SEA\LNG

LNG AS A MARINE FUEL – OUR ZERO EMISSIONS FUTURE STARTS NOW

SEA-LNG'S 'VIEW FROM THE BRIDGE' 2019 / 2020

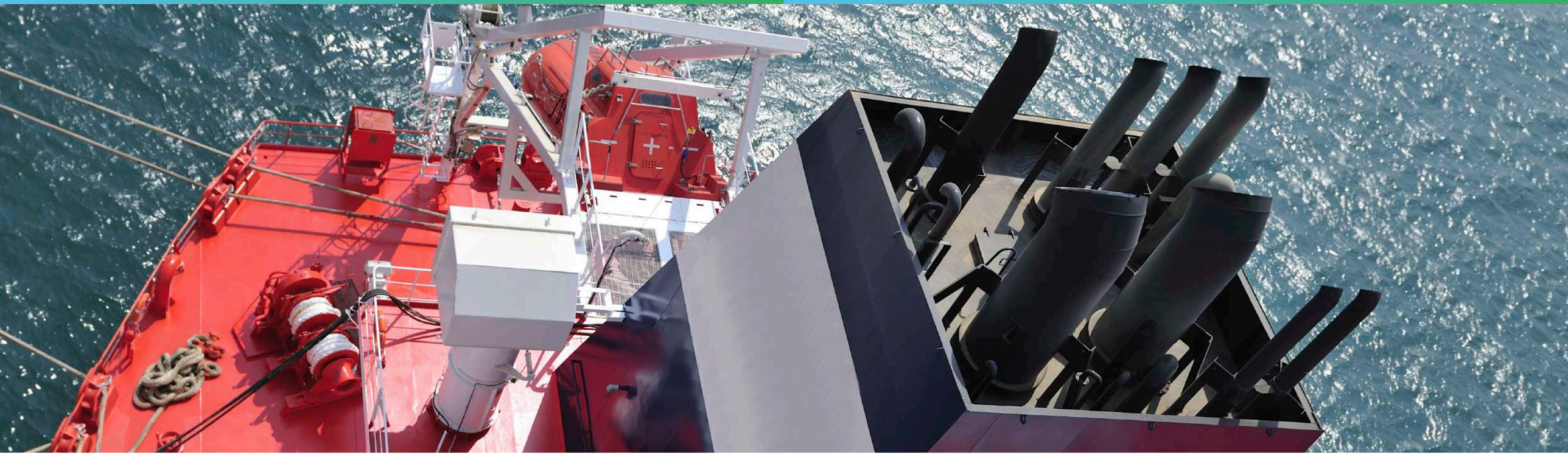
INTRODUCTION

Now that we have passed 1st January 2020, the much anticipated global sulphur cap is finally a reality. The importance of this clean air initiative for global health is widely agreed and should not be under emphasised. Likewise, the critical role that LNG can play in clean air and global health initiatives must not be forgotten or trivialised as these are still matters of real concern to the world's citizens.

This time last year I said 2019 would be the year of acceleration for LNG, and it was! With increasing orders for LNG-fuelled vessels and LNG bunker vessels, together with expanding infrastructure shoreside to provide the critical last-mile delivery of LNG to ships; LNG as a marine fuel remains THE economic and environmental choice. Increasingly too, LNG is seen as THE transition fuel to a net-zero carbon future. While we anticipate LNG as marine fuel will evolve into bio or synthetic methane, the LNG safety and operational guidelines, as well as infrastructure, will act as best practice for the adoption of alternative fuels over the longer term.

As attention now turns to the carbon emissions reduction targets for 2030 and 2050, we must recognise that, in 2020, we are well down the road from the 2008 baseline and there must be a pragmatic chronology to achieving a more sustainable, decarbonised future for shipping. The global deep sea fleet consists of more than 60,000 vessels with an average life expectancy well in excess of 25 years. This fleet, that fuels the economy - upon which we all depend - cannot be turned around overnight. This is precisely why there is increasing recognition and acceptance that LNG as a marine fuel must play a central role in transitioning to a zero carbon industry. LNG is the only commercially viable fuel widely available today. This process has already been started by many leaders in our Industry but must be embraced globally by the broader ship-owning community. By starting to move now to LNG we reduce carbon emissions immediately and build a strong foundation for future reductions using liquefied biomethane (LBM) and liquefied synthetic methane (LSM) as the technology required continues to mature.

Underpinned by LNG's compelling emissions and investment credentials, 2019 has seen unprecedented and remarkable uptake across many sectors of the deep sea fleet, as we anticipated this time last year. Perhaps more importantly, the infrastructure to support LNG as a marine fuel has grown significantly. It can now be delivered to vessels in some 93 ports with a further 54 ports in the process of facilitating LNG bunkering investments and operations. This begins to answer the "chicken or egg" dilemma as both new LNG-powered vessels are being ordered and major ports around the world are developing infrastructure to service this growing fleet. This process will continue and accelerate as the real benefits of LNG as a marine fuel continue to be demonstrated for forward-thinking vessel owners and operators.



ENVIRONMENT & EMISSIONS

When it comes to improving air quality and human health, LNG boasts unrivalled emissions credentials, cutting SOx and particulate emissions to negligible amounts and reducing NOx by around 85%. It is a perfect example of a 'no brainer'. Moreover, when combined with Energy Efficiency Design Index (EEDI) improvements to ship design, LNG is forecast to meet the IMO 2030 target for decarbonisation on new ships. The Life Cycle GHG Emission study published by thinkstep in April 2019 is widely regarded as the definitive study into GHG emissions from current marine engines i.e. those available in the market today. It is comprehensive, using the latest primary data to assess all major types of marine engines and global sources of supply. It is quality assured assessing the supply and use of LNG as a marine fuel according to ISO standards, and is objective, having been peer-reviewed by a panel of independent, academic experts in life cycle analysis and marine engine technologies.

