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JUNE 2022 | PRIVATE CIRCULATION ONLY

What is the future of LNG as alternative fuel

Whether LNG can be a mature, scalable, and commercially viable alternative fuel for maritime industry is the point of discussion for many in the industry today.

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Advancing ethanol blending targets augurs well for sugar industry

The target of target of 20 per cent blending in petrol in the country was recently advanced by five years to 2025, from 2030 by the Indian cabinet.

The government has taken the decision to advance 20 percent ethanol blending in petrol by five years after quickly achieving 9.99 per cent ethanol blending in petrol in May 2022, and increasing demand for sugar in the country. The decision to advance the target of 20 blending target by five years has enhanced optimism in sugar producers in the country.

The sugar industry which has been experiencing very slow growth over the years has witnessed an all-time high production of 31.2 million tonnes of sugar in 2020-21.

The government has also hiked the price of ethanol extracted from sugarcane for blending in petrol for 2021-22, as part of its target to achieve 20 per cent blending target by 2025.

The decision to advance the ethanol blending targets also promotes the production of biofuels in the country, under the Make in India programme, by units located in Special Economic Zones (SEZ)/ Export Oriented Units (EoUs). These decisions will help India, which depends on imports for meeting 85 per cent of its oil needs, to cut reliance on overseas shipments.

The new policy of the government also allows ethanol production from B-molasses, sugar syrup, sugar cane juice, crops such as sugar beet, corn, sweet sorghum, rotten potatoes, cassava, and surplus and rotten food grains which are unfit for human consumption.

Let us hope that government's roadmap for ethanol blending with petrol will enhance sugar manufacturers to go for significant expansion of the renewable fuel in the country.

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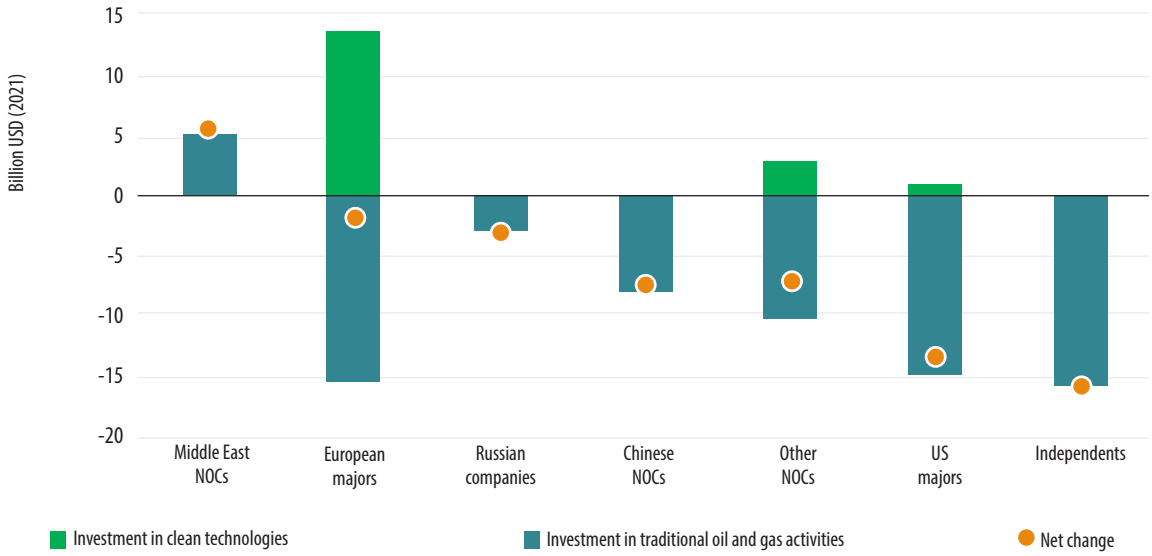
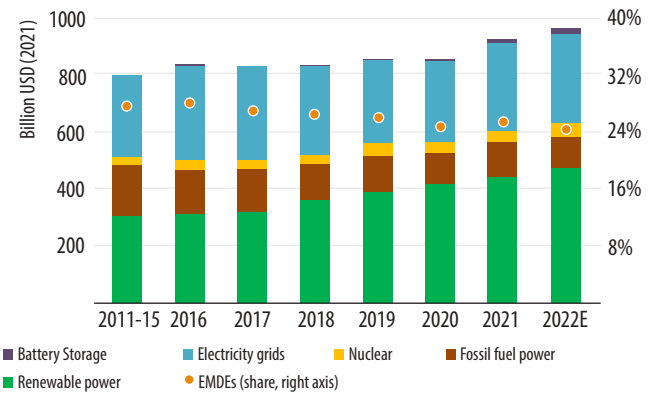
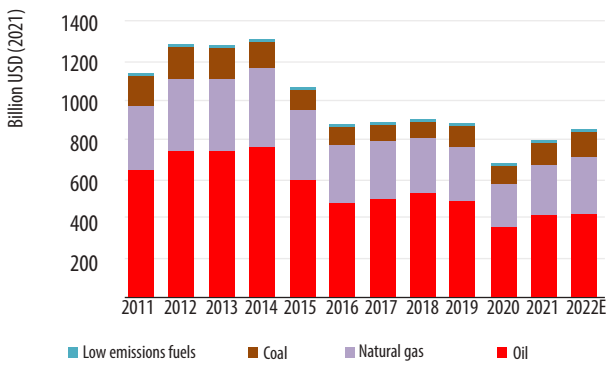
CHANGE IN INVESTMENT BY DIFFERENT GROUPINGS OF OIL AND GAS COMPANIES, 2022E VS 2019



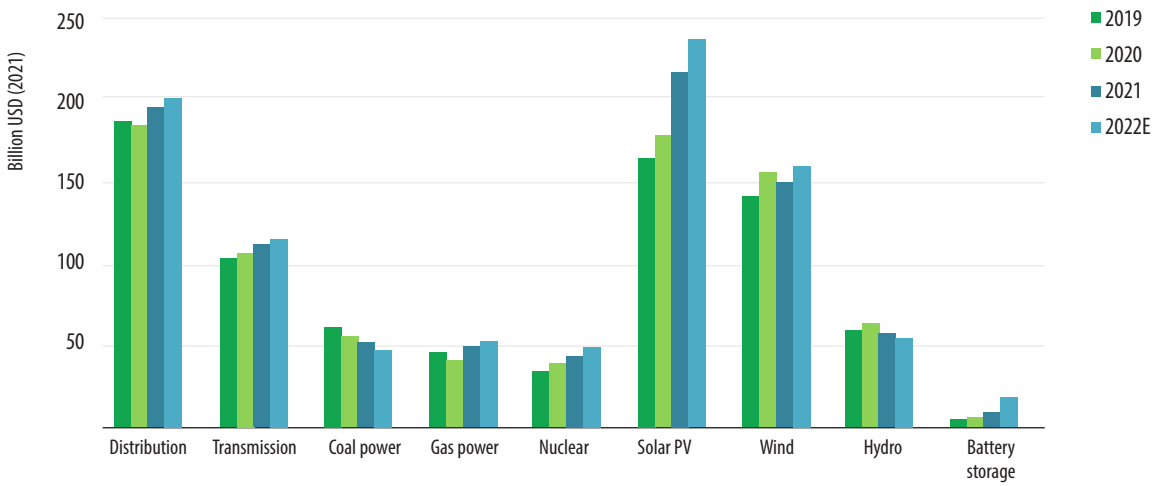
GLOBAL ANNUAL INVESTMENT IN THE POWER SECTOR BY CATEGORY, 2011-2022E



GLOBAL INVESTMENT IN FUEL SUPPLY, 2011-2022E



SOLAR PV INVESTMENTS REMAIN HIGH



Source: IEA

QUOTES

"The world does not need to choose between solving the energy crisis and climate crisis, we can do both."

- Fatih Birol
Executive Director, International Energy Agency (IEA)

"From the perspective of energy transition and energy security there is a need to create a strong pipeline of green hydrogen projects including electrolyser and manufacturing facilities in India."

- Dr Vandana Kumar
Additional Secretary, Ministry of New and Renewable Energy, India

"Governments around the world should be urgently investing in a green energy sprint to shift decisively off destructive, expensive, and volatile fossil fuels for good."

- Ed Miliband
The shadow climate change and net zero secretary, UK

"We must decrease emissions at the same time as increasing supply, Energy is good, emissions are bad."

- Lorenzo Simonelli
Chief Executive, Baker Hughes

"To achieve our goal to limit the global temperature rise to 1.5 degrees, we have to decarbonise our industries. This decade is key to set the tracks to climate neutrality. Especially in sectors where emissions are high but hard-to-abate like steel and cement."

- Robert Habeck
Federal Minister for Economic Affairs and Climate Action, Germany

MARINE

Proman Stena Bulk JV takes delivery of first methanol-powered tanker

Shipping joint venture Proman Stena Bulk has taken delivery of the first of six 49,900 dwt methanol-powered dual-fuel medium-range tankers. The methanol-powered ship is the first of six IMOIIMeMAX dual-fuel MR tankers being built at Guangzhou Shipyard International Co Ltd (GSI) in China for Proman Stena Bulk and Proman. Stena Pro Patria will leave GSI Shipyard to load methanol fuel in Ulsan, South Korea and will arrive in Trinidad and Tobago for its naming ceremony later this year. Stena Pro Patria is preparing for commercial operation with Swedish shipping company Stena Bulk.

Mitsubishi's conceptual design of VLGC completed

Mitsubishi Shipbuilding Co., Ltd has completed the conceptual design of a Very Large Gas Carrier (VLGC). The VLGC is powered by liquefied petroleum gas (LPG) but can be adaptable to future use of ammonia as the main fuel. Approval in Principle (AIP) for the design has been acquired from the Japanese classification society ClassNK. The conceptual design was developed based on Mitsubishi Shipbuilding's experience and expertise in the construction and delivery of more than 80 very large LPG carriers and multi-purpose gas carriers capable of carrying ammonia. Creation of a design enabling conversion to ammonia fuel in line with future needs is expected to permit relatively small-scale ship retrofitting when use of ammonia fuel becomes a viable option.

MINING

FMG set to receive redesigned locomotives from Wabtec for emission reduction

Fortescue Metals Group (FMG), a leading company in the iron ore industry, set receive the first tranche of locomotives rebuilt by Wabtec, a US rail giant. The locomotives provide greater efficiency and help meet the company's aggressive emissions reduction targets. The first 12 of 28 rebuilt GE AC44C6M locomotives are due to arrive at Port Hedland this month by ship after being refitted at Wabtec's Fort Worth plant in Texas. The GE AC44C6M locomotives have been re-designed and re-built to reduce fuel consumption, cut maintenance and repair costs by up to 20 per cent, provide a 55 per cent increase in tractive effort and a more than 40 percent improvement in reliability.

REFINERIES

Private refiners from India profiting from Cheap Russian Crude

India's private refiners are tapping cheap Russian crude and getting profits from exports. However, on the other hand, the state refiners are getting squeezed by high oil costs and government-capped domestic fuel prices. According to the Industry sources the state refiners are much smaller buyers of Russian crude as they largely buy oil under annual term supply deals. They face potential losses in the June quarter, as they grapple with rising global crude costs and controlled retail fuel prices that are unchanged since early April to rein in spiraling inflation. India has bought about 62.5 million barrels of Russian oil since Moscow's invasion of Ukraine on Feb. 24 – more than three times more than in the same period in 2021 – more than half for private refiners Reliance Industries and Nayara Energy, Refinitiv Eikon data shows.

ARDA says refining sector accounts for 3% of global energy emission

According to the African Refiners and Distributors Association (ARDA) the refining sector only accounts for 3% of the global energy sector emission. This was revealed at the second Refining and Specifications Virtual Workshop organised by the ARDA and monitored by Investors King. According to them, as the fuel combustion accounts for 80% of refinery carbon emissions, fuel source and energy optimization would provide the greatest chance to minimize emissions. The association further revealed that Nigeria and other African countries would need to minimize sulphur levels while noting that upgrading their existing refineries would require at least $15.7 billion.

BUNKER

ESL Shipping to use low emission Neste Marine fuel

ESL Shipping will become the world's first shipping company to start utilising new low-emission Neste Marine 0.1 co-processed marine fuel in its vessels in Finland and Sweden. The ISCC PLUS certified marine fuel enables up to 80% reduced greenhouse gas emissions over the life cycle compared to fossil fuels, the fuel's developer claims. Neste Marine 0.1 co-processed marine fuel is currently in the piloting phase.

