PRESS RELEASE

Ethanol blends run successfully in pilot marine engine tests, finds joint study by GCGF and NTU Singapore

Interim findings from a feasibility study compare six alternative marine fuels and demonstrate that ethanol-biodiesel-diesel blends maintain engine efficiency while cutting greenhouse gas emissions

SINGAPORE, 16 November 2026 –The **Global Centre for Green Fuels (GCGF)** and **Nanyang Technological University, Singapore (NTU Singapore)** have released interim study findings demonstrating that blends of ethanol, biodiesel, and conventional diesel can run successfully in a pilot-scale marine diesel engine without compromising thermal efficiency.

The findings are part of the ***Feasibility Study on Adopting Ethanol as a Sustainable Marine Fuel for Ships in Singapore***, a joint research initiative by GCGF and the **Maritime Energy and Sustainable Development Centre of Excellence (MESD)** at NTU Singapore.

The study evaluates ethanol against five other alternative marine fuels and tests ethanol blends designed for use in existing conventional marine engines, offering a practical decarbonisation pathway for the global commercial fleet.

Significant potential lifecycle emissions reduction

Engine testing demonstrated that the highest blend evaluated, E30B30D40, replaces 60 per cent of conventional diesel with renewable ethanol and biodiesel by volume, 53 per cent by energy.

Lifecycle greenhouse gas (GHG) emissions intensity for this blend is estimated at 64.91 to 67.90 gCO_2eq/MJ, representing a 28 to 31 per cent reduction compared to the 94 gCO_2eq/MJ baseline for conventional fossil diesel.

The pilot trials were conducted on a four-stroke marine diesel engine of harbour-craft size with technical support from the Seatrium New Energy Laboratory at NTU's School of Mechanical and Aerospace Engineering.

Overcoming fuel blending and stability barriers

While ethanol does not form a stable blend with diesel on its own, researchers found that adding biodiesel as a co-solvent produces stable, single-phase fuel blends. A 1:1 ethanol-to-biodiesel ratio gave stability at the highest ethanol content tested, and lower co-solvent ratios are being investigated.

Three blend formulations were tested: E10B10D80, E20B20D60, and E30B30D40. All three formulations ran reliably during pilot engine operations. Blend flash point and fuel-system requirements are still being assessed; these blends are not yet a drop-in fuel under current rules.

Preliminary test measurements indicated that estimated brake thermal efficiency was maintained or slightly improved across all test points, rising by up to 0.73 percentage points for the E30 blend.

Maximum engine power output decreased by up to 12.9 per cent for E30, an expected result reflecting the lower energy density of ethanol compared to fossil diesel.

In emissions testing, all blends reduced carbon monoxide emissions, achieving cuts of up to 43 per cent with E30. The E10 and E20 blends reduced nitrogen oxides (NO_x) emissions at matched-power test points, while E30 results varied depending on engine load. Crucially, the ternary blends moderated the increase in NO_x typically observed when using pure biodiesel.

Comparative evaluation across alternative fuels

Beyond engine trials, the interim report evaluated ethanol against five other candidate low- and zero-carbon marine fuels: **methanol, fatty acid methyl ester (FAME) biodiesel, liquefied natural gas (LNG), ammonia**, and **hydrogen**.

In **production readiness**, ethanol achieved the top score of 9 out of 9 on the study's assessment scale, supported by a mature worldwide distribution and manufacturing infrastructure. Global ethanol production reached approximately 118.5 billion litres in 2024, equivalent to 61.9 million tonnes of very low sulphur fuel oil (VLSFO) in energy terms and is projected to expand to 80.9 million tonnes of VLSFO equivalent by 2033.

In **operational safety**, ethanol scored 8 out of 9. Ethanol is less acutely toxic than methanol and remains liquid under ambient conditions. However, researchers noted that ethanol's low flash point requires dedicated ignition controls, vapour management systems, and material compatibility protocols on board vessels.

On **commercial cost,** ethanol was assessed at USD 956 to 1,451 per VLSFO-equivalent tonne, overlapping the study's VLSFO price benchmark. At the midpoint, ethanol is approximately 42 per cent higher in cost than fossil fuel oil and requires approximately 1.9 cubic metres of bunker storage space per tonne of VLSFO energy equivalent.

