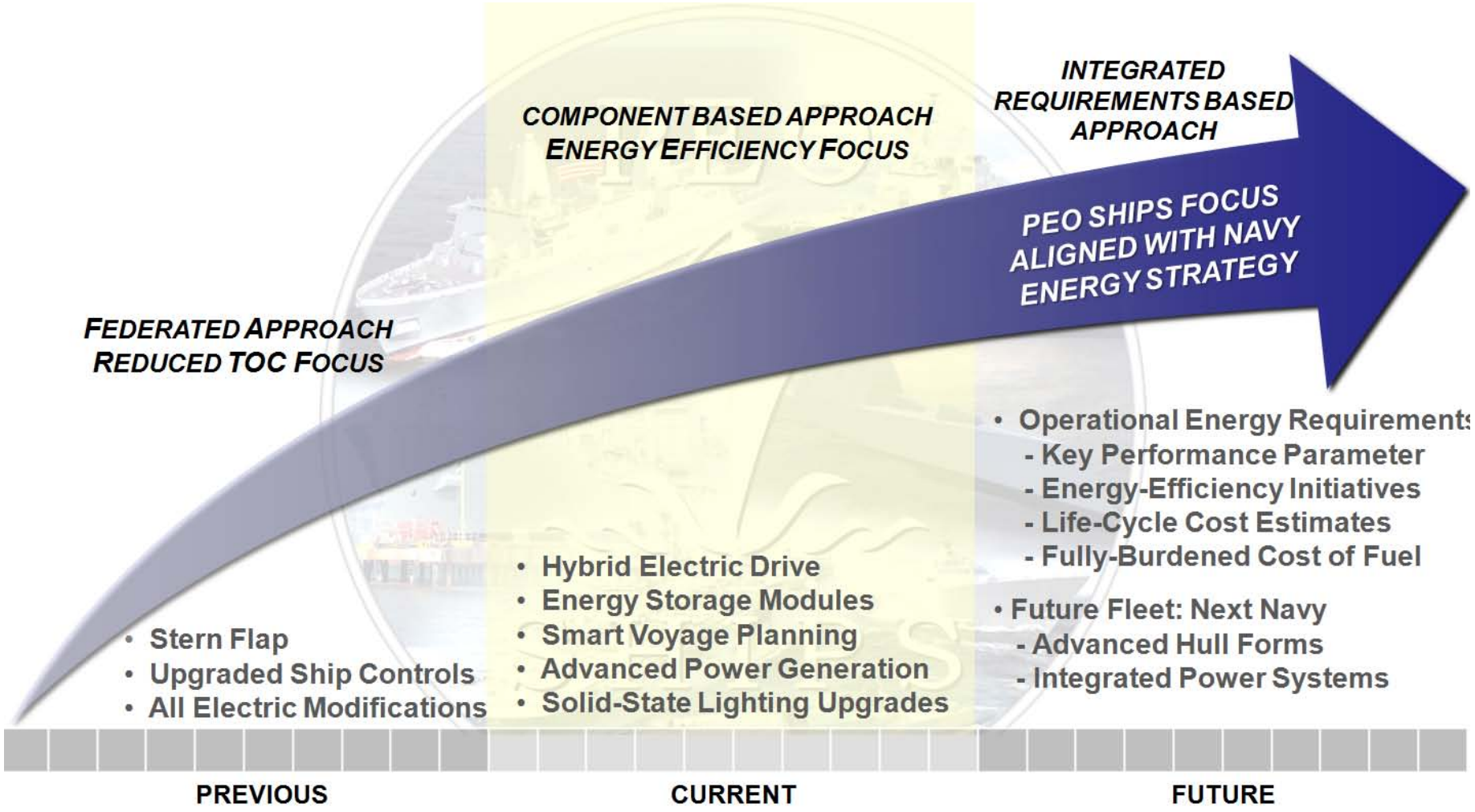
Opportunities for Energy Savings

- **Prime Movers**
  - Technical advances
  - Combined cycles
- **Ship Propulsion**
  - Propulsor efficiency
  - Hullform resistance
  - Energy Recovery
- **Electrical Loads**
  - Fans / Pumps
  - Mission Systems
  - Lighting
  - VFD's
- **Operating Concepts**
  - Alternate Architecture optimizes efficiency