ABS's AIP for project Sabre ammonia-fueled, ammonia bunker vessel

ABS has issued approval in principle (AIP) to Keppel Offshore & Marine for the ammonia-fueled ammonia bunker vessel at the heart of Project Sabre, an initiative from a consortium of leading maritime organizations to develop an ammonia bunker supply chain in Singapore. As well as ABS, the consortium includes A.P. Moller – Maersk, Fleet Management Limited, Keppel Offshore & Marine, Maersk Mc-Kinney Møller Center for Zero Carbon Shipping, Sumitomo Corporation, Kawasaki Kisen Kaisha, Ltd. and the Maritime & Port Authority of Singapore.

Bunker sales in Singapore increased in May 2022

Bunker sales in Singapore for May 2022 totalled more than 4mnt, up by 373,000t from the previous month and by 1.1pc from a year earlier. It was the first time this year since January that monthly sales have been above 1mnt this year, as well as the highest total so far in 2022. According to Maritime and Port Authority of Singapore (MPA) data, the sales of high-sulphur fuel oil (HSFO) reached 1mn t. Demand for very-low sulphur fuel oil (VLSFO) reached 2.64mnt in May, up from 2.48mnt in April. Consumption of low-sulphur marine gasoil (LSMGO) rose by 97,000t to 376,000t. A total of 3,168 vessels called at Singapore to bunker in May, up by 143 from April, according to MPA data.

K Line, MPA join hands for development of ammonia bunker supply chain

Japanese shipping major Kawasaki Kisen Kaisha (K Line) and the Maritime and Port Authority of Singapore (MPA) have joined a consortium which has set out to develop an ammonia bunker supply chain in Singapore, the world's largest bunkering hub. The consortium, comprising A.P. Moller – Maersk, Fleet Management Limited, Keppel Offshore & Marine, Maersk Mc-Kinney Moller Center for Zero Carbon Shipping, Sumitomo Corporation and American Bureau of Shipping (ABS), launched a feasibility study last year to identify potential ammonia supply sources and indicative costs, as well as undertaking the preliminary design and cost estimation for critical infrastructure, such as ammonia storage tanks and bunkering vessels. This was followed by a memorandum of understanding penned with K Line and MPA in April this year to develop an ammonia bunker vessel for the world's largest bunkering port, which has now received a stamp of approval from ABS.

HEAVY OILS

Europe is reluctantly turning to coal, as gas supplies from Russia drop

Germany, Italy, Austria and the Netherlands have all indicated that coal-fired plants could be used to compensate for a cut in Russian gas supplies. European governments are scrambling to fill underground storage with natural gas supplies ahead of the winter. German Economy Minister Robert Habeck has warned that the situation is going to be "really tight in winter" without precautionary measures to prevent a supply shortage. Reduced flows of Russian gas and the specter of a full supply disruption have prompted some European governments to reconsider coal, one of the dirtiest and most polluting ways of producing energy. It has stoked fears that the energy crisis could see Europe delay its transition away from fossil fuels, although policymakers insist the burning of coal is a necessary stopgap to help prevent a winter supply shortage. Coal is the most carbon-intensive fossil fuel in terms of emissions and therefore the most important target for replacement in the pivot to alternative energy sources.

ABS and Texas A&M Qatar agree on landmark carbon capture joint study

A landmark study into carbon capture and the global supply chain is to be carried out in collaboration between ABS and Texas A&M University at Qatar (TAMUQ). The project will research the potential of carbon capture technology at sea. It will explore CO2 reduction strategies as well as emerging onshore CO2 reduction technology and establish a model for effective CO2 capture on an LNG vessel. The study will also examine the effect of the energy transition toward a hydrogen-based economy on processing, emissions and shipping across Qatar as an energy exporter.

MAN ES and UGS make joint decarbonization commitment

Following a meeting during the 2022 Posidonia trade fair in Athens, MAN Energy Solutions and the Union of Greek Shipowners (UGS) – the leading trade association for Greek shipowners – have announced their mutual commitment to a policy of decarbonization, especially in regard to the testing and development of alternative fuels and, more generally, the maritime value chain. This recognizes the vital role that engine designers and manufacturers play, and that shipping's decarbonization requires the contribution of multiple stakeholders.

Oil exports from Russia increased by 12% in 2022

According to Deputy Prime Minister Alexander Novak, Russian oil exports grew by 12% in the first five months of 2022, as demand persists, despite Western sanctions reducing oil exports to Europe. He added that the increase is linked to lower refining volumes and the reconfiguration of refineries in Russia. Sanctions against Russia include a US oil import ban and the EU gradually introducing an embargo on most oil imports. This will lead to a drop of 2.3 million b/d of Russian crude imports, and 1.2 million b/d of product imports to Europe in eight months.

Crude oil output in India increased by 4.6% in May

India's crude oil production has increased by 4.6 per cent year-on-year to 2.6 million tonnes (MT) in May 2022. Compared with the target for the month, the output was higher by 2.4 per cent. Cumulatively, the output during the first two months of FY23 rose around 2 per cent Y-o-Y to 5.1 MT, while it was higher by 2.9 per cent compared with the target for April and May 2022, the Ministry of Petroleum and Natural Gas (MoPNG) said. Indian refineries' crude processing during May this year stood at 22.6 MT, which is 4.96 per cent higher than target for the month as well as 19.34 per cent higher than May 2021.

Chevron plans to accelerate investments in low-carbon hydrogen

Oil major, Chevron plans to spend about $2.5 billion building up its hydrogen business to accelerate its investment in low-carbon technologies. The company will develop both green and blue hydrogen. Chevron announced last autumn that it was allocating $10 billion toward developing renewable fuels, hydrogen and carbon capture through 2028, but it didn't specify how that money would be split among various technologies.

LNG

Reliance on the lookout for inexpensive green hydrogen technologies

Reliance Industries targets to produce green hydrogen at $1 per kilogram by the end of this decade. For this the Indian company is assessing new technologies for making electrolyzers in its efforts to produce low-cost green hydrogen in the country. As part of the push, the company also plans to bid for any production-linked incentives the government may offer to encourage. The Indian government unveiled the first phase of its green hydrogen policy in February, offering a range of incentives for companies to set up projects. To push this policy forward, India is considering offering more "sweeteners" for producers, Power and Renewable Energy. At the time, the cost of producing the fuel was between $2.22 and $4.62 a kilogram in India.

Samsung bags orders for 14 LNG carriers construction

South Korea's Samsung Heavy Industries has bagged orders worth $3bn for the construction of 14 liquefied natural gas (LNG) carriers. The shipbuilder said it would build twelve 174,000 cu m units for an undisclosed Bermuda-based shipowner, who is paying $2.57bn to have the vessels delivered by July 2026. In a separate order the shipbuilder received order worth around $428m from an African shipowner for two LNG carriers set to deliver by December 2024.

H2FA partners with CLARA Energy for green hydrogen distribution network

Hydrogen Fuels Australia (H2FA) and CLARA Energy have agreed to plan and build a green hydrogen distribution network along the Hume Highway corridor. The project is worth about $600 million, with the first hydrogen refuelling station scheduled to open in 2025. The two companies have agreed to fast-track their joint development of up to five hydrogen refuelling stations between Melbourne and Sydney. The two companies are collaborating on the large-scale hydrogen project in Tarcutta, NSW, whereby CLARA Energy will be developing production capacity at scale, and H2FA will act as distributor and station operator.

MSC's LNG-powered cruise ship completes sea trials

MSC World Europa completed sea trials in the Atlantic as she prepares to enter service in November 2022. The LNG-powered cruise ship is also set to become the largest LNG cruise ship, and one of the world's largest cruise ships. Measuring 1,092 feet in length, the new cruise ship will be approximately 205,700 gross tons, making the MSC class of LNG-fueled ships more than 10 percent larger than Carnival Corporation's LNG cruise ship platform. The MSC World Europa is the first ship in the news class and MSC's first LNG cruise ship.

Volvo launches hydrogen fuel cell truck

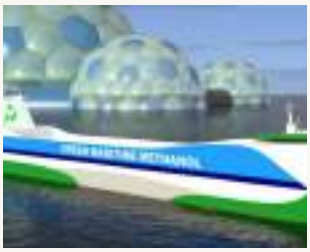
Volvo Trucks has launched a hydrogen fuel cell truck, which will have a range of up to 1,000 kilometres and a refuelling time of less than 15 minutes. The Swedish truck manufacturer's truck will join other zero-emission truck options already on offer, battery-electric trucks and trucks that run on renewable fuels such as biogas. Volvo has been developing the technology for some years now. The truck comes with a combination of battery electric and fuel cell electric to eliminate CO2 exhaust emissions from the trucks.

UAE to partner with IPHE on hydrogen and fuel cell tech

The Ministry of Energy and Infrastructure has revealed that the UAE has joined the International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE), which is a global collaborative initiative for the development and deployment of hydrogen and fuel cell technologies. It is the first Middle East nation to join IPHE global initiative on hydrogen and fuel cell tech. Joining the international initiative will support the UAE's long-term policies related to energy and hydrogen, and attract foreign investments. The partnership will enable access to a global hydrogen knowledge database and encourage cooperation with related initiatives and concerned entities.

METHANOL

China's first methanol-powered tanker delivered



China's first indigenously built dual-fuel tanker powered by methanol has been delivered in Guangzhou City in south China's Guangdong Province. The 49,900-deadweight tonnage (dwt) vessel, which runs on a methanol dual-fuel drive system, can be driven by four fuel modes: fuel, fuel hydrate, methanol and methanol hydrate. It is also equipped with a variety of energy-saving devices such as front-facing conduits and vortex elimination fins, which can effectively improve propulsion efficiency, save energy consumption, and reduce ship operating costs. Pilot tests have proven that the new ship can reduce carbon emissions by 75 percent, nitrogen emissions by 15 percent, and sulfur and particulate emissions by 99 percent. Methanol is already available at over 100 ports worldwide. It is a clean-burning, safe-to-carry and fully biodegradable fuel which provides an immediate reduction in CO2 emissions. Compared with similar alternatives such as LNG, methanol is more convenient to store and transport, and costs less in terms of infrastructure construction.

NLC proposes to set up $56.41 mn methanol project in India

NLC India Ltd, a public sector company involved in integrated lignite/coal mining-cum-power generation, has proposed to set up a 1,200 tonne per day (TPD) methanol project at an outlay of $56.41 mn (Rs 4,400 crore). Engineers India Ltd (EIL) was selected as project consultants for the methanol project, and the plant is expected to be commissioned by 2027. The Niti Aayog had earlier recommended to implement the project on fast-track mode and will be monitoring its progress. The methanol project is part of NLC's diversification and it has requested the Ministry of Coal to include it under the proposed Production Linked Incentive Scheme.

Acta Marine signs contract to build methanol-powered CSOVs

Acta Marine has signed a contract for the construction of two next-generation, Methanol MDO/HVO powered DP2 Construction Service Operating Vessels (CSOVs) at the Tersan Shipyard in Turkey. The Netherlands-based maritime support provider has also reserved options for two additional CSOVs for delivery at a later stage. The vessels are primarily aimed at the offshore wind construction market and carry the new SX-216 TWIN-X Stern design from Ulstein Design & Solutions AS that was exclusively designed for and in cooperation with Acta Marine.

CMA CGM orders for six additional methanol-ready ships

French carrier, CMA CGM, decided to extend its methanol-ready fleet with an order for six ships of 8,000 teu from Hyundai Samho Heavy Industries's Korean yard. CMA CGM has ordered six new-Panamax ships that are methanol-ready with a second order, worth a reported $736m in total, with expected deliveries of the vessels in 2025. CMA CGM joins competitor Maersk as among the first in the sector to embrace the use of e-methanol, which is produced from hydrogen and carbon dioxide using renewable sources by ordering vessels capable of using the alternative fuel.

Construction on methanol-ready Mein Schiff 7 cruise ship commences

Construction on the first large cruise ship designed to be methanol-ready begins in Turku, Finland. The ship is being built for Germany's TUI Cruises, and marks a milestone for the cruise industry and for its builder Meyer Turku, which has also been a pioneer in large LNG-fueled cruise ships. TUI and Meyer Turku announced during the first steel cutting ceremony at the Finnish shipyard that the new build, Mein Schiff 7, has adapted its design to become the first methanol-ready cruise ship. The 111,500 gross ton cruise ship, which is due to enter service in 2024, will be a sister to two earlier builds at Meyer Turku delivered in 2018 and 2019.

Advent to collaborate with Laskaridis in developing methanol-powered ship

Advent Technologies Holdings has agreed to collaborate with Laskaridis Shipping Company Ltd to conduct a pilot programme. As per the agreement, Advent, a Fuel cell developer and manufacturer, will supply Laskaridis Shipping, a ship management company based in Athens, Greece, with its SereneU methanol-powered fuel cells. As part of the deal, Laskaridis Shipping will install the systems on selected dry bulk vessels to assess their overall performance as auxiliary, back-up, or emergency power sources. Both the companies will collaborate on manufacturing and testing the next generation of Advent's fuel cells.

