

Energy Efficiency in Very Large Gas Carrier (VLGC) by Implementing Combined Energy Saving Device (ESDs): Accelerating Pathways to Net Zero Emission 2050

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Abstract

This study examines the initiatives and innovations within the shipping industry aimed at addressing the critical challenge of reducing greenhouse gas (GHG) emissions while enhancing fuel efficiency in compliance with global regulations. Research on PT Pertamina International Shipping (PIS) indicates the establishment of a green shipping roadmap in 2021, which was subsequently updated in 2024. As part of its decarbonization initiatives, PIS developed the Vessel Emission Reduction Strategy 2025–2050 to support the International Maritime Organization’s (IMO) Net Zero Emissions (NZE) target by 2050. This strategy forms an integral component of PIS’s broader sustainability agenda, aligning with the IMO’s Energy Efficiency Existing Ship Index (EEXI) regulations and incorporating the systematic retrofitting of Energy Saving Devices (ESDs) during scheduled dry docking. PIS has introduced combined ESDs on its Very Large Gas Carrier (VLGC) fleet, integrating propeller duct modifications (e.g., Mewis Ducts, Pre-Swirl Ducts) with rudder bulbs. This study presents a comparative analysis of combined ESDs on two VLGC vessels, evaluating their performance against single ESDs installations and baseline operations without ESDs. The results indicate that combined ESDs deliver significantly superior performance compared to single-device applications or pre-installation conditions. Key improvements include higher vessel speed, reduced hydrodynamic resistance, increased distance-to-fuel ratios, enhanced fuel efficiency, and improved Carbon Intensity Indicator (CII) ratings. The adoption of combined ESDs represents an innovative solution for PIS to reduce both operational costs and carbon emissions. Their implementation generated substantial benefits, including an 11.9% reduction in fuel consumption, cost savings exceeding USD 840,000 (based on 2025 fuel prices), and a 29% decrease in carbon emissions—all achieved without a single incident. Additionally, the CII score rating was improved by 23%. Beyond improving business efficiency, the combined ESDs initiative supports global decarbonization targets and provides a replicable model for adoption by other shipping companies worldwide. This study contributes to an enhanced understanding of the actual effect of applying combined ESDs, which optimizes the hydrodynamic flow of the water body around the ship, leading to improved fuel consumption, speed, and CII rating.

Keywords

Energy Saving Devices, Energy Efficiency, Green Innovation, Emission Reduction, Decarbonization.

Biographies

Santi Manurung is the Vice President of Sustainability at PT Pertamina International Shipping. She holds a Bachelor's degree in Chemical Engineering and a Master's degree in Management, both from Gadjah Mada University. With over 20 years of experience in LNG operations and a proven track record of managing strategic LNG projects in Indonesia, she leverages her expertise to drive sustainability initiatives in her current role. Under her leadership, the Sustainability Function has developed a clear vision and roadmap aligned with the company's strategic direction and global guidelines, prioritizing initiatives based on risk, opportunity, and optimal resource allocation to achieve sustainability goals. She is an active speaker at various prominent events in Indonesia, focusing on sustainability, green business, LNG, and green shipping. She is also a Professional Engineer and a Certified Energy Manager.

Kemas Ahmad Widad is currently a Manager of Sustainability Strategy at PT Pertamina International Shipping. He holds a Bachelor's degree in Mechanical Engineering from the University of Indonesia and a Master in Occupational Health and Safety from the same university. He has over 20 years of extensive experience in the downstream oil and gas industry, both domestically and internationally, with a strong focus on sustainability, green business, business development, energy management, and Health, Safety, Security, and Environment (HSSE). With a proven track record of developing and implementing sustainability strategies, leading green business initiatives, driving corporate strategy formulation and business expansion, while also demonstrating capabilities at both operational and strategic levels, Widad has consistently aligned his efforts with the organization's vision and mission. He has been a speaker on green business and sustainability at several national and global events. He is also a Certified Energy Manager.

