LNG – A FUEL IN TRANSITION

SEA-LNG

A VIEW FROM THE BRIDGE

JANUARY 2022

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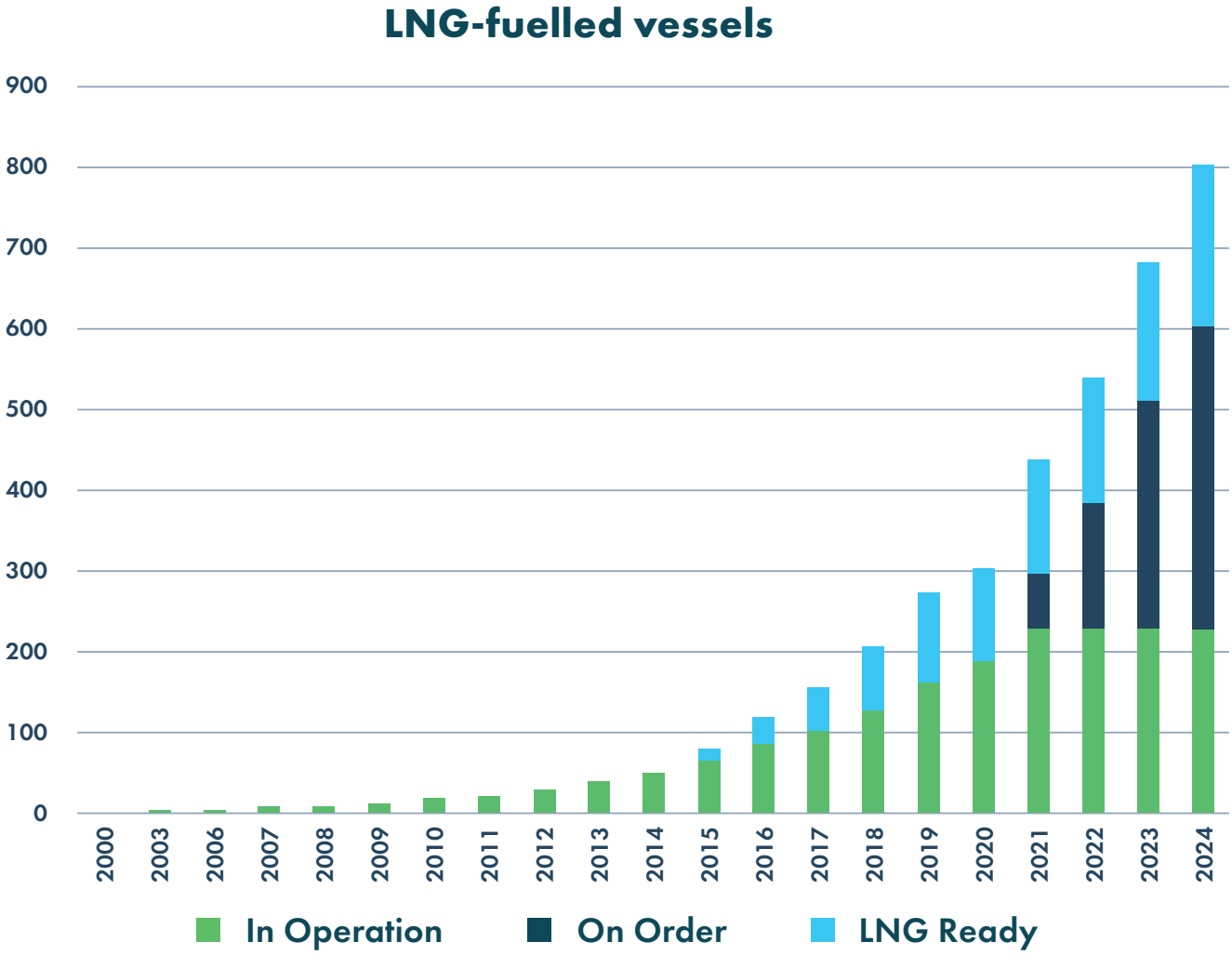
LNG - TRANSFORMING THE GLOBAL SHIPPING INDUSTRY

2021 was a year of dramatic progress and growth for LNG (Liquefied Natural Gas) as a marine fuel and its pathway to decarbonisation. Orders for LNG-fuelled vessels hit record levels while the bunkering infrastructure continued to expand at pace.