Blue World to work with Tuco for methanol fuel cell solutions

Blue World has agreed to work with Tuco, a supplier of ProZero series fast boats, to develop and demonstrate a flexible methanol fuel cell solution for electric workboats. The collaboration between Blue World Technologies and Tuco has been established through the BlueDolphin project, in which Aalborg University is also a partner. The project funding has been granted by EUPD to support the development and demonstration of methanol fuel cells in workboats. The methanol fuel cell technology by Blue World is designed to provide a green alternative to the maritime industry. The system provides low maintenance which has zero SOx, NOx, and particle emission and a CO2 neutral operation.

Auramarine launches methanol fuel supply system

Auramarine Ltd has invested in the development of the first Methanol Fuel Supply Units to meet the demand for methanol as a promising future fuel. The units are suitable for both two-stroke and four-stroke engines and can be adapted to suit the conversion of existing engines to dual-fuel methanol operation. The company has received substantial interest in the units and is in advanced conversations with shipowners, operators, OEMs, and shipyards on supply and installation. The company expects to deliver the first system in 2023. Existing fuel oil tanks can be used for storage with little modification, as methanol can be stored at ambient pressure and temperature.

BIOFUELS

IMO removes regulatory impediment to encourage biofuels

The International Bunker Industry Association (IBIA) elaborated on the new "Unified Interpretation (UI)" approved by the IMO's Marine Environment Protection Committee in June 2022 on the application of regulation 18.3 MARPOL Annex VI in relation to biofuels.
This regulatory hurdle is now set to be cleared thanks to a new "Unified Interpretation (UI)" approved by the IMO's Marine Environment Committee in June 2022 on the application of regulation 18.3 MARPOL Annex VI in relation to biofuels. This UI means that biofuel blends up to 30% (B30) will be regarded in the same way as regular oil-based fuels.

Sugar producers in India happy with ethanol blending and rising demand

The government's decision to implement the ethanol blending target of 20% to 2025-26 from 2030 has brought an added optimism to sugar producers in the country. Now, under the renewed target, 10% blending of fuel-grade ethanol with petrol should happen this year, increasing gradually each year thereafter and reaching 20% by 2025-26. India's sugar industry over the years had been experiencing very slow growth. Between FY14 and FY21, growth was just 3.6%. The government's decision to bring forward the ethanol blending target provided the icing.

Largest biofuels plant expected to come up in Paraguay

A biofuels plant set to be the largest in South America has been announced in Paraguay. The Omega Green plant aims to produce renewable diesel and renewable aviation fuel, as well as processing by-products, including propane, butane, naphtha and acid gases. It is expected to start operating in 2025 and will be located near the city of Villeta, 45 kilometres south of the capital, Asunción. The plant will be located in an industrial complex of 384 hectares, according to the environmental impact assessment study. The project envisages a total production volume of 20,000 barrels per day of renewable diesel, renewable jet fuel and by-products, according to the environmental impact assessment.

Cargill's first waste-to-biofuel facility opens in Ghent

Cargill has completed its first biodiesel plant in Ghent, Belgium, the plant converts waste oils and residues into renewable fuel. The advanced biodiesel produced at the facility will be used by the maritime and trucking sectors, enabling customers to lower the carbon footprint associated with their maritime and road transport activities. The project is the one of the largest waste-to-biofuel facility in Europe and Cargill's first, employing industry-leading technology to convert all types of liquid waste oils and fats, including used cooking oils, tallow and residues from edible oil production, into advanced biodiesel.

Ethanol gas emerging as cheap alternative in the US

At certain gas stations across Sacramento, the capital city of the US state of California, E-85, a gasoline blend of 85 percent ethanol and 15 percent gasoline, is priced significantly lower than normal gasoline currently because the price of corn is trading below the price of petroleum. In the mid-2000s, Chevy and Ford created many cars that were known as flex fuel vehicles. A Ford F-150 or a Chevy Tahoe, for example, are E-85-compatible vehicles.

POLICY

Power ministry issues green energy open access rules for 2022 in India

According to the new rules issued by the Ministry of Power (MoP), the consumers will be eligible for green energy open access if they have a contracted demand or sanctioned load of 100 kW or more. For captive consumers, there will be no load limitation. All applications for open access to green energy will be allowed by the nodal agency within fifteen days. The rules will be applicable for the generation, purchase, and consumption of green energy, including the energy from the waste-to-energy projects. Reasonable conditions such as the minimum number of time blocks, which should not be more than 12, for which the consumer should not change the quantum of power consumed through open access, may be imposed to avoid high variation in demand to be met by the distribution licensee.

Sri Lanka to implement renewable energy generation plan

It has been announced in Sri Lanka that a 'Renewable Energy Generation Plan' will be implemented starting from June 1, 2022. The policy is aimed at enhancing the renewable energy generation and its share in the energy mix of the country. As part of the new plan government will implement measures like rooftop spaces for the installations of solar panels on a range of buildings: industrial, hospitals, government, hotels and so on.

TECHNOLOGY

Research focuses on molybdenum disulfide for less expensive hydrogen fuel

It is often found that electrocatalyst platinum, a metal so rare that it's typically more expensive than gold, and using it for hydrogen production makes production process more costly than traditional sources of renewable energy and fossil fuels. Recently, scientists have been studying a lower cost alternative called molybdenum disulfide, which is a two-dimensional compound used in motorcycle engine lubricants and other products. While promising, it's not nearly as efficient as platinum. A University at Buffalo-led study published in April in npj 2D Materials and Applications could change that. Its findings suggest that molybdenum disulfide, when enriched with two additional materials, has the potential to supplant platinum as an electrocatalyst, allowing for the more widespread adoption of hydrogen in fuel cell electric vehicles, electricity production and other applications.

What is the future of LNG as alternative fuel

Tougher international regulatory emission standards have been compelling shipowners to shift to environmentally friendly energy sources. Liquefied natural gas (LNG) is one such alternative fuel that currently presents an alternative for simultaneous application with fossil fuels derived from crude oil. Whether LNG can be a mature, scalable, and commercially viable alternative fuel for maritime industry is the point of discussion for many in the industry today.

Of late, the LNG bunker market is poised for maturity, with many shipowners considering or undertaking forward long-term contracts in this space. LNG bunkering is already available at 141 ports worldwide and it is estimated that this will grow to 170 ports by the end of 2022.

The LNG-fueled vessels have increased from 18 vessels in 2010 to 175 vessels by second quarter of 2022, and more than 200 vessels are on order in 2020.

Containership owners and operators too are moving to LNG-fueled tonnage, with orders for LNG-fueled liners increasing fivefold since January 2020. Tankers and bulkers are also following suit, with increases of sevenfold and twofold, respectively, over the 18-month period.

According to DNV GL, currently, there are 805 confirmed LNG fueled ships operating, and 229 additional LNG ready ships worldwide. There are also 87 crude oil tankers that run on LNG, either in operation or under construction, 70 oil/chemical tankers, and 62 bulk carriers.

Most of the vessels in service are operated in Europe and it is expected that the shift from heavy oil to LNG or other alternative fuels

will be further accelerated as a result of the strengthening of IMOs SOx regulations.

MSC Cruises has recently announced the construction of its first LNG powered cruise ship, MSC World Europa. The ship has 50-kilowatt LNG powered solid oxide fuel cell technology which has the potential to reduce greenhouse gas emissions by 25% compared with standard LNG engines.

Asper the recent report by Clarkson Research Services, the LNG-fueled ship orders are approaching 30% of gross tonnage on order, representing a substantial part of shipping's overall capacity when these are delivered.

The research firm also believes that more than 90% of the new Pure Car and Truck Carriers that will enter the market in the coming years will be LNG dual fuel.

CMA CGM, the French shipping liner, has 80 percent of its owned and chartered orderbook dedicated to LNG propulsion, and it is in advanced negotiations for another nine LNG dual-fuel vessels of 23,000 TEU each for a total potential order of 207,000 TEU.

When compared LNG to other alternatives like methanol, ammonia, biofuels, the question that arises prominently is uncertainty shrouding its widespread adoption, developing supply chain, getting the product to ship, and training seafarers, and the infrastructure required for it.

Advantages of LNG-powered vessels

LNG is an environmentally friendly energy source that emits less carbon dioxide than coal or oil. Natural gas is cooled to minus 162 degrees Celsius which turns it into a liquid. Liquefaction reduces the volume to 1/600 of that of gas and enables it to be transported in large quantities by sea. The volume of LNG trade, which plays a leading role in international gas trading, is expected to increase by 21% in 2025 compared to 2019.

> The shipping industry is under increasing pressure from the market, the public and from regulators to reduce its emissions to air. What is already clear, however, is that LNG can play a valuable and positive role in improving the maritime industry's emissions to air as we head toward 2030 and on to 2050.
>
> **TORSTEN SCHRAMM**
> President, DNV GL

> For many alternatives, we have not done life cycle analysis and that adds a tremendous amount of uncertainty ... What is future regulation going to look like? That's why we're seeing an emphasis on LNG right now.
>
> **PETER KELLER**
> Chairman SEA-LNG.

The shipowners are currently inclined to go for LNG-fueled vessels as they do not use heavy oil. LNG is said to have a low environmental impact because it removes sulfur in the pre-liquefaction process, so it emits almost no Sulfur Oxides (SOx) or Particulate Matter (PM) when burned and emits less NOx (nitrogen oxides) and CO2 than other fossil fuels.

LNG is also relatively safe because its specific gravity is lighter than that of air and it is easy to diffuse, so there is less risk of explosion.

LNG reserves exceed that of oil and its ability to provide a stable long-term supply for more than 50 years is a key advantage.

LNG is fully compliant with all global Emission Control Areas (ECAs) and the IMO's global sulphur cap, and future-proofs ship owners against more stringent local emissions regulations.

The use of LNG cuts greenhouse gases (GHGs) by up to 28% on a tank-to-wake basis and it offers a potential decarbonization pathway for shipping via liquefied biomethane, produced from biomass, or liquefied synthetic methane, produced from renewable electricity.

LNG offer the economical aspect and environmental protection and it will be a potential bunker option on 2030.

Disadvantages of LNG-powered vessels

There are also some general disadvantages associated with using LNG as fuel for ships.

- Installation of engines that can use LNG fuel
- Capital investment is also required in equipment other than engines, such as fuel tanks 2 to 3 times larger than conventional ones and re-liquefaction equipment.
- Cost at the time of new construction is 15 ~ 30% higher compared to conventional fueled vessels

LNG-powered ships usage in Europe

The use of LNG in shipping is predominant in Europe due to EU policies like FuelEU Maritime aimed to clean up the sector which led to replacement of conventional marine fuels with fossil liquid natural gas (LNG).

It is estimated that LNG will make up 23% of the total energy used in EU

shipping by 2030, up from the existing 6%.

The number of LNG ships arriving into Europe also increased in the recent, as continued uncertainty about Russian pipeline gas supplies amid the war in Ukraine lured cargoes to the region.

Studies conducted on LNG as alternative fuel

According to class society DNV GL, being LNG-ready could be the best option for many ships in the future.

The class society has conducted a comparative study known as 'Comparison of Alternative Marine Fuels' that has analyzed the commercial and operational viability of six alternative marine fuels namely hydrogen, ammonia, methanol, LPG, hydrotreated vegetable oil (HVO), biofuel and full battery-electric systems.

> When looking at the advantages and disadvantages of alternative fuels, we should be assessing the characteristics of each fuel type on a like-for-like basis. Greenhouse gases in the atmosphere are a stock problem as well as a flow problem. The industry needs to consider the pathway to decarbonization, not just the destination.
>
> **STEVE ESAU**
> Chief Operating Officer
> SEA-LNG

The study evaluated how well they performed compared to LNG and heavy fuel oil against a set of 11 factors.

The key factors evaluated in the study included energy density in each tonne of fuel, technical maturity and proven operational performance in terms of safety and reliability, local emissions associated capital cost of engines and fuel storage onboard, and availability in terms of geographic bunkering.

The study findings showed that while there are a variety of lower or zero carbon alternative fuels that could help to meet the goals of the International Maritime Organisation's (IMO) 2030 and 2050 GHG reduction targets, many of these alternatives – such as hydrogen and ammonia – require significant development to meet the industry's needs.

Apart from challenges such as lack of regulatory framework, production capability, and bunkering infrastructure for widespread adoption, other fuel options also demand massive investment in supply chains and bunkering infrastructure.

LNG – which has been widely used for more than 50 years for power and heat generation – is according to the DNV study the only alternative fuel that is compliant with the current and future emissions regulations and requires lower capex compared to others.

A study conducted by SEA-LNG coalition proves that LNG-fueled engines have GHG benefits compared with current oil-based engines of between 20% to 30% for 2-stroke slow-speed engines, and 11% to 21% for 4-stroke medium speed engines, inclusive of methane slip.