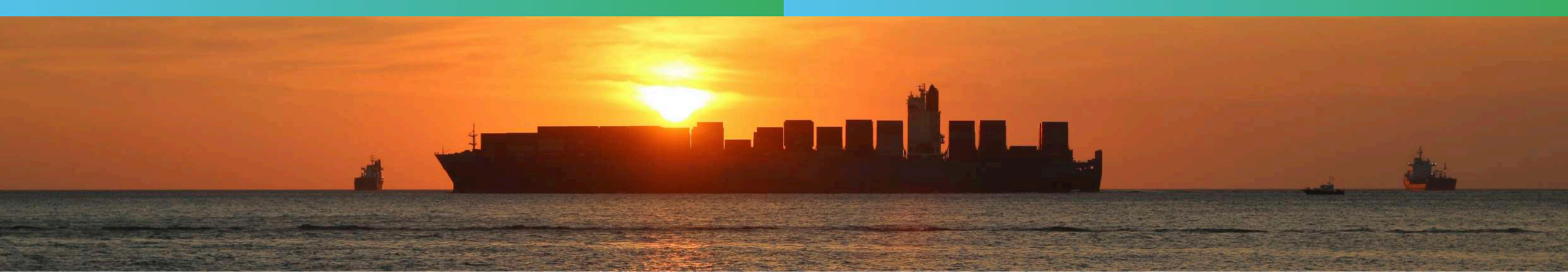
The study clearly shows that on an engine technology basis, the Tank-to-Wake emissions reduction benefits for LNG fuelled engines compared to HFO fuelled ships are between 18% to 28% for 2-stroke slow speed engines and between 12 to 22% for 4-stroke medium speed engines. The absolute Well-to-Wake emissions reduction benefits, accounting for methane emissions, for LNG-fuelled engines compared with HFO fuelled ships today are between 14% to 21% for 2-stroke slow speed engines and between 7% to 15% for 4-stroke medium speed engines. Importantly, around 70% of the marine fuel consumed today is by 2-stroke engines with a further 18% used by 4-stroke medium speed engines.

The expected developments in LBM and LSM provide LNG users a pathway to 2050 and beyond. At a molecular level LBM and LSM are identical to (fossil-fuel derived) LNG meaning that there are no blending issues and existing assets, such as LNG-fuelled ships and bunkering infrastructure will not be stranded. Therefore, LNG with growing substitution by LBM and LSM represents the most compelling decarbonisation journey, starting now, for deep sea shipping. We will shortly publish a study which analyses the current and future global availability of LBM and LSM.

In summer 2019, SEA-LNG released the results of its Alternative Fuels Study, which was conducted by DNV GL. The study highlighted that while meeting the IMO carbon targets of 2050 requires the introduction of zero emission technologies, the reality is that they are simply not ready and nor will they be for the foreseeable future. Alternative fuels such as hydrogen and ammonia may have a role to play in certain maritime applications in the future. But these alternatives currently lack the regulatory framework, production capacity, acceptable safety protocols, and bunkering infrastructure for widespread adoption across deep sea shipping.

Mandated global speed restrictions purported by some as the 'silver bullet' to achieve emissions targets is another red herring. Speed limits take no account of the consequences of this action on other parts of the highly efficient international multimodal logistics chain where shipping plays a vital role. This action could act as a disincentive for shipowners and managers to innovate and implement alternative fuels with lower GHG emissions and develop other technological efficiencies.

What we can all agree on is the need to act now – doing nothing is not an acceptable solution - we cannot wait for the "magic elixir". Indeed, in its 2050 Marine Energy Forecast, DNV GL confirms that, "In almost any scenario, LNG will be the single most important fuel in the market."



INVESTMENT

As recognition of the business case for LNG as a marine fuel grows, so too does the order book for LNG-fuelled vessels, across all sectors. In June 2019 there were 163 LNG-fuelled ships in operation (excluding over 500 LNG carriers) and a further 155 ships on order. Today (February 2020) these numbers have increased to a total of 175 LNG-fuelled ships in operation, with 203 on order and a further 141 LNG-ready vessels in operation and sitting on the order books.

Last year, SEA-LNG published three key Investment Case Studies commissioned from independent simulation and analytics expert Opsiana. Each study produced a positive result for LNG investment, evaluating returns under current legislation: were future legislation to impose additional financial burdens as a result of CO2 emissions, the investment case for LNG against oil-fuels would be strengthened further.

CONTAINERS

The container investment case was the first study by Opsiana to support shipowners and operators in analysing their investment opportunities in an informed way. The study analysed the case of a newbuild 14,000 TEU container vessel operating on an Asia-US West Coast (USWC) liner routing and compared six fuel pricing scenarios. The study showed that for this vessel type, on this trade route, LNG as a marine fuel delivers the best return on investment on a net present value (NPV) basis over a conservative 10-year horizon, with fast payback periods ranging from one to two years.

Other examples that illustrate progress in this sector include:

The total number of LNG-fuelled container ships on order or already operating add up to 49 according to estimates from DNV GL, making them the largest deep-sea LNG-fuelled ship type after LNG carriers.