There was significant progress on increasing production of bioLNG and renewable synthetic LNG. LNG vessels will maintain value as shipping moves towards a net-zero future. LNG is indeed a fuel in transition and leading the move to a cleaner future for the deep-sea maritime industry.

> **Doing nothing today is wrong. Do not let the good be lost in the search for the best.**
>
> Svein Steimler, President and CEO, NYK Group Europe

2021: A RECORD YEAR FOR NEWBUILDINGS



Since our last review in January 2021, the volume of LNG-fuelled newbuilding orders has accelerated dramatically to approach 30% of gross tonnage ordered according to Clarksons. For some segments, such as the ultra-large container vessels which underpin the global trading system, more than 50% of the order book is either LNG-fuelled or LNG-ready.

It is noteworthy that orders for LNG-fuelled container liners increased five-fold since January 2020. It is anticipated that over 90% of the new Pure Car and Truck Carriers (PCTC) that will enter the market in the coming years will be LNG dual fuel (DF). Tankers and bulkers are also following suit, with increases of seven-fold and two-fold, respectively, over the 18-month period. Gibson highlighted that almost a quarter of tanker orders are LNG-fuelled: twenty Very Large Crude Carriers, 41 Aframax/Long Range product tanker and two Suezmax tankers plus forty LNG-ready tankers.

2021 marked exponential growth in LNG-fuelled deep sea-vessel orders, with more than a dozen operators announcing multi-vessel orders over the year:

- CMA CGM welcomed nine new container vessels to its fleet in 2021[1] and ordered another ten with KSOE.[2] Zim chartered ten more,[3] while Hapag Lloyd ordered six container ships.[4] MSC joined these liner companies investing in LNG by announcing fuelling switches to LNG for newbuildings on order in China.[5]
- Mitsui OSK Lines, NYK Line, K Line[6] and Langh Ship[7] all announced orders for LNG-fuelled bulk carriers.
- UECC launched an additional three car carriers, these also featured combined LNG-battery propulsion,[8] and Volkswagen will bring four new LNG-fuelled car carriers into service in 2023.[9] K Line[10] and NYK have orders for eight and twelve dual-fuelled PCTCs respectively. NYK announced that their LNG-fuelled PCTC fleet will approach 40 vessels by the later part of this decade.[11] While placing an order for four LNG-fuelled PCTCs, MOL announced it wants a 90-strong fleet of LNG-fuelled vessels by 2030.[12] Wallenius also ordered two LNG-powered car carriers with options for four more in addition to the two LNG PCTC vessels ordered by Wallenius SOL, its joint venture company with Swedish Orient Linien.[13]
- In the passenger world, Brittany Ferries[14] and TT Line[15] both ordered two LNG-fuelled ferries, while P&O Cruises' *Iona* made its maiden LNG-fuelled voyage,[16] and both AIDA and Costa Cruises took delivery of their second LNG-fuelled vessels, AIDAcosma and the *Costa Toscana*,[17] respectively.