In another study conducted by the University Maritime Advisory Services in collaboration with the World Bank has evaluated the sector-wide and technologically agnostic approach to assess the short- and long-term impact of GHG emissions across a 20- and 100-year timeframe.

The study report acknowledged that emissions during LNG extraction are difficult to estimate and may be higher than generally assumed, depending on the extraction method.

The report also suggested that LNG infrastructure and vessels built today could later be reused from 2030 onward with compatible zero-carbon bunker fuels. It can be used until 2030 before it is supplanted by emerging zero-carbon bunker fuels, and it can also be used as a bunker fuel for only limited, niche applications.

Opposition for LNG-powered vessels

The opposition for the LNG-propelled ships is also raising from environmental groups, as they say that switching to LNG will increase the climate footprint of vessels and lock in fossil fuel dependence, making the transition to zero-carbon energy even more difficult.

> It is simply reckless and irresponsible to promote highly polluting LNG during a climate crisis.
>
> **KENDRA ULRICH,**
> Shipping Campaigns Director and lead of the 'Ship It Zero' campaign at environmental advocacy organization Stand.earth,

Another factor affecting the LNG-powered vessels is the current high LNG prices, which are compelling even the early proponents of the fuel to cool their interests this year.

CMA CGM, which has so far been most heavily investing in LNG propulsion, has recently ordered for six 15,000 teu dual-fuel methanol-powered vessels. The company has put all its LNG vessel investment plans on hold, as it waits and see whether LNG prices are going to stay elevated.

According to Transport & Environment (T&E) investigation into LNG ships it is found that significant amounts of invisible methane being released into the atmosphere. Infrared images show unburned methane being released from LNG ships. The study warned European politicians that support for LNG is dangerous as it is over 80 times more climate warming than carbon dioxide over a 20-year period.

Despite the opposition LNG is the only alternative marine fuel available for the shipping sector to switch to achieve decarbonization goals. International shipping emits 15 per cent of global sulfur oxide (SOx) and 13 per cent of global nitrogen oxide (NOx) emissions and other air pollutants, such as particulate matter (PM). In order to provide effective emission benefits to shipowners LNG will be offered as bioLNG and renewable synthetic LNG which can gradually replace fossil fuels in the years to come.

The option to blend bioLNG with traditional LNG allows ship operators to incrementally introduce the lower carbon fuel in line with availability and increasingly stringent emissions requirements.

LNG is suitable for ferries, passenger ships, tankers, bulk carriers, supply ships and containerships. The reliable long-term supply of natural gas is also a key factor in LNG being more feasible in the long term than current fuels. The safe refueling of LNG-powered ships and the safe evacuation of LNG fuel from ships in an emergency are of paramount importance for the protection of LNG as a commercially viable and acceptable marine fuel.

LNG is recently becoming more popular for many ship owners because bulk infrastructure has already been developed in many ports and matches up well against existing liner trades. Of the top 25 global ports ranked by volume of trade, bulk LNG is already available in, or close to, 24 of them.

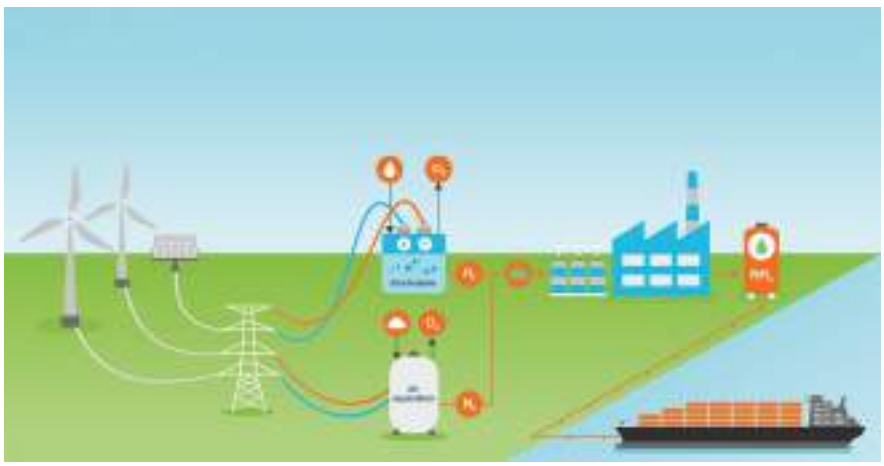
Though there are some questions raised over LNG as alternative fuel in shipping due to the perception that it is a dangerous and highly flammable liquid/gas. But industry has put in place some mitigating measures to protect people and assets from the hazards and risks that exist. So far, no significant accident has taken place where LNG was used as the marine fuel. The equipment like safety break-away couplings is designed to prevent and pull-away accidents when bunkering LNG as marine fuel.

In spite of opposition and perceived disadvantages LNG is currently widely considered as the leading 'bridge fuel' to other alternative fuel options. FF

Two-stroke ammonia engines for maritime energy transition

Green ammonia is among several synthetic fuels key to establishing a greener shipping industry in the near future.

By Nils Lindstrand



MAN Energy Solutions aims to have a commercially available two-stroke ammonia engine by as early as 2024, followed by a retrofit package for the gradual rebuild of existing maritime vessels by 2025.

"Today we have a chance to change the shipping industry and its environmental impact on a global scale," says Brian Østergaard Sørensen. A sailor who once taught thermodynamics, you can certainly argue that he has a suitable background for the task. Before receiving a degree in mechanical engineering from the Technical University of Denmark, Østergaard Sørensen had already earned the highest seafarer qualification – master mariner – allowing him to serve as shipmaster on any merchant ship anywhere in the world.

"Now I've found my place in the machine industry at MAN Energy Solutions," he says, where as Head of Two-Stroke Research and Development he and his team at the Research Center Copenhagen (RCC) are working on flexible fuel solutions that will allow engines to burn a broad variety of environment-friendly fuels, including methanol and ammonia. The company already aims to have a two-stroke ammonia engine for large-scale container ships available by 2024, and a year later a retrofit package to make existing ships capable of running on ammonia as well.

The need for flexible fuel solutions

According to the International Maritime Organization (IMO), maritime shipping emits around 940 million tons of carbon dioxide (CO2) per year and is responsible for around 2.5 percent of all greenhouse gas (GHG) emissions. Without mitigation, emissions are projected to grow by at least 50 percent over the next three decades, which is why the IMO has adopted mandatory measures to reduce 70 percent of emissions from ships by 2050 and eventually phase them entirely out within this century.

Ammonia has unquestionable advantages that could help create a sustainable maritime shipping industry. It can literary be produced from air and sunshine – and it's carbon-free. Moreover, as with methanol, solutions using ammonia build on established technologies and infrastructure, making the road to sustainability much shorter. However, it will take time to build capacity – and time to rebuild ships' two-stroke engines to run on ammonia. "The interest from shipping companies in new fuel technologies is huge today, and we already have a number of collaborations running. But the conversion to green engines also depends on economic realities." Østergaard Sørensen adds: "No shipping company can risk having its fleet stranded during the transition, which is why we need to create flexible solutions that allow a transition by degrees."

Double walls and clean combustion

The development of such solutions isn't without challenges. Østergaard Sørensen points out that ammonia is a toxic and potentially corrosive chemical: "So we're currently focusing R&D in the creation of a complete system from fuel tank to engine, making trials with double walls, using different materials solutions, developing smart software and finding the optimal process solutions." The process also has to be designed right to avoid emitting nitrous oxide (N2O) or "laughing gas" into the air. "But the issue can be solved," says Østergaard Sørensen. "We're already working on a number of options to develop the most efficient solution." FF

Source: MAN Energy Solutions

LNG is not a transition fuel, it's a fuel in transition'

In an exclusive interview with *Future Fuels*, **Steve Esau,** Chief Operating Officer, SEA-LNG, shares his views on how Liquified Natural Gas (LNG) can be a potential alternative fuel for maritime industry.

Q. Recently, the new build orders for LNG-powered ships have been on the rise. Is this because there are no readily available alternative fuels for bunkering other than LNG? Or is it because the fuel has more benefits to decarbonize maritime industry?

The growth in orders for LNG-powered ships shows that the industry acknowledges the clear benefits that LNG offers, while also recognising that, because it's readily available, these benefits can start today. This growth is set to continue; DNV, a SEA-LNG member, recently forecasted that by 2028 there will be at least 864 LNG-fuelled and LNG-ready vessels in the global fleet.

One key benefit that shipowners and operators recognise is that fossil LNG reduces shipping emissions right now. According to Sphera's 2nd lifecycle GHG emission study on the use of LNG as a marine fuel, on a well-to-wake (WtW) basis, LNG offers a 23% cut in greenhouse gas emissions over oil-based marine fuels. The study also reaffirmed that LNG combustion in modern engines produced next to no emissions of SOx, NOx or particulate matter. LNG improves local air quality for seafarers, dockworkers and port communities and is safe. Other alternatives are challenged by issues, such as toxicity and flammability, which will need to be addressed before they can be safely used as marine fuels.

Shipowners and operators increasingly recognise that LNG infrastructure is more established than alternatives. It can already safely be bunkered, stored and transported worldwide. By the end of 2022, LNG bunker vessels will be operating in northern Europe, the Mediterranean, USA, Canada, South Korea, Japan, Malaysia, China, Singapore, Brazil, South Africa and Australia. In January 2022 LNG bunkering was available at 141 ports worldwide and Clarksons forecasts that this will grow to 170 ports by the end of 2022.

Existing infrastructure can transport, store and deliver carbon-neutral bio-LNG and renewable synthetic LNG (or e-LNG) without any modifications or additional investment. Meanwhile, these fuels can also be dropped into LNG-powered vessels or blended with fossil LNG without any changes required. Being able to transition to these fuels means owners won't end up with stranded assets. Ultimately, shipping stakeholders are investing in LNG because it provides a low risk, incremental pathway for decarbonisation, one which is already underway and offers other benefits along the way.

Q. Do you think LNG has the potential to be an effective alternative fuel for fossil fuels in shipping industry in the years to come?

We are transparent about the fact that, despite its strong emissions reductions, traditional LNG is a fossil fuel. However, it's important to note that LNG is not a transition fuel, it's a fuel in transition. This evolution to bioLNG and renewable synthetic LNG can gradually replace fossil fuels in the years to come.

BioLNG can be produced from domestic and agricultural waste capturing methane that would otherwise be vented into the atmosphere; and the waste streams from bioLNG production can support the circular economy. It is commercially available right now, with suppliers in Europe, for example, quoting prices for delivery in Rotterdam, the biggest marine fuel bunkering hub in Europe, and several North Sea and Baltic Sea ports.

Biomethane production is growing rapidly in regions such as Europe and North America. And supplies of bioLNG for maritime are forecast to rise dramatically as businesses like Wärtsilä, Biokraft, Gasum, Titan and CMA CGM step in to increase production capacity. For example, SEA-LNG member – Titan – recently announced a partnership with Attero and Nordsol on an EU-backed bio-LNG production plant, which it says will produce around 2,400 ton/year of bio-LNG by 2023. Further waste to energy production discussions is already underway across the shipping industry, although timescales for replacing fossil fuels depend on policy and regulations.

Renewable synthetic LNG is carbon neutral. It is produced from hydrogen and biogenic carbon dioxide, or carbon dioxide taken directly from the atmosphere. Renewable hydrogen is made by splitting water into oxygen and hydrogen, using electrolysis, powered by renewable electricity. All of the processes required in the production of synthetic LNG are technologically mature - the main focus is now on driving down the cost of renewable electricity and hydrogen electrolysis – which is the same challenge facing all other alternative, synthetic fuels, such as e-methanol and e-ammonia.

There are plants already operational today, such as the Audi e-fuel plant in Werlte, north Germany, and others planned such as the Wallumbilla Renewable Methane Demonstration Project run by Southern Green Gas in Australia, using solar power to create synthetic methane.

Q. Do you think LNG will remain a contender in the bunkering market after the commercial advent of future fuels like methanol, ammonia and green hydrogen?

It is important to compare alternative fuels on a like-for-like basis, so while, in the long-term, fossil LNG may be less of a long-term contender for decarbonisation than e-methanol and e-ammonia, bioLNG and renewable synthetic (or e-LNG) are likely to play a key role in zero-carbon shipping.

The adoption of a fuel pathway will not occur as a big-bang effect, with a sudden switch to new fuels and propulsion systems. The process is likely to be incremental, relying on the build-out of renewable electricity, electrolysis and fuel production capacity.

This is where the ability to blend bioLNG and/or renewable synthetic LNG with traditional LNG at any ratio is so valuable. It allows ship operators to gradually introduce these zero-emission fuels in line with availability and as regulations become increasingly stringent.