- In September, CMA CGM launched the world's largest LNG fuelled container ship, the 23,000 TEU CMA CGM Jacques Saadé. By 2022, this company will have 20 LNG-powered container vessels: eight others at 23,000 TEU, five at 15,000 TEU and six at 1,400 TEU of which three are in operation with Containerships.

- In February 2019, Hapag-Lloyd announced it will undertake the world's first conversion of a container ship to LNG. The retrofit of the Sajir will take place in 2020, and presents the opportunity for its 16 LNG-ready sister ships to also undergo conversion.

- Matson took delivery of its newest LNG dual-fuel vessel, the largest combination container / ro-ro ship ever built in the US, in December 2019.

PCTC

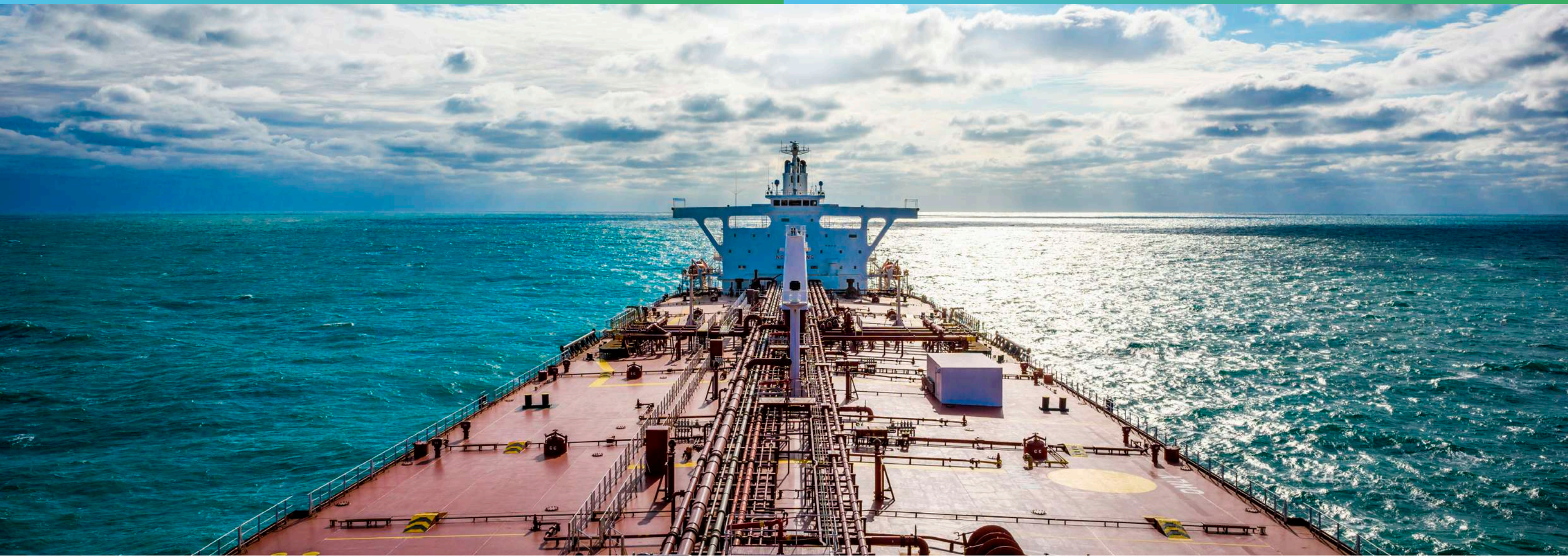
The second in the series of investment case studies was for newbuild Pure Car and Truck Carriers (PCTC) on Pacific and Atlantic trade lanes. The study considered two PCTC trading scenarios using a 6,500 Car Equivalent Unit (CEU) vessel on the Atlantic Trade and an 8,000 CEU vessel on the Pacific Trade. The study indicated that LNG as a marine fuel delivers the best return on investment on a NPV basis over the same conservative 10-year horizon, with fast payback periods ranging from one to three years on the Atlantic Trade and from less-than-one year to two-years on the Pacific Trade.

Other examples that illustrate progress in this sector include:

- Siem Car Carriers has officially launched the Siem Confucius and Siem Aristotle - the first, trans-Atlantic PCTCs to operate full-time on LNG. The vessels will transport cars for the VW Group between Europe and China.

- United European Car Carriers (UECC) signed a contract to build three new hybrid-powered, LNG-fuelled PCTCs to be operating by 2022. The new ships will be equipped with a battery hybrid LNG propulsion system which will place UECC beyond IMO's target for a 40 percent reduction in carbon intensity by 2030.

- In September, SEA-LNG Member NYK, one of UECC's two parent companies, announced an order for the world's largest LNG-fuelled PCTC. The ship is scheduled to be delivered in 2020 and will be the first large LNG-fuelled PCTC to be built in Japan.



TANKERS

The third, and latest, investment case study demonstrates clear benefits of LNG as a marine fuel for a newbuild 300,000 dwt VLCC on the Arabian Gulf to China trade route, in comparison with other alternatives currently available and scalable to the shipping industry across three fuel pricing scenarios. The study clearly indicates that LNG delivers a strong return on investment on a NPV basis over a conservative 10-year horizon, with compelling paybacks from three to five years. Moreover, recent public announcements by COSCO which state a $6 million additional investment for installing an LNG-propulsion system is $10 million less than that modelled by Opsiana, which if comparable to their study would make the investment case for LNG-propulsion of VLCC's much stronger.

Examples that illustrate progress in this sector include:

- The Cosco Shipping Energy Transportation (CSET) order for a dual-fuel VLCC newbuilding that will use LNG as its marine fuel. This 319,000 dwt crude tanker is due for delivery in 2020 having been ordered at Dalian Shipbuilding Industry Co (DSIC) two years ago.

