SNAME

ENERGY CONSERVATION EFFORTS ON NAVY SURFACE SHIPS

NAVSEA Energy Office

23 January 2012
The USS COLE was attacked 12 October 2000 while refueling in the Yemeni port of Aden. 17 Sailors were killed and 39 injured.

“Fuel supply lines are the umbilical cord and lifeline of the crusader community...focus operations on oil...since this will cause them to die off.”

-- Osama bin Laden
Overview – Navy Energy Profile

Navy Petroleum Consumption

U.S. Petroleum Consumption

U.S. Gov't Petroleum Consumption

Department of Defense (93% of Gov’t)

U.S. Gov't (2% of U.S.)

Navy (22% of DoD)

1% Expeditionary

4% Shore

43% Aviation

52% Maritime

Non-Domestic Sources

Navy Petroleum Consumption

Energy: Our Greatest Combat Enabler… and Greatest Vulnerability

Overall Energy Consumption

~84%

~16%

Tactical

Shore

Overall Energy Sources

57%

Tactical

Shore

Energy Consumption

Petroleum

Nuclear

Electricity, Natural Gas, Other

Electricity, Natural Gas, Other

Petroleum Ashore

Renewables

54%

23%

16%

1%

3%

3%

<1%

Overseas

Navy

Tactical

Shore

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Overview – Leadership Goals

**INCREASE ALTERNATIVE ENERGY USE DON-WIDE**
- By 2020, 50% of total DON energy consumption will come from alternative sources.

**SAIL THE “GREAT GREEN FLEET”**
- DON will demonstrate a Green Strike Group in local operations by 2012 and sail it by 2016.

**ENERGY EFFICIENT ACQUISITION**
- Evaluation of energy factors will be mandatory when awarding contracts for systems and buildings.

**EFFICIENCY AND CONSERVATION AFLOAT**
- By 2020, the Navy will increase efficiency and reduce overall fuel consumption afloat by 15%.
Energy Management in Waterspace

- Commercial Satellite Communications
- MILSATCOM
- Carrier Strike Group
- Command Ship
- Combat Logistics Force
- GASOLINE ALLEY
- UHF/VHF/HF
- Amphibious Ready Group
- Amphibious Task Force
- Landing Craft
- TBMD
- Objective Area
- Helicopters, MV22
- GASOLINE ALLEY

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Navy Alternative Fuel Program

Alternative fuel must be a drop-in replacement, operationally transparent to the operator

- Meets current fuel performance requirements
- Can be mixed or alternated with petroleum fuel
- NO change to aircraft or ship configuration
- NO change to transport/storage infrastructure

Past
First Gen biofuels not fit for operational use
- Water separability
- Stability issues
- Material compatibility, corrosion
- Lower energy density

Current
Hydrotreated Renewables
Test & Certification
- Chemical & Physical Properties
- Component Performance
- Platform Performance
- Long-term Operability

Near-Term Future
Process Validation
- Biological Conversion
- Biomass-Butanol-Fuel
- Pyrolysis
- Others

Longer-term Biofuel Solution
Integrated Alternatives
- Multiple Feedstocks
- Increased Production
- Decreased Cost

Engineer the fuel, not the platform

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Maritime Energy Way Ahead
Estimating Fuel Savings Is Difficult

What is the power requirement for a DDG in this scenario?

How often are we configured in various plant alignments?

Develop baselines using energy surveys
Speed time profiles from actual ship data
Improve/Continuous Monitoring
- Shipboard Energy Dashboard
Strategic Planning

**PROCESS**
- DOTMPF
- DCR
- CBA
- ICD
- MDD
- JCID
- Document Synchronization
- MS A
- MS B
- MS C
- P&D
- O&S

**PARADIGM**
- Current Approach:
  - Enables Energy Intensive Systems
  - Drive To Reduce Costs
  - Increased Energy Requirement
  - Efficiency
  - Capability Requirement
  - Life-cycle Cost Increases
  - Analysis of Alternatives (AoA)

- Future Approach:
  - Capability Requirement
  - Operational Energy Requirement
  - FBCE
  - Energy Efficiency KPP
  - Life-Cycle Costs
  - Efficiency Initiatives

**Considering Energy earlier and centering around AoA tradeoffs**
Operational - Behavioral

Training and Education

- Mandate accession training for officers and enlisted that include energy awareness as core element
- Incentivized ENergy CONservation Program (iENCON)

Incentives

- Create energy subspecialty codes for officers and enlisted
- Energy efficiency, conservation, and leadership recognized at unit level afloat and ashore

Monitoring and Reporting

- Energy Audits/Baselines
- Fleet Energy Managers monitor, track, and report shore services usage by each ship on the waterfront
- Provide energy conservation training onboard ships to reach sailors more frequently

Decision Aids

- Shipboard Energy Dashboard
- Energy Management System
- Smart Voyage Planning Decision Aid
Integrates with the existing Integrated Condition Assessment Systems (ICAS) and new sensors, as necessary, to provide recommendations needed to minimize energy consumption while still meeting system performance and reliability requirements.