Analysis from SEA-LNG performed last year determined that for every 10% of bio-LNG dropped in and blended with LNG as a marine fuel, a vessel can achieve two extra years' compliance with the Annual Efficiency Ratio (AER) curve used to secure preferable funding under the Poseidon Principles.

Q. What needs to be done to create international consensus on decarbonization of shipping Industry?

The level of investment supporting the LNG route to maritime decarbonisation – more than one third of tonnage in the new build order book is LNG fuelled - indicates many shipowners already agree on the leading alternative fuel pathway today. However, it is unlikely that there will ever be complete consensus on alternative marine fuels. This is partially because different fuels or technologies may be superior for different vessel types and their unique operating profiles.

In order to create more consensus, it is vital that all actors have access to objective data and fact-based analysis. Regulators, the industry, investors and NGOs must compare apples with apples. Analysis of a fuel's impact on the environment must also be compared on a full life-cycle basis. In shipping that means on a well-to-wake basis for fossil fuels, "waste-to-wake" basis for biogenic fuels and "wind turbine-to-wake" basis for synthetic fuels. If these rules are followed, properly informed-decisions can be made on maritime decarbonisation. FF

‘We are adopting fuel-flexibility approach regarding future fuels’

Mr Sachin Kulkarni – Head of Sales, Marine Power (South Asia), Wärtsilä shares his views with *Future Fuels* on how his company has been spearheading shipping’s decarbonisation efforts, and what needs to be done to accelerate lower emissions in the maritime industry

Q. What is the engine technical solutions Wartsila offers to ship owners for green fuel transition?

We know there are particular uncertainties around future fuels – such as when and where they will be available and at what price. However, one thing remains certain: investing in fuel flexibility and where appropriate - retrofitting & upgrading existing vessels, offers a hedge against any potential risk.

Our approach to Sustainable Fuels & Decarbonisation in Marine is to remain fuel agnostic. Instead of predicting what fuels will be available, we are adopting an approach of full-flexibility regarding future fuels and green technologies.

The engines we are currently designing reflect this by being able to run on a variety of fuel blends.

Wärtsilä is also investing continuously in the development of new technology and this is our current future fuel roadmap in summary.

CH4 Bio- or Synthetic methane: Contains about 99% methane and can readily be used in liquid form with equipment made for LNG.

MeOH Methanol: A methanol conversion package is available for the ZA40 engine and we have many years of experience running methanol successfully on the ICE.

Industrialised technology achieved – product development applied to W32 engine series, currently on the market. The next step is to industrialise this technology on the other relevant portfolio engines according to market needs – this work is currently underway and products will be brought to market accordingly.

NH3 Ammonia: We have developed engine technologies capable of running on Ammonia blend.

The needed combustion concepts to maximise engine performance and related safety technologies are currently being investigated. Given today’s development and current estimates, Wärtsilä will have a technical concept available within 2023.

H2 Hydrogen: Our gas engines are currently able to blend LNG with up to 25% hydrogen and combustion concepts made for 100% hydrogen. Our future efforts will be directed towards maximising engine performance.

However, infrastructure & availability of green fuels need time to mature – the Multi-fuel (DF) Engine is an excellent fuel-flexible choice for future peace of mind. The Multi-fuel (DF) engine makes it easier to introduce new fuels in an economically viable way, by preserving performance while reducing emissions.

As the supplier of complete solutions regardless of fuel, we will have fuel storage and supply systems for most future fuels and are as well positioned in this regard as we are with our fuel-flexible engine technologies.

Q. What are the main challenges in the transition to zero carbon - and what solutions have caught your attention?

The challenge we have is that there are many different options and no consensus today on which of the future fuels will be commercially available. Commercial availability depends on various factors like geographic location, national interests & legislations, and the availability of feedstock.

These uncertainties create business risks regarding fuel availability, increased CAPEX / OPEX, vessel design / structure / storage &

handling, including complexities in managing cryogenic requirements & toxicity.

Then we also have the timing issue: when should one make the investment & go for another fuel? We only have a limited amount of shipyard capacity in the world, so it would not be possible / feasible to upgrade all commercial vessels at the same time.

In addition to global CO2 emissions, local emissions, and the effects of energy production to local surroundings should also be considered. Finding the balance between local and global emissions will be another factor affecting fuel development and discussion. Even with carbon-free fuels, exhaust after treatment will be needed to reduce emissions and prevent the deterioration of local air quality.

The availability of future fuels is the main uncertainty. By investing in DF technology and LNG as fuel, the ship owner will have several options to transition to the future.

Wärtsilä is recommending an approach of being fuel agnostic and our product development will support this. The fuel tanks are the most difficult to replace and flexibility can be ensured via the selection of tank material or by facilitating future replacement through the vessel design.

Electrification is another solution, enabling reduction in carbon foot print on board. e.g. Wärtsilä Hybrid solution delivers tangible values such as – lower fuel consumption, reduced noise & vibration level, greater operational flexibility, lower maintenance, minimized exhaust emissions, smokeless operations, enhanced system redundancy.

The goal is to have enough power output with as low fuel consumption as possible. Best is to use less fuel in the first place.

Q. Traditionally bunker has been costly for Indian tonnage due to its tax structure. Considering that eco-friendly fuels will initially be costly compared to bunker fuels, how do you suggest should be the transition from conventional bunker to green fuels?

Every owner, business operation & region is different, which changes the propensity for various fuels. Investing in a combustion engine which will support fuel flexibility will mitigate compliance and business risks introduced by future fuels.

Green synthetic fuels are not expected to become widely available to the shipping industry before 2040. Converting all IMO-classed ships to accept carbon-neutral fuels will take many years considering the limited shipyard capacity

LNG can already reduce the GHG footprint by -5 to -21% and can enable decarbonisation when mixed with biomethane or green synthetic methane without changes to the vessel.

Introducing LNG as a transition fuel is the first step towards decarbonising the shipping industry. Fossil LNG can be seamlessly mixed and replaced by Bio-LNG; in the future also Synthetic LNG made from renewable hydrogen.

A key aspect in this is that the supply chain for LNG is rapidly maturing. There are of course other options, but for a large-scale implementation a supply chain, mature fuel storage technology, safety rules, experience and economical aspects play a vital role.

Q. While it's still early days in fuel transition, do you foresee a single alternative fuel replacing the fossil fuels, or do you expect a variety of fuels to emerge in market as alternatives?

There is no one single future fuel – there will be a variety of fuels in use.

When we are talking about Green Fuels, it means they are synthetically made, based on hydrogen, and are produced by using renewable energy.

First, we have Green Hydrogen, an essential element in most synthetic fuels. In short-sea shipping with strict emissions legislation and frequent bunker opportunities it can offset low energy density.

Hydrogen is going to play an important role in building other fuels, for example green ammonia.

Green Ammonia will be one of the main fuels that we will see in the future. This fuel will require additional investment from the toxicity point of view and the way it is dealt with. For this reason, we see challenges for passenger vessels, due to its relatively low energy density by volume, it will be most suited to vessels that don't have space limitations.

Green Methanol is also of interest for the future, mainly due to the ease-of-storage on board. It doesn't have any specific requirements, doesn't need to be stored at low temperatures or under pressure, and allows for more flexibility when it comes to tank design and location on vessel.

Let's also have a look at biofuels.

It is important to point out that we only consider sustainable fuels, i.e., waste that doesn't compete with food production.

Green biomethane is interesting since the end result is the same as LNG. likely the most economical alternative due to maturity of technology, fuel availability, existing rules & regulations, availability of feedstock, and higher carbon efficiency than biodiesel. Can be used as a drop-in alternative to natural gas.

Green synthetic methane uses green hydrogen and CO2. Same as biomethane, we can use it directly in our LNG packs and engines.

Biodiesel, (first and second generation) can be used today in diesel engines without the need for additional investment, provided they comply with the fuel specification.

We need to be careful when mixing bio-fuels with some fossil diesel due to potential compatibility issues between certain types of bio and fossil diesels.

Variations in local availability & price are the main challenges, as there will be competition from other industries that are ready to pay a premium. FF

Bringing fuel efficiency through hull enhancements

The phenomenon of biofouling creates friction between a ship's hull and the sea, leading to increased drag and more fuel consumption to compensate for loss of speed.

Maritime transport or shipping is responsible for the release of approximately 940 million tonnes of CO2 into the environment every year. Yet, as most of global trade depends on the shipping industry, it has become a necessary evil of sorts.

Biofouling, or the accumulation of microorganisms, plants or small marine animals on ships' submerged hulls, has been one of the factors in maritime transport's contribution to environmental hazards. When a new ship's hull is submerged in seawater, a thin film will form on it within minutes, and a biofilm of bacteria will grow within an hour. This will slowly graduate to diatoms and protozoa—commonly called slime. In a week, macrofouling occurs as algal spores and animal larvae appear, and in the next few months shell fouling will occur, as these will develop into adult organisms known as weed.

The phenomenon of biofouling creates friction between a ship's hull and the sea, leading to increased drag and more fuel consumption to compensate for loss of speed. Even a layer as thin as 0.5 mm, covering just half a hull, can boost CO2 emissions by as much as 25%. This could even skyrocket to 55% if a layer of barnacles or tubeworms is formed. To tackle these conditions, the marine industry has introduced technology-generated antifouling coatings for superior hull smoothness.

Minimizing biofouling also helps in halting the transfer of aquatic species to other regions, as the local marine life could be altered, disturbed or even damaged, like in the case of North America's zebra mussel infestation of the Great Lakes.

Types of hull coatings

There are two types of premium hull coatings presently available in the market: biocidal polishing systems and biocide-free foul-release coatings.

Biocidal coatings are based on acrylate technology, which is either metal (copper or zinc) acrylate or silyl acrylate. Here, copper is the primary biocide, with support from organic co-biocides.

Biocide-free, foul-release coatings are of two types – silicone elastomers-based "soft" products, and fluoropolymers-based "hard" products that are manufactured using various resin technologies.

The different choices of products show that there is no 'one coating for all occasions'. Adding to this, other factors are involved when it comes to the proper choice of underwater coating for a ship, such as ship type, cost, trading pattern, service speed, maintenance painting or for a new ship.

Coating brands and their benefits

The premium products segment of coatings has seen many improvements in the past year, with several strategies being launched to minimize either friction or biofouling. The EU-funded AIRCOAT (Air Induced friction Reducing ship COATing) project

combines both.

The AIRCOAT solution, helped by project partner Karlsruhe Institute of Technology, Germany, was inspired by the free-floating aquatic fern Salvinia molesta, which creates a permanent layer of air on its surface under water. Similar to Salvinia molesta, AIRCOAT has developed a passive air lubrication foil for the submerged ship hulls, making them environment-friendly and more fuel efficient as it reduces drag. Such a method also avoids the use of toxic substances to thwart biofouling, thus avoiding the release of harmful chemicals into the water.

Coatings supplier Hempel has launched a foul-release technology called Hempaguard or ActiGuard that features a hydrogel surface modification. It offers better resistance to the build-up of slime during idle periods, while also showing significant fuel savings. ActiGuard is based on silicone-hydrogel and biocide science, where the biocide's surface retention property activates the hydrogel, which repels the fouling organisms, while simultaneously minimizing drag and biocide use. The product claims to release 95% less biocide than the self-polishing co-polymer type antifouling, while keeping the surface equally smooth as silicone-based, biocide-free foul-release coatings. It has also shown about 6% in fuel savings.

Nippon Paints also uses hydrogel technology supported by biocidal polishing antifouling. Its recent 'improved version' of its seven-year-old low-friction LF-Sea product claims a reduction of up to 10% in shipping fuel expense. This enhanced version employs water-trapping technology and biomimetic technology, alongside a rheological, anticorrosive control additive. Due to the hydrogel in the antifouling, the hull surface takes on liquid-like properties, which not only reduces friction but also deters fouling. The technology is embedded within a self-polishing, antifouling, copper-silyl-acrylate paint in which the hydrogel's effect is maintained and renewed as long as the ship is in service. The company asserts that this version can be applied over existing antifouling coatings inexpensively and expeditiously.

International Paint has come up with its latest premium hull coatings, which include an advanced Intersleek coating and a new Intercept system.

The Intersleek 1100SR is an advanced version of the previous generation fluoropolymer that is armed with a patented slime release technology. The coating's static fouling resistance is said to be very effective even in warm waters, and whatever slime is formed during this time is washed away as the ship moves. It also claims to offer fuel savings up to 10% and is said to be appropriate for slow-steaming vessels, although suitable for all ship types.

The Intercept 8000 LPP is based on Lubyon polymer technology. This biocidal antifouling coating is different from the silyl or metal acrylate biocidal systems. It creates a "superhydrophilic" surface, which has a lubricating effect and also swells in water, due to which the surface becomes smoother and reduces friction. Furthermore, the polymer's reaction with seawater releases the appropriate amount of biocide, which is mostly not affected by seawater temperature. Although this coating is specifically designed for deep-sea vessels, it is suitable for all ship types and all-season global routes. This coating is said to save 5% in fuel and emission costs.