- South Korean shipbuilder Samsung Heavy Industries (SHI) will build 10 LNG-powered crude tanker vessels. The order was placed by an unnamed "Oceanian" customer and the 113,000 dwt LNG-fuelled tankers will be delivered by January 2022.

- Shell Tankers (Singapore) Private Ltd has agreed a long-term deal to charter a fleet of 10 LNG dual-fuel Aframax crude oil tankers from Sinokor Petrochemical Co Ltd, which expects to take delivery of them from Samsung Heavy Industries in South Korea in 2021. Separately, Shell agreed long-term charters for four new LNG dual-fuel oil products tankers, with delivery of the vessels expected from 2021.

- Gothia Tanker Alliance's fifth LNG-fuelled vessel, the Fure Ven, was delivered - part of the six-vessel series ordered by Alliance members Furetank, Älvtank and Erik Thun. All the 16,000 dwt tankers are equipped with dual-fuel engines for LNG operation, featuring ice class 1A.

- Gas4Sea partners ENGIE, Mitsubishi Corporation and NYK have ordered four, dual-fuel crude shuttle tankers vessels which are scheduled to come into service in early 2020 and will be operated by Equinor in Northern European seas.

- MISC, the shipping division of Malaysia's state oil firm Petronas, announced its commitment in December 2019 to convert half of its 60-strong oil tanker fleet to run on dual-fuel LNG by 2030.

CRUISE & FERRY

The cruise and ferry sector was an early adopter of LNG as a marine fuel and continues to evolve. As highlighted last year, the cruise sector has recognised the clear environmental benefits of LNG as a marine fuel, and with high capital costs for cruise vessels the economic investment case is even stronger. Carnival's AIDAnova commenced its operation life at the end of 2018 and has been operating smoothly powered by LNG throughout 2019. Carnival's second LNG-powered cruise vessel the Costa Smeralda entered service in 2019.

Examples of progress include:

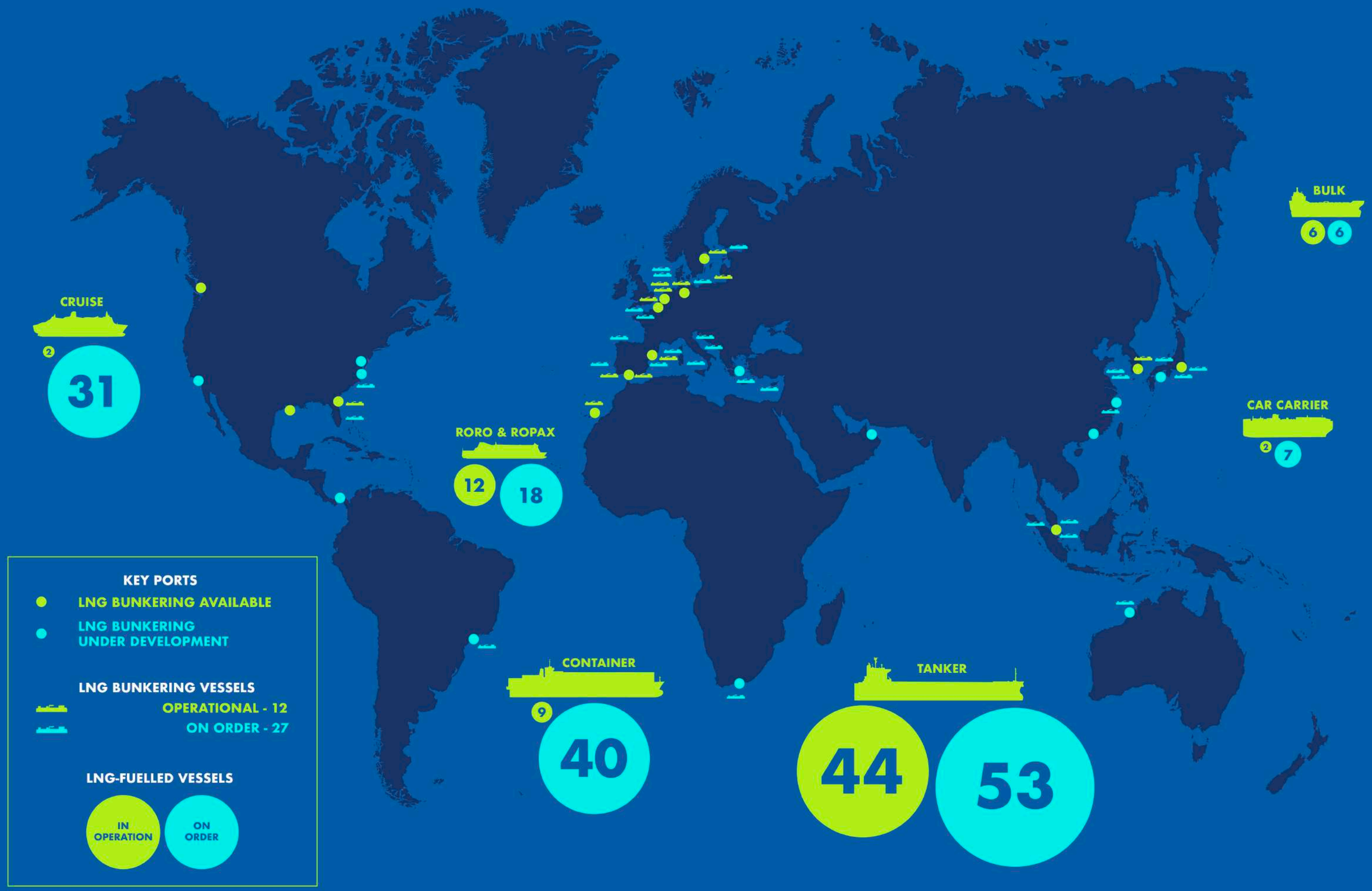
- MSC Cruises started construction on MSC Europa, its first of five liquefied natural gas (LNG)-powered cruise ships that will come into service between 2022 and 2027.
- Disney Cruise Line has announced plans to build three additional LNG-fuelled cruise ships. Three 135,000 gt LNG-fuelled ships are already under construction at Meyer Werft and scheduled for completion in 2021, 2022 and 2023. The first of these, Disney Wish, is scheduled for delivery in late 2021 and is expected to set sail beginning in January 2022.
- Finnish shipbuilder Meyer Turku hosted a naming and steel-cutting ceremony for Costa Cruises' second LNG-powered newbuild. The Costa Toscana, will be delivered in 2021. Float-out of LNG-fuelled Costa Smeralda took place in March, with delivery of the vessel taking place on 5th December.
- Canadian ferry operator, BC Ferries plans to build five LNG-fuelled ferries as part of its fleet renewal drive. It has two Spirit Class units already running on LNG.
- Princess Cruises has signed the final contracts for the construction of two LNG dual-fuel cruise ships with Fincantieri. The 175 000 gt cruise ships will be delivered in late 2023 and in Spring 2025.