Assists pre-underway planning by recommending efficient equipment lineups.

Calculates and instantly displays daily energy consumption rates.

Increased energy awareness reduces energy consumption.
Energy Database

- Track Fleet Fuel vs. SECNAV Goals
- Reduce underway replenishments
- Develop Fleet Energy Metrics
- Measurement and Verification
- Evaluate equipment performance
- Lessons learned
- Monitor and Plan Maintenance Activity
  - Hull Comparisons
  - System Efficiency
  - Component Metrics

User interfaces customized to meet requirements
AMPHIB Technology Installations

- **Solid State Lighting**: 0.2%
- **Combustion Trim Loop**: 2.8%
- **Propeller Coatings**: 1.0%
- **Stern Flaps**: 2.8%

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CRUDES Technology Installations

Shipboard Energy Dashboard

Solid State Lighting
0.5%

Bow Bulb Optimization
2.8%

Thermal Management Control System
3.3%
Maritime Technology Lifecycle

ECC Discovery and Analysis

- DISCOVERY
- GRAY Tool
- Business Case Favorable?
- YES
- SME Tech Assessment
- Complete BCA (includes fielding plan)

ECC RDT&E

- Assessment Favorable?
- YES
- Energy Portfolio – Balance Initiatives Against Goals
- ECC Prioritization
- Impact to Goal
- Allocate RDTE Funding
- Perform Testing and Validate BCA

ECM Fleet Implementation

- Approval for Fleet Intro?
- YES
- Energy Portfolio – Balance Initiatives Against Goals
- ECM Prioritization
- Impact to Goal
- Allocate OPN Funding
- Implement

Fuels Savings Validation

- Verify Savings
- Re-assess Fuel Budget

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Maritime Energy Portfolio Scorecard

- Illustrates initiatives business case and financial metrics
- Tracks historical and future milestones
Maritime Energy Portfolio – Budget/Fielding Plan

- Portfolio tool prioritizes initiatives based on business case metrics
- Tracks research and development costs
- Develops fielding plans based on highest valued initiatives and budget constraints

**Sets requirements for overall energy program**

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<thead>
<tr>
<th>Initiatives</th>
<th>RDTE ($'000)</th>
<th>Implementation ($'000)</th>
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Fiscal Year 14 RDTE Starts
No Planned Starts
Fiscal Year 15 RDTE Starts

Sets requirements for overall energy program.
Bow Bulb Concept

- Near surface, small volume Bow Bulb designed for a Combatant bow with a Sonar Dome

- Performance is derived primarily by reducing the bow wave generated by the ship, through destructive interference between the bulb wave and the bow wave

- Direct application to 66 scheduled DDG 51 Class (DDG 51-116) and any future DDG 51 Class builds
If the bow bulb were to be installed across Fielding Plan 20 ships in 2014-2019, a possible cumulated fuel savings of over 93,000 barrels could be realized in the 6 years through 2019, with a consequential cumulated fuel cost savings on the order of $16.3 Million.

1Refs. 3,4,5  2Relative to total annual fuel burn (underway & non-underway)
Tactical Turns: Bulb vs Baseline

The bulb caused a small increase in the tactical diameter.

The impact is minimal at larger rudder angles and increases slightly as rudder angles are reduced.
Zig-Zags: Bulb vs Baseline

The bulb had no impact on 10-10 Zig-Zag. The bulb had a small improvement on the 20-20 Zig-Zag, where it produced a slight reduction in overshoot angle.
Propeller Roughness Reduction

Roughness & Still Photo Locations

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## Propeller Roughness Over Time

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1st Insp. Post Clean

2nd Insp. Post Clean

3rd Insp. Post Clean

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Blade Condition: 2 ½ Months Post-cleaning & Pre-deployment

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<th>May '12</th>
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Contact

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Enables higher efficiencies by efficiently loading ship service generators to provide propulsion at low speeds where the main propulsion gas turbines are least efficient.
High Efficiency Small Capacity Chiller