Alternate Architectures Maximizes Energy Savings

Evolutionary Ship Efficiency Gains



Shifting to Integrated Approach

Component Efficiency Gains

Hybrid Electric Drive
Electric Propulsion System

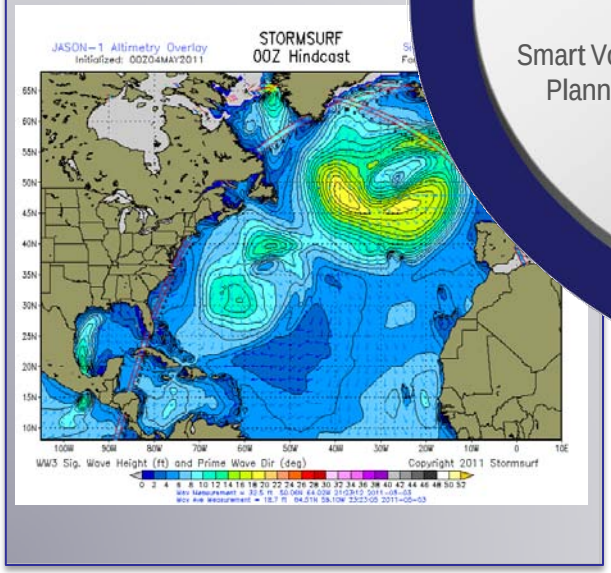
Advanced Power
Generation Module

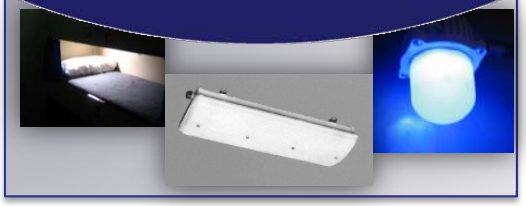
Energy
Efficiency
Focus

Smart Voyage
Planning

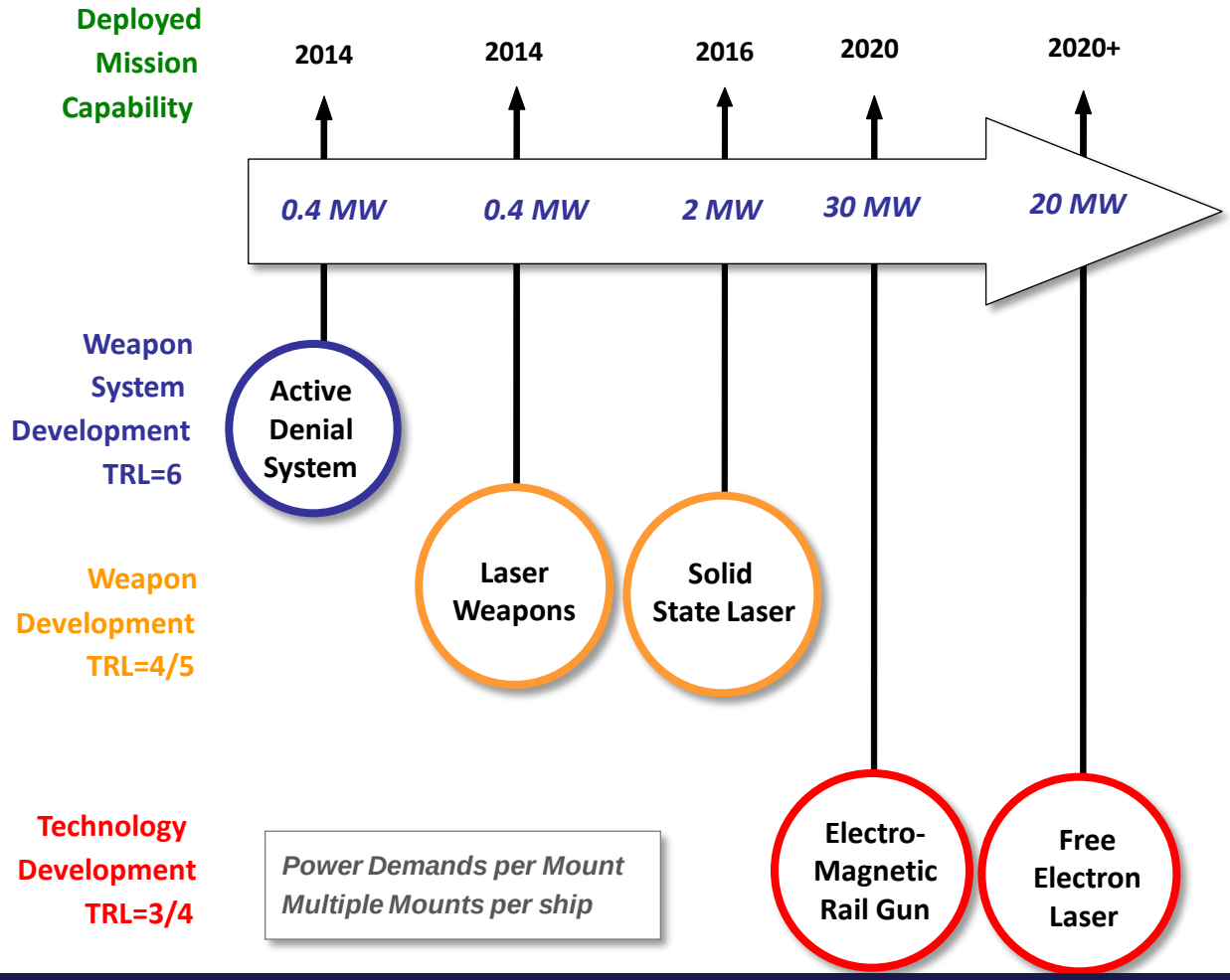
Energy Storage
Module

Solid State
Lighting





Mission Systems: Increasing Electrical Power Demands




Laser Weapon System

Sensor and Weapon System Power Demands will soon rival Propulsion Power Demands

Other Naval Key Technologies

UK (23 + IPS/hybrid ships)

- Type 23 Frigate, in-service – hybrid electric/mechanical drive
- Type 45 Destroyer, in-service – full Integrated Power System
- Albion Class LPD, in-service – full Integrated Power System
- Wave Class Oiler, in-service – full Integrated Power System
- CV(F) under contract – full Integrated Power System

Netherlands (2 ships)

- LPD "Rotterdam" Class, in-service – full Integrated Power System
- IPS declared for future surface combatants

France

- BPC (LPD) in-service, Podded Integrated Power System
- Future CV in design – full IPS, maybe Pods

France, Italy, Greece, Morrocco

- FREMM Frigate – Hybrid Drive (28 planned, 4 under construction)

Australia (2 ships)