BULK

While the bulk sector may be a little behind obvious early adopters in terms of uptake due to its tramp nature, there is now a clear direction in this segment for liner-type operations as well, for example:

- BHP has released the world's first bulk carrier tender for 12 LNG-fuelled vessels for the transport of 27 million tonnes of its iron ore from Australia to North Asia. These will be able to transport the equivalent of about 10% of BHP's iron ore sales.
- H-Line shipping has ordered the construction of two,180,000 dwt LNG-fuelled Newcastlemax bulk carriers from South Korean shipbuilder Hyundai Samho Heavy Industries. The vessels are expected to be delivered in 2022, and be deployed on a route between South Korea and Australia.

WORLDWIDE GROWTH IN LNG USE & INFRASTRUCTURE



INFRASTRUCTURE

In terms of expanding the LNG bunkering infrastructure from a well-developed LNG bulk infrastructure already well placed and aligned to supply the world's major shipping lanes, dramatic progress has been made on a global scale. DNV GL forecasts for 2050 show up to 41% of marine fuel being LNG.

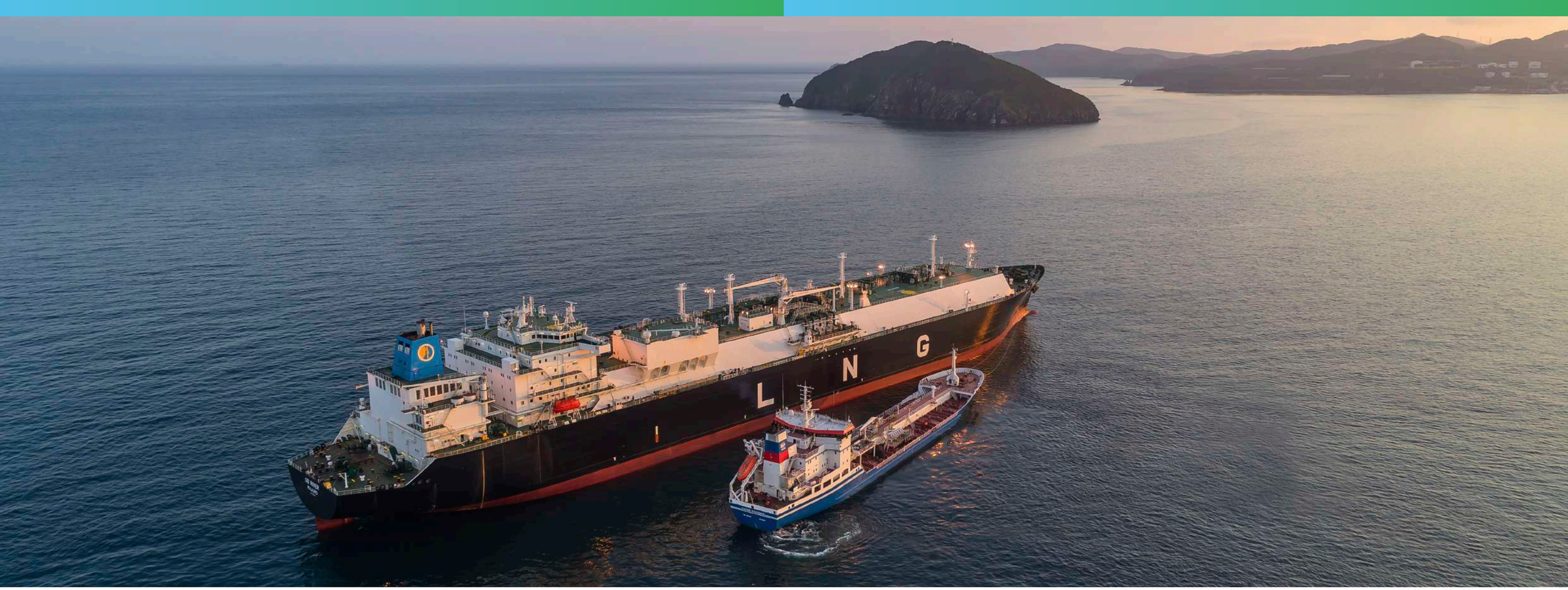
In early 2019 there were just six bunkering vessels around the world. As of February 2020 there are 12 in operation with a further 27 on order and / or undergoing commissioning.