Coatings manufacturer Jotun's newly developed SeaQuantum X200-S range offers superior resistance to fouling, slime, and mechanical damage, apart from providing controlled and linear polishing. The range of products is suitable for all kinds of ships and claims fuel savings of 10% above market average.

Another manufacturer PPG's premium products include the third generation SIGMAGLIDE 990, SYLADVANCE 800, Sigma EcoFleet 690 and Sigma NEXEON range. SIGMAGLIDE 990 is a silicone-based foul release coating that boasts enhanced slime-resistance and -release features. SYLADVANCE 800 is a silyl acrylate antifouling coating with enhanced self-smoothing characteristics that claims to keep away weed and shell fouling for prolonged periods. The Sigma EcoFleet 690 coating is said to provide superior antifouling protection for short-sea and coastal shipping in fouling prone environments. The copper-free antifouling solution Sigma NEXEON's range of coating uses self-polishing, zinc-acrylate binder technology. The absence of copper, significantly improves the leveling and smoothness straight after applying the coating, thereby increasing fuel efficiency.

Japanese company Chugoku has come up with SEAFLO NEO and Bioclean. SEAFLO NEO is a high-performance, TBT-free hydrolysis antifouling that employs a unique polymer to give an ultra-smooth surface and self-polishing performance to a ship's hull. This enables decreased drag and long-term antifouling protection and claims to reduce fuel consumption by about 5%. Biocide-free, foul-release coating Bioclean, is Chugoku's olive branch to the environment. It is said to be 25% smoother than other silicone coatings, reducing fuel consumption, fouling and CO2 emissions by that much more.

Sherwin-Williams' latest specialty is its silicone-based, two-coat Sher-Release System. This foul-release system comprises the SeaGuard Tie Coat and the SeaGuard Surface Coat. FF

Capturing the carbon for emissions control

There is no way to achieve climate targets without carbon capture.

Carbon capture, utilization and storage, or CCUS, which can trap and use the CO2 released from fuel combustion or industrial activities is necessary for achieving global netzero goal. Currently, industry leaders are calling for an international strategy that will make CCUS financially feasible and create a circular carbon economy.

How carbon capture works

CCUS starts with carbon capture, removing emissions directly from the air or, more usually, before they're released into the atmosphere in the first place. The captured gas is then compressed as a liquid or solid and either stored deep underground or made available for further processing. For example, the captured carbon can be combined with green hydrogen to create climate-neutral methane fuel or methanol, or it can be transported to industries that need it to produce everything from plastics to fertilizer.

Capturing carbon can be done in a few different ways, either before or after combustion or by using oxyfuel, which involves burning fuel using pure oxygen. Or, as already mentioned, it can also be removed from the air after it's been emitted by using a technology called direct air capture (DAC). However, with only 16 plants currently in operation worldwide, development on DAC technology is still in its early days, and the large amount of energy required to separate CO2 from ambient air makes it more costly.

Many scientists are pointing to carbon sequestration as a solution. Carbon sequestration is a method of trapping carbon dioxide preventing it from going into the atmosphere. Some sources claim that carbon sequestration has an 85-90% efficiency rate. Carbon dioxide can be captured physically or chemically. By Henry's law, stating the amount of dissolved gas is proportional to the partial pressure of the substance dissolving, and carbon dioxide's high partial pressures, this is made possible. Chemical absorption relies on carbon dioxide reacting with certain chemicals. Low temperatures and high pressures are used in order to efficiently execute both methods of carbon capture.

Capturing CO2 directly from industrial exhaust gases is right now the more promising approach, and from a technological point of view, CCUS is already feasible.

However, there are three main ways of capturing carbon dioxide including pre-combustion capture, post-combustion capture, and oxy-fuel.

Pre-combustion capture

In this way of carbon capture to make necessary blend of hydrogen and carbon dioxide fuel goes through gasification, which is a process where organic or fossil fuel gets converted to carbon monoxide, hydrogen, and carbon dioxide.

Post-combustion capture

It can be captured by the exhaust of a combustion process. This is done by absorbing carbon dioxide in a suitable solvent like monoethanolamine (MEA) and diglycolamine (DGA), a high-pressure membrane filtration which rely on the permeability of carbon dioxide in order to capture it, adsorption/desorption process which binds carbon dioxide to a solid or liquid condense plate, or cryogenic separation which involves using low

temperatures to cool certain gases in order to liquify carbon dioxide.

Oxy-fuel

Oxygen diluted with flue gas is used to combust the fuel resulting in a release of carbon dioxide and water. This then produces a stream of carbon dioxide making it easier to purify carbon dioxide.

Carbon capture facilities in the world

Achieving carbon capture foremissions require extraordinary measures. It requires commitment from governments and the private-sector to tackle climate change. In fact, the measures that will accelerate the deployment of carbon capture and storage will also be vital to catalyzing the green transition. It is larger policy and financial frameworks that matter.

There are currently over 19 large-scale carbon capture and storage facilities in operation globally. To reach climate and sustainable development goals, some 2,000 are needed, equating to a 100-fold scale-up between now and mid-century.

Petra Nova Carbon Capture Project at Fort Bend County in Texas. The project was seen as the biggest of its kind to date. It later closed operations in 2020 as a result of increased oil costs brought on by the pandemic.

The Northern Lights project, Norway is the CCS project recently received backing from Microsoft, adding to the already impressive team of collaborators including Shell, Total, and Equinor. The site has been designed to process 1.5 million tons of liquid CO2 each year — amounting to more than 100 million over its lifecycle.

There are also largescale projects underway that prove the technology works, including 76 in North America and 38 in Europe, mainly in the United Kingdom, Netherlands and Norway.

HeidelbergCement is constructing the cement industry's first largescale plant with CCUS in Norway, which will begin operations in 2024. Around half of the plant's carbon emissions will be captured – some 400,000 tonnes annually. The compressed carbon will then be transported by ship and injected into depleted gas reservoirs under the North Sea for storage underground.

The Boundary Dam project in Canada was built to capture and bury around 6 million tons of carbon dioxide a year, but the project has been experiencing some problems. A few more projects have come up since then.

How it helps climate change

Carbon capture and storage (CCS) is one of the few technological solutions that can contribute to a significant reduction in emissions from industrial operations based on coal or gas power, keeping CO2 out of the atmosphere that would otherwise worsen climate change.

Important contributions can also be made by applying CCS to the sement and steel industries, which represent 14 % of the world's CO2 emissions.

The faster CCUS gains mainstream attention now, the sooner companies will be able to build largescale carbon capture projects. Over and above that, the amount of emission reductions in different sectors will eventually show how much direct air capture and other activities that remove CO2 from the atmosphere will truly be needed. FF

Role of electrolysers crucial for India to be leading green hydrogen producer

Green hydrogen is derived from splitting water (hydrogen + oxygen) molecules through electrolysis and letting out the oxygen molecules safely and in an environment-friendly way into the atmosphere. Thus, the vitality of electrolysis and controlling the electrolyser market is crucial for India's plans to lead the green hydrogen manufacturing segment. However, this process is yet to achieve mass scalability, although knowledge of it has been around for almost 200 years, not to mention the cost component, which still hovers on the expensive side.

Importance of the electrolyser

An electrolyser functions through two main features: the stack and the system. The stack is where the water molecules are split and the system involves the water supply, the power supply, and the purification and compression processes.

There are four common methods used to electrolyse water: namely, Alkaline Electrolysis, Proton Exchange Membrane Electrolysis, Anion Exchange Membrane Electrolysis, and Solid Oxide Electrolysis. All four procedures are quite different from the other. Each uses a different electrolyte, operates at a different temperature and pressure, and uses different materials in the stack. Alkaline and Proton Exchange are commercial technologies, while Anion Exchange and Solid Oxide (although promising) have not yet graduated from the research stage. Currently, only a few companies and Original Equipment Manufacturers (OEMs) in Europe make these electrolysers.

The most economical method of the four is the well-established Alkaline Electrolysis due to its nickel-coated stainless steel stack composition. However, it is only 70-80% efficient due to its thick membranes. Proton Exchange, on the other hand, has thin membranes and is about 80-90% efficient, but due to its stack components being made out of gold and platinum-coated titanium electrodes, the cost is high.

The vitality of electrolysis and controlling the electrolyser market is crucial for India's plans to lead the green hydrogen manufacturing segment.

Economization of electrolysis

Both, the stack and the system, need to play equally important roles in terms of economizing the process. There are three major areas in the system (namely, power supply, deionized water circulation and hydrogen processing) that can help in minimizing the cost of electrolysis. About 50-60% of the total cost of electrolysis is incurred in the system, with power supply being responsible for about 50% of the expenditure incurred here, while 22% of the expenditure is incurred by deionised water circulation and 20% by hydrogen processing. In the stack, the biggest cost components are the bipolar plates/electrodes, which are made out of precious metals, such as platinum and gold. Research is being conducted to replace the gold and platinum-plated titanium electrodes with other cheaper materials, such as tantalum, niobium and stainless steel. This step alone will be able to significantly reduce an electrolyser's production cost.

India's goal

Given the huge potential of India's renewable energy, the country has earmarked a target of 5 million tons of green hydrogen production per year by 2030. If India plans on becoming the global hub for green hydrogen, it needs to take the proverbial bull by the horns and expedite its electrolyser production efforts. FF

Role of metals and mining in the transition to green energy

For energy transition towards greener technologies, the mining sector will need to provide the required demand for metals and minerals - a demand that is estimated to be as high as three billion tons.

As the world moves towards its goal of net zero (i.e., preventing the planet from exceeding a temperature of 1.50C), this transition is set to witness an increase in the demand for key raw materials; especially metals and minerals. Analytical giants such as McKinsey and even the World Bank strongly point to a metals and minerals-led net zero economy.

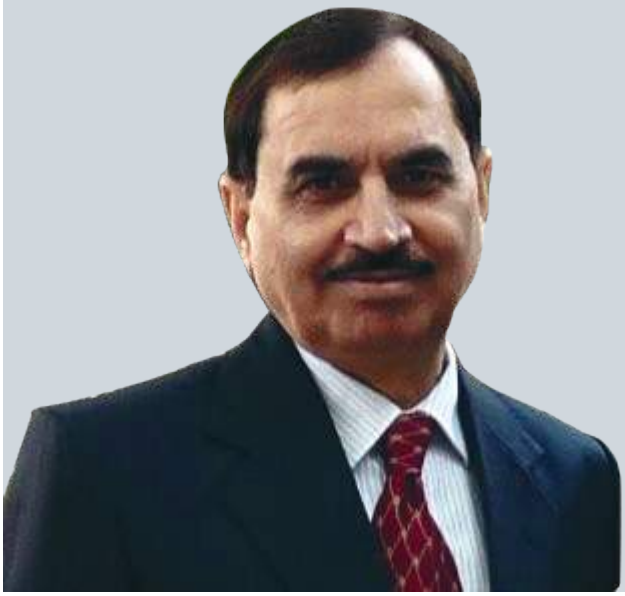
For this energy transition towards greener technologies, the mining sector will need to provide the required demand for metals and minerals - a demand that is estimated to be as high as three billion tons. A recent World Bank Group report, "Minerals for Climate Action: The Mineral Intensity of the Clean Energy Transition," reveals that, by 2050, there could be an increase of almost 500% in the production cobalt, lithium and graphite. Even earlier, in 2017, the World Bank report titled "The Growing Role of Minerals and Metals for a Low Carbon Future" had expressed a similar sentiment regarding a low-carbon or net zero future.

No doubt, this demand for metals and minerals will usher in economic opportunities, but there are bound to be huge challenges if this clean energy transition is not handled delicately. A climate-smart mining approach (the sustainable and responsible extraction, processing and recycling of metals and minerals required to minimize carbon emissions and the climate, environmental and social footprint) is the need of the hour. This Climate-Smart Mining initiative was formed to work in tandem with the UN's Sustainable Development Goals to not only decarbonize the mining and energy sectors but also help the resource-laden countries.

Raw materials will play a vital role in the decarbonization efforts via the paradigm shift from fossil fuels towards solar and wind energy, hydrogen production and Electric Vehicles (EVs). Additional supply requirements are expected not just from bulk raw materials such as copper and nickel but from niche commodities such as cobalt and lithium too. Copper will be utilized in electrification, while nickel will be diverted for EVs. Lithium and cobalt will be needed for batteries, tellurium for solar panels, and neodymium will be used for the permanent magnets required for EVs and wind power generation. Commodities such as steel will also see a significant demand wherever additional infrastructure is required.

