

COVER STORY

WÄRTSILÄ 31DF
FUTURE-PROOF SOLUTION
WITH WORLD-CLASS
EFFICIENCY

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ON THE PATH TO FUTURE FUELS

One year ago, we started aligning our technology strategy with the goals of the Paris agreement, the IMO targets and the radically dropping price of renewable energy generation. An important outcome of that alignment has been an update to our fuel strategy. We took future environmental targets as goals we could use to adapt both technologies and fuels. Our starting point, as we work towards this goal, was targets for the Marine Business. But very soon we noticed that they are also closely connected to energy. So, in mid-2019, we redefined the fuel strategy for the Energy Business as well. It is an indication that planning for the fuels of the future is at the forefront of Wärtsilä's thinking as we develop solutions to help our customers prepare for a world where 100% renewables are the norm.

There are three stages in the progression towards future fuels. Stage one is the present, up to 2030 or so. In this stage, we are (and will be) still using primarily fossil fuels. There are some renewables like biofuels and biogases penetrating the markets, but in small amounts. The next phase, from 2030-2050, will be the transition phase. In this phase, we will start to have more widespread use of biofuels with the addition of synthetic fuels like Power-to-Gas or Power-to-Liquid fuels. Then, in the third phase, 2050 and beyond, we will have made the transition to fully synthetic fuels, with some biofuels and very few fossil fuels left.

Successfully managing this transition requires planning and innovation. We are already developing the infrastructure for a fully synthetic future. The new Wärtsilä 31DF engine is a perfect example here. This multi-fuel engine offers flexibility and reliability to both marine and energy customers, allowing them to gradually transition to LNG as it becomes available.

I recently had the opportunity to meet with the vice president of new builds at one of the large cruise companies and discovered that the cruise industry has the same vision as Wärtsilä regarding the fuels of the future. Altogether, the world's major cruise companies currently have 20 vessels either ordered or under construction that will run on LNG. The cruise industry and LNG are a good fit because, as it turns out, their customers don't want smoke over their heads or particulates in the air as they sit on the sun deck. But cruise companies also see LNG only as the first step in the fuel transition. Fortunately, if you invest in LNG as a solution, it is very easy later to move to bio-LNG and synthetic LNG. And this is also just starting point. In the future we will see more solar panels and energy from wind onboard these ships. There is already a passenger ferry running between Stockholm and Turku that uses a rotor sail in combination with LNG. We can see that the technology of the future is here, we just need the fuels to catch up with it.

Mikael Wideskog
General Manager,
Technology Strategy & Innovation Process
Wärtsilä
Editor-in-Chief of *In Detail*



FROM SMART TO SMARTER

Wärtsilä Operim is developed with the help of
product engineers and data scientists.

REFERENCES



Engine+ Hybrid, reliability and efficiency combined

Wärtsilä's energy system
integration solution is helping
power producers to future-
proof their businesses.

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An LNG-fuelled world

Wärtsilä's LNG solutions are
playing a key role in meeting
the maritime industry's high
demand.

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Introducing Ultramax 2030

The Ultramax 2030 65K
DWT Bulk Carrier is one of the
smartest bulk carriers in the
market.

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Wärtsilä Modular Block challenges high-speed

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Medium-speed combustion engines have the highest efficiencies of all simple cycle solutions, can run on clean fuels, and their flexibility is unmatched. While they have many different applications – from big baseload plants to local power plants, to small combined heat and power plants – there are situations where these cannot be used. The new Wärtsilä Modular Block can change that.

4 **indetail**

Generally, two classes of reciprocating engines are used in the modern power industry: high-speed and medium-speed. The high-speed engines, typically 1500 or 1800 rpm (for 50 and 60 Hz systems respectively), have simpler designs. They are smaller, lighter, and also somewhat less expensive per unit of output. On the other hand, the medium-speed engines (most typically 750/720 rpm, although

there are designs with speeds like 1000 rpm or 500 rpm), are heavy-duty machines characterised by considerably better efficiencies, better dynamic performance, lower maintenance costs per unit of produced energy, and considerably longer service life. This comes at a higher investment cost and with a generally heavier and bulkier design.