- Canberra Class LPD - Podded IPS
- Collins Class SSG - diesel-electric

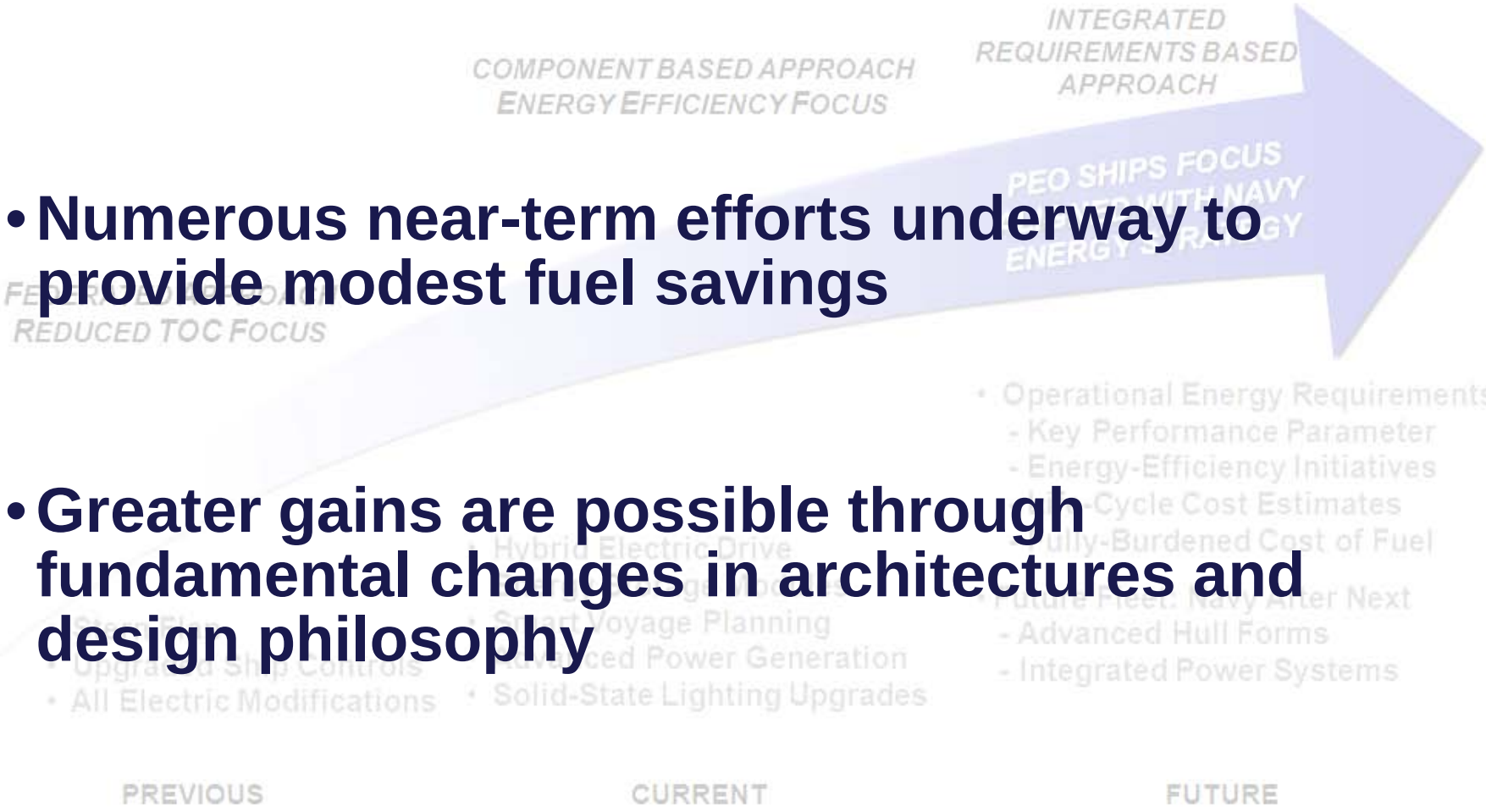
Germany

- U-212 Submarines
  - Diesel Electric w/ PM Motors
  - AIP systems using fuel cells

All diesel submarines are electric drive

Other Navies are already experiencing the benefits

Take-away



- **Numerous near-term efforts underway to provide modest fuel savings**
- **Greater gains are possible through fundamental changes in architectures and design philosophy**