Power and road transport sectors appear to be better prepared regarding the reduction of Greenhouse-Gas (GHG) emissions. However, carbon emission reduction in both these sectors will take a toll on material volume. Same is the case with battery or fuel-cell EV production, which will need more materials than producing an Internal Combustion Engine (ICE) vehicle. Hence, in this transition to green energy, metals and minerals will play a crucial role.

Metal requirement goes way beyond batteries, solar power and windmills. It is vital for national defense as its utilization encompasses aircraft engines, high tech devices, and other military vehicles and equipment. A World Bank report affirmed that to meet the expected demand by 2050 the production rate of critical mineral mining must increase by five times the current production rate. FF



'Complete transition to green fuel in mining is challenging'

Mr B K Bhatia, Additional Secretary General, Federation of Indian Mineral Industries (FIMI) in an exclusive interview with *Future Fuels* shares his opinion on sustainability and decarbonisation efforts made Indian mining sector.

Q. What are the initiatives/steps being taken by FIMI with regard to decarbonisation in mining industry in the country?

FIMI's efforts in sustainability started in 1999, where 10 global mining companies met in Melbourne (Australia) to analyze poor reputation of the mining industry worldwide and to address the sustainability challenges. Only 2 industry associations were invited – FIMI and Minerals Council of Australia. This led to formation of Global Mining Initiative (GMI) in 1999, which later became International Council for Mining & Metals (ICMM) in 2001.

Realizing the need to mainstream sustainability and importance of decarbonisation in the mining sector, FIMI through 10 leading Indian mining companies, launched 'Sustainable Mining Initiative' (SMI) in 2009. FIMI-SMI has been engaged in policy and regulatory interventions with the Government of India, Hon'ble Supreme Court of India, various national and international organizations.

- SMI's sustainability review system: As part of its objective, SMI has been assisting and advising mining companies to improve their performance in operational, environmental, H&S, social and governance through its Sustainability Review System.
- R&R plans for iron ore mining leases in Karnataka: As per the directions of the Hon'ble Supreme Court, SMI prepared the Reclamation & Rehabilitation plans (R&R Plans) for 100 iron-ore mining leases of Karnataka, subsequent to which operations in leases were allowed to resume as per approval of the Central Empowered Committee.
- Developing sustainable development framework and star rating scheme: The Ministry of Mines has appreciated the pivotal role of FIMI-SMI played in formulating and finalizing the star rating scheme which has been mandated for all the major mineral mines in the country.
- FIMI-SMI administers annual awards in order to motivate and recognize the efforts of mining industry. FIMI Awards instituted in 1990-91 with the support of Ministry of Mines and MoEF & CC, it consists 12 awards in 6 categories - Excellence, Sustainability, Innovation, Environment, Social Responsibility and Health & Safety.

FIMI-SMI undertakes various other activities such as conference, workshops, knowledge sharing, networking with national and international organizations like ICMM, IUCN, UNEP, WEF, ILO, GRI, EITI, IFC, etc to achieve its objectives of mainstreaming scientific and sustainable mining practices, technology adoption for decarbonization.

Q. Do you think the agenda on green fuel transition in mining is heading in right spirit and right direction after COP26 global summit at Glasgow?

Government of India has articulated its ambitious target of 500 Gigawatt of non-fossil energy at the 26th session of the Conference of the Parties (COP26) to the United

Nations Framework Convention on Climate Change (UNFCCC) held in Glasgow, United Kingdom in 2021. It also envisioned reduction of total projected carbon emissions by one billion tonnes till 2030, reduction of the carbon intensity of the economy by 45 per cent by 2030, over 2005 levels and achieving the target of net zero emissions by 2070.

Mining companies are engaging a range of modern technologies including digitised mining, artificial intelligence, electric vehicles using modern equipment like surface miner, GPS enabled HEMM, many are generating their own energy from micro-grids powered from renewable sources like solar and wind energy.

Moreover, the Indian mining industry has been following SMI's code of conduct since 2012, which is a set of 10 sustainable mining principles meant for voluntary adoption. Our member companies have already made a commitment to advance their sustainability performance and are required to report against their progress on an annual basis. Over the years, there has been significant improvement in the sustainability performance of the mining sector.

Fuel-wise installed generation capacity in meeting energy demand as on 31.03.2022, for fossil fuel accounts 59.1% out of which only coal and lignite holds 53% and total non-fossil fuel consisting hydro, wind, solar, waste to energy in total holds 40.9%. It clearly shows coal remains the single largest fuel in the energy mix.

The Government has set a target of 175 Gigawatt of Renewable Energy Capacity by the year 2022 and the renewable energy sector has witnessed 16.07% growth in 2021-22 the preceding year. Despite the long-term importance of renewable energy, seeing the recent coal demand in the country, Coal will continue to have a major role to achieve future energy transition in India. So, the complete transition of green fuel from fossil fuel energy will be challenging and may not be achieved in short and medium term.

Q. What kind of technology solutions can enhance fuel transition in mining industry?

Mining companies are increasingly implementing technological solutions such as automated vehicles, remote operating centres, hi-tech drilling in mining operations and gradually shifting from the traditional way of mining operations. These new technologies are reshaping the mining sector by making the operations more efficient and environment friendly. For decades, the mining industry has been dependent on diesel-powered machines but now the industry has started to embrace the benefits of electrification such as electric vehicles which helps in reducing carbon emissions.

The mining companies are leveraging Artificial Intelligence, Machine Learning, automation, robotic drilling, as well as drone mapping and surveying to enhance fuel transition. The Fleet Management System has enabled the operator in capturing health and performance of heavy earth moving machineries on a real-time basis while reducing the haulage time. Digital Mine Management System is helping the mines to optimize mine operation, increase productivity, HEMM availability, reduce cost along with real-time analysis for decision-making. Many mining companies in the country are implementing conveyor belt system including pipe conveyors, slurry pipelines or using railway rakes replacing transportation through road thus reducing GHG emissions and saving use of fuel.

Mining companies are not just only making substantial efforts for reducing carbon emissions but putting excellent efforts in afforestation, rehabilitation and reclamation. Some mines have deployed tree transplanters for nurturing trees, besides adoption of Miyawaki and vetiver techniques for waste dump rehabilitation, which is eco-friendly, cost effective leading to efficient dump rehabilitation. Rainwater harvesting is adopted for ground water recharge and recycling purpose.

Q. What is expected by the mining companies/operators from the government to switch over to green fuels in mining operations?

The pressure to change to green fuels is building on all sides not limited to mining sector only. The emergence of a low-carbon, circular economy is now possible and regulators are starting to show their support that spur climate action and establish a circular economy.

To switch over to green fuels, Government may scale up the efforts towards coal gasification/liquefaction by providing incentives or rebates for development and operationalization of such projects.

Further, the gestation period of auctioned blocks should be reduced through ease of regulatory regime of various mining clearances and approvals such as EC, FC, land acquisition along with rationalization of taxes. This will reduce cost burden and delays in commencing mining operations and boost investors' confidence in the sector.

Along with this, more emphasise needs be provided on exploration of critical minerals such as lithium, cobalt, rare earths as these minerals are essential for manufacturing wind turbines and electric vehicles required to transition to a low-carbon economy.

New technologies in decarbonization strategies such as Renewable energy storage, Carbon Capture, Usage and Storage (CCUS), Waste-to-hydrogen plants are reality now and should be encouraged. Since, renewable energy is rapidly descending the cost curve, instead of considering how to dispose of CO2 and other waste, many companies may by 2030 view everything they produce, including emissions, by-products and end-products, as a resource that can be traded to create economic value. FF

Taking automobile industry towards clean mobility movement

Passenger vehicles account for a significant amount of air pollution. Several cities across the world are now working toward phasing out or banning fossil fuel-powered vehicles.

In order to reduce the environmental footprint of automobiles, automakers need to focus on improving fuel efficiency and reducing SOx, NOx, CO2 and particulate emissions. They also need expand the life of vehicles and components, and recover, recycle and reuse metals in addition to other materials for decarbonization. European Parliament lawmakers recently voted to support an effective EU ban on the sale of new petrol and diesel cars from 2035. The vote upholds a key pillar of the European Union's plans to cut net planet-warming emissions 55% by 2030, from 1990 levels - a target that requires faster emissions reductions from industry, energy and transport.

What should auto makers do to decarbonise

Replacing internal combustion engines with battery and fuel cell electric technologies will not by itself resolve the carbon issue, because the energy-intensive production systems of electric vehicles offset the sustainability advantages of usage. Environmental equilibrium can only be maintained across phases by improving materials efficiency, eliminating waste during production and promoting regenerative practices for resource conservation. Automakers need to adopt circularity-focused design practices and

maximise consumption of renewable and reusable materials for producing new vehicles. Meanwhile, e-Learning modules can train engineers to better understand direct and indirect sources of emissions, and make smarter decisions by leveraging predictive algorithms. At the same time, analytical frameworks enable production teams to incorporate carbon targets and monitor real-time metrics, be it from the shop floor or a limited-edition luxury model.

The extensive footprint of gas stations has contributed to the growth of the passenger vehicles market. Manufacturers should build an equivalent network of hydrogen refilling stations and power charging points for mass adoption of clean energy solutions. Partner engagement programmes will also be required to create an inclusive community for sharing specific know-how, developing best practices for disposal management and enabling the sharing economy.

A carbon-neutral vehicle fleet requires a carbon-neutral logistics supply chain. In addition to reducing fuel consumption, energy usage for production, tailpipe emissions, and the delivery of automobiles and spare parts should also be environmentally friendly. Manufacturers should encourage transportation partners, car carriers or trailers, and cargo shippers to pivot to cleaner fuels and minimise airborne particulate matter from the freight fleet.

Development of EV market in India

India is the third-largest emitter of CO2 in the world, behind mainland and the United States. The CO2 emissions have doubled in the last decade. Although India's contribution to the cumulative global CO2 emission, since the industrial revolution of the mid-19th century, is insignificant, its current position as an emerging economy and hence a big CO2 emitter comes under environmentalists' lenses.

The Electric Vehicles (EVs) have been introduced much before in India to combat increasing CO2 emissions. But the EVs seem to have lost the race to internal combustion engine (ICE) vehicles, running on liquid fuel. But with the rising threats of global warming and air pollution, EVs are back on the discussion tables of policymakers, as ICE-powered conventional vehicles emit several pollutants, among which carbon dioxide (CO2) is considered the most concerning emissions from a climate change perspective.

Over the years, India has been an active and important participant in all global climate action summits and conferences, negotiating for emerging economies. India ratified the Paris Agreement during the COP21 held in 2015 and pledged to reduce the carbon intensity of its economy by 33- 35% by 2030 compared with 2005 levels and committed to achieving a non-fossil share of cumulative power generation of 40% by 2030. The country has also announced to install 2.5-3 billion tons of CO2 equivalent carbon sink by 2030.

Faster Adoption and Manufacturing of Electric Vehicles (FAME) scheme was rolled out between April 2015 and 2019, but the phase 1 of the scheme did not exactly produce the results as intended barring expansion of the low-speed e-scooter segment.

The government has redesigned Phase 2 of the FAME scheme with an outlay of $1.4 billion in 2019. Fewer than 10,000 electric passenger vehicles (PVs) and fewer than 300,000 electric 2Ws were sold.

At the COP26 climate summit held in 2021, the Indian Prime Minister Narendra Modi has announced that India would achieve net-zero emissions by 2070. As per that announcement road transport sector is expected to be a significant contributor to India's decarbonization plans as it is the third-largest CO2 emitter in India.

The road transport sector in the country is estimated to account for about 270- 290 metric tons (Mt) CO2 emissions and 18% of the country's total CO2 emissions in 2020. If the emissions grow at the same rate, then they may result in 1.2- 1.5 Gt CO2 emissions from the transportation sector in 2050.

Increased personal vehicle ownership and use is foreseen with the economic and pollution growth combined, and will inevitably result in more annual CO2 emissions.

The transportation sector may have to lag the overall 33- 35% decarbonization goal from 2005 levels by 2030, thus needing significant innovative technologies, strategic planning, and effective regulatory leverages to keep the sector aligned with the net-zero climate ambition. Acceleration in further vehicle efficiency improvement, fleet electrification, alternative fuels, along with mobility mode innovations will be the key solutions.

The FAME II scheme has been extended through 2024 to promote EV production and charging infrastructure deployment.

The share of EVs to reach about 9% by 2030 in a base case scenario in the country. But if policy support in terms of the special tax on manufacturing and sales and direct subsidy continues, with stricter CO2 regulations, the share of EVs could be higher ranging from 16% to as high as 21% by 2030.