CAPABILITIES

• These new compressors are projected to:
  • Reduce power usage by 40%
  • Increase cooling capacity by up to 50%
  • Eliminate refrigerant leakage and hazardous waste
  • Improve reliability
  • Reduce maintenance

• The technologies incorporated include:
  • Oil-free, magnetic bearings
  • Variable speed drives
  • High speed permanent magnet motors

BENEFITS

• Dramatically improves existing chill water plants.
• Increases cooling capacity.
**Propeller Coatings**

**BENEFITS**

- A fouled hull and propeller can reduce fuel efficiency by 5% to 12%.
- Propeller coatings maximizes efficiency, and extends the time between cleanings.
- Creates reduced drag and turbulence, improving propeller efficiency.
- Saves maintenance costs by reducing number of propeller cleanings and minimizing propeller wear.

Coating reduces roughness and bio-fouling of ship's propeller
Thermal Management Control System

CAPABILITIES & BENEFITS

• Provides a centralized control system and efficiently operated HVAC systems.

• Does not overcool spaces below the design temperature, thus reducing the use of recirculation heaters to control temperature.

• Gathers space temperature and humidity information compartment by compartment.

• Reduces energy by optimizing on-line Air Conditioning (AC) plants based on size and location.
L-Ship Directional Stability

CAPABILITIES

• Large Amphibious Assault ships require significant rudder action to maintain course, which increases drag and fuel consumption.

• Fixed-fin stabilizer modifications improve the directional stability of the LHD 1 class without negatively impacting the ship’s maneuverability.

• Improves steering performance of ship at low speeds.

• The Navy is also evaluating options to improve directional stability of DDG 51 class ships and T-AKE 1 class ships.

BENEFITS

• Ship maintains course with less effort, and less fuel.

• Significantly reduces fuel consumption.
Combustion Trim Loop

**BENEFITS**

- Combustion Trim Loop (CTL) integrates the Stack Gas Analyzer (SGA), which measures oxygen, carbon monoxide, and other combustible gases in the stack exhaust, with the Electronic Automatic Boiler Control (EABC) system to fine-tune boiler burner combustion richness.

- Excessive air decreases gas temperature and boiler efficiency, particularly at lower steaming rates.

- Stack Gas Analyzers and a Programmable Logic Controllers send control signals to existing boiler controls to trim excess air.

- Average fuel savings of CTL is 2% per ship per year.
## Advanced Reverse Osmosis

### HOW DOES IT WORK?

- Reverse Osmosis (RO) uses hydraulic pressure on seawater to force fresh water through a semi-permeable membrane, while the remaining brine is rejected overboard.
- This results in a potentially low-energy method to produce fresh water for sailor consumption and machinery needs.
- There are two layers of filtration: one to remove the particulate matter and one to remove the dissolved salts.

### BENEFITS

- Improved capability to purify water from turbid seawater sources.
- Significantly increased energy efficiency.
- Decreased maintenance and manning.
Variable Speed Drive Port Use Fan

CURRENT ISSUES

- Existing Port Use Fans (PUF) on amphibious assault ships are unreliable, thus forcing the ship’s crew to use the Forced Draft Blowers while steaming in-port
- Fuel is wasted creating large amounts of exhausted steam.

CAPABILITIES

- A modification will facilitate the use of the PUF with a VSD to throttle the speed of the PUF as needed to provide proper combustion air while keeping the PUF vanes wide open.

BENEFITS

- Provides ships force a reliable alternative to operating the Forced Draft Blowers.
- Eliminates issues experienced with the operation and control of the PUF vane actuators.
Advanced Solid State Lighting (SSL) uses Light Emitting Diodes (LED) to replace conventional fluorescent and incandescent lights. SSL requires less than 20% of the power of an equivalent incandescent bulb and lasts roughly 100 times as long. SSL is 50% more energy efficient than fluorescent lights, lasts about seven to 10 times as long and is not hazardous material. SSL is ideal for difficult-to-access overhead fixtures that cannot be changed underway, because of SSL’s long operating life.
Stern Flaps

**BENEFITS**

- Creates reduced drag and turbulence, causing reduced hull resistance.
- Increases propulsion efficiency and ship speed.
- Decreases strain on main engines.
- Decreases propeller loading, cavitation, vibration, and noise.
- Extends the service life of the propulsion machinery.

**IMPLEMENTATION**

- Over the past ten years the Navy aggressively installed stern flaps on surface combatants and amphibious warfare ships.
- Always On; improves efficiency without sacrificing maneuverability or combat capability.