ONLINE NOW...

Today there are active bunkering capabilities or plans to provide LNG bunkers in numerous locations around the globe, including nine out of the world's top ten ports. Port infrastructure is improving all the time and key regions are investing heavily into the bunkering infrastructure that supports LNG as a marine fuel. There are numerous examples of this, including:

- Europe's largest bunker port, Rotterdam nearly doubled its LNG bunkering operations in the third quarter of 2019, compared to the previous three months. Volumes rose substantially in 2019 as the marine industry began a shift to less polluting fuels ahead of the IMO 2020 sulphur cap. This year Rotterdam will have seven to eight bunker vessels operating in the port area.
    - It expects growth to reach a million tonnes by 2025-2030, which would be around 10% of all bunker fuels sold in Rotterdam.
- Nearby, the arrival of Titan LNG's Flexfueller001, which features both small and large-scale bunkering capabilities, added to the truck-to-ship bunkering capabilities at the Port of Amsterdam. Along the coast in the ENGIE Zeebrugge started operations back in 2017 and the vessel continues to perform ship-to-ship LNG bunkering services in the port of Zeebrugge, Belgium. The ENGIE Zeebrugge holds an LNG capacity of 5,000 m3 and is designed to serve a full range of shipping customers.

- Further north, Nauticor's 7,500 cbm Kairos - currently the largest operational LNG-bunkering vessel - started LNG bunkering early in 2019, delivering LNG to a range of vessels since it began operations in the Port of Visby, Sweden. Elenger this year started providing LNG bunkering services to LNG-powered vessels in the Port of Hanko, Finland, in addition to the ports of Tallinn and Helsinki.
- Also in Finland, Gasum's first ship-to-ship bunkering involving a cruise ship took place at the Meyer Turku shipyard during November of this year. Gasum's LNG bunker vessel Coralius mainly operates in the North Sea and the Skagerrak area. She performs ship-to-ship bunkering to different types of vessels and in November, bunkered to Carnival Corporation's cruise ship Costa Smeralda.
- Elsewhere in the Mediterranean, Barcelona is currently the largest cruise port to offer LNG bunkering, thanks to Carnival's partnership with Shell Western LNG, which uses Anthony Veder's Coral Methane - a 7,500-cbm vessel that has been modified from an ethylene/LNG carrier to an LNG bunker vessel.
- Bunkered by the LNG carrier, Coral Fraseri, chartered by Titan LNG, the refuelling of the Panamanian semi-submersible crane vessel (SSCV), Sleipnir, with 3,200 metric tonnes of LNG marked the first LNG bunker supply within British Gibraltar Territorial Waters (BGTW) and it is the largest LNG bunker supply to date in Europe.
    - Titan LNG also completed the largest LNG bunkering in the world when it supplied over 3000 metric tonnes of LNG to the Sleipnir in Singapore.



- In North America there has been rapid development of LNG as a fuel – especially along the East Coast of the United States. At Eagle LNG's Talleyrand LNG Bunker Station and JAX/LNG at Dames Point in the Port of Jacksonville, three LNG powered cargo ships, the first two at Tote Maritime Puerto Rico and the third at Crowley Maritime, already sail regular voyages to Puerto Rico supported by the elaborate infrastructure of LNG bunkering accomplished by both barge and shore-based methods.

- In Japan, Toho Gas Co., Ltd. and Mitsui O.S.K. Lines, Ltd. (MOL) carried out the first LNG bunkering at a major Japanese port - the Port of Nagoya. LNG was transported via truck from the Toho Gas Chita-Midorihama LNG Terminal and supplied with a truck-to-ship system to the LNG-fuelled tug, Ishin, berthed at the Port of Nagoya's Garden Pier. The same vessel was also bunkered at the Port of Kobe

- NYK, together with Kyushu Electric Power Co. Inc., Saibu Gas Co. Ltd., and The Chugoku Electric Power Co. Inc., successfully conducted a truck-to-ship LNG bunkering demonstration at the port of Kitakyushu, the first LNG bunkering in the Setouchi and Kyushu areas of western Japan.

OPERATIONAL IN 2020...

Plans and funding are currently moving forward for the following locations for operational delivery of LNG in 2021 and 2022. In addition, a number of owners are building, or planning to build, more LNG bunker vessels on spec.

- Singapore is LNG bunkering ready and pushing LNG as shipping's fuel of the future, readying a swathe of incentives for shipping companies that decide to use gas instead of bunker fuel. The Maritime Port Authority (MPA) of Singapore expects the first of its two LNG bunker tankers to facilitate ship-to-ship LNG bunkering for ocean going vessels from the second half of 2020 onwards.

- A steel cutting ceremony marked the start of construction of Singapore's largest LNG bunkering vessel. Built by Sembcorp Marine for Japan's Mitsui O.S.K. Lines (MOL), the bunker ship will be the second vessel of its kind in Singapore and is scheduled to start services after its scheduled delivery in early 2021.

- DNG Energy will provide LNG bunkers in Algoa Bay, South Africa's largest bunkering port, from the second quarter of 2020.

- Malaysia's Petronas is poised to provide LNG bunkering services starting 1 January 2020 as part of efforts to support the government's move towards developing the country as a bunkering hub. Petronas signed a time charter party with MISC Berhad and Avenir LNG to charter a 7,500 cbm LNG bunker vessel.