Backups

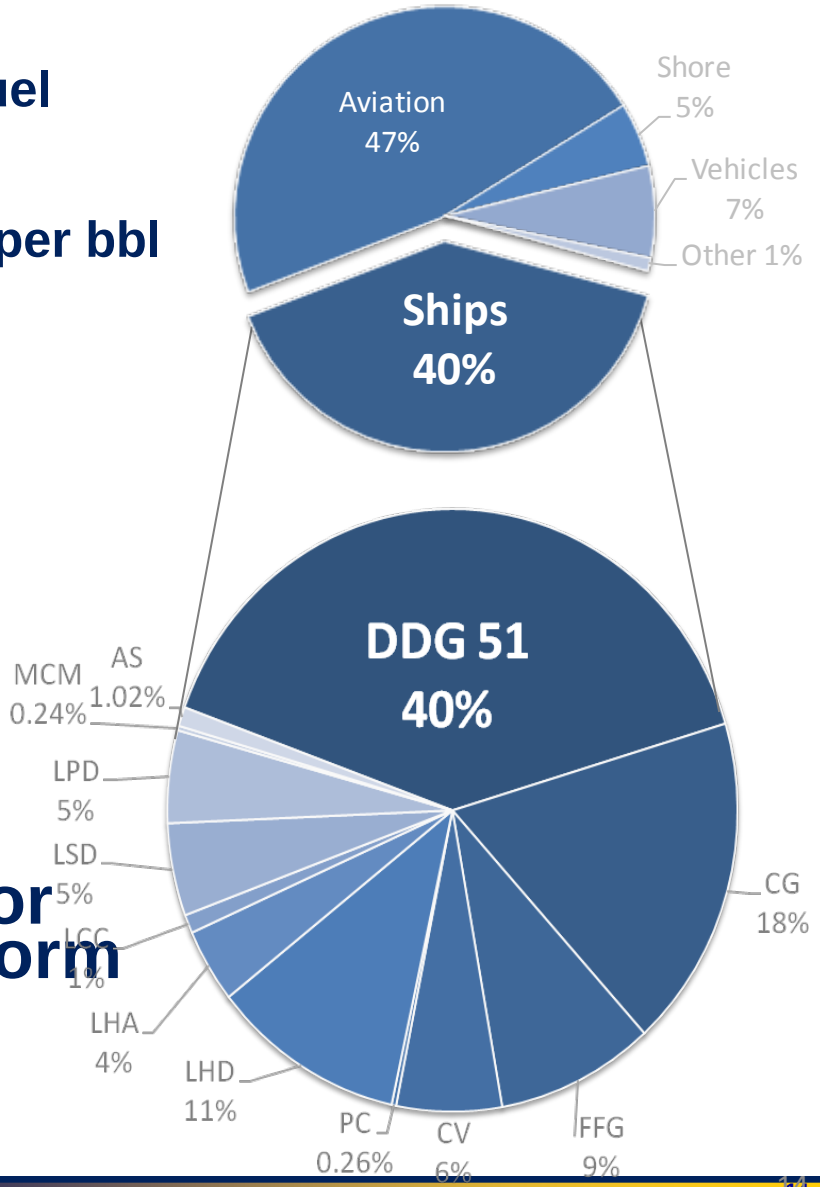
Today's Platform Initiatives

PLATFORM	RESULTS
	**Amphibious Assault (LHD 8 and LHA 6)** ◆ The first U.S. Navy amphibious ship built with Gas Turbine Engines and Hybrid Electric Drive resulting in **significant fuel savings compared with steam driven LHD**
	**Combat Logistics Force (T-AKE)** • T-AKE is powered by a commercial Integrated Power System, realizing **reduced acquisition and life cycle costs**
	**Surface Combatants (DDG 51)** • USS TRUXTUN (DDG 103) Hybrid Electric Drive (HED) and USS PREBLE (DDG 88) Energy Storage Module (ESM) to **demonstrate significant reductions in fuel usage**. HED acquisition program underway to backfit Flight IIA ships

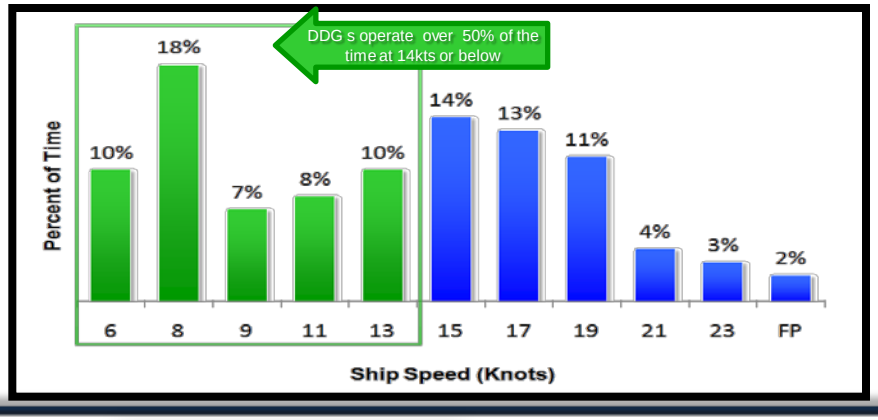
Enhanced Operational Capability at Reduced Costs