The fiscal year FY 2021 was a positive year as sales of electric PVs grew 110% owing to a low base; from about 2,850 units in FY 2020 to about 6,000 units in FY 2021 as reported by the Society of Electric Vehicle Manufacturers (SMEV) of India. And the electric PVs sales for the first half of the current FY 2022 have already crossed the FY 2021 annual sales. The main driver for this was the introduction of EV policies by several states of India led by Maharashtra, New Delhi, and Gujarat, which acted as an additional incentive over the FAME subsidies. FF

Biofuels can cut shipping emissions

Substituting fossil fuel with fuel made from wood waste, waste fats, oils and greases could considerably cut emissions from the shipping industry

The shipping industry is a large consumer of petroleum fuel. The marine traffic has grown steadily over the past decade and the greenhouse gas emissions too have grown along with it.

Without any changes to the status quo, greenhouse gas emissions from shipping in 2050 could be 40% higher than they are today, according to the United Nations' International Maritime Organization (IMO). The IMO has set a target to instead cut those emissions by at least half.

Using biofuels instead of heavy oils could lower greenhouse gas emissions from the sector. Substituting biofuel could decrease the amount of GHGs and other pollutants entering the air from ocean shipping, according to a study from researchers at the US Department of Energy (DOE) and Department of Transportation. Compared with conventional heavy fuel oil, the study found, biomass-based fuel could reduce GHG emissions between 40 and 93%.

Shipping is also a key source of sulfur oxides and soot or particulate matter emissions, which worsen air quality and have been linked to human health problems. The IMO recently imposed new fuel standards aimed at reducing emissions of sulfur oxides, requiring lower concentrations of sulfur in shipping fuel.

The vast majority of cargo ships today run-on heavy fuel oil, which is cheap and energy dense but very dirty to burn.

To conduct the emissions analysis, the researchers used Argonne's Greenhouse gases, Regulated Emissions, and Energy use in Transportation model (GREET). GREET is an analytical tool used to calculate the energy and environmental impacts of different fuels across their full life cycle. Instead of just considering the energy use and emissions that result when a fuel is burned, a life-cycle analysis considers the bigger picture, including extracting the fuel, refining it, and transporting it to users.

The GREET model is a well-established tool for life cycle analysis of transportation and other technologies. For this study, Argonne researchers significantly expanded the fuel pathways considered for marine shipping. Their collaborators at Pacific Northwest National Laboratory (PNNL) and the National Renewable Energy Laboratory (NREL) analyzed costs of the various fuels compared. They found the 100% biofuel options offered emissions reductions up to 93% compared with heavy fuel oil and also the lowest cost among the alternative fuel pathways considered.

The biofuels lowered emissions of greenhouse gases, sulfur oxides and particulate matter - and at costs that could be competitive with heavy fuel oil, after considering incentives like low carbon fuel standard. Due to the low sulfur content of the biobased feedstocks, the biofuels analyzed reduced sulfur oxides emissions by 97% or more; particulate matter emissions came down between 84 and 90%.

The research, which was funded by the Department of Transportation Maritime Administration and DOE's Bioenergy Technologies Office within the Office of Energy Efficiency and Renewable Energy, is part of a broader effort at DOE to study the feasibility of using biofuels to lower emissions from cargo ships.

Recently, DOE also announced a partnership with the governments of the United States, Denmark and Norway to develop technologies for zero-emission shipping as part of Mission Innovation, a global initiative to accelerate affordable, accessible clean energy solutions. FF

Emissions can be slashed by 10% with low carbon measures at refineries

If low carbon measures are not adopted, CO2 emissions from oil refineries may increase up to 16.5 Gt by 2030

The global carbon emissions can be reduced by 10 per cent by 2030, if oil refineries adopt low carbon measures. The measures oil refineries can take for improving their efficiency include upgrading heavy oil processing technologies.

Calculating carbon emissions from refineries

The annual emissions in refineries are calculated based on corresponding emission factors including Carbon Emission Accounts and Datasets (CEADs)-Global Refinery Emission Inventory (GREI). CEADs-GREI can be used to identify the largest annual CO2 emissions in the refinery industry at the unit, regional and global levels.

According to CEADs-GREI, 755 refineries were operating in 2000 worldwide, with a total capacity of about 87 million barrels per day (Mbpd) and annual CO2 emissions of 1,000 million tonnes (Mt). The number of refineries in operation increased to 946 in 2018, with a combined capacity of about 98 Mbpd and annual CO2 emissions of 1,242 Mt.

The oil refining industry in 2003 witnessed a spurt in growth in China and India, directly leading to a rise in CO2 emissions. China's refinery output increased by 11 per cent in 2003 and 12 per cent in 2004.

Current technologies can address emissions from refineries

One option is to implement initiatives that offset emissions by tapping into natural carbon sinks, including oceans, plants, forests, and soil; these remove GHGs from the atmosphere and reduce their concentration in the air.

Plants and trees sequester around 2.4 billion tons of CO2 a year. The Italian energy giant ENI has announced programs to plant 20 million acres of forest in Africa to serve as a carbon sink. Other companies are looking at how to fund these offset programs; Shell offers Dutch consumers the possibility of paying to offset emissions from retail fuel. The cost of carbon sinks is uncertain; estimates range from $6 to $120 per tCO2e in 2030, depending on the source and the sequestration target.

The refining sector can meet its annual heat demands while cutting emissions by switching from fossil fuels to low- and zero-carbon hydrogen fuel and/or through electrification of low-to-medium-grade heating. Process emissions can be abated through carbon capture and storage technology.

Most of the technological options are available today at various levels of development, and innovation and deployment will expand their usage.

Immediate access to carbon dioxide and hydrogen uniquely situates refineries to produce low-carbon and carbon-negative fuels today through existing approaches such as Fischer-Tropsch synthesis.

In the long term, refineries could switch from processing crude oil for conventional fuel to renewable feedstocks for synthetic fuels, primarily for aviation and trucking. This could reduce fuel carbon intensities by up to 80 percent.

Barriers for decarbonising refineries

The biggest obstructions that come in the way of decarbonising refineries include regulatory, fiscal or financial related barriers. These barriers however could be overcome by adopting measures like carbon pricing mechanisms, emissions intensity targets, and financial incentives for research and development of novel decarbonization technologies. FF

Innovative technical solutions necessary for carbon-neutral shipping

The forum attended by top business executives, policymakers, innovators, and technology experts across the world discussed and debated over the greener maritime future.

ALJ Group has conducted 3rd Decarbonizing Shipping Forum in Hamburg on June 21st-22, 2022. The event has focused on transition of decarbonisation in maritime industry covering topics including future fuels, sustainable and innovative solutions, and smart Shipping. It was sponsored by MSC, NAV Tec Naval Technologies, GTT, ATPI Marine Energy, FuelSpec®, Andritz, BRS, DeepSea Technologies, SEA-LNG, e-Fuel, and Methanol Institute.

At the beginning of the event, **Mike Guggenheimer, President & CEO, RSC Bio Solutions** introduced forum attendees to the topic of 'Sustainability is a Journey - An Industry perspective'. **Jonny Hudson, Market Leader for Oil Tankers, Bureau Veritas Group** in his presentation elaborated on Bureau Veritas's services, support and solutions on decarbonisation in shipping. Another speaker **Ralf Diemer, Managing Director, eFuel Alliance** has shared his view on 'Fit for-55: Role of Europe's Sustainable Future'. **Martin Koller, Global Product Manager, Head of Laboratory KAP - Air Pollution Control Marine Solutions**, has spoken about carbon capture for shipping and solutions offered by Andritz.

On the second day in the forum **Linden Coppell, Director of Sustainabilty MSC Cruises** shed light on the road to netzero. Another speaker **Karl Lander, Director, Regulatory Complience from Armach Robotics, Inc.** shared presentation on autonomous robots on make proactive in-water cleaning a reality topic. **Jason Miles, CEO of Quadrise Fuels International plc.,** presented insightful inputs on accelerating the transition to netzero.

Regina Asariotis, Chief, Policy and Legislation Section TLB, Division on Technology and Logistics, UNCTAD, through virtual mode presented her views on the topic 'Climate change impacts and adaptation for seaports – Some key challenges'. **Frederic Bouthillier, Head of Sustainable Shipping, Vertis Environmental Finance** who introduced forum attendees to the topic 'EU ports for shipping – Getting ready to ride the wave'.

The forum has organised a first panel discussion on 'Regulatory requirements and sustainability goals – Different stakeholders' perspectives. Bernard Vanheule, EU Affairs Director, Costa Group, Thomas Klenum, Executive Vice President, Innovation & Regulatory Affairs, LISCR, Wolfram Guntermann, Director Regulatory Affairs, Hapag-Lloyd, Wayne Lundy, Senior Engineer, US Coast Guard, Sebastian Ebbing, Technical Advisor Climate, Marine fuels, Innovation and Funding, German Shipowners Association have participated in the panel discussion which was moderated by Martyn Griffiths MCIPR, Director Public Affairs, CLIA Europe.

Berit Hinnemann, Head of Decarbonisation Business Development, A.P. Moller – Maersk, has elaborated on the measures taken by Maersk for transitioning shipping industry into future fuels. **Vinita Venkatesh, MD of Ocean2door India**, has presented Fuelspec®, a bunker fuel catalyst, to the attendees at the forum. FF

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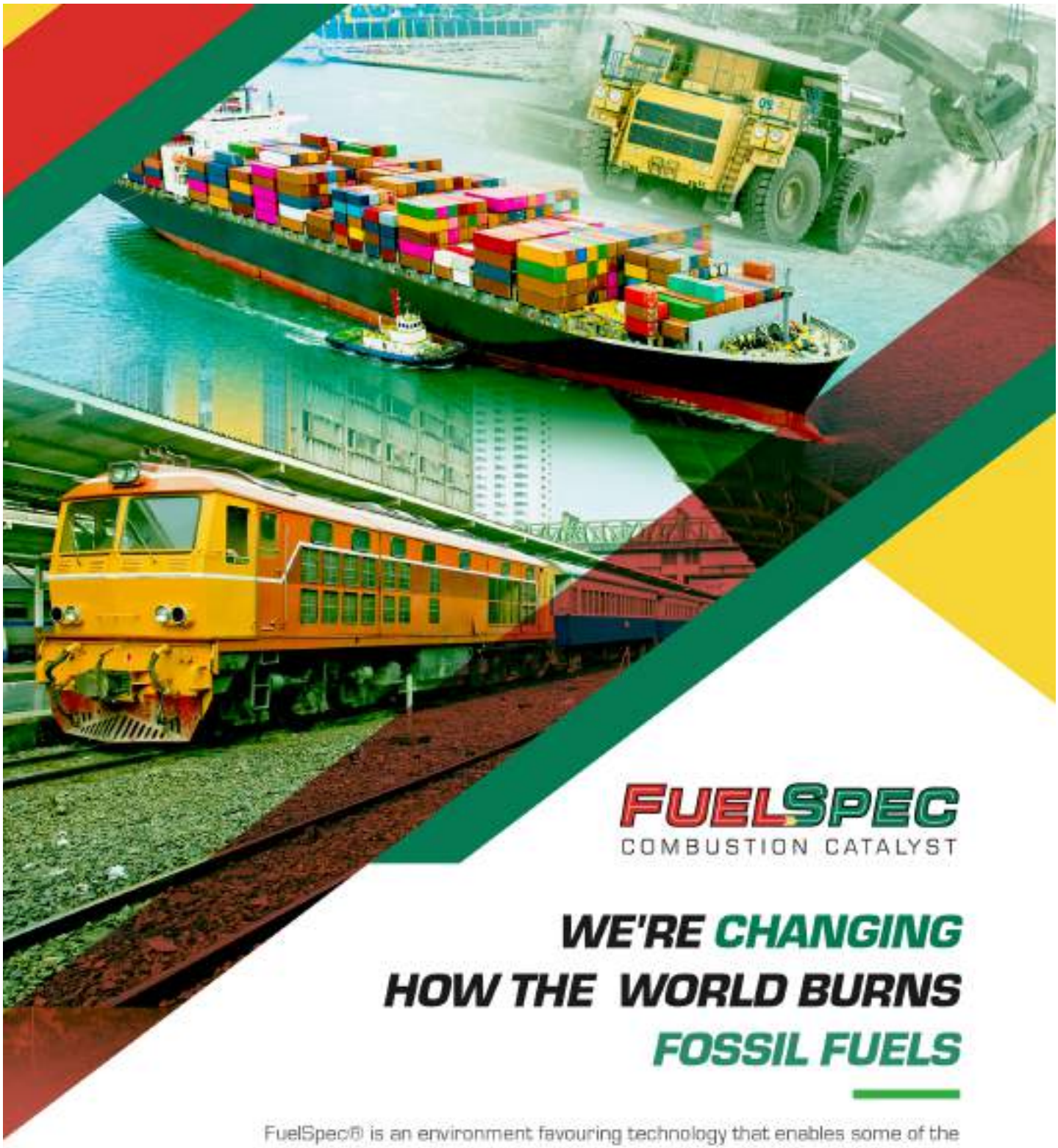

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