- Two consortiums of private Japanese firms are planning to launch the nation's first LNG bunkering ships by the end of 2020. They will provide services in Tokyo Bay and Ise and Mikawa bays in central Japan.

- Keppel Offshore & Marine has been tasked with designing and constructing an ice-class LNG bunker vessel. Commissioned by Shturman Koshelev and due for delivery in Q4 2020, the bunker ship will be chartered to Gazprom Neft for operations in the Baltic Sea.

- Jamaica is taking steps to become a true logistics hub for the Caribbean region and the coming on stream of its LNG facilities will clearly help position Jamaica as a major supplier of LNG bunkers in the region.

- Total's first LNG bunker vessel will be delivered in 2020. The 135-meter-long giant will supply LNG to ultra-large container-ships in the Europe-Asia trade, including 300,000 tons per year for CMA CGM's nine ultra-large newbuild containerships in Europe-Asia trade, for a period of at least 10 years.

- Shell will charter an articulated tug barge (ATB) when it enters service in early 2020. The ATB will bunker dual-fuel ships from under a long-term contract with Shell that has pledged to deliver LNG to various ports in Florida and southeast US. To begin with, the barge will supply two 180,000 gt Carnival ships of and two Volkswagen PCTCs sailing from Europe.

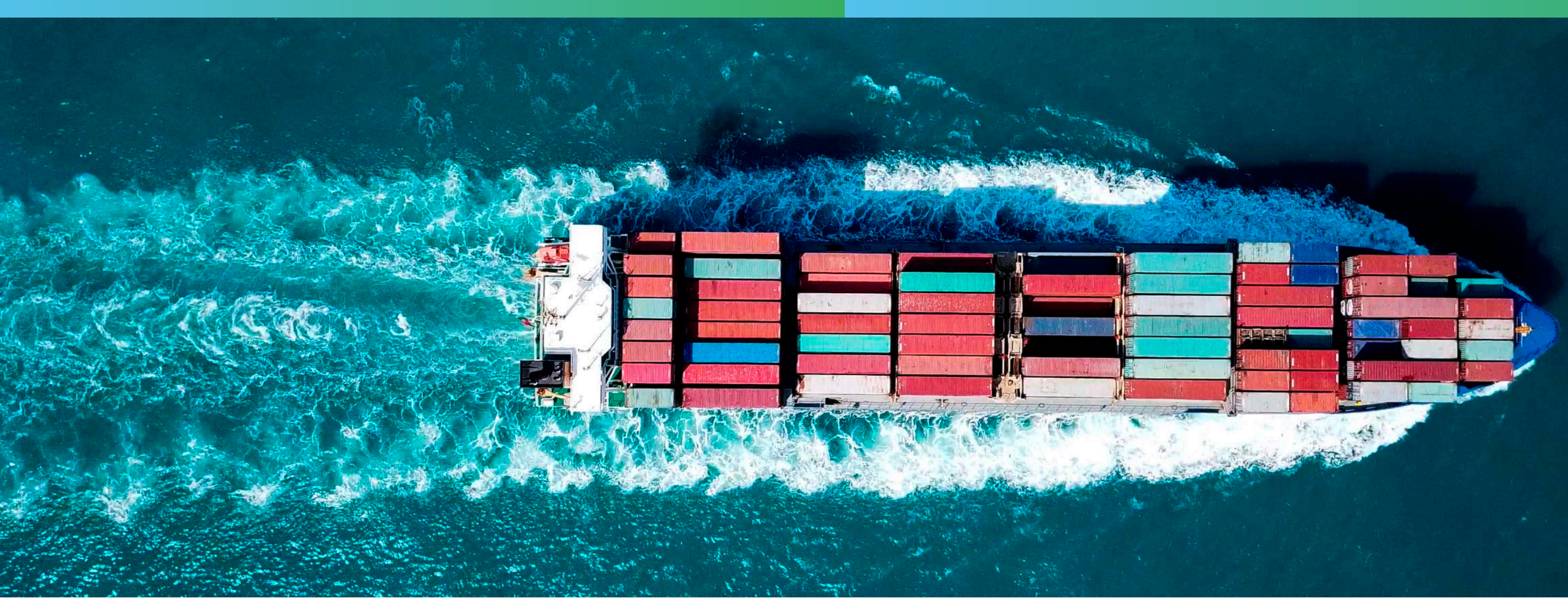
AND PLANNED IN THE FUTURE...

- Vard Marine recently completed the concept design of a new 5,400cbm LNG bunker barge - expected to be delivered in November 2021 - for Polaris New Energy's bunkering operations that will support LNG-fuelled ships on the east coast of the US.

- The British Columbia Government has joined SEA-LNG members Vancouver Fraser Port Authority and FortisBC to establish the first ship-to-ship LNG marine bunkering facility on the west coast of North America. B.C. has been in the LNG bunkering business since 2017. Five BC Ferries vessels and two Seaspan cargo ferries are fuelled with LNG from FortisBC via truck.
This proposal would expand to develop ship-to-ship bunkering so that large vessels can be fuelled from a fuelling vessel that fills up at an on-shore jetty at Tilbury Island on the Fraser River.

- Australia's largest LNG producer, Woodside Energy, is tendering for an LNG bunkering vessel.

- There are a number of shipowners that have ordered or will order LNG bunker vessels for charter on a global basis as demand dictates. We anticipate this will continue as new vessel order books continue to favour LNG-powered vessels.