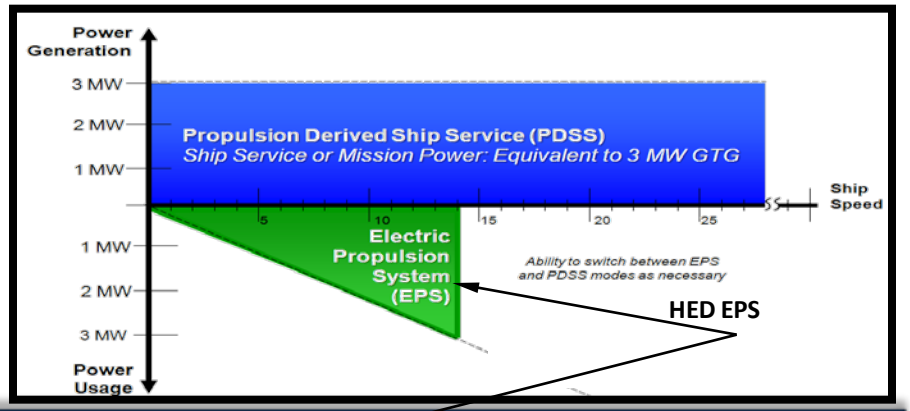
U.S. Navy Fuel Usage and Trends

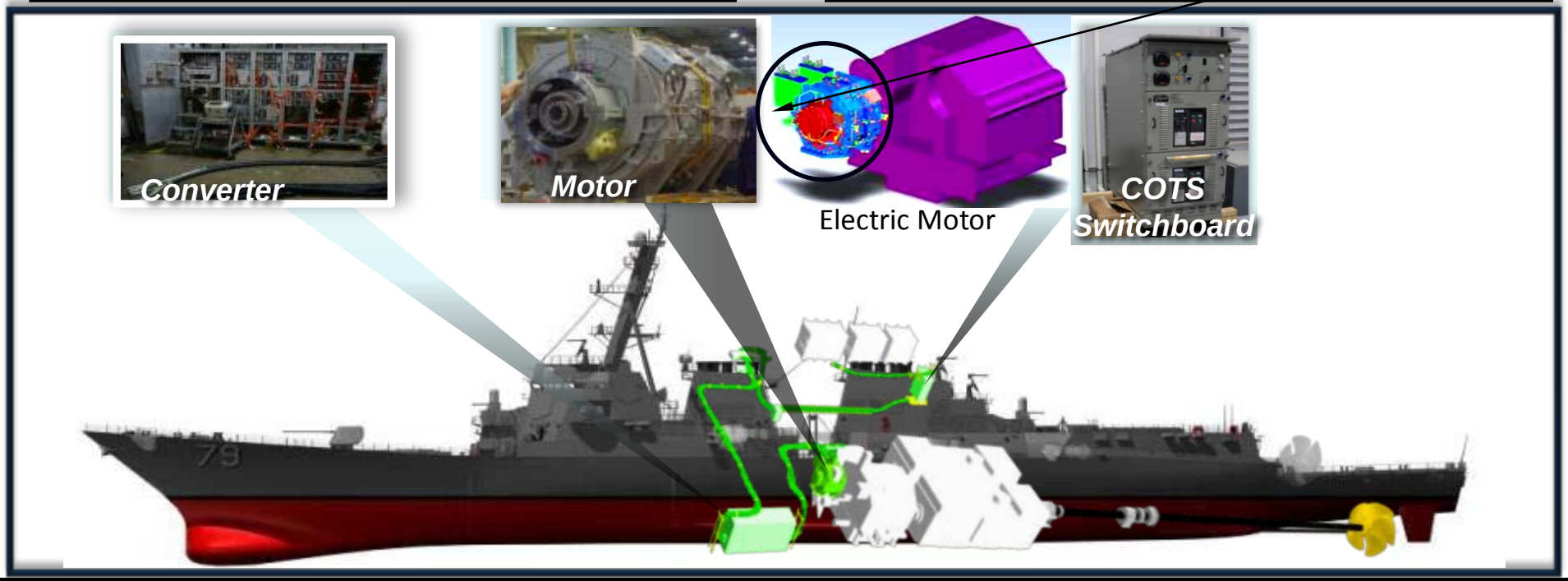
- Surface ships account for 40% of Navy fuel consumption
- Fuel cost uncertainty (~400% per bbl increase since FY03)
- Energy (fuel) Demand Increasing
  - Combat / Weapons Power
  - Force Structure Changing: Higher Fuel Consumption
  - Operational Requirements
- Why focus on DDG 51 Class?
  - Provides best opportunity for long term payoff given platform age, production restart, and quantity