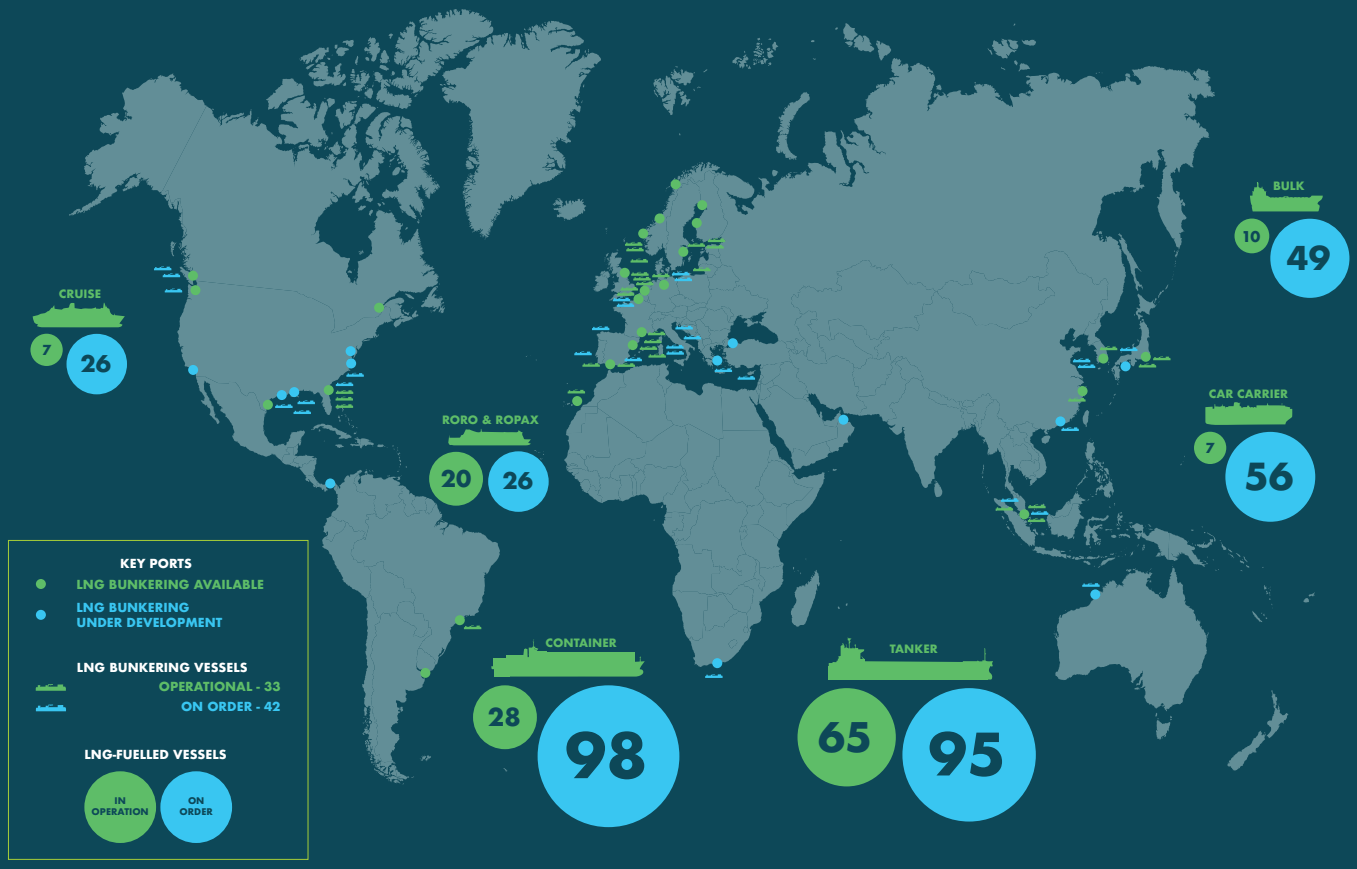
The rapidly growing order book for LNG-fuelled vessels demonstrates that increasing numbers of ship owners and operators understand that the LNG pathway is clear and well defined.

Assets that come online today will be a part of a net-zero shipping future because they will be able to operate on bioLNG and renewable synthetic LNG without costly retrofit.

> **LNG is a proven, compliant, and immediately viable solution to reduce shipping greenhouse gas emissions. Flexibility is the name of the game and that's what we have by choosing LNG.**
>
> **Glenn Edvardsen, CEO, UECC**

GROWING GLOBAL INFRASTRUCTURE

WORLDWIDE GROWTH IN LNG USE AND INFRASTRUCTURE



Given the exponential growth in LNG newbuildings, DNV forecasts that demand for the fuel will triple to more than 3.5m tonnes by 2024. In support of this demand the build-out of LNG bunkering infrastructure continued in 2021.

According to DNV – there are **now** 33 LNG Bunker Vessel (BV) in operation with a further 42 on order or under discussion. By end of 2022 BVs will be operating in northern Europe, the Mediterranean, USA, Canada, South Korea, Japan, Malaysia, China, Singapore, Brazil and South Africa. Other regions such as Australia are also investing in LNG bunkering.

LNG bunkering is available at 141 ports worldwide. Clarkson forecasts that this will grow to 170 ports in 2022. TotalEnergies is forecasting that LNG bunkering will represent 10% of global bunkering by the end of the decade.

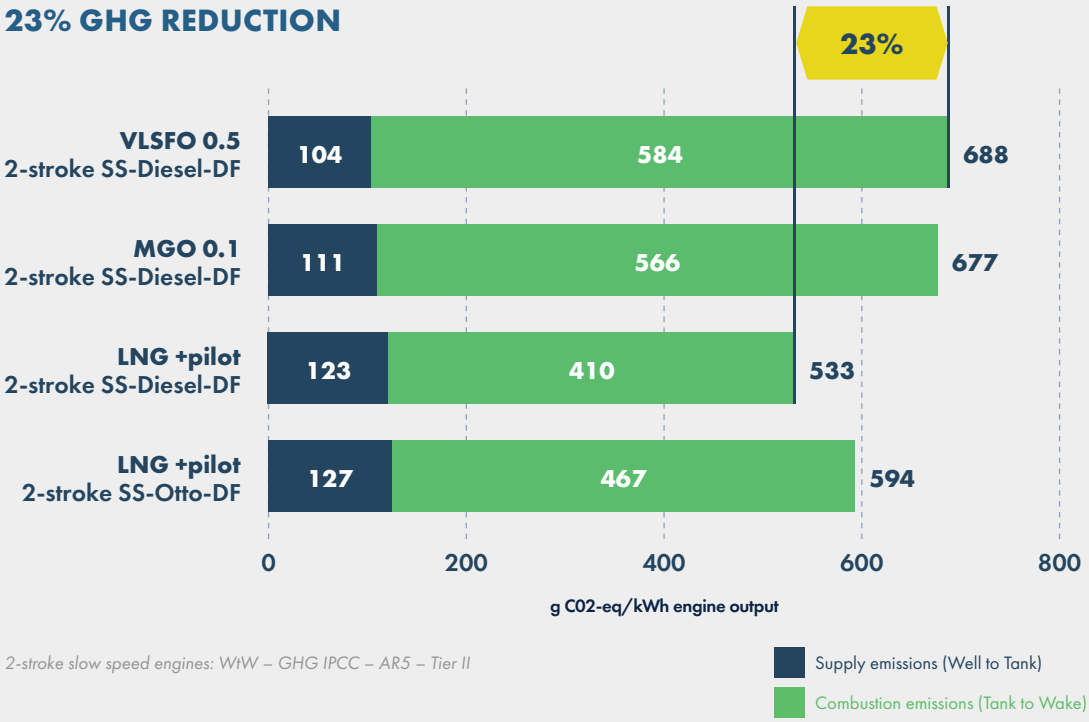
- In 2021 Singapore bunkered its first LNG-fuelled container ship, when the *FuelLNG Bellina* provided ship-to-ship bunkering for the *CMA CGM Scandola*.[18] Singapore MPA also awarded its third LNG bunkering licence to Total Marine Fuels.[19]
- TotalEnergies also announced plans for LNG bunkering in Oman.[20]
- Sumitomo Corporation announced it would partner with Turkish pipeline operator BOTAŞ and Arkas Bunkering to bring an LNG bunkering hub to Turkey.[21]
- Stabilis Solutions Inc have signed memoranda of understanding to bring LNG as a marine fuel to the Port of Galveston, Galveston Wharves,[22] Cameron Parish Port,[23] Port Isabel[24] as well as the Port of Corpus Christi.[25]
- Puget LNG opened for business in the Pacific Northwest of America.[26]
- Shell supplied LNG for AET Tanker the *Pacific Ruby* in Port Canaveral.[27]
- Class society, RINA, was awarded a framework contract by the European Maritime Safety Agency that will help expand LNG bunkering and storage at ports in the Mediterranean, Black, and Caspian seas.[28]
- ENN Natural Gass won China's first LNG Bunkering License to become a supplier at the Port of Zoushan.[29]

On the bunker vessel front:

- Shell continues to charter new Bunker Vessel tonnage, including a 20,000 m^3 newbuilding from Avenir.[30]
- TotalEnergies ran sea trials for its LNG bunkering vessel in Marseille.[31]
- Norway-based Kanfer Shipping ordered two LNG bunker vessels.[32]
- Societe Generale facilitated the provision of financing to Pan Ocean for one of the world's first purpose-built LNG bunkering vessels.[33]
- Seaspan ordered a bunker vessel for the US West Coast[34] and Fratelli Cosulich for operations in the Mediterranean.[35]
- The largest Articulated Tug and Barge Unit (ATB) ever built in the USA, the *Clean Canaveral* was delivered to Polaris New Energy by Fincantieri Bay Ship Building. A second ATB of similar size has already been contracted between the two parties.[36]
- Shell entered an agreement with Crowley Maritime Crop to develop an LNG bunker vessel along the East Coast of the USA.[37]

All LNG bunkering infrastructure as well as the supporting bulk LNG and natural gas systems can transport, store and deliver bioLNG and renewable synthetic LNG without any modifications and additional investment.

STARTING SHIPPING'S DECARBONISATION JOURNEY NOW



The LNG pathway offers a viable route towards a zero-carbon future for shipping through its bioLNG and renewable synthetic LNG variants. Crucially, this well-defined and accepted pathway enables shipping to make progress towards decarbonisation immediately. On a well-to-wake (WtW) basis, LNG offers a 23% cut in greenhouse gas emissions over oil-based marine fuels **today.** There is no need to wait a decade or longer for other, untried and unproven fuels. LNG and the pathway provide real carbon reductions **now.**

In April 2021, Sphera, an ESG consultancy, published its 2nd Lifecycle GHG Emission Study on the use of LNG as a Marine Fuel. This updated its earlier 2019 paper with the latest data available from engine OEMs and fuel suppliers. Participants included Caterpillar, GE, MAN Energy Solutions, Rolls Royce (MTU), Wärtsilä, and Winterthur Gas & Diesel, as well as ExxonMobil, Shell, and **now** TotalEnergies on the supply side.

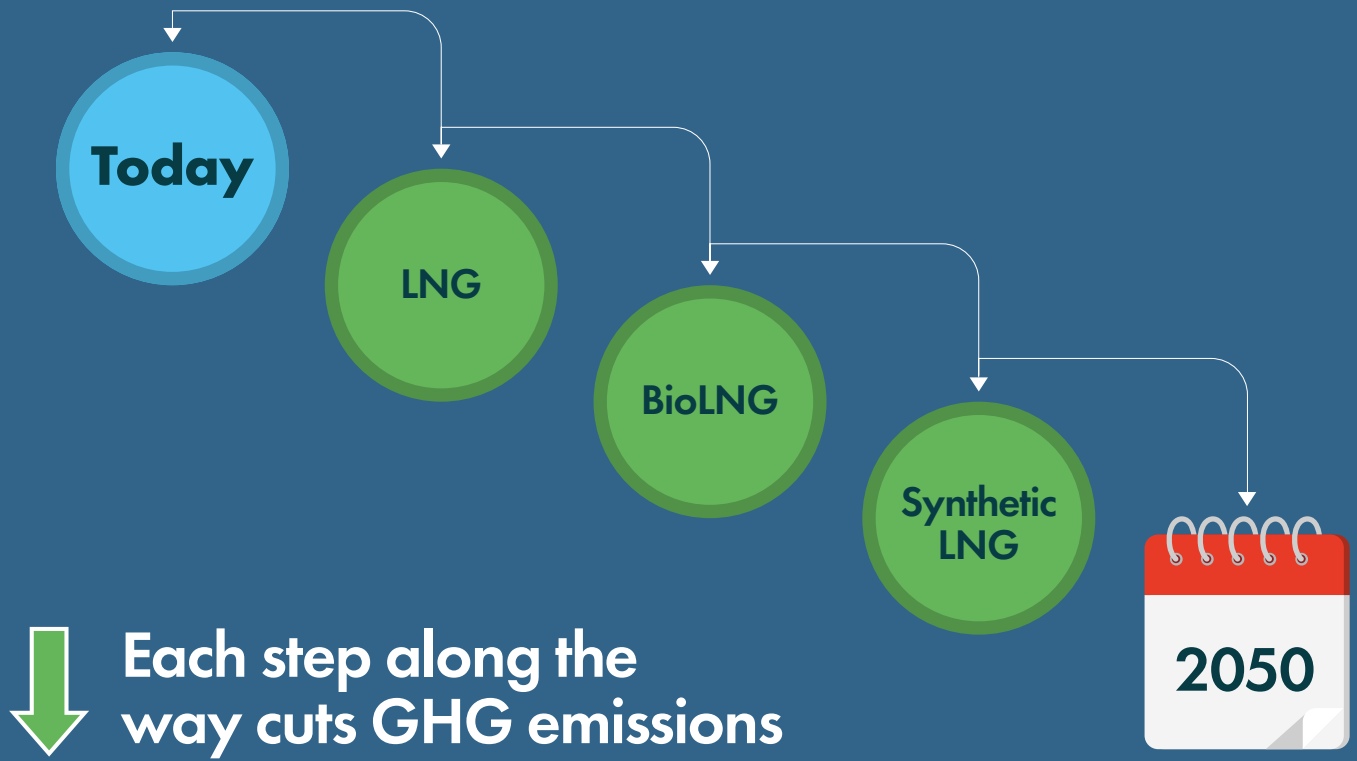
As well as demonstrating the 23% reduction in GHGs, the study reaffirmed the benefits to local air quality with analysis showing LNG combustion in the latest engines produced next to no emissions of SOx, NOx or particulate matter.

The Sphera study also stated that by 2030, engine manufacturers forecast that technological improvements will mean all LNG-fuelled engine technologies have will negligible levels of methane slip. This prediction was backed up by engine manufacturer Wärtsilä's November announcement of the commercial launch in 2022 of their bespoke technology which, when retrofitted to low pressure engines, effectively eliminates methane slip. Further, 2021 orders show that around three-quarters of all newbuildings are opting for high-pressure engines which already have minimal slip. Methane slip is **now** no longer a viable argument against the use of LNG, as technological innovation has essentially solved the problem.

To ensure a level playing field, alternative fuels must be evaluated using a full lifecycle GHG analysis conducted to international standards. The Sphera study meets these criteria for LNG and its pathway forward. The Sphera study shows the potential for bioLNG and renewable synthetic LNG. This study adds to the growing body of evidence which proves that we can **decarbonise shipping now** using LNG.

> **It is also important to do things today, not only in the future.**
>
> **Rolf Habben Jansen, CEO, Hapag Lloyd**

LNG'S STAIRWAY TO A DECARBONISED FUTURE



LNG technology to deliver GHG cuts is available **now** and is lighting the way for wider adoption of bioLNG and renewable synthetic LNG. Bio and synthetic LNG will produce no new carbon emissions when used in shipping. LNG is different to alternative marine fuels, as the change from heavy fuel oils to fossil LNG to bioLNG and onwards to renewable synthetic LNG cuts GHG emissions down a virtuous environmental stairway. With existing vessels, established supply chains and decades of investment in bulk infrastructure, the cost to the industry of using LNG pathway fuels, both financially and in terms of carbon emissions, is significantly less than for other alternative fuels being considered. Suggesting that the industry can spend trillions on new infrastructure when the LNG pathway is clear and already funded to a large extent is neither financially appropriate nor necessary.

BioLNG is available commercially in northwest Europe, **now.** Suppliers are quoting prices for delivery of bioLNG bunkers in Rotterdam, the biggest marine fuel bunkering hub in Europe, and in a number of North Sea and Baltic Sea ports. No changes are needed on board the vessel for its safe use. The world's largest LNG-fuelled vessel, the *CMA CGM Jacques Saade* used a 13% BioLNG mix when refuelling in Rotterdam as early as 2020. In September 2021 JAXLNG together with Element Markets supplied a BioLNG blend to Tote's *Isla Bella* in Jacksonville, completing the first renewable LNG bunkering in the USA.

BioLNG produced from sustainable biomass resources has massive potential, as shown in the CE Delft study and analysis by the International Energy Agency. Supplies are forecast to rise dramatically as businesses like Wärtsilä, Biokraft, Gasum, Titan LNG and CMA CGM step in to increase production capacity. Gasum is confident it has enough capacity to meet market demand for carbon neutral fuels with its bioLNG production and at a lower cost than other future alternative fuels.

For renewable synthetic LNG, the pathway is becoming clearer. Like other synthetic fuels, such as green ammonia and green methanol, it is made from hydrogen produced from electrolysis using renewable electricity. Between 70% and 80% of the cost of all of these synthetic fuels is related to the cost of producing the hydrogen feedstock. However, the fact that renewable synthetic LNG can be used in existing vessels and transported, stored and bunkered using existing infrastructure means the total cost of the pathway is likely to be significantly lower for renewable synthetic LNG than it is for other synthetic fuels.

In September 2021 Unifeeder, working with MAN Energy Solutions conducted the world's first bunkering of carbon-neutral synthetic LNG when it fuelled the ElbBlue in Brunsbüttel, Germany. And in November CMA CGM and ENGIE signed a wide-ranging partnership aimed at developing e-methane (renewable synthetic LNG), with several projects already identified in Europe.

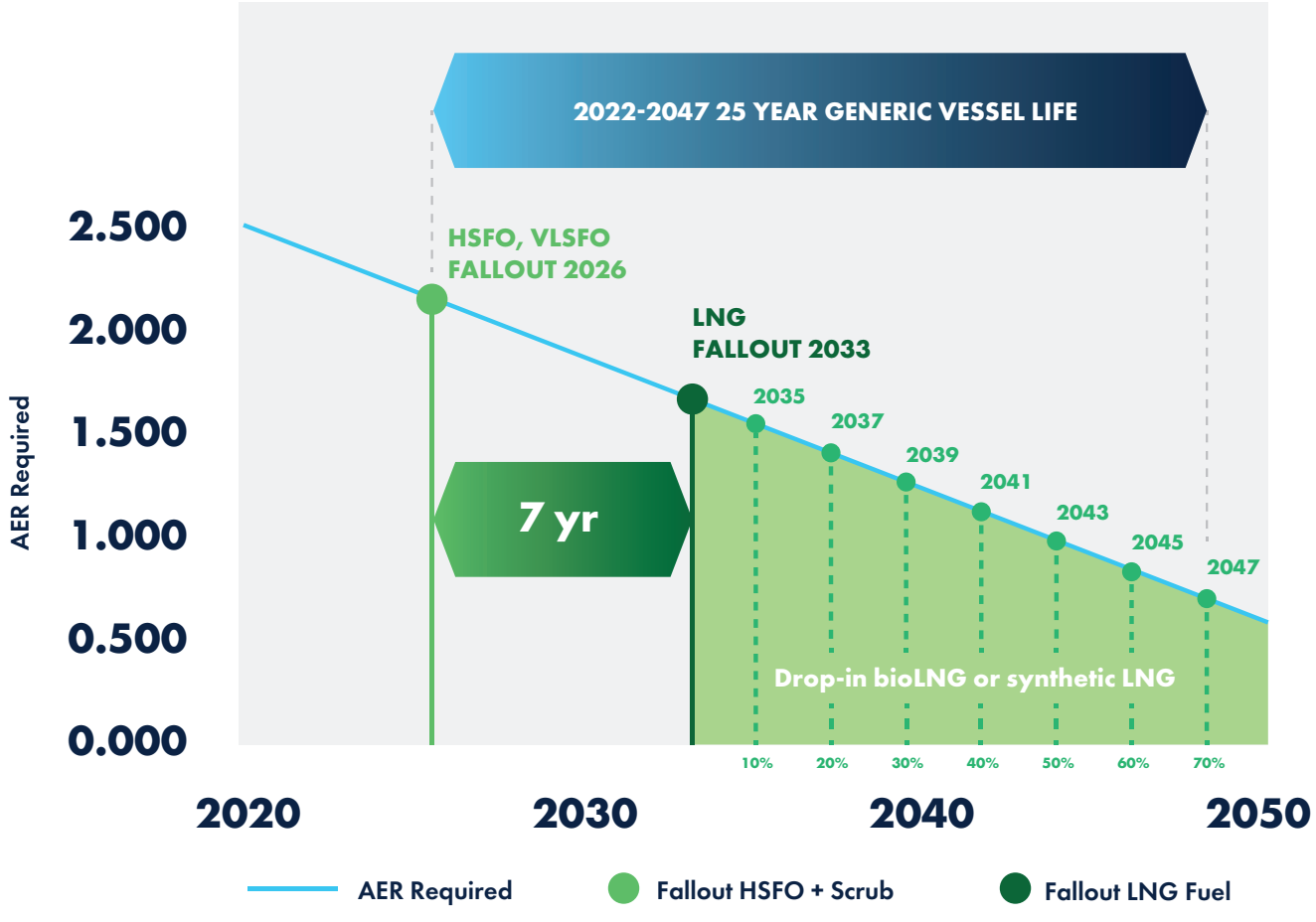
> **We are convinced that bioLNG and e-methane will be part of the solution for decarbonation of shipping. That's why we are partnering with global industrial leaders and lawmakers to accelerate its production and promote its usage.**
>
> **Christine Cabau Woehrel, EVP Operations and Assets, CMA CGM**

DELIVERING COMPLIANCE

LNG is a fuel in transition able to meet existing and expected regulation. By switching to the LNG pathway, operators can immediately cut carbon emissions with fossil LNG and - combined with other energy-efficiency measures - meet the IMO's decarbonisation targets for 2030.

In the longer-term towards 2050, as the LNG pathway progresses to carbon-neutral fuels, they will be able to meet increasingly stringent regulatory targets through the use of drop-in fuels and eventually total conversion to bioLNG or renewable synthetic LNG.

LNG also provides a long-term competitive advantage for owners seeking preferable lower-cost finance through the Poseidon Principles. Analysis shows that ships opting for LNG can benefit for seven plus years of emissions compliance for preferable asset financing versus conventional vessel fuels like HSFO, VLSFO, and MGO. Likewise, LNG as a marine fuel may benefit vessels with an immediate elevation of two grades, vaulting a moderate 'C' rating ship to major superior 'A' on the IMO's Carbon Intensity Indicator (CII) for operations. CII is a gauge of how efficiently all ships transport cargo measured in grams of CO2 emitted per deadweight ton capacity nautical mile.



The EU's proposed "Fit for 55" package of legislation is broadly aligned with SEA-LNG's position that goal-based and technology-neutral policies are needed to ensure innovation and a level playing field for all low and zero-carbon marine fuels. Decarbonisation of shipping will require a basket of different fuels and propulsion systems each evaluated on a full well-to-wake GHG lifecycle basis.

From COP26 in Glasgow, the Global Methane Pledge, backed by 100 countries calling for a 30% reduction in methane emissions by 2030, is also a welcome development. It incentivises stronger action on methane emissions, which will create certainty for the shipping industry around fuel and engine choices, tackling the challenges of methane in the value chain.

> **There is no doubt that low or net-zero forms of natural gases must be in the basket of future fuels, which will power the global shipping fleet in the coming decades.**
>
> **Bud Darr, Executive Vice President, Maritime Executive & Government Affairs, MSC Group**

CONCLUSION

Record year

The rapidly growing order book for LNG-fuelled vessels illustrates that increasing numbers of ship owners and operators understand the environmental and climate benefits of LNG.

LNG-fuelled vessels and infrastructure invested in **today** will be part of a net zero-future as they can use and deliver bioLNG and renewable synthetic LNG once these fuels become more broadly available.

Decarbonisation can start **now.** On a well-to-wake basis, LNG offers a 23% cut in greenhouse gas emissions over oil-based marine fuels **today.** There is no need to wait a decade or longer for other, untried and unproven fuels.

BioLNG from sustainable biomass resources is increasingly available and has massive potential to scale while renewable synthetic LNG will play a key role in maritime decarbonisation as renewable electricity and the electrolyser capacity to produce hydrogen feedstock grows.

The road ahead will not be easy. Polices, at both the global and regional level, should be goal-based and technology-neutral, creating a level playing field for the development of low and zero-carbon marine fuels and propulsion systems. But the fact remains that, as of **today**, the LNG pathway is the only clear, practical and financially realistic route to decarbonising shipping.

Waiting is not an option.

> **LNG offers the simplest and lowest risk transition to zero-emissions for the maritime sector, starting now.**
>
> Peter Keller, Chairman, SEA-LNG

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