FUTURE GAZING

Momentum behind LNG as a marine fuel continues to gather at pace in line with the growing acknowledgment that LNG is the only safe, available, competitive fuel that:

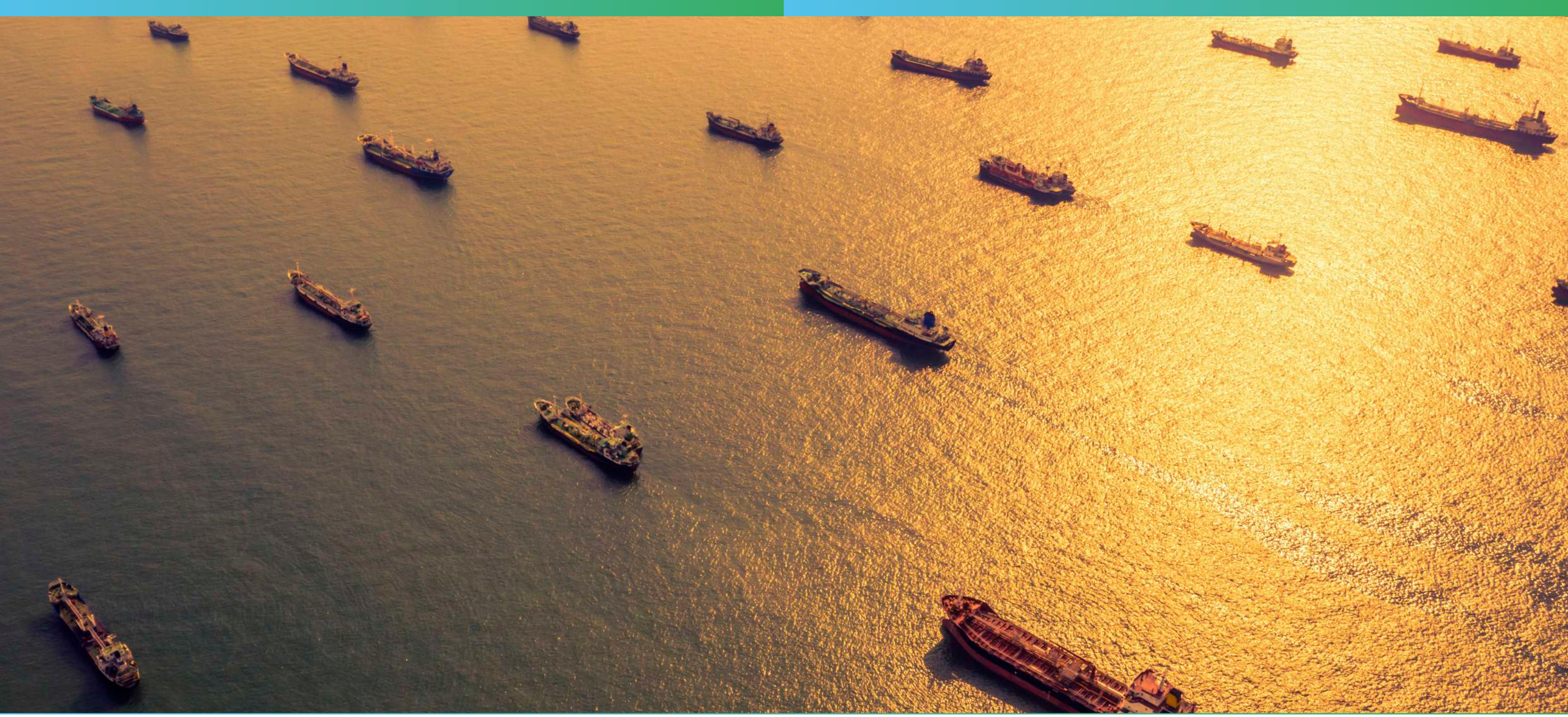
- Provides clean air benefits which exceed those demanded by the IMO's 2020 mandate
- Meets the IMO's 2030 emissions targets when combined with Energy Efficiency Design Index (EEDI) improvements to ship design
- Presents a viable pathway to the IMO's 2050 carbon reduction targets through the use of LBM and LSM products.

As a coalition, SEA-LNG whole heartedly believes in collaboration. To develop the net-zero carbon future that we desire within a couple of decades will need to be a team effort. The maritime industry, academics and NGOs must develop collaborative solutions, based upon technologies that are safe, feasible and achievable, as we take the next step on the road to a zero-emissions industry. Expecting others to do the work, developing the necessary fuels and technology is not helpful; both fuel producers and consumers need to take responsibility - there needs to be a continuing commitment, from across the board, to providing factual, quality information which supports the industry in assessing how we are going to achieve the energy transition.

In support of this, the next independently conducted report from SEA-LNG explores the availability of liquid biomethane and liquid synthetic methane. Although research continues, the initial findings on the potential global availability of bio-methane in the next decade are particularly exciting. The final results are expected in the first quarter of 2020.

If we are to make effective, meaningful progress with emissions reductions across the board, waiting for utopia and the 'perfect' solution is simply not an option. We must continue to act from today. And LNG is the only option that moves us forward, now.

LNG is a clear winner when it comes to local emissions and world health goals.



LNG is a solution – available now - that could move the industry forward, on a pragmatic pathway towards carbon-neutral bio and synthetic methane produced from renewable energy.

With unrivalled emissions credentials, LNG cuts SOx and particulate emissions to negligible amounts, reduces NOx by around 95% and reduces CO2 emissions by up to 21% on a well-to-wake basis today.

For more information:

SEA-LNG.ORG

SEA\LNG LTD
Contact us via:
communications@sea-lng.org
www.sea-lng.org
twitter.com/SEALNGcoalition

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