DDG 51 Hybrid Electric Drive

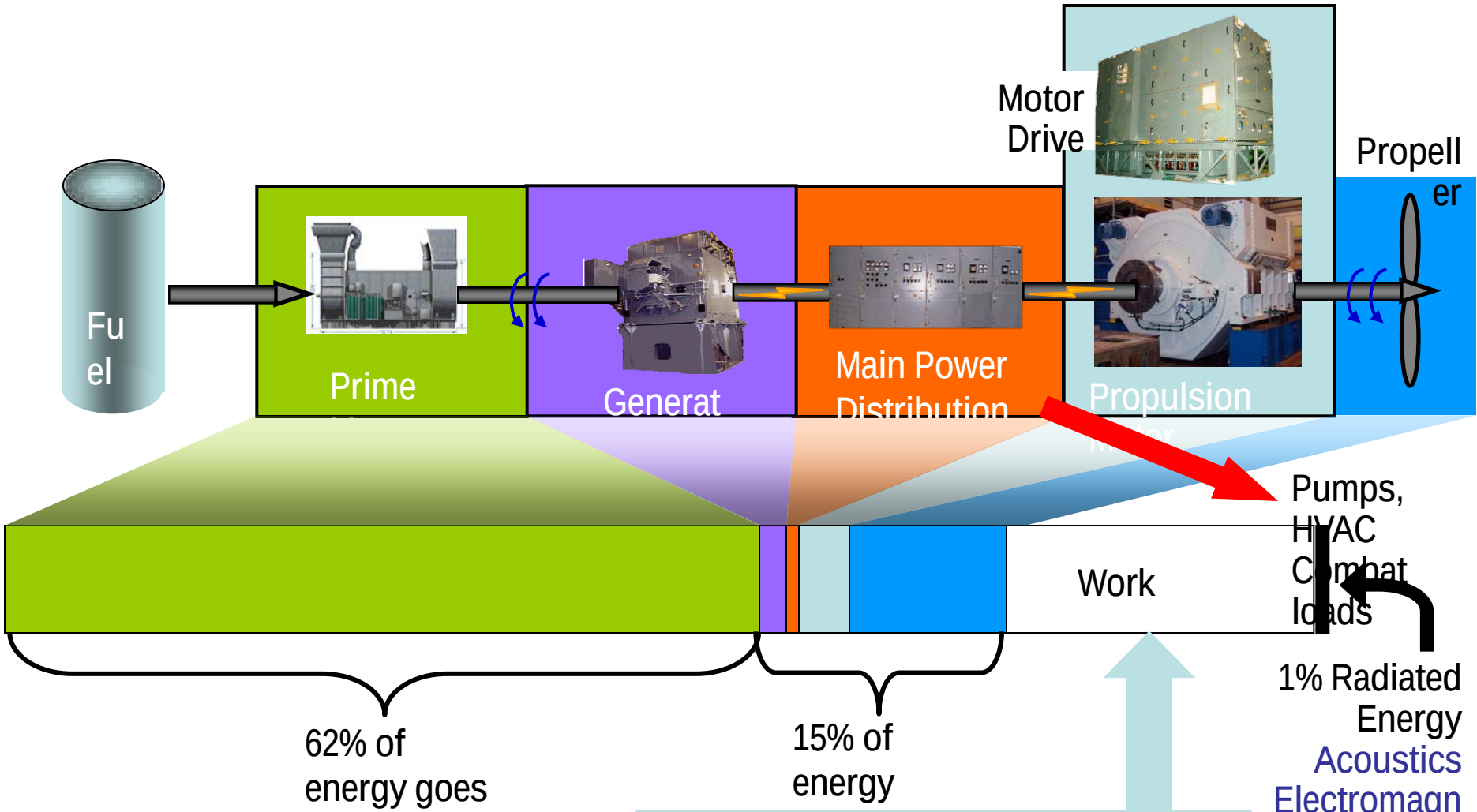






8,000 bbls of fuel saved per ship

Where the losses are: Energy Flow for Electric Ship



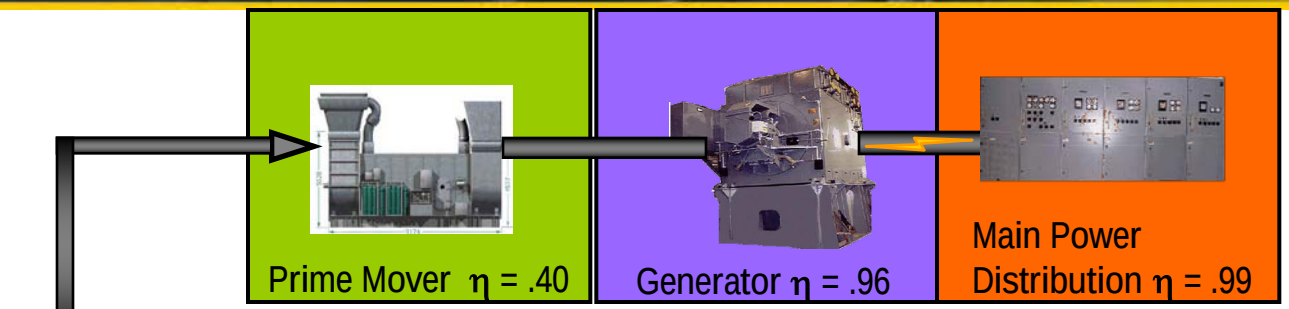
- *~22% of fuel energy provides useful work.*
- *The rest is left behind in the water or air.*

