

Research Roadmap Development

- **INITIAL ASK: If any members have roadmaps or roadmap development processes that have worked well in the past, please share as we'd like to leverage your collective experience and see no need to re-create the wheel**
- **Today's Focus:**
 - **Discuss Initial Technology Focus Areas**
 - **Consortium Partners Existing Efforts**
 - **Identify core areas where existing research can be extended to address Navy-specific concerns**
 - **Identify commercial tech that could be adapted to Navy use**
 - **Identify gaps in R&D efforts that need to be pursued**
- **Develop white papers for high priority efforts for potential FY23 ONR Funding**

Contact:

Bill Muras

william.j.muras.ctr@us.navy.mil

703-261-5059



Platform Decarbonization Focus Areas

- Across multiple existing studies, there seems to be general agreement on technology “focus areas”
 - MARAD META-funded Glosten report – “Energy Efficiency and Decarbonization Technical Guide” – November 2022
 - OECD/International Transport Forum – “Decarbonising Maritime Transport” – 2018
 - IATA Fly Net Zero
- Broad Focus Areas
 - *Technology – this is primary focus for this Consortium*
 - Operations
 - Fuels



MARAD META Glosten Report

Part 2 – Technology Evaluation.....

2.1 Efficiency Technologies (ET)

→ DIRECT DRAG REDUCTION

Advanced Hull Coatings

Anti-Fouling Coatings

Nanocoatings

Hull Cleaning and Maintenance

Hull Form Optimization

Air Lubrication

→ PROPULSIVE LOSS REDUCTION

Propellers

Pre-Swirl Devices

Post-Swirl Devices

→ PROPULSION AND POWER GENERATION.....

Diesel-Electric propulsion (DEP).....

Variable Speed Generator (VSG)

Power Take-Off/Power Take-In (PTO/PTI)

Magnetic Gearing

Printed Circuit Board (PCB) Stator Motor

→ ELECTRICAL ENERGY STORAGE

Hybrid Mechanical/Electrical

Battery (All-Electric).....

Shore Power.....

Supercapacitor Energy Storage (ScES).....

Superconducting Magnetic Energy Storage (SMES).....

→ WASTE HEAT RECOVERY

Waste Heat Recovery Systems

HVAC Optimization

→ RENEWABLE ENERGY.....

Kite Sails

Rotor Sails.....

Rigid Wingsails.....

Flexible Sails

Inflatable Sails

Wave-Assisted Propulsion

Solar Power.....

2.2 Fuel Technologies (FT)

Fuel Colors

Transitional Fuels

Hydrogen

Ammonia

Biofuels.....

Fischer Tropsch Diesel (FTD).....

Methanol.....

ICE Technology.....

Fuel Cell Technology.....

Fuel-Ready Vessel Design.....

Onboard Carbon Capture and Storage (oCCS).....

Marine Nuclear Power.....

2.3 Operational Measures (OM).....

Navy Specific Constraints/Considerations

Some aspects of the Navy unique mission(s) to keep in mind

- Navy platforms operate:
 - Forward presence
 - Contested logistics
 - Replenishment at sea
- Navy platforms are:
 - Space constrained
 - Often/Sometimes power constrained
 - Operated by 18-19 year old sailors
 - Long-lived \$1B+ assets

Some other Consortium considerations

- Short-, Mid- and Long-Term Horizons
- Retro-fit versus new build
- Not just an economic decision
- Potential future force structure – UxVs
- “Collaborate with the past”



BACKUP



OECD / International Transport Forum

Table 1. Overview of measures to reduce shipping's carbon emissions

Type of measures	Main measures
Technological	Light materials, slender design, less friction, waste heat recovery
Operational	Lower speeds, ship size, ship-port interface
Alternative fuels/energy	Sustainable biofuels, hydrogen, ammonia, electric ships, wind assistance

Table 2. Main technological measures

Measures	Potential fuel savings
Light materials	0-10%
Slender design	10-15%
Propulsion improvement devices	1-25%
Bulbous bow	2-7%
Air lubrication and hull surface	2-9%
Heat recovery	0-4%

Table 3. Main operational measures

Measures	CO ₂ emissions reduction potential
Speed	0-60%
Ship size	0-30%
Ship-port interface	1%
Onshore power	0-3%

Table 4. Main measures related to alternative fuels and energy

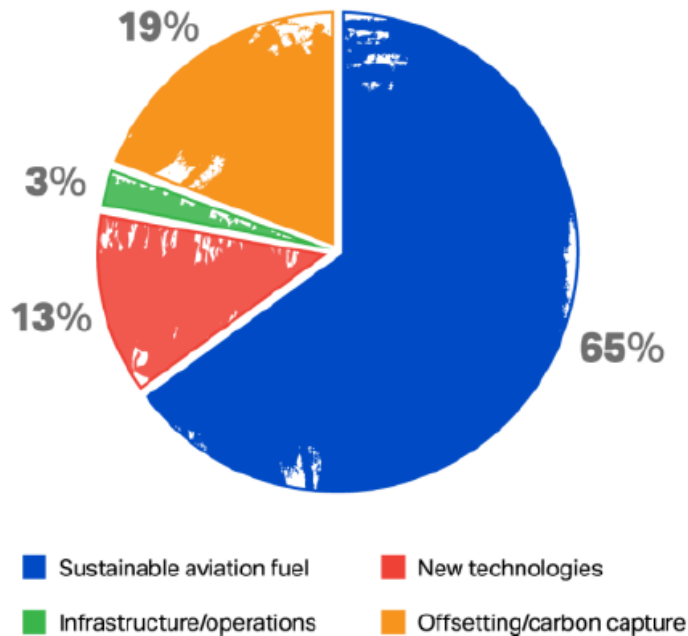
Measures	CO ₂ emission reductions
Advanced biofuels	25-100%
LNG	0-20%
Hydrogen	0-100%
Ammonia	0-100%
Fuel cells	2-20%
Electricity	0-100%
Wind	1-32%
Solar	0-12%
Nuclear	0-100%

Note: Emission reduction potentials are assessed individually. Data are only indicative and do not include fuel savings dependent on operational measures.

IATA Fly Net Zero

The plan

Contribution to achieving Net Zero Carbon in 2050



Net Zero 2050 is achievable through:

Combination of measures

- Sustainable Aviation Fuel, new , technologies, operational and infrastructure improvements, and offsetting/carbon capture

Collective effort

- of the entire industry together with governments, oil producers and investors