Sidha Asmawangi serves as a Manager of Tanker & Offshore Projects at PT Pertamina International Shipping. She received her Bachelor's degree in Information Technology from Gadjah Mada University. Sidha is an experienced engineer with over 20 years of expertise in the shipping industry, she has a proven track record in among others shipbuilding budgeting, tonnage management, tanker operations, and strategic initiative improvement. She also leads sustainability initiatives for owned vessels, focusing on energy efficiency and decarbonization, and serves as project owner for new shipbuilding projects, leveraging her expertise at both domestic and international experience.

Muhammad Shidqi Hibatullah is a Sr Admin Office I - Project Control Tanker & Offshore Project at PT Pertamina International Shipping. He holds a Bachelor of Applied Science in Mechanical Engineering with a major in Energy Conversion from Sepuluh Nopember Institute of Technology. With experience in project management and sustainability initiatives within the maritime industry, Shidqi has demonstrated expertise in managing shipbuilding projects, developing digital monitoring tools, and implementing decarbonization strategies aligned with IMO Net Zero 2050 targets. Recognized for his active contributions to continuous improvement, Shidqi has received various company awards. He also drives sustainable initiatives focused on energy efficiency, decarbonization, and ESD, allowing him the role of ESG Champion, where he promotes innovative solutions for sustainable shipping and green energy.

Lizar Afiq Fadli is a Project Supervision Engineer at PT Pertamina International Shipping (PIS). He holds a Bachelor degree in Oceanography from Diponegoro University and a Master in Ocean Engineering from the Bandung Institute of Technology. Before joining PIS, he worked as a weather and ocean researcher as a private consultant. With expertise in ocean modeling and climate forecasting, he collaborates with the naval engineering team at PIS to develop sustainable solutions for the shipping industry. Recently, he has been appointed as the ESG (Environmental, Social, and Governance) Champion at PIS, recognizing his relentless efforts in finding best practical and long-term solutions for shipping sustainability and green energy.

Agung Ibrahim holds the position of Officer II Fleet Management Solution, with a strong technical foundation in vessel operations and maintenance. He excels in leading strategic initiatives that enhance fleet reliability, safety, and performance. He holds a bachelor's degree in Shipping Engineering from the University of Indonesia. With expertise in equipment hierarchy optimization, system integration, and predictive maintenance, Agung leverages hands-on experience in technical evaluations and full-cycle digitalization to drive transformation. He champions structured programs, data-driven planning, and clear service standards to bridge onboard and shore teams. He focuses on reliability, digital maturity, and sustainability to ensure vessels operate efficiently, meet compliance requirements, and stay future-ready. He is also a Certified Energy Management Auditor, a Certified Maintenance & Reliability Professional (CMRP), and a Certified Risk Professional, demonstrating his commitment to holistic, forward-thinking maritime solutions.

Aden is currently a Sr Admin Office I - Project Control Tanker & Offshore Project at PT Pertamina International Shipping and is a Naval Architecture graduate from Sepuluh Nopember Institute of Technology. He has a strong track record in managing strategic projects, including supervising drydocking operations, developing vessel decarbonization plans to comply with global regulations (e.g IMO, CII), implementing emission-reducing measures, leading Onboard Carbon Capture Storage (OCCS) feasibility studies, and designing energy-saving devices. He also serves as an ESG Champion driving the company's sustainability initiatives and recognized as Carbon Cutter Champion.

Mira Tyas Annisa is a Sr Analyst of Sustainability Strategy at PT Pertamina International Shipping. She brings 14 years of experience in CSR and sustainability reporting in the oil & gas and coal mining industries. Notably, she was recognized as one of the top 6 teams at the SDG Innovation Accelerator for Young Professionals 2024 in Indonesia, earning an invitation to the UN Global Compact Leaders' Summit at the UN Headquarters. In addition to her professional role, she engages in various pro bono initiatives, provides Sustainability Reporting training for SMEs in Indonesia looking to export, and serves as a peer reviewer for the Global Reporting Initiative (GRI). She holds a Master's degree in Management with a focus on CSR, and is certified in Sustainability Reporting and as a Certified Risk Professional.