Todays Platform Initiatives

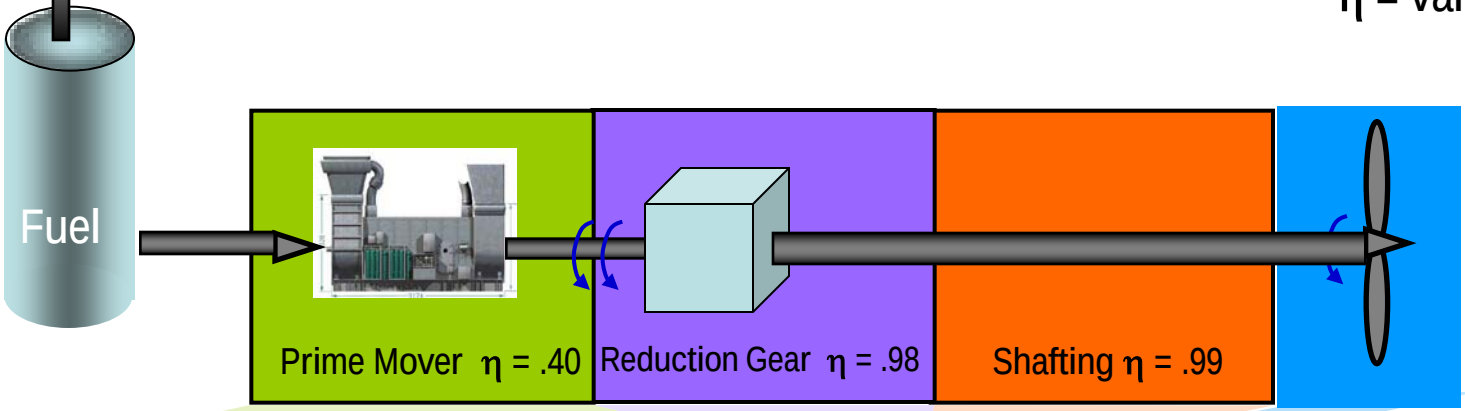
PLATFORM	RESULTS
	**Aircraft Carriers (CVN)** ◆ Compared to steam catapults, EMALS **weighs less, occupies less space, requires less maintenance and manpower, is more reliable, and uses less energy**
	**Surface Combatants (DDG 1000)** ◆ ZUMWALT's Integrated Power System (IPS) combines **78MW of installed power** generation for propulsion and ship service into a single unified electrical system
	**Submarines** ◆ Replacing conventional hydraulic systems with electric actuators realize **significant savings in installation and maintenance costs as well as being cleaner and more safe**

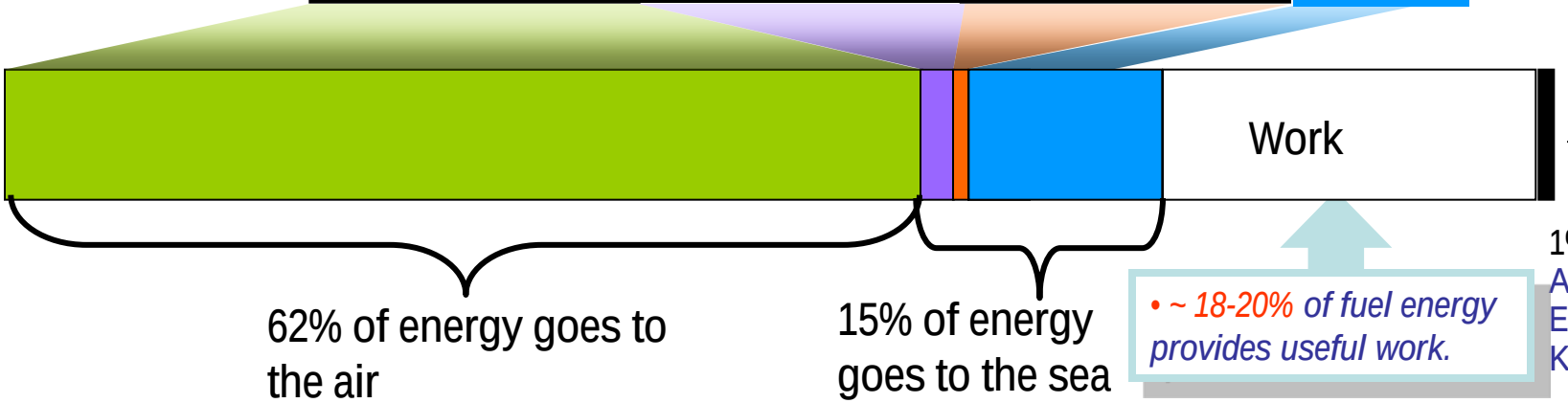
Enhanced Operational Capability at Reduced Costs

Where the Losses are: Energy Flow for Mechanical Drive Ship



LOADS:
Pumps
HVAC
Combat
η = varies





At design operating point