Medium-speed engines are also larger



Fig. 1 - The heart of the Wärtsilä Modular Block is a Wärtsilä medium-speed engine. Three types of engines are available: Wärtsilä 34SG spark-ignited gas engine, Wärtsilä 34DF dual-fuel engine, and Wärtsilä 32 diesel engine. Each of those can come in one of three different cylinder configurations: 12V, 16V, and 20V, with outputs ranging from approximately 6 to 10 MW.

in terms of single-engine output as it is not feasible to build small engines of this class. Typically, the vast majority of commercially available engines below 5 MW of output are high-speed designs, while those above 5 MW are medium-speed units. All Wärtsilä engines currently offered for the energy market, for instance, are medium-speed designs. (Figure 1)

Because of all these factors, medium-speed engines are typically used in larger commercial and industrial power plants, while really small facilities, for which medium-speed technology is not available, have to rely on less efficient high-speed technology. There also are some applications where both technologies may be a good solution, and the choice there depends on a project's specific requirements. There are also, however, situations where a project could greatly benefit from medium-speed technology, but its deployment proves too complicated, forcing investors to satisfy

themselves with a less efficient option. This is because of the physical properties of medium-speed engines: they are relatively large and heavy.

So far, the main method of installing medium-speed engines involves building a solid power house around them: quite a simple structure compared with other power generation technologies but nonetheless requiring a considerable amount of engineering and time. In the case of commercial power generation projects, this typically does not matter, as construction time for an engine power plant is still much shorter than in case of other technologies. But there are applications where this need to build a solid power plant around the engines may prove prohibitive. Those can, for example, be facilities such as data centres or some industrial plants, where adopting a custom-designed power plant concept would require extending the construction time of the whole facility beyond acceptable

limits. There are also situations where power generation is only needed for a limited time, for example several years, and then assets need to be relocated.

Finally, there can be situations where for a variety of reasons it is desirable to minimise the amount and duration of on-site works, due to the cost of local labour, scarcity of qualified workers or security concerns. All these may lead to a preference for inferior high-speed engine technology only because it can come to sites in an easy-to-install, containerised form.

Going modular

Wärtsilä has been facilitating the installation of medium-speed engine power plants for many years. This has led to standardised general power plant designs, standardised auxiliary modules and equipment, and layouts. This enabled very competitive delivery times even for large power plants. However, the need to build a structure



Fig. 2 - A view inside a Wärtsilä Modular Block with a Wärtsilä 12V34SG gas engine. The engine-generator set is connected to auxiliary systems contained in the modules forming walls of the enclosure. Note the maintenance platforms and ladders, providing access to all components as needed for maintenance. The cooling radiators are installed on top of the Wärtsilä Modular Block, creating a fully closed engine cooling system, requiring no water supply.

around all this equipment, and the associated costs and time, still prove to be a challenge. The new Wärtsilä Modular Block is a way to overcome that barrier.

It is a fact that it is not possible to install a high-efficiency generating set inside any form of transportable one-piece enclosure – it is simply too big for that. In the Wärtsilä Modular Block, nearly all auxiliaries needed to operate a generating set are placed inside box-shaped modules already at the production facility. Modules are then transported to the site with the generating set and stacked around it, thus forming a modular enclosure.

The individual modules of the Wärtsilä Modular Block have a dual role: they are process modules containing process equipment, such as compressors, heat

exchangers, valves, fans, air filters, pipelines and cables, and elements of a weather-proof enclosure. Once on site, the modules are set and connected with simple bolted joints, with no welding required. The amount of on-site work is therefore considerably limited. It is only necessary to prepare a simple concrete foundation (the generating set's base frame is designed in such a way that it does not transfer any dynamic loads), with ducts for cabling, and embed in it a special positioning frame, which is a part of the Wärtsilä Modular Block delivery, and to which all other modules are later bolted. Then, the actual modules are delivered as containerised cargo. Three modular walls are set up using three 'module layers' each, and then covered with a prefabricated modular roof, also supplied in containers.

After this partial structure is completed, the generating set is slid into the created chamber and connected to auxiliary systems, and finally, the fourth wall is built, closing the module. Certain external systems still need to be attached, most noticeably a short exhaust duct with a stack and a fuel supply system (gas pipeline). The generator needs to be connected to an external medium voltage switchgear providing power off-take; this switchgear may be delivered as a prefabricated containerised unit. The Wärtsilä Modular Block can be used to build both a single-engine facility and a multi-engine power plant: further engines may be added with further extension blocks alongside the first one (as shown in Figure 3). In such a case, each new engine only gets three new



Fig. 3 - A data centre with nine Wärtsilä Modular Block Compact units, each with a Wärtsilä 12V34SG engine rated at 5.8 MW. Thanks to the impressive dynamic performance of the engine, and possibility of storing liquefied natural gas (note the tanks in the left), such a construction may be a clean and resilient power source for the facility, removing a need for any emergency diesel generators.

modular walls and shares the fourth one with the previous unit, which reduces the cost and footprint of a multi-engine plant.

A multi-engine plant may be built in stages, and further modules may be added when the previous ones are already in operation, as all the auxiliary systems needed for the operation of the engine are engine-specific. It is worth emphasising that while the Wärtsilä Modular Block is a completely new design, in process engineering terms it follows the same general designs as standard Wärtsilä modules used in other power plants – they simply are rearranged spatially to fit the limited space of the modules. This

means, that although the Wärtsilä Modular Block is a new product, it relies on years of experience with proven process designs. (Figure 2)

While the exact amount of time required will invariably change depending on site conditions, labour laws, the number of personnel (shifts) involved and other local constraints, the assembly of a complete Wärtsilä Modular Block, excluding the foundation construction, may be accomplished within around five weeks. It also does not require specialised equipment, with a relatively simple crane being all the heavy machinery that is needed.

Despite being very compact, the Wärtsilä Modular Block is designed to ensure easy maintenance of the engine. Personnel access is provided to all components that require human intervention at any stage of a plant's lifetime. As is standard in other Wärtsilä power plants, the engine and generator remain within the block during operation and are never removed from the site for maintenance – only engine components are replaced or transported to a local Wärtsilä service workshop for reconditioning, as prescribed by the engine maintenance manuals. Each engine cell is also provided with an overhead travelling crane with sufficient capacity to

Generating set type	50 Hz	60 Hz
12V32 12V34DF 12V34SG	5,838	5,587
16V32 16V34DF 16V34SG	7,832	7,496
20V32 20V34DF 20V34SG	9,800	9,389

■ Table 1 - Outputs of generating sets available for the Wärtsilä Modular Block.

lift all engine components that might require replacement during overhauls. Doors and laydown areas are provided, so it is not necessary to dismantle the enclosure for scheduled maintenance. Dismantling is, however, perfectly possible, in case the owner wants to relocate (or sell) the plant at some point in the future.

This makes the Wärtsilä Modular Block a good product for medium- and long-term rental. After dismantling all the components except for the concrete foundation, it may be transported to another site and reassembled. (Figure 3)

The engine

The Wärtsilä Modular Block is designed for engines of the Wärtsilä 32/34 family. There are three engine types available: Wärtsilä 34SG spark-ignited gas engine, Wärtsilä 34DF dual-fuel engine, and Wärtsilä 32 diesel engine. Each of them can come in one of three cylinder configurations: 12V, 16V and 20V. The 12V configuration uses the Wärtsilä Modular Block Compact, while the 16V and 20V are installed within the Wärtsilä Modular Block Extended, characterised by longer side walls.

Engines of the Wärtsilä 32/34 are currently the most popular medium-speed in the world. They are characterised by their very high efficiency, low environmental footprint and ultimate flexibility. Engines of this family can reach full power from standstill in less than one minute. This impressive performance applies to all engine types,

including gas-fired models. Thanks to this feature, a Wärtsilä Modular Block with a gas engine can be used as a clean alternative to emergency diesel generators for critical infrastructure such as data centres, hospitals or airports. In such a case, such a power source may be used not only as a back-up, but also for regular power supply alone, together with the grid (generating power whenever grid electricity prices go up) or in conjunction with local renewable resources (firming up wind or solar power generation), ensuring much more efficient utilisation of assets. (Table 1)

The options

While the Wärtsilä Modular Block is a highly standardised prefabricated product, it nevertheless can be customised to a considerable extent, to meet requirements of a specific project. Customisation options include:

- Selection of engine type (diesel, gas, dual-fuel) and fuel (pipeline natural gas, liquefied natural gas, biogas, ethane, LPG, light or heavy fuel oils)
- Selection of engine cylinder configuration and output, as well as the number of generating sets
- Adjustment of generator voltage in frequency to the local power system (same options as for standard Wärtsilä engines)
- Optional use of selective catalytic reduction (SCR) technology with an outdoor reactor to further reduce NO_x emissions

- Heat recovery from exhaust gas using an outdoor exhaust gas boiler
- Automated lubricating oil replenishment system
- Remote plant operation and monitoring through a secure gateway.

In its current form, the Wärtsilä Modular Block is designed for sites with ambient air temperatures from -25 to +40°C. The design follows relevant European (EN) standards for structures, and EU directives for pressure equipment and electrification. The modules are manufactured in the European Union.

Conclusion

With the Wärtsilä Modular Block, investors for whom a simple, standardised, and quick on-site installation process is critical get access to highly efficient medium-speed engine technology. This new innovative solution enables the construction of even bigger power plants with ease, with a minimal amount of project-specific engineering.

The Wärtsilä Modular Block ia an attractive option for various projects where high-speed engine technology with its inherent lower efficiency used to be the only possible solution.

It may also be a cost-effective alternative to standard power plants with medium-speed engines in those locations where site works are expensive and reduction of installation time can bring cost savings to an entire project. ●





Photo: 123RF

Heat and power for Energiewende, Germany's renewable energy transition

AUTHOR: Ben Hargreaves

Wärtsilä has recently been awarded contracts to develop hundreds of megawatts of combined heat and power (CHP) plants in Germany – all thanks to the flexibility, efficiency and environmental credentials of its technology.

There's no doubt the announcement about Wärtsilä delivering an eight-engine 92 MW combined heat and power (CHP) plant to DREWAG in the city of Dresden, the capital of Saxony, is an important step in Germany's transition to a renewable energy future.

The facility has been ordered by

DREWAG, Dresden's local utility company, and is a milestone for Wärtsilä. It's the first project in Germany to employ Wärtsilä 31SG engines, the company's most flexible and efficient engines to date. In fact, the extremely high efficiency and flexibility of the Wärtsilä 31SG engine were cited as key factors in the award of the Dresden contract. Another major consideration was the power plant's ability to deliver electricity and district heating simultaneously. The installation is set to be operational by 2021.

The Wärtsilä engines that will be used in Dresden can reach full output in a matter of minutes, enabling them to provide

immediate balancing of the grid as the system uses more and more energy from intermittent renewable sources, such as wind and solar.

Technologies such as these are integral to Germany's pioneering Energiewende (energy transition) – an ambitious change programme where the goal is a low-carbon, environmentally sound, reliable and affordable energy supply. Germany is targeting an 80-95% reduction in greenhouse gas emissions by 2050 relative to 1990 levels. It also wants to produce 60% of its energy from renewables by mid-century, and to phase out coal-fired power

generation by 2038 and nuclear power by 2023.

Germany: A 'showroom' for clean technology

Integrating increasing levels of renewable power onto the grid is not without its challenges. While energy from solar and wind is intermittent, the energy system requires a constant flow of uninterrupted power.

That's where the flexibility, responsivity and reliability of Wärtsilä's Smart Power Generation technologies for generating electricity and heat can play a key role. "Germany is a showroom for a new renewable energy-based system and supporting technologies," explains Pekka Tolonen, Energy Business Director, Europe. "It's a great place to demonstrate what our products can do."

Although the Energiewende will take time to deliver its vision of a 100% renewable energy system, renewable energy is already delivering baseload power. Technologies that Wärtsilä has developed such as engines and energy storage are providing the means of balancing electricity supply with demand as an ever-greater level of renewable power comes online.

In Germany, municipalities are incentivised by the government to build and maintain CHP plants. In 2016, Wärtsilä announced a deal to supply a 100 MW CHP plant to Kraftwerke Mainz-Wiesbaden (KMW) consisting of 10 Wärtsilä 34SG engines running on natural gas. In addition, a 10 MW CHP plant featuring one Wärtsilä 34SG engine running on natural gas has been delivered to Thüringer Energie. And there will be more: Germany has committed to increasing the share of electricity generated by CHP power plants to 25% of total electricity production by 2025.

Quick-start, flexible and clean technologies

Wärtsilä's technologies are attractive for a number of reasons: not only are they flexible, reliable and sustainable, they also start up very quickly and can be used in the electricity balancing markets. With a response time of even less than two minutes, they flex according to demand. Plus, CHP combined with heat storage technologies also means heat can be stored and released according to the demand for hot water.

The German deals are significant achievements for Wärtsilä, and a testament to the company's ability to understand customer needs and support an asset through its entire lifecycle. With Wärtsilä as partner, performance of customer installations can be also optimised through upgrades, modernisations, fuel conversions and safety solutions. At the end of the day, it was these capabilities that helped win the DREWAG deal, with the customer investing in a first-of-its-kind Wärtsilä 31SG CHP plant.

Added to that, the development of the 100 MW KMW project means Wärