

2019 VOLUME 3

# SURVEYOR

AN ABS MAGAZINE

**GASTECH  
SPECIAL  
ISSUE**



# PRESCRIPTION FOR A LOW-CARBON DIET

The maritime industry's journey of decarbonization will be a long voyage in many stages, requiring evolution of known technologies and practices and the invention of entirely new ones. Today our eyes are collectively fixed on the promising beacon of a carbon-minimal future, but its light, shining through a dense fog of unknowns, leaves us with many questions and few solid answers as to how to best get there.

In June this year, ABS published an Outlook analyzing the industry's present position on the voyage to decarbonization. Designed to serve as a decision-making guide for stakeholders trying to plan a path towards IMO's emissions reduction targets for 2030 and 2050, the Outlook summarizes the pros and cons of various alternative fuels (including LNG), operational strategies and other technologies available or on the horizon today.

The Outlook also includes a concept design exercise, developed with Herbert Engineering, specifying requirements for two futuristic low-carbon container carriers which shine a light on the gap between industry's present technological capabilities and the demands of the 2050 greenhouse gas targets.



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## ON THE COVER

An LNG carrier sails into a hazy digital sea, symbolizing the maritime industry's journey of decarbonization. Use of LNG as a marine fuel by the global merchant fleet is integral to achieving the challenging goal of a carbon-minimal future, but it is not the only leg on which that effort stands. This issue of *Surveyor* examines several aspects and issues surrounding LNG's development as a marine fuel.

### PUBLISHED BY ABS

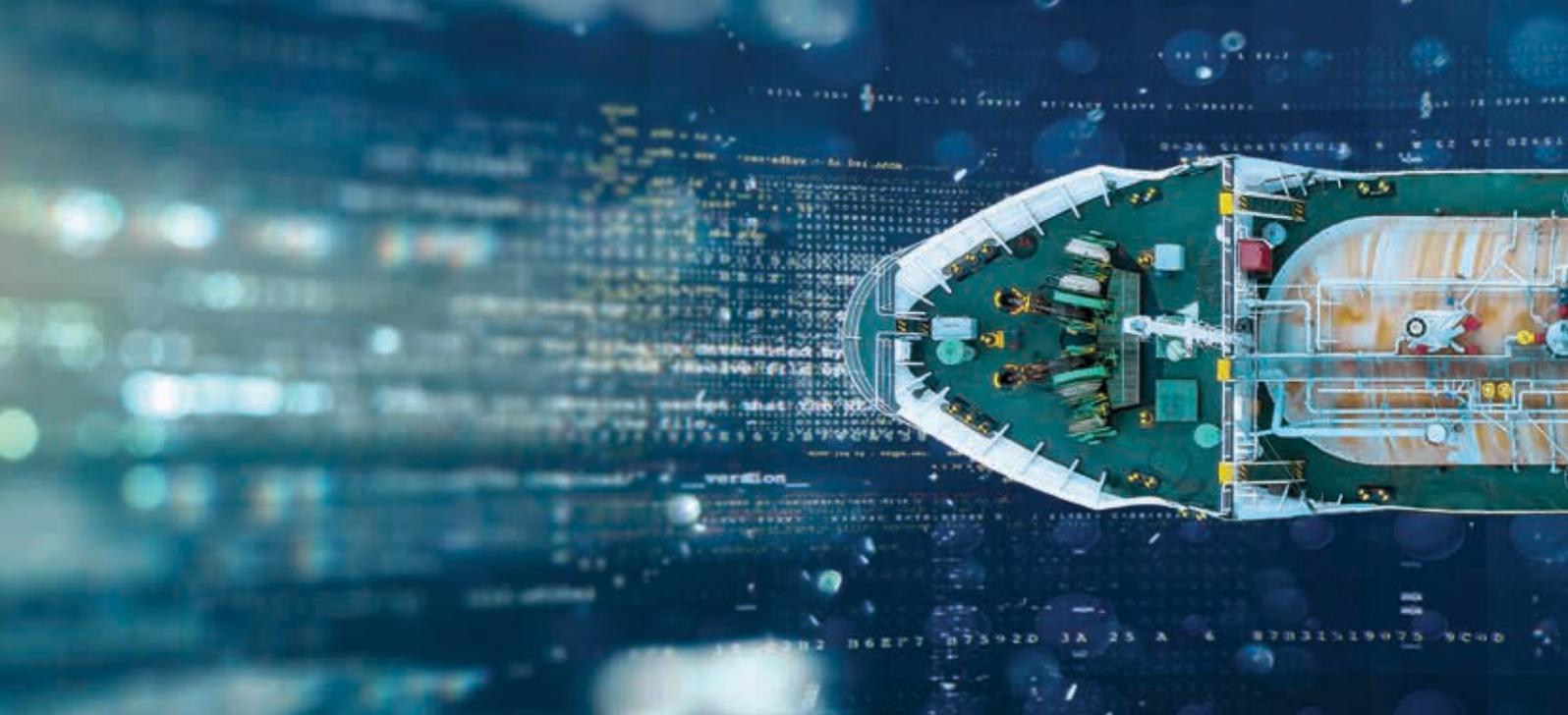
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# HANDLING THE FUEL OF THE FUTURE

The growing global fleet of LNG-fueled vessels requires a growing base of personnel trained to handle and use the new fuel safely. Recognizing this, IMO's Maritime Safety Committee (MSC) adopted new rules governing the use of gas as a fuel on ships in 2015. The International Code of Safety for Ships using Gases or other Low-flashpoint Fuels (IGF Code), with amendments made to the International Convention for the Safety of Life at Sea (SOLAS) to make the code mandatory, subsequently came into force in January 2017.

The IGF Code aims to minimize risks to the ship, its crew and the environment that stem from the fuels involved. It contains mandatory provisions for the arrangement, installation, control and monitoring of machinery, equipment and systems making use of low-flashpoint fuels, focusing initially on LNG. The Code takes a goal-based approach to address all areas needing special consideration for vessels using low-flashpoint fuels, providing goals and functional requirements for their design, construction and operation, according to the IMO.

At the same time, related amendments were adopted for the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW Code), covering new mandatory minimum requirements for the training and



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qualifications of masters, officers, ratings and other personnel on ships subject to the IGF Code.

These training rules apply only to ships receiving LNG as fuel. Bunker barges, being small LNG carriers, are already covered by the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code), which has been mandatory under SOLAS chapter VII since 1986 and applies to ships of all sizes. In fact, seafarers trained under IGC Code requirements who have valid LNG endorsements (Tankerman LG or Tankerman Assistant LG) are exempt from the new training requirements.

Crew preparation for gas-fueled vessels that are not themselves gas carriers is divided into three essential parts: basic- and advanced-level training, conducted in a classroom environment and ship-specific training, which takes place aboard the vessel on which the mariners will serve. In addition, a very basic ship-specific familiarization is required of everyone working onboard.

Under the IGC and STCW rules, any mariner working aboard a gas-fueled vessel that has a responsibility related to the fuel or designated duties related to safety or emergency response has to be trained to the basic level. This could include the entire crew, or at least a fairly large portion of it.

Basic training is a prerequisite for the advanced course, which is intended for mariners that will have immediate responsibility for the care and use of the gas fuel. Engineering officers are the typical candidates for advanced training, as they are in charge of bunkering operations, but oftentimes masters and chief mates take the course as well.

In order to meet the requirements of the US Coast Guard training guide, as well as the IGF and STCW Code mandates, all basic and advanced courses have to be generic in nature. The logic behind that direction is that a person certificated to the basic or advanced level should be qualified to serve aboard any type or size vessel using LNG or any other low-flashpoint fuel.

### **BRINGING NEW SKILLS TO THE WORKFORCE**

When Harvey Gulf International Marine made maritime history in 2014 by becoming the first owner/operator in the Western Hemisphere to use LNG as a marine fuel, the company credited crew training by the United States Maritime Resource Center (USMRC) and ABS as critical to the achievement. This made the USMRC the first organization in the Western Hemisphere to offer advanced training for personnel serving on gas-fueled vessels. The course it developed pre-dates the establishment of USCG regulations governing LNG bunkering and even the release of its policy guidance letters. Today, USMRC and ABS partner



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● Business  
● Development  
● & Lifecycle,  
● Wärtsilä Marine

to deliver IGF Code-compliant and STCW Code-compliant basic and advanced level LNG crew training in the Americas.

“Regarding LNG as a marine fuel, industry is in a basic evolutionary stage right now, where most LNG-fueled vessels are built as one-off projects; and we’re nowhere near the point where LNG bunkering is ubiquitous like conventional fuel bunkering – a shipowner can’t say I need 500 tons of fuel and have 10 suppliers run up making offers,” says Robert Kamb, who was part of the training team for the Harvey Gulf vessels and is now Manager of LNG Services for ABS Advanced Solutions and a lead trainer in the ABS/USMRC partnership. Today, bringing an LNG-fueled vessel into the world is a kind of closed-loop process, including the crew training, he says.

“Typically, the shipowner decides to build an LNG-fueled ship, they select an LNG fuel supplier, and then they select equipment vendors and a shipbuilder and then they all work together to develop what is essentially a custom solution,” Kamb says. “In this scenario, we at ABS Group are part of the project team, just like the shipbuilder or gas provider, selected by the owner to provide the necessary safety training.”

The classroom part of the training program has consisted mainly of classic teacher-student instruction and acting-type simulations in which each student is assigned a role in a variety of scenarios involving normal operations and emergencies. This is followed with training onboard using the actual vessel system. Activities include: interactive classroom exercises to examine each phase of the LNG bunkering process for each available transfer mode; guided role-playing exercises for the LNG fueling procedure, including all activities from pre-planning through post-bunkering; and completion of bunker safety checklists and ship-specific procedures

One critical component of the course is that students complete a full day of LNG emergency response and

firefighting training, in which they wear a complete fireman’s outfit and employ various techniques for vapor control and fire extinguishing using actual LNG cryogenic material in intensive scenarios, including LNG pool and flange fires.

### STRENGTHENED BY SIMULATION

The power plant for Harvey Gulf’s groundbreaking offshore service vessels is a Wärtsilä 50DF dual-fuel engine connected to the manufacturer’s LNGPac – a customizable LNG-fuel gas handling system that includes bunkering station, storage tank, process equipment and control and monitoring system. Adaptable to any vessel design, over one hundred LNGPac systems have been contracted since 2011, when the first was installed aboard a small Swedish chemical tanker. Of these, over half are currently in operation.

“Wärtsilä clearly see a growing need for LNG-fueled vessels, which is supported by the increasing number of enquiries and contracts materializing every year,” says Piero Zoglia, Manager, Business Development and Lifecycle, Wärtsilä Marine. “In the last year the number of LNG-fueled vessel contracts increased by 50 percent and is expected to grow further in the next years. Experienced and qualified crew members are mandatory in each gas-fueled vessel, which surely implies an increasing demand for specialized and certified training”

Growing demand for LNG-capable crew has inspired training providers around the





world to develop simulator systems to aid in building this critical skill set.

“When we started our program in 2014, running LNG marine fuel courses for Harvey Gulf personnel, we employed a custom-built Wärtsilä LNGPac desktop simulator,” says Brian Holden, President of the USMRC. “It worked very well, but only two students could use it at any given time. Now Wärtsilä has developed a new simulator that will give each student their own system model to work with. Wärtsilä is the manufacturer of the LNG fuel package, so we expect the simulator to be very close to the actual system experience.”

In 2018, Wärtsilä acquired Transas, a leading provider of marine navigation solutions (such as bridge systems

and electronic charts) and also of professional training services and simulation equipment. Its TechSim simulator systems cover a broad range of equipment and are installed in hundreds of companies and institutions around the world. Now under Wärtsilä Marine, TechSim technology forms the basis of Wärtsilä’s new LNGPac simulator.

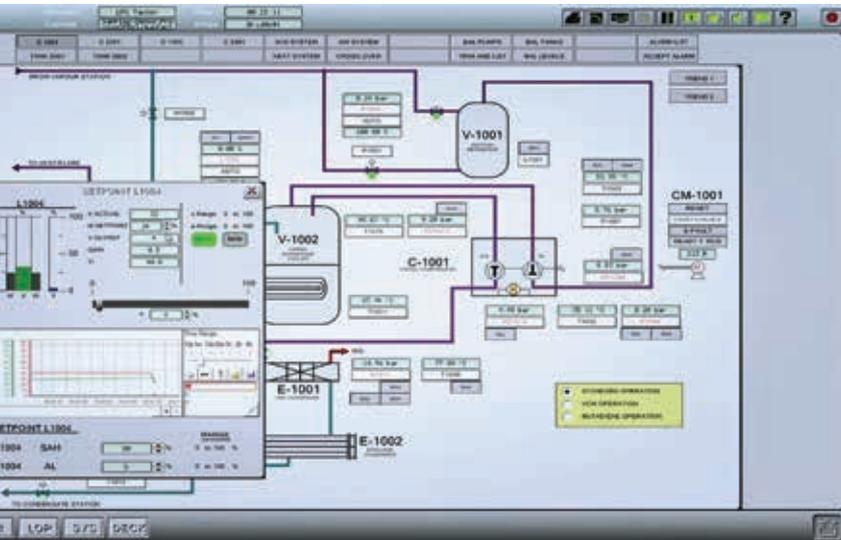
“Given the growing request for training from the LNG market, it was paramount for Wärtsilä to have this model available,” says Vittorio Esposito, Solutions Manager, TechSim, for Wärtsilä Marine. “Together with Wärtsilä Gas Solutions, which provided all the technical documentation, the TechSim team of experts has developed the mathematical model in order to provide operational training, re-creating all the





Wärtsilä has re-designed the Graphical User Interface, replicating one-hundred-percent the animation and interlocking functionalities of the real system, giving the possibility to the final user to interact with the system in both full auto and manual modes





functionalities and modus operandi of the actual real system. In addition to this, the team equipped the model with all the tools for the instructor to conduct IGF and STCW compliant training,” he says.

“Wärtsilä has re-designed the Graphical User Interface, replicating one-hundred-percent the animation and interlocking functionalities of the real system, giving the possibility to the final user to interact with the system in both full auto and manual modes,” he adds. “On top of this, the existing TechSim instructor module allows the instructor to insert faults, score the student and even completely automate the exercise. The underlying engine is the mathematical model which has been designed in order to seamlessly have the system to respond to all the user’s inputs, allowing the student to learn all the different procedures in any condition.”

### **EVOLVING WITH THE SECTOR IT SERVES**

Being based on conventional hydrocarbon transfer safety procedures and informed by 60 years of safe LNG maritime transport,

LNG fuel training for crews is a fairly straightforward process, Holden says. Although a new field, it doesn't present trainers or trainees with burdensome challenges. In fact, its biggest challenge to date, he says, stems from the fact that the STCW Code requires firefighting and emergency response training to be performed under as realistic conditions as possible, which means simulating disasters using actual cryogenic product. At the moment, in North America only three training centers do so, in Texas, Massachusetts and Vancouver, British Columbia. Across the Atlantic the number of such centers is also quite slim.

A fourth U.S. facility, now under development in Florida, is where the USMRC plans to base its future LNG firefighting and response training.

“We have partnered with Port Canaveral, Florida, which is building on an existing firefighting facility with a ship mock-up that is right in the port,” Holden says. “Port Canaveral expects that over the next few years several of its cruise line clients will take delivery of LNG-powered cruise ships and homeport them in Canaveral. The port is developing the facility to be able to offer various value-added services to its clients; these include LNG marine fuel training, which USMRC will deliver. The classroom and simulator training is simple - all we need is a computer lab and a classroom. The key to doing it right is having access to the correct LNG firefighting and emergency response props,” he explains.

“Since we began training crews for LNG fuel in 2014, we’ve taught about a thousand mariners between our U.S. and Canada-based clients. At this point, at least for markets in the US and Canada, we’ve pretty much trained everyone that needs training,” Holden says. Although training activity is at present in a quiet period, with most requests related to turnover with the operators, he expects that to change soon, and dramatically.

“We expect the crew demand for the coming crop of LNG-fueled ships will exceed the total number of people we have trained over the past five years,” he says. “Training demands will surge up and down as the LNG-fueled fleet grows, and we’re ready to surge up and down with that evolution.”



# OPENING THE DOOR TO THE LNG ERA

The past 18 months have seen numerous milestones in the progress of LNG bunkering. Through advances in equipment innovation, service expansion at ports worldwide and significant changes of attitude, it appears that the LNG Era is at last beginning to dawn.

At the end of last year, the U.S. Coast Guard (USCG) addressed many aspects of using LNG as a marine fuel during its fourth Liquefied Gas Senior Executive Forum in Houston. Standing out from the usual presentations on gas markets, gas carriers and liquefied gas import/export facilities were announcements relating to LNG bunkering in US ports.

The thrust of the presentations was that the USCG wants to ensure it has sufficient time to vet the practices employed by all links in the LNG supply chain, and to be sure that all players will do their due diligence and carry out their duties with safety foremost in mind.

Existing USCG regulations address the design, equipment, operations and training of personnel on vessels that carry LNG as cargo in bulk and address fueling systems for boil-off gas used on LNG carriers. The use of LNG as fuel for ships other than those carrying LNG as cargo is a relatively new concept in North America.



To assist LNG stakeholders, ABS developed the *Bunkering of Liquefied Natural Gas-Fueled Marine Vessels in North America* report. The study helps owners and operators of gas-fueled vessels, LNG bunkering vessels and waterfront bunkering facilities by providing information and recommendations to address North American (U.S. and Canada) federal regulations, state, provincial and port requirements, and international codes and standards.

For foreign-flagged LNG gas-fueled vessels, the USCG asks operators to familiarize the agency with the specific vessel's bunkering arrangement and to pre-identify its supply arrangements (such as bunkering barges, terminal loading or dockside truck delivery).

Consider that the six-decade safety record of LNG, arguably the best safety record of any hazardous cargo in history, was established in a unique, controlled environment by a small number of extremely high-quality operators with vigilant attitudes towards safety in an atmosphere of rigorous caution and respect for the product. With the rapid widening of the LNG market and entry of many players that have no previous LNG experience, authorities can be forgiven for concerns that the sector's safety mindset may be getting diluted, and for taking action to ensure its established legacy of safety continues.

### **STEPS FORWARD AROUND THE WORLD**

To date, LNG bunkering in the U.S. is limited to domestic shipping. For example, in the Port of Jacksonville, Florida, two 764-foot Marlin-class vessels for TOTE Maritime, the *Perla del Caribe* and the *Isla Bella*, have been bunkering by truck until

*Clean Jacksonville*, was delivered to provide ship-to-ship bunkering. In Port Fourchon, Louisiana, Harvey Gulf International Marine, the pioneer whose LNG-fueled OSVs introduced LNG-fueled vessels in North America, has been operating a shoreside facility for LNG bunkering.

Last year, the ABS-classed *Clean Jacksonville*, the first U.S.-built LNG bunkering barge, was delivered by Conrad Industries to TOTE Maritime for use in the Port of Jacksonville, where it is providing bunkering services for the two LNG-fueled container carriers that TOTE operates between Florida and Puerto Rico.

On the other side of the world, ABS was also selected to class Singapore's first LNG bunker vessel. Being built at Keppel Singmarine for a reported S\$50 million (\$37.5 million), the 7,500 m<sup>3</sup> capacity vessel will be owned and operated by FuelNG, a joint venture between Shell and Keppel Offshore & Marine. It is another step forward in Shell's push to widen the global availability of LNG as a marine fuel. The company already operates three LNG bunkering vessels in Europe, including a 3,000 m<sup>3</sup> capacity vessel out of Rotterdam that provides fuel to vessels operating on Europe's inland waterways. The company has also announced a charter agreement for a 4,000 m<sup>3</sup> bunkering barge with QLNG for the U.S., which is intended to support the growing fleet of LNG-powered cruise ships and for service along the country's southeast coast.

Singapore, as part of its effort to become a total maritime hub for Southeast Asia, began a pilot program in LNG bunkering that began in 2017 and will continue through 2020. The port announced that the program will test operational protocols,

build operational experience among participant companies and generally beef-up Singapore's LNG bunkering capabilities and develop a reliable and efficient safety regime governing this fledgling service.

Under a vision of cultivating a globally consistent safety regime for LNG bunkering, Singapore's Maritime and Port Authority (MPA) began building a coalition of like-minded ports around the world. Beginning in

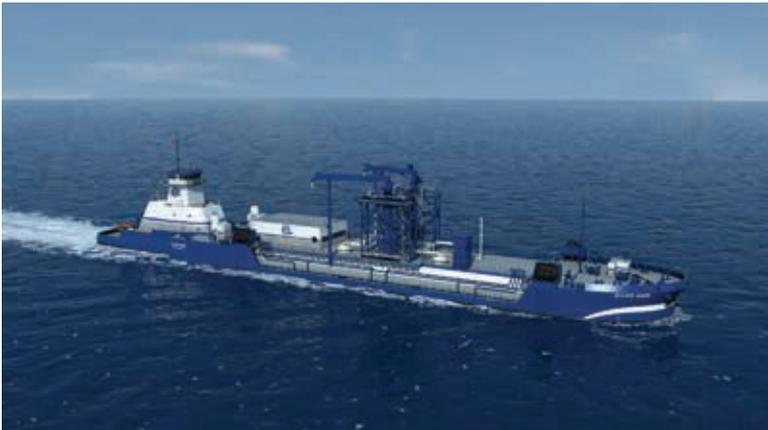
2016, the MPA signed a memorandum of understanding (MOU) with the Antwerp Port Authority, Japan's Ministry of Land, Infrastructure, Transport and Tourism, the Norwegian Maritime Authority, the Port of Jacksonville, the Port of Zeebrugge, the Port of Rotterdam Authority, the Ulsan Port Authority, the Port of Ningbo-Zhoushan, the Port of Vancouver and the Port of Marseille. Through the MOU, Singapore aims to:

1. establish a network of LNG bunker-ready ports across the East and the West to encourage the adoption of LNG bunker by shipowners;
2. deepen cooperation and information sharing in relation to LNG bunkering; and
3. promote the adoption of LNG as a marine fuel by coordinating with international organizations and private operators.

### STARTUPS, MILESTONES AND PLANS

In another demonstration that LNG bunkering is becoming routine in many areas, Finland-based Gasum reports that its 5,800 m<sup>3</sup> bunkering vessel *Coralius* carried out its 100th LNG bunkering in February. As experience has built, the operation has increased in efficiency to the point where it is nearly as quick as normal oil bunkering, Gasum reports.

The largest number of bunkering operations is currently performed by trucks, which typically drive up to a vessel and connect via hoses. Around the world, truck-to-ship (TTS) bunkering has proven to be a successful, low-cost means of starting up LNG bunkering services. FuelNG got started that way and recently celebrated its 100<sup>th</sup> such operation. Last year, TTS bunkering debuted in the Copenhagen-Malmö Port and has helped introduce LNG bunkering in ports



throughout Europe from southern Italy to Poland. It also has a central role in the development of a planned LNG hub in France.

In November of last year, the Marseilles-Fos Port, a major Mediterranean cruise ship call, unveiled a 'master plan' to developing an LNG bunkering infrastructure as part of a vision for cutting ship pollution supporting the decarbonization of the maritime industry. The plan is based on a rapid development of truck-based bunkering followed by the introduction of one or more bunkering vessels.

Not all startups start slowly. In July this year, U.S. engineering company McDermott was awarded the front-end engineering design (FEED) contract for a planned LNG bunkering project for the Sohar Port, in Oman. The port, situated near the Strait of Hormuz, hopes to build a regional center for LNG bunkering. This initial project is for a mid-sized liquefaction facility with a capacity of one million tonnes per year (MTY) - much smaller than most LNG export terminals, which usually have capacities in the range of 5-15 MTY. French oil major Total is partnering with the Oman Oil Company to develop the terminal, which will be fed by several new onshore gas discoveries that the producers hope will reach production levels of 500m ft<sup>3</sup>/day. These fields are operated by Shell which has a 75 percent stake, with Total holding the remaining 25 percent. Total and Shell are the leading oil majors pushing to solidify the global distribution of LNG bunkering. Meanwhile, Korea Gas Corporation has been studying the feasibility of an LNG bunkering service at the nearby Port of Fujairah, which is the region's primary hub for conventional bunker fuel.

For proponents of the LNG revolution, these are indeed exciting times, made even moreso by the silent advance of the far future. Even visionaries longing for carbon-neutral shipping by the end of the century received encouraging news from the expanding world of liquefied gas bunkering, in an agreement recently penned by the Port of Gothenburg in Sweden with FordonsGas to make liquefied biogas available through its permanent LNG bunkering facility.



## INNOVATION SNAPSHOT:

# CONTAINERIZED LNG FUEL DELIVERY

In 2018, ABS granted Approval in Principle (AIP) to German designers Technolog for an innovative LNG fuel gas delivery system packaged in a portable standard 20 or 40 foot container frame.

Straightforwardly called the LNG Fuel Gas Container, the self-contained system includes its own fuel gas preparation system, which the designers say simplifies the bunkering process and limit the risks of cryogenic materials handling onboard. Conceivably, it could be either a main means of bunkering or a backup system providing peace of mind to LNG-fueled tramp vessels.

The idea is that the fuel tank would be filled at a land-based LNG terminal and delivered to the user via rail, road or vessel according to standard procedures for transport of hazardous cargoes - in concept, it is rather like the way local filling stations deliver bottled cooking gas to suburban homes for backyard grills, but with considerably more care taken.





# WHAT FUEL OF WHICH FUTURE?



Is LNG a transitional fuel or part of the final solution?

There are so many unknowns facing shipowners today as to render that question, along with many others, unanswerable. For while it is clear that LNG has the qualities needed to become a major global marine fuel of the future, what's not clear is when that future will get here, what it will look like or how long it will last.

There seems to be three futures in play now: one involving the existing fleet, one involving the young and newbuilding fleets, and one involving the post-2023 fleet. They are not entirely separate from one another but interconnected via economic threads. For certain sectors, the bulk trades in particular, these individual futures are conditioned by both perception and reality – the reality of freight rates and fuel prices and the perception of where they are headed.

Certainly, LNG is not the future fuel for most of the existing fleet. The average age of the world fleet, according to the 2018 UNCTAD Review of Maritime Transport, is about 20 years. At least half these ships are not likely to see 2030. Conceivably, many will be nursed along until after 2023, when IMO revises its greenhouse gas (GHG) strategy. Until then, existing vessels will continue burning either compliant



low-sulfur fuel oils or traditional heavy oil with the exhaust cleaned by a scrubber.

For the young and newbuilding fleets, LNG is a possibility. As this issue went to press, of around 2,000 ships on order, approximately 330 were LNG fueled. The remaining fleet could be candidates for conversion post-2023, but the high cost of conversion, regional availability of fuel, trading patterns and possibilities for other substitute fuels are all potential factors that should be carefully considered when evaluating potential contenders. Most conversions done to date have been on vessels about five years old, as is the Hapag-Lloyd mega-containership due for conversion over the coming year.

LNG has the potential to emerge as a major new world fuel with the post-2023 fleet. That year, IMO will revise its GHG strategy and let industry know what's really going to happen. Certainly, by then the global markets for oil and gas as marine fuels will have stabilized, or at least solidified their trends. When those twin hammers come down, attitudes may change dramatically towards joining the LNG club - it's possible to envision the start of a scrapping and building boom in the mid-2020s given the right market conditions.

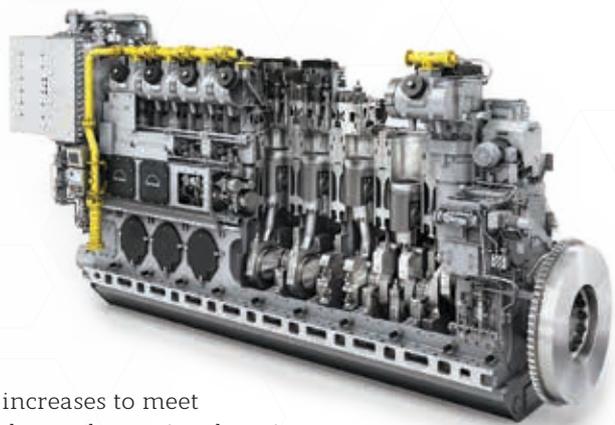
For many shipowners, the decision of whether to make the switch to LNG fuel hinges purely on vessel economics. For the wet and dry bulk trades, this specifically means whether freight rates and fuel price will support the higher building cost of an LNG-fueled ship.

The conflict between commerce and fleet investments has long plagued the industry. In the typically low-margin bulk trades, low freight rates do not cover

the cost of introducing technological advances; periodically over the years, lack of investment in fleet enhancements has slowed adoption of many advances among tankers and bulk carriers. In the current atmosphere of activist government policies, where climate action laws and consumer tariffs to support alternate energy production have become commonplace, it is no longer inconceivable that a carbon tax or premium could be imposed on freight transactions as a means of driving fleet changes. Certainly, room remains for markets to rise naturally in recognition of GHG reduction pressures, but how much room is unknown - just one more unknown in a sea of unknowns complicating the journey forward for many shipowners.

Another obstacle to the advancement of LNG as a fuel is concern over the pricing of compliant fuels post-2020. For bulk carriers fuel cost is a large part of operating expenses. So, if the difference between compliant oil and LNG is small, owners may opt for the devil they know and continue with oil, unless of course new GHG regulation puts its future in doubt. If the difference is large, the numerous advantages of LNG are likely to make it the clear winner. Thus stalled, many owners have chosen a 'wait and see' approach, which as a practical matter means deciding to go with compliant fuels. No one can say whether early adoption of LNG fuel or staying the course with oil is the better choice for today.

That said, there are indications that LNG is going to be very cheap for a very long time. One indicator is the overabundance of natural gas on the market. Sparked by the US shale oil revolution and furthered by energy development projects around the world, gas has broken its traditional lockstep relationship with the price of oil. Now, as the price of oil rises and production



increases to meet demand, associated gas is flooding the market and creating what is shaping up as long-term low-price stability for LNG as fuel.

Recognizing this, several oil majors have begun a serious push to develop the LNG-as-marine-fuel market. Shell, for example, already has three bunkering vessels in service and told the press earlier this year that it looks forward to more entering its fleet. With such support, and with a worldwide network of bunkering ports in place, fears that it won't be available in sufficient quantities to support a global LNG-fueled fleet can now be dismissed.

### 2023 AND ME

There are many alternatives for satisfying IMO's 2020 pollution-centric emissions requirements, but few that can also meet the GHG reduction targets set for 2030. Ammonia, batteries, biofuels, ethane, hydrogen and methanol are probably the most-discussed of the CO<sub>2</sub>-friendly alternatives to LNG. While most offer enticing possibilities, and a few have limited use cases today, none offer global access and all are marred by technical, logistical and/or developmental barriers that eliminate them from the 2030 discussion. Even if they become technologically practicable, they then have to become available worldwide. Considering how long it took LNG to become a globally available marine fuel, despite six decades of global distribution for power generation, the actual prospects for alternative fuels pre-2050 will present a significant challenge.

The lack of alternatives is one reason LNG is a potential path forward towards a carbon-minimal future. Another is that it offers an attractive basket of advantages over oil, principally significantly reduced emissions including 25 percent less CO<sub>2</sub>, 99 percent less sulfur and particulate emissions and no carcinogenic

soot. Together with other fuel efficiency measures and operational changes, LNG can help take industry through 2030 and towards more ambitious future goals - Forward Maritime, for example, says its business model proves that only a slight speed reduction will do the trick.

Reaching 2050 CO<sub>2</sub> targets is another matter, but as no existing technology alone can achieve those aims, the industry needs to be considering new innovations and different strategies that can serve as foundational steps as it prepares for 2050.

Clarity in this regard is not likely to descend fully until 2023, when IMO's GHG targets get their first reality check.

In developing the Energy Efficiency Design Index (EEDI), regulators' initial intent was to introduce a progressively stricter series of efficiency/CO<sub>2</sub> emissions requirements: Phase 0 in 2013 followed by Phase 1 in 2015, Phase 2 in 2020 and, finally, Phase 3 in 2025. Cynics were not surprised when 2025 quickly became 2022, and talk emerged of an as-yet unspecified Phase 4 for the future.

Phase 0 did not require reduction of fuel consumed but concentrated on the calculation and recording of verifiable fuel consumption data to ensure ships were able to attain results equal to or better than a reference figure for that particular ship type, the reference being drawn up by IMO. Generally, excluding the numerous exceptions and variations, under Phase 1 ships were required to achieve an EEDI value at least 10 percent better than the reference point; in Phase 2 that increased to 20 percent and in Phase 3 increased to 30 percent.





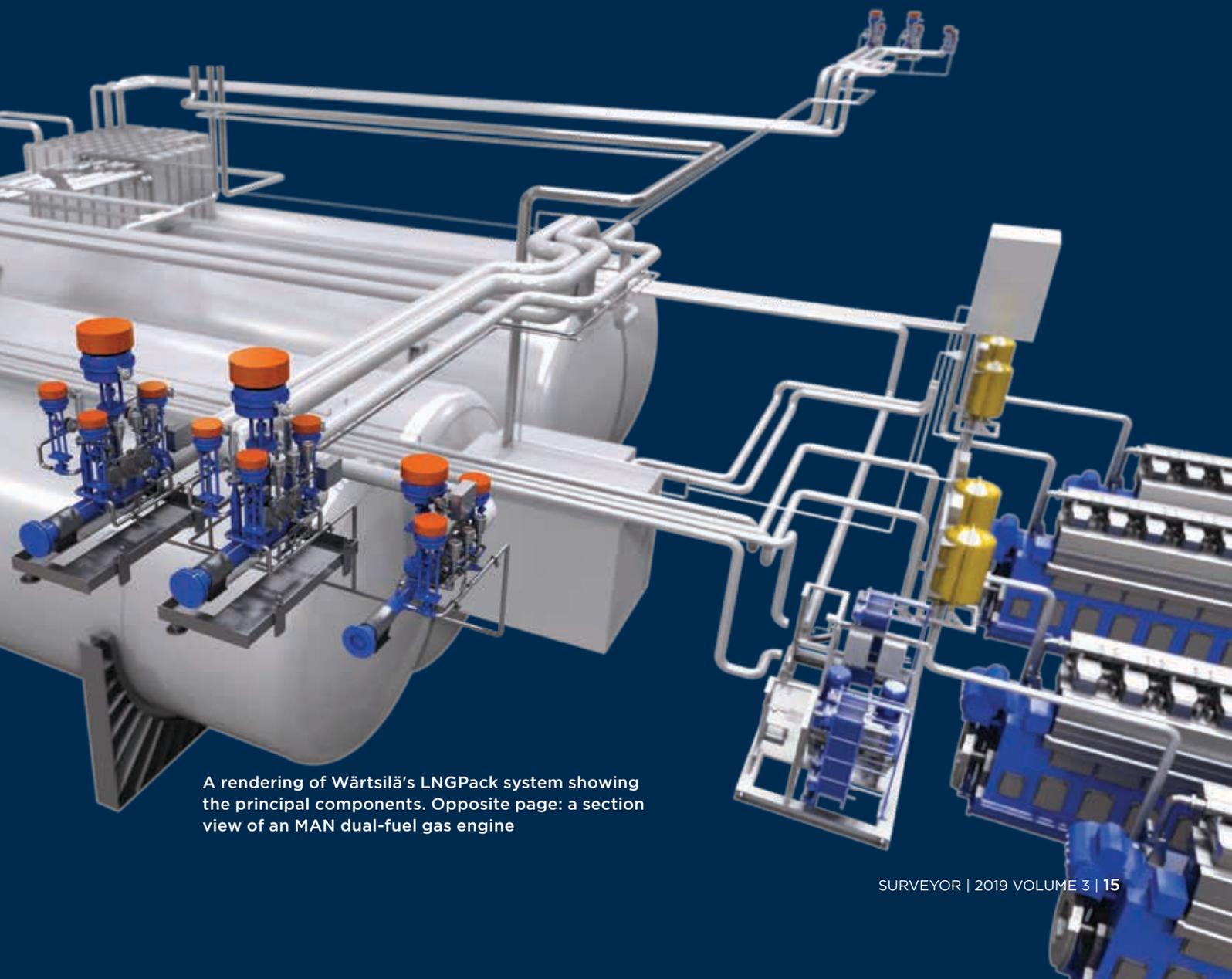
Then in 2019 IMO's Marine Environment Protection Committee (MEPC) approved for adoption in 2020, amendments to Marpol Annex VI that bring Phase 3 into effect in 2022 for certain ship types and agreed to look into the possibility of developing an even stricter Phase 4 requirement.

The 2023 GHG revision will be based on hard data collected from all ships over 5,000 gt, a program that became mandatory in January of this year. Under this mandate, ships of 5,000 gt and above must collect fuel consumption data for each type of fuel oil used. The aggregate data is passed to the flag State at the end of each calendar year and passed from the flag State to an IMO Ship Fuel Oil Consumption Database. IMO will then summarize the data in an annual report to the MEPC.

### **BUILDING THE FUTURE, SLOWLY**

So, when does the true future of LNG as a marine fuel begin? Has the LNG era already started? Will it begin with a sudden world fleet renovation following IMO's 2023 GHG strategy revision, or will it creep up slowly as LNG-fueled startups become economically viable? With so many unknowns in play at the moment, only the backwards glance of history will be able to assign the LNG era its official start date.

Today, LNG-as-fuel proponents have a lot to be optimistic about. At present, some 60 percent of the LNG-fueled vessels under construction (that are not LNG carriers) are above 10,000 dwt. This is a huge advance from the time when most were tiny cross-fjord ferries and other highly-incubated experiments.



A rendering of Wärtsilä's LNGPack system showing the principal components. Opposite page: a section view of an MAN dual-fuel gas engine

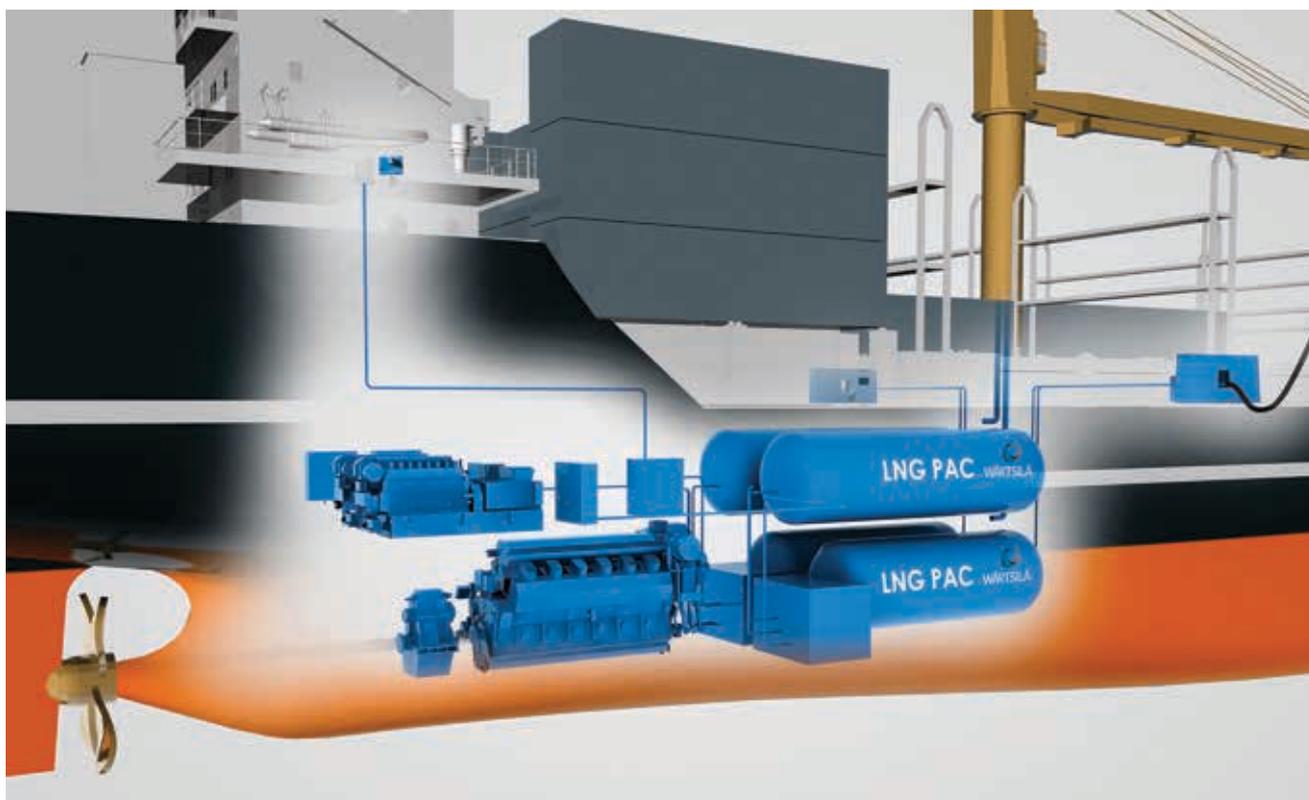
For example, last year saw the delivery of *Containerships Nord*, the first of four ABS-classed LNG-fueled 1,400 TEU feeder container carriers for *Containerships Oy*, and among the first such to regularly serve northern European container ports. The ships are part of a green vision under which *Containerships* is investing in a sea-land logistics chain based on LNG fuel, the target of which is to create an LNG-based door-to-door supply chain in Europe. This is being done with the support of parent company CMA CGM, which in 2017 became the first boxship owner to commit to building a series of LNG-fueled ULCVS. *Containerships* estimates that the LNG-fueled logistics supply chain will cut GHG emissions by up to 25 percent compared with traditional multimodal transportation and up to 60 percent compared with traditional land transportation.

Canadian operator BC Ferries has already put its LNG vision into practice. After converting its two largest ferries to LNG fuel and putting three smaller LNG-fueled newbuilds in service, the company expects to reduce fuel costs by millions of dollars annually while reducing CO<sub>2</sub> emissions by 21,500 tonnes and virtually eliminating pollutant emissions.

Meanwhile, on the large vessel end of the spectrum, last year Norwegian owner Siem began construction of a pair of ABS-classed LNG-fueled car carriers that will be chartered by the Volkswagen Group.

Admittedly, LNG as fuel is still tied to confined trades, such as the ferries, containerships, ro/ros and car carriers under virtual lifetime service between fixed endpoints, or the cruise ships soon to come online that will operate long-term under regional return-to-base scenarios. In that sense, it hasn't broken through a last important barrier to achieving truly global status, the dry bulk and tanker sectors.

Ultimately, while LNG may not take the industry to the end of the decarbonization journey, it can certainly take it through the critical early and middle parts of that voyage. And, while it may not be the perfect vehicle to carry to completion the carbon-free goals of the IMO, it is the cleanest-burning, lowest-carbon marine fuel that is accessible globally, available cheaply and supported by robust, mature technologies - which is good, because it is also the only taxi in town.





FROM THE FRONT LINES

# THE MISSING PIECE OF THE REVOLUTION

The dream of a clean-burning, carbon-minimal maritime industry can be achieved, but it is a shared dream that can only be realized through shared effort, says Antonis Trakakis, Chief Technical Officer of Forward Maritime. All stakeholders with this bold vision must not only rally around the green flag and sing songs of revolution, he says, but must also join hands to carry their share of the burden of creating disruptive change.

For him, that means generating social, political and economic action directed at bringing the new maritime industry into being. The first step, he says, is to unite together behind LNG as the global marine fuel of the near- and mid-term future.

Earlier this year, Trakakis made a compelling presentation to the Hellenic American Maritime Forum entitled 'LNG as a Fuel: Key Considerations,' in which he reviewed the pros and cons of the primary maritime fuel alternatives for satisfying IMO's 2020, 2030 and 2050 greenhouse gas (GHG) and pollution goals and concluded that only LNG stands ready today to lead the reforming of the industry's emissions profile.

Since bulk carriers and tankers collectively comprise the majority of ships at sea, those sectors must decarbonize if the industry is to meet its GHG obligations. The reason this hasn't begun to happen yet,



**Antonis Trakakis,**  
Chief Technical  
Officer, Forward  
Maritime

he says, has little to do with LNG or the technologies surrounding its use, and much to do with the nature of the shipping world itself and the complex, volatile and risk-filled elements that govern it.

Forward Maritime emerged as a voice for gas as a marine fuel and decarbonization of the global bulk fleet in 2018, when it unveiled a novel design for an 82,000 dwt LNG-fueled dry bulk carrier, the culmination of an intense three-year development project by an international coalition of experts including Forward's parent Arista Shipping, classification society ABS, ship designer Deltamarin, containment system builder GTT, energy major Royal Dutch Shell and engine maker Wärtsilä. Possibly the most striking feature of the design is that a near-empty engine room containing only two four-stroke Wärtsilä 31DF dual-fuel engines, a gearbox and two shaft generators – no diesel generators, boilers, incinerators, separators, after-treatment or any of the other equipment so necessary to modern oil-fueled operations. By eliminating all that machinery, and doing some very clever hull refinement, the designers were able to absorb the large fuel tanks needed for LNG operation with no loss of cargo space over a conventional ship of equal size. The project also included thorough business case analyses that, Trakakis says, prove conclusively the commercial viability of LNG fuel for all shipping activities, including tramp service.

"Model testing our ship design confirmed that, first of all, with LNG as fuel it easily meets IMO's EEDI phase III requirements, and further study

confirmed it can meet 2030 emissions targets with a very small drop in operating speed," he told the Hellenic American Maritime Forum. "To meet 2050 targets, speed would have to be reduced significantly, unless a blend of carbon-neutral (from capture, biogas, etc.) and fossil LNG is used. Vessel speed would depend on that mix, but if 55 percent carbon neutral methane is used there would be no need to reduce speed at all," he forecasted.

"We also analyzed the cost-effectiveness of what we suggest, calculating the vessel's running costs under different fuel scenarios using today's prices for the various fuel oils, LNG and carbon-neutral methane, and accounting for liquefaction and distribution costs. Adding a small greenhouse gas tax, which is likely to come, we arrive at a very surprising conclusion: the cost of running on 0.5 percent heavy fuel oil, which offers absolutely no greenhouse gas improvement, is the same as running on the fuel that meets the IMO 2050 targets," he explained.

"LNG is the only fuel that can meet all emissions targets and get the industry to 2030 and beyond," he says. "Its main commercial advantage is that it is an exceptionally abundant low-cost fuel and, now that the price of LNG is decoupling from the price of oil, will remain a low-cost fuel for many years to come. In addition, the existing bunkering stations and those due to come online in the near future serve very well as critical mass for the chain reaction to commence," he says.

Citing the six-decade history of LNG at sea, in which it has been used to





drive steam and gas turbines and two- and four-stroke internal combustion engines, he says the technologies of its use, transport and transfer are not only mature, but are also, as a practical matter, as well-established as those of fuel oil – the only alternate fuel that can make such a claim.

All together, its price, its green advantages – zero sulfur emissions, near-zero particulate emissions and greatly reduced CO<sub>2</sub> output compared with oil fuels (from 10 to about 30 percent, depending on the operations scenario) – and the global reach of its nascent network of bunkering ports tell Trakakis that the gas revolution is ready to ignite, to blow open the door to a future of truly clean and sustainable long-term operations.

Despite all this, growth of the LNG-fueled fleet is far slower than one would expect from a “gas revolution”. Of the LNG-fueled ships presently in service and on order, nearly all are confined to routes between fixed endpoints or return-to-base scenarios. There is virtually no penetration into tramp shipping, which represents the greater portion of global ship activity and, arguably, is the place where the success of environmental initiatives is determined.

## WANTED: DETERMINATION, COMMITMENT AND CONTRIBUTION

There are more than 500 LNG carriers of all sizes currently in service and, as of July this year, a further 148 on order – evidence, Trakakis says, of a growing global commitment to use of LNG as a fuel on land. At the same time, the world orderbook according to Clarksons reported orders for 158 gas-fueled non-LNG carriers and almost 2,000 oil-fueled vessels (602 tankers, 933 bulk carriers and 403 containerships). This disparity leads Trakakis to two conclusions: first, the high number of LNG carriers indicates that shipowners do recognize LNG as the next global fuel and are preparing for its increased distribution; and, second, the low number of gas-fueled ships indicates that the commitment to decarbonizing the maritime industry is not as broad-based and determined as it needs to be in order to achieve that challenging goal.

“Decarbonization, and all that comes with it, is not a commercial demand but a social demand,” he says. “As such, the burden of making it happen must be shared among all stakeholders. Two that come to mind are charterers and shipyards.”

It is an old argument, but one that never loses its bite: if the market doesn't support change, the change will





not happen. In this case, the door of change is hinged on freight rates.

Shipping markets are both cyclical and volatile. Bulk carriers and tankers experience the greatest fluctuation in earnings, typically cycling from a brief spike of record highs into a long descent with record lows. For example, market rates for a panamax bulker spiked to a peak of about \$80,000 a day 12 years ago, dropped to \$40,000 a day 10 years ago and sunk to around \$10,000 a day five years ago. According to the Baltic Briefing, over the past five years day rates for these ships have hit historic lows under \$7,000 but have generally hovered in the \$10-12,000 range, where they stood at the time this issue went to press.

Although LNG-fueled operation is efficient and competitive, it comes with a buy-in cost that, like the vessel building price, must be paid off over time. For the traditionally low-margin dry and wet bulk sectors, the bottom range of the rate cycle cannot provide the cover needed to incubate an LNG-fueled fleet, Trakakis says.

While industry can wait for rates to rise before initiating a transformation, regulations cannot. Therefore, he says, the forces pushing for decarbonization should bear some of the cost of making it happen. This could come in the form of

a 'green premium' on chartering contracts to bridge losses caused by incubating LNG-fueled operations through hard times – a fiscal variation, perhaps, on the 'ballast bonus' charterers typically pay to compensate ships that have to travel empty from the last port of discharge to the port where the charter commences.

Trakakis' point is that the cost of establishing a carbon-minimal world fleet should not be borne solely by shipowners, especially if by law it must be done out-of-sync with the market. The mechanism by which support for the green transition would be provided remains to be determined, but if social pressure can't make it happen, a mandated fee may be necessary for governments to ensure that their sustainable development goals are achieved, he says.

The suggestion is not without precedent. Mandated support for green technologies is becoming increasingly common in the western world, with many countries enacting 'climate action laws' that require from the people specific behaviors and expenses designed to create a cleaner future. One example of this is the surcharge applied to home electric bills in some European countries, which goes into a fund that acts as an economic incubator for providers of solar power – in Germany this year, the green power premium for households was about



6 cents/kWh, around 20 percent of the total rate. A maritime green premium would not take so big a bite, and would in fact be quite digestible, Trakakis says.

“A lot can happen without too much cost,” Trakakis says. “Our studies show that a rate increase of one US dollar per ton would make the model viable even today. That’s not too big a burden on society, considering the clear and noticeable cost and health benefits that come from eliminating all this pollution, while the cost benefits are applicable to the charterers as well as to society” he says.

## AN LNG-FUELED FUTURE IS ACCESSIBLE TO ALL

Shipyards are another stakeholder segment needing encouragement, Trakakis says. When Forward Maritime went looking for a yard to build its LNG-fueled bulker, the company discovered that, around the world, their request for bids met with a strange combination of interest and reluctance.

“Shipyards hesitate when it comes to technologies unknown to them; they don’t like the risks of a new business line because they tend to live at the edge of profitability and cannot afford major losses. A new ship design introducing major new technology onboard will cause big changes in the shipyard that affect its bottom line – the material flow and building course will change, their production times will change in ways they can’t anticipate and, on top of it all, they don’t know the end value of the ship that will be produced. So, to cover their unknowns and their risks, they add large margins of safety into all areas of the price that ultimately push the building cost out of the realm of possibility.”

One way society could help shipyards ease into the LNG revolution is by encouraging them to develop their own production designs, perhaps through international contests or the concentrated interest of shipowner associations; another would be to draw on a

green incubation fund, should one be created, to cover losses associated with putting the new technologies into practice.

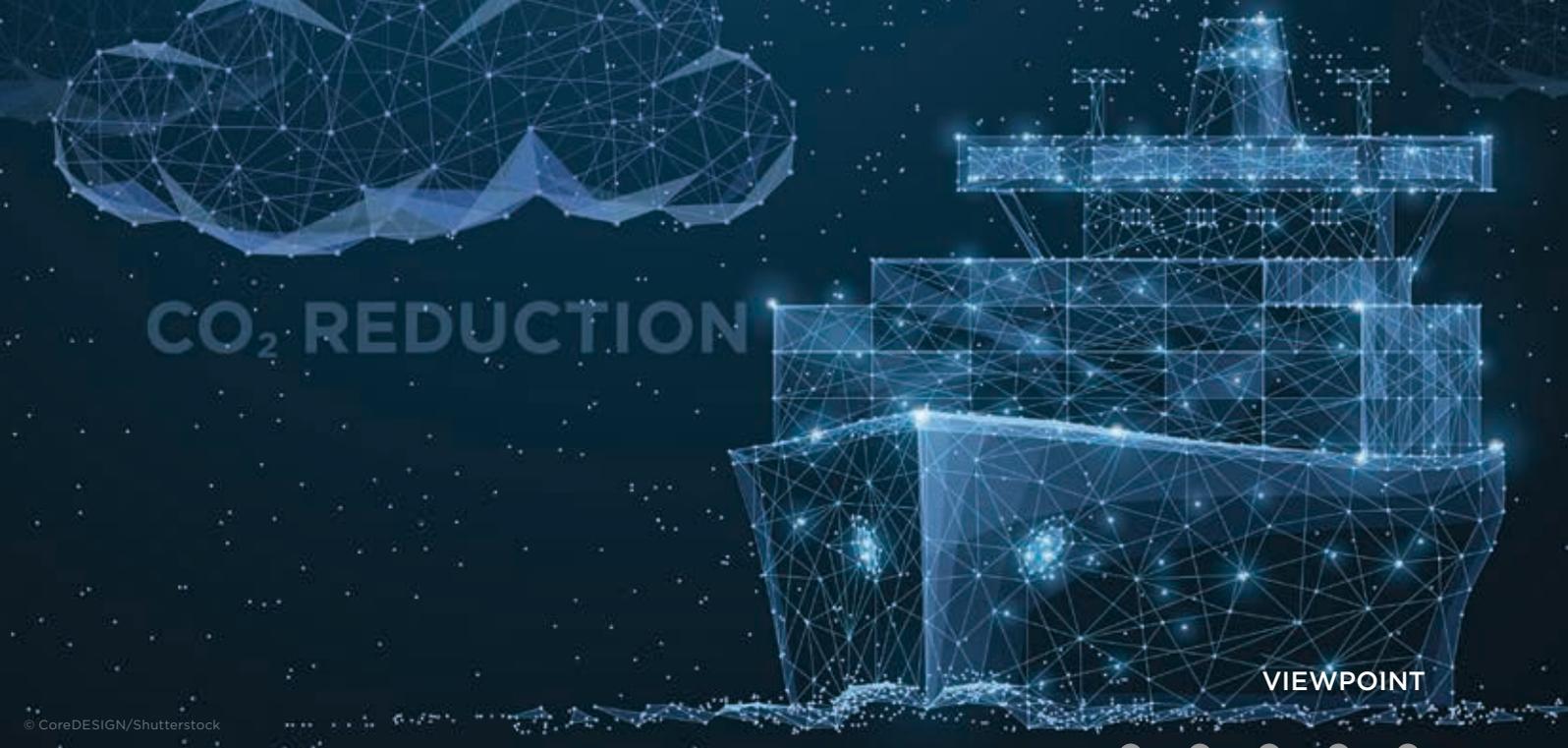
But new vessels alone will not change the emissions profile of the shipping world, he stresses. For the maritime fuel transition to work as intended, its solutions must be accessible to the existing fleet – which, he says, is one of the strongest reasons why LNG is the only choice for the new global marine fuel.

Converting a diesel engine to LNG operation is a straightforward and well-established process. Wärtsilä did the world’s first such conversion on a small cargo ship in 2012, turning a five-year-old L46 engine into a new 50DF for dual-fuel use. This year, MAN began the conversion of a mega-containership to LNG fuel, turning a five-year-old oil-burning 9S90ME-C engine into a dual-fuel ME-GI model.

The process isn’t cheap, but the benefits are immense. Operators of converted vessels have reported not only improvements in operational efficiency, but also noticeable cost savings due to the low price of the new fuel. Further, by eliminating the smoke, the sludge and all the waste associated with oil-fueled operation the ships themselves became cleaner and the crews happier. All things considered, and depending on freight rates, conversion to LNG operation could be a commercially viable move for the youngest bit of the existing fleet. That, of course, would be something for operators to determine. The important thing for Trakakis is that anybody can buy into the LNG-fuel club, and that that accessibility is what will make the revolution happen.

“All of us have responsibility in greenhouse gas reduction. Decarbonization is not a problem for shipowners alone to solve. If environmental problems are everybody’s problems, then everybody has to contribute to the solutions. Work with the shipowners, focus on solutions that are doable, practical and reliable,” he urges.

“All the boxes around LNG as a fuel have been checked. That’s what Project Forward has shown,” he adds. “There are no more technical showstoppers preventing LNG from becoming our new global marine fuel solution. Only social obstacles remain, and these we can overcome with determination, resolution and commitment.”



CO<sub>2</sub> REDUCTION

VIEWPOINT

# NAVIGATING A SEA OF UNKNOWNNS

In trying to build the world fleet of the future, owners today are faced with the unenviable task of planning a voyage through a sea of unknowns, beset by a fog of unanswerable questions and enticed into the mist by many beguiling possibilities.

New vessels must simultaneously reduce pollutants for 2020 and, looking towards 2030, also satisfy the carbon-connected demands of the International Maritime Organization's (IMO) sustainability goals. Slow-steaming has been successful in reducing CO<sub>2</sub> output of oil-fueled ships so far, but we are reaching the point where only incremental gains will be achieved by further slowing due to utilization needs. While there are a handful of operational approaches that could take us to 2030, no known technology today can, by itself, carry us through IMO's aspirational emissions targets for 2050.

Now, 2050 is obviously a long way off, and it will be another generation of leaders making practical decisions in that respect. But it would be a mistake to put the question in a box to be opened by the next generation. It must instead be on the radar today because, although current technologies cannot get us there, it falls to the present generation to make a commitment to develop and mature these solutions so that the next generation can implement them.

There are some very attractive alternatives that promise greatly reduced CO<sub>2</sub> emissions, but none have the present-day combination of mature technology, global accessibility and downwards-trending price that LNG does. That said, while natural gas can solve many current problems as a fuel for the global maritime industry, its promises come at a price. The key question confronting many owners today is whether the markets in which they are active will support the investment.

The reality of our industry is that charterers don't willingly pay extra to support fleet enhancements, but there is a precedent for self-generated change, as evidenced by the startling evolution forced on the tanker sector a generation ago by the oil majors' SIRE and TMSA programs. For now, whether the global fleet adopts LNG will fuel more broadly, will depend very much on market forces. And therein lies the dilemma facing the bulk trades, where margins are narrow and the commitment to LNG fuel represents a significant portion of vessel values.

Simply put, no one can say what the pricing of compliant fuels will be post-2020. If the gap between oil and gas fuel is small, oil will likely remain the status quo until carbon penalties change its market realities. If the gap is great, LNG will likely emerge as a clear winner in the near term. This great unknown has become a stalling point for many owners. As a result, a number have chosen a 'wait and see' approach to the future fuels issue - which, effectively, is a decision to go with compliant fuels. That is not a criticism, because, given the unknowns, 'wait-and-see' may turn out to have been the right course to take.

Further complicating the voyage is the question of what IMO will do in 2023, when it reexamines its greenhouse gas (GHG) policies. If history is any guide, we can make the informed guess that those policies are not likely to loosen. The possibility of increased pressure on carbon emissions does push the needle towards LNG, but it will only hold position if the price is right. And so, like a ship lost in the fog, we pass a familiar rock: will the market support the move?

Two things, at least, are emerging from the mist. The first is that owners should no longer dissipate their mental energies worrying about LNG accessibility. It is, quite literally, everywhere. And, now that gas



**Christopher J. Wiernicki,**  
Chairman,  
President and  
CEO, ABS

is decoupling from the price of oil, we see a new phenomenon occurring: as the price of oil rises, the price of natural gas falls.

Gas is relatively inexpensive because there's far too much of it, and more is coming. In part, this excess exists because gas production very often accompanies oil extraction. The abundance will not be made to disappear, and in fact LNG production capacity is predicted to increase by half again at least over the next five years. Recognizing this, several energy majors have begun a serious push to increase the global availability of LNG as fuel, which includes building bunkering vessels.

Altogether, LNG checks all the boxes required of an environmentally-friendly fuel for today, 2020 and 2030. Further, while present LNG fuel technologies would fail to meet IMO's 2050 goals, they might get us there if carbon-neutral methane (derived, for example, from capture or biogas processes) can be brought into the equation. Of all alternative fuels today, it offers the clearest path to a carbon-minimized future powered by simple, cost-effective solutions.

An LNG-fueled future would no doubt be most welcome by the many shipowners who, as ex-seafarers, would love to see their vessels free of soot and sludge, with shining machinery spaces and consequently contented crews. If only that familiar rock didn't keep emerging from the fog: will the market support the move?

All things considered, gas is likely to emerge as the marine fuel of the near-future, through either persuasion or enforcement, because, ultimately, although LNG is not as complete of an answer as many of us would wish it to be, at this stage of the game it's as good as it gets.

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