Quotes

Clarence Woo, Managing Director, Global Centre for Green Fuels, said: "Most of the world's fleet will be running on conventional engines for years to come, so decarbonisation cannot wait for newbuilds alone. These interim results show that ethanol–biodiesel–diesel blends can run successfully in a conventional marine diesel engine with comparable efficiency, and ethanol is already produced at industrial scale. Through this work with NTU MESD, GCGF is building the evidence needed to show how ethanol can play a practical role in marine decarbonisation. We look forward to presenting the findings to the industry at the IBIA Alternative Marine Energy Forum during Hong Kong Maritime Week, and to working with partners to take the testing further."

Dr Shu Fen Tan, Research Lead and Senior Research Fellow at NTU's Maritime Energy and Sustainable Development Centre of Excellence (MESD), said: "Ship operators and maritime regulators require rigorous, independent evidence before alternative fuel blends are introduced into commercial bunkering. Our collaborative work with GCGF bridges comprehensive fuel comparison with hands-on engine validation. By examining chemical blend stability alongside

physical combustion performance, NTU MESD is delivering the empirical data the maritime sector needs to make informed transitional decisions."

Next steps

GCGF and NTU MESD will present the interim findings at the "IBIA – Fueling Now and the Future: Hong Kong Forum on Alternative Marine Energy" on 19 November 2026 during Hong Kong Maritime Week, where GCGF serves as an event partner.

Phase two of the research will involve expanded engine testing and durability assessments, with the final comprehensive study report scheduled for publication in 2027.

The Executive Summary of the interim report is available for download on the GCGF website www.green-fuels.org/ethanol-blends.

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Notes to editors

1. About the Study

The *Feasibility Study on Adopting Ethanol as a Sustainable Marine Fuel for Ships in Singapore* is a collaborative research initiative led by the Global Centre for Green Fuels (GCGF) in partnership with the Maritime Energy and Sustainable Development Centre of Excellence (MESD) at NTU Singapore. Experimental testing was conducted using a harbour-craft-scale, four-stroke marine diesel engine housed at the Seatrium Lab in NTU's School of Mechanical and Aerospace Engineering.

2. Blend Notation and Specifications

- **E10B10D80:** 10% ethanol, 10% biodiesel, 80% conventional marine diesel by volume.
- **E20B20D60:** 20% ethanol, 20% biodiesel, 60% conventional marine diesel by volume.
- **E30B30D40:** 30% ethanol, 30% biodiesel, 40% conventional marine diesel by volume (about 21% ethanol, 32% biodiesel and 47% diesel by energy).
- The biodiesel component used across all blend testing was palm methyl ester (PME). PME was used as the co-solvent in this phase; other biodiesel types may be assessed in later phases.

3. Lifecycle Emissions Methodology

The estimated lifecycle GHG emissions for E30B30D40 (64.91–67.90 gCO_2eq/MJ versus 94 gCO_2eq/MJ for baseline fossil diesel) are indicative and based on well-to-wake feedstock assumptions detailed in the Executive Summary. Assessment scores reflect scientific evaluation and do not represent formal certification or regulatory endorsement.

About the Global Centre for Green Fuels

The Global Centre for Green Fuels (GCGF) is a Singapore-based, not-for-profit think tank that advances the adoption of sustainable, low-carbon biofuels, with a focus on ethanol. GCGF

advises policymakers, regulators and industry leaders worldwide on biofuel policy, technology and market integration, supporting global efforts to decarbonise transport.

GCGF operates the Maritime Ethanol & Methanol Alliance (MEMA), a science-based platform that brings together fuel producers, shipowners, ports, engine makers and classification societies to accelerate the adoption of ethanol and methanol as marine fuels, in line with IMO, ISO and EU frameworks.

For more information, visit www.green-fuels.org.

About Nanyang Technological University, Singapore

Nanyang Technological University, Singapore (NTU Singapore) is a premier technological university that develops leaders and creates societal impact through education, research, and service. Ranked amongst the world's top universities, NTU has 40,000 undergraduate and postgraduate students in the Business, Computing & Data Science, Engineering, Humanities, Arts, & Social Sciences, Medicine, Science, and Graduate colleges. NTU is also home to world-renowned autonomous institutes – the National Institute of Education and S Rajaratnam School of International Studies – and various leading research centres such as the Earth Observatory of Singapore, Nanyang Environment & Water Research Institute, Energy Research Institute at NTU, and Singapore Centre for Environmental Life Sciences Engineering. The University aspires to shape an AI-enabled future. By bringing together global talent across disciplines and combining technology with human creativity, NTU nurtures AI-ready graduates, drives breakthrough discoveries, and forges partnerships that tackle the challenges of our time. For more information, visit www.ntu.edu.sg

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