



YOUR ULTIMATE GUIDE TO SUSTAINABLE MARITIME TECH



We will consider the advantages and disadvantages of various fuel efficiency technologies. The emission-reducing technologies examined in this report include:



Slow steaming



Weather routing



Antifouling - New coatings, ultrasound and robotics



Wind-assisted propulsion



Air lubrication



Smart steaming or Just-in-Time shipping arrival



Autonomous, AI-assisted navigation, planning and control

A SUMMARY OF FUEL-SAVING TECHNOLOGIES FOR EXISTING SHIPS

Our survey of fuel-saving technologies focuses on those that can be used on existing ships. Of course, those methods that can be applied to existing ships can also be employed with new ships.

1 Slow Steaming

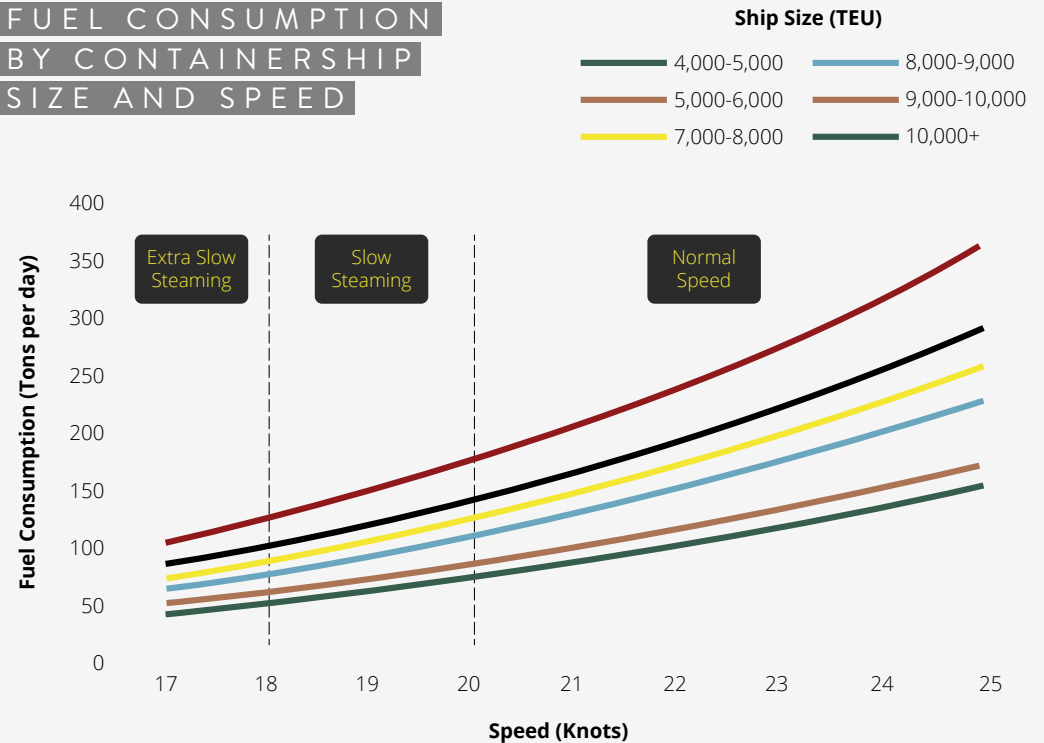
Now widely used by container vessels, slow steaming is effective because the drag caused by a fluid increases proportionately to the square of the speed. In other words, to go twice as fast requires four times more force and therefore fuel.

See below a graph showing speed and fuel consumption by ship size. To take one example from the chart, a ship in the 10,000+ TEU size can reduce its fuel consumption from about 240 tons per day to about 175 tons per day by reducing its speed from 22 knots to 20.

That's a 27 percent decrease in fuel consumption from only a 10 percent reduction in speed.

Reducing speed for a ship this size from 22 to 18 knots results in a decrease in fuel consumption from 240 tons per day to about 125 tons per day. In other words, an 18 percent reduction in speed yields a 48 percent lowering in fuel consumption.

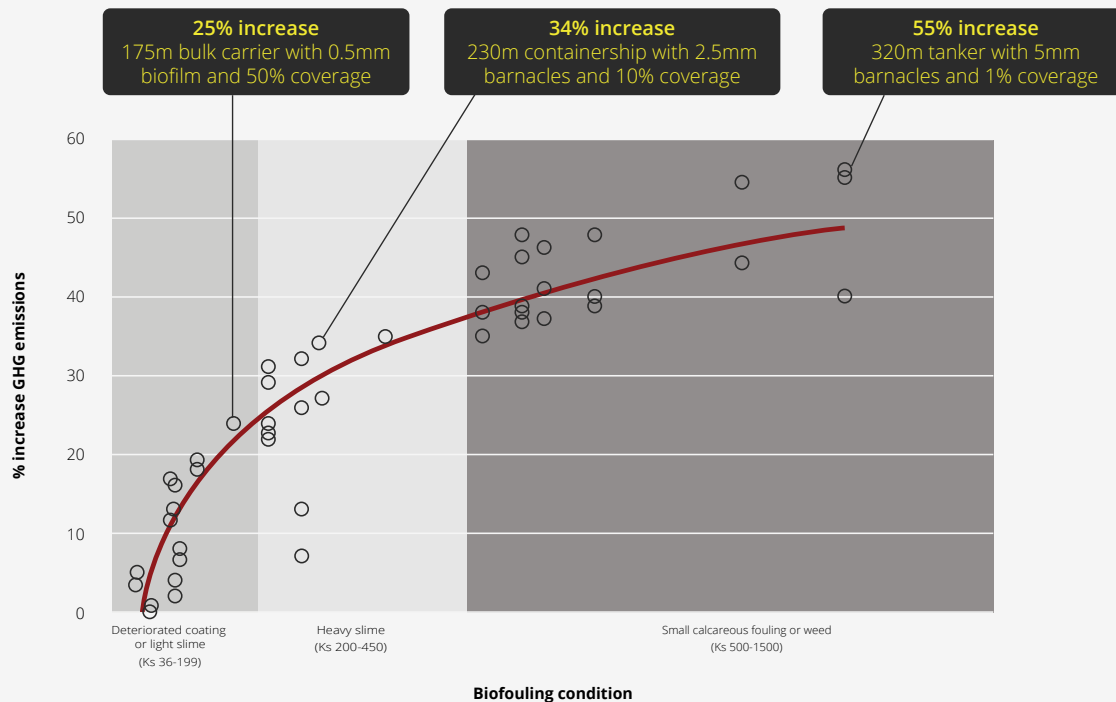
FUEL CONSUMPTION
BY CONTAINERSHIP
SIZE AND SPEED



Source: Adapted from Notteboom, T. and P. Carriou (2009) "Fuel surcharge practices of container shipping lines: Is it about cost recovery or revenue making?". Proceedings of the 2009 International Association of Maritime Economists (IAME) Conference, June, Copenhagen, Denmark.

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IMPACT OF SHIP HULL BIOFOULING ON GHG EMISSIONS



The banning of tributyltin in 2008 created a void. Without an effective antifouling coating, hulls need to be regularly scraped, an expensive and time-consuming process.

Yet, progress has been made in creating ecologically benign alternatives.

New, zwitterionic coatings show promise in preventing fouling while remaining cost-effective and ecologically harmless. However, such coatings do not yet appear to be commercially available at the time of this writing.

Alternative approaches include ultrasonic transducers attached to the ship's hull to repel the marine organisms. Additionally, robotic devices have become available that "skate" across the hull of a boat while at anchor and clean the hull. The devices use magnetic wheels to adhere to the vessel and rotating brushes to clean.

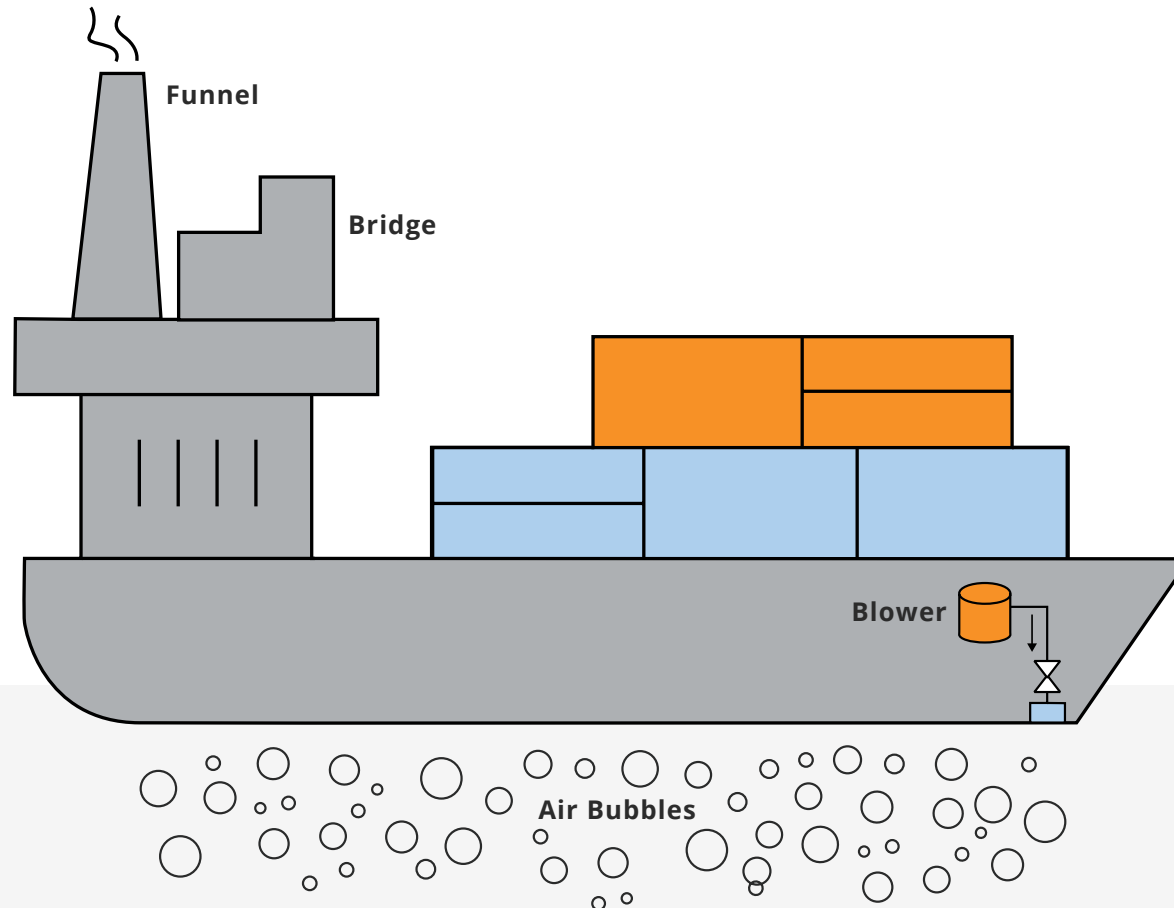
5 Air Lubrication

The goal of an air lubrication system is to reduce the friction and drag of a vessel moving through the water. An onboard blower creates air bubbles to act as a layer between the ship's hull and the water, making hull "slippery."

A paper by the American Bureau of Shipping (ABS) reports as of 2018, 23 vessels were identified to have air lubrication systems installed. Sea trials show net energy savings between 4 and 10 percent.

As of October 2021, the Danish shipping giant Maersk reported its testing of an air lubrication system.

Air lubrication systems can be retrofitted onto existing vessels.



Smart steaming would enable an LSP to receive advance warning of congestion at one port and re-route its ship to another nearby port without congestion.

Unfortunately, the real-time availability of all the data necessary does not exist today. The obstacles lie more in the realm of standards and cooperation than in technology. The technology exists today or is rapidly emerging. Given the many benefits smart steaming would bring, it would appear to be only a matter of time before the necessary data sharing becomes a reality.

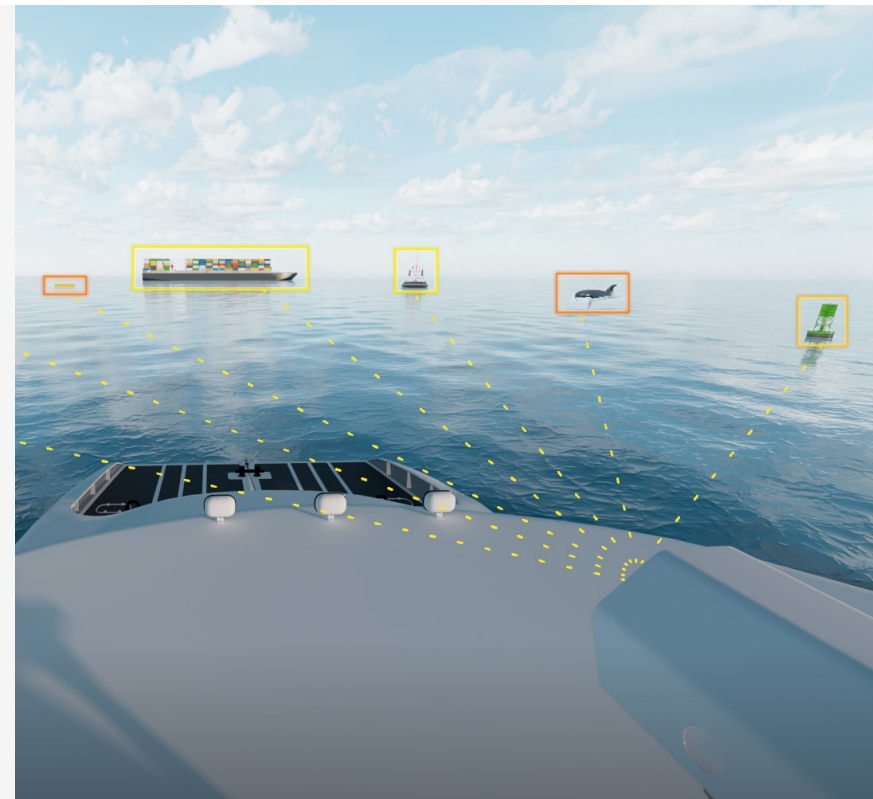
To facilitate the necessary cooperation, the IMO has created a new Global Industry Alliance (GIA) that brings together “leading shipowners and operators, classification societies, engine and technology builders and suppliers, big data providers, oil companies and ports.” The purpose of the GIA is to “collectively identify and develop innovative solutions to address common barriers to the uptake and implementation of energy efficiency technologies and operational measures.”

7 Autonomous, AI-Assisted Navigation, Planning, and Control

Advances in technology have made it possible to create “vessel intelligence.” By equipping ships with the appropriate sensors, communication gear, and actuators, remote command-and-control of a ship is a reality today.

Man-in-the-loop autonomous navigation is now possible, yielding many benefits in safety and the ability to optimize fuel efficiency continuously. The concept is similar to the way an automobile can reduce fuel emissions when operating on cruise control. The AI optimizes engine speed and determines acceleration and deceleration actions. The fine-tuning is done automatically, without the need for human intervention. The result is lower fuel consumption and reduced wear and tear on the engine.

These new technologies additionally provide the technological platform for just-in-time shipping arrival and smart steaming.



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MARINE ACCIDENTS - COSTLY AND POLLUTING

No review of how to reduce harmful pollution at sea would be complete without considering the role of marine accidents.

Although the good news is that annual shipping losses have decreased over the last decade, there were still 2,703 shipping incidents in 2020, according to the Allianz Safety and Shipping Review 2021. Over the last decade, there were more than 26,000 incidents reported. In 2020, the industry saw 49 total losses. Cargo vessels made up 40 percent of the total losses. Contributing factors included bad weather, poor visibility leading to contact, flooding and water ingress and machinery breakdown.

Allianz estimated that 75 to 96 percent of marine accidents involve human error.

SEA MACHINES ROBOTICS | 13

An aerial photograph of a port facility. The water is a vibrant turquoise color, heavily contaminated with large, irregular patches of dark brown oil or sludge. Several concrete piers extend from the shore into the water. A large container ship is docked at one of the piers. Another smaller vessel is visible further out in the polluted water. The overall scene depicts significant marine pollution.

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An aerial photograph showing a port area. The water is a vibrant turquoise color, contrasting sharply with the dark brown, rocky seabed visible through it. Several concrete piers extend from the land into the water. A large cargo ship, loaded with colorful containers, is docked at one of the piers. In the lower right, another smaller vessel leaves a white wake as it moves across the water. The overall scene suggests a busy maritime hub.

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A decorative graphic consisting of a series of vertical bars of varying heights, creating a stylized bar chart or signal-like pattern.

SEA MACHINES ROBOTICS | 13

The bad news is that as the size of ships has continued to grow, each incident has become more costly. Removing the wreck of the *Golden Ray*, a large car carrier that capsized outside the U.S. Port of Brunswick with more than 4,000 vehicles on it in 2019, has taken more than a year and cost several hundreds of millions of dollars.

“Large vessels and the ports required to handle them present a massive accumulation of risk, while the costs are disproportionately greater when things go wrong,” says Captain Andrew Kinsey, Senior Marine Risk Consultant at AGCS.

Container losses at sea spiked in 2020 and continued at a high level in 2021. More than 3,000 containers were lost at sea in 2020, and more than 1,000 fell overboard during the first months of 2021.

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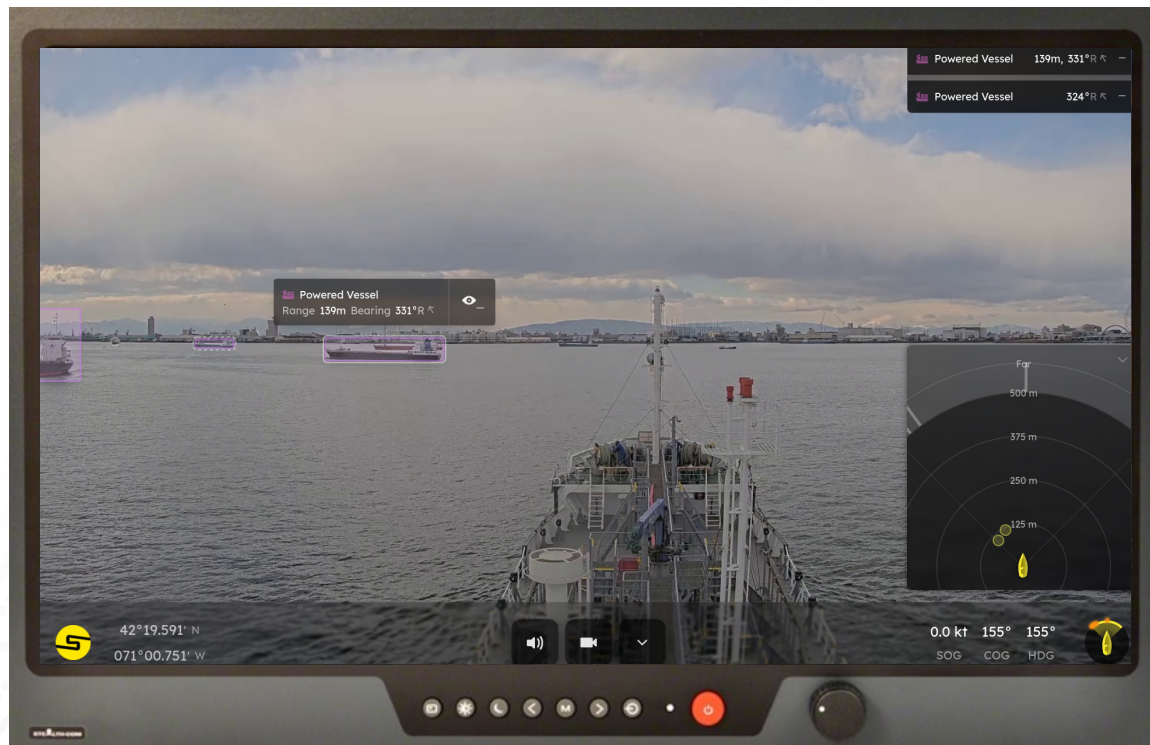


Sea Machines Robotics, a leading developer of autonomous and advanced perception systems for vessels, has products on the market that can be implemented today.

Reducing Emissions

By integrating sensors and actuators into maritime vessels, Sea Machines has created a technology platform that makes Smart Steaming and Just-In-Time (JIT) arrival possible.

Autonomy engines constantly measure the average speed, calculate ETA, and other environmental factors (like wind, current, swell and weather systems) and continually adjust the engine speed accordingly.



In 2022, Sea Machines intends to launch a new autonomous navigation and control system for the commercial maritime market that can immediately reduce vessel fuel use by 10 percent, and through ML/AI learning and incremental development will be able to achieve more than 40 percent improved productivity and efficiency within five years.



SEA MACHINES. SEA BETTER.

For more information,
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