Environmental and Energy Study Institute

Fact Sheet

Technologies to Improve Shipping Efficiency

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International shipping produces more emissions from energy use than all but five countries, ranking in between Japan and Germany. The shipping sector is responsible for 2.7 percent of global carbon dioxide emissions, roughly equal to 870 million metric tons per year. The International Maritime Organization (IMO) estimates that shipping emissions will increase by a factor of two to three by 2050 under "business as usual" conditions.[1,2] Ships also emit one to two percent of global black carbon, a component of soot particulate matter that reduces air quality and contributes to climate change.[3]

IMPROVED EFFICIENCY

A 2011 agreement among the 170 member nations of the IMO represents massive implications for the entire shipping sector. The newly-established Energy Efficiency Design Index (EEDI) will set energy efficiency standards for new large ships. The standards will go into effect for ships ordered after January 1, 2013, and/or delivered after January 1, 2015.[4] The EEDI will initially require 10 percent efficiency improvements over the 1999-2009 baseline, scaling up to 20 percent in 2020 and 30 percent in 2025. The EEDI does not require any specific technologies, allowing the industry to determine how best to reach the efficiency standards.

The EEDI represents the first major global and legally binding effort to control emissions from an entire sector.[5] The EEDI should help to overcome many of the economic barriers to increasing marine efficiency, namely that ship owners typically charter out their vessels to ship operators. Operators are responsible for fuel and other operating costs, leaving owners little incentive to invest in more efficient technologies.

If implemented on schedule, the EEDI is estimated to save $52 billion in fuel costs and prevent 263 million tons of CO2 emissions each year (over business as usual) by 2030.[6] However, any country can choose to delay the requirements by up to four years. In conjunction with the EEDI, the IMO also established the Ship Energy Efficiency Management Plan (SEEMP), which will require all ships to have an operations plan to optimize energy efficiency, but does little to approve or enforce such plans.

Apart from the EEDI, speed reduction remains one of the greatest opportunities to decrease emissions and fuel use from all ships. A 10 percent speed reduction would decrease fuel consumption by 15 to 19 percent, while a 20 percent speed reduction would decrease consumption by 36 to 39 percent.[7] Slower speeds would not necessarily impact a ship's port-to-port travel time, because many ships sit offshore upon arrival for one or more days waiting for space to open up in port. Most ports currently operate on a "first-come first-served" basis, incentivizing ships to race to their destination to avoid longer lines.[8] Some in the industry are seeking to replace this system with a virtual arrival system, where ships are assigned a time slot at their destination port soon after setting sail. Ships can then lower their transoceanic speeds and arrive on time, reducing port congestion, fuel costs and emissions.[9]

Once in port, shore-based power allows a docked ship to plug in to the local grid to run its auxiliary systems rather than idle its engines and release harmful emissions. Both ship and port must have the proper infrastructure to make the power connection, requiring each to act for either to see a return on investment.[10] Emission reduction technologies that ships can adopt independently include waste heat recovery systems for their engines, upgrades to the propeller and the autopilot system, and air lubrication systems that pump compressed air across the hull to reduce friction between the boat and the water.[11]

PARTICULATE EMISSIONS

Several technologies are available to specifically reduce shipping emissions of black carbon and other particulate matter (PM). Diesel particulate filters (DPFs) placed in the ship's exhaust stream can scrub out black carbon emissions by 70-90 percent, but can only be used when the ship burns higher-quality low-sulfur fuel.[12] Aside from higher fuel costs, marine DPFs will likely remain prohibitively expensive in the near-term due to upkeep needs.

Slide valves, however, inexpensively reduce PM emissions by approximately 25 percent. Replacing conventional fuel valves, slide valves allow for more complete fuel combustion at lower peak engine temperatures. Many new ships are equipped with slide valves, and older ships can be retrofitted with this technology.[13]

Water-in-fuel emulsification (WiFE) on-demand systems for ships can reduce PM emissions by 25 to 50 percent at relatively low-cost. The process adds water (often 10-20 percent by volume) to fuel just prior to combustion, increasing fuel dispersion and allowing for a cleaner burn.[14] Adding water to the fuel decreases fuel efficiency by up to one percent and reduces engine torque, but on-demand WiFE systems can be shut off when additional power is needed. WiFE systems can be paired with slide valves for further PM reductions, and both technologies also provide substantial NOx emissions savings.

Ship particulate emissions have garnered additional attention now that shipping routes through the Arctic are becoming increasingly popular as ice coverage disappears. With the ships come concentrated black carbon emissions which are deposited on snow and ice and accelerate melting. It is estimated that shipping emissions of black carbon in the Arctic may double or triple over the global rate by 2050.[15] Cost-effective technologies to reduce marine black carbon and other emissions are therefore especially critical for climate mitigation within the region. The eight nations of the Arctic Council, which currently account for 90 percent of Arctic shipping activities, are now working to address the environmental impacts of heavier shipping traffic. Norway, Sweden and the United States submitted a document to the IMO in 2010 that laid out potential approaches to reduce black carbon emissions in the Arctic. The submission received support from all Arctic nations.[16]

After a long dormant period, shipping efficiency technologies are poised to become much more prevalent following the IMO's strong actions on energy efficiency and the increasing pressure to protect the Arctic from shipping impacts. Additional information on the emission savings and cost-effectiveness of different efficiency technologies and practices will be necessary to help guide ship builders, owners and operators to make the best decisions possible.

For more information see: United Nations Review of Maritime Transport 2011
Sustainable Shipping Initiative: Vision 2040

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This fact sheet is available electronically (with hyperlinks and endnotes) at *www.eesi.org/papers*.

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The Environmental and Energy Study Institute (EESI) is a non-profit organization founded in 1984 by a bipartisan Congressional caucus dedicated to finding innovative environmental and energy solutions. EESI works to protect the climate and ensure a healthy, secure, and sustainable future for America through policymaker education, coalition building, and policy development in the areas of energy efficiency, renewable energy, agriculture, forestry, transportation, buildings, and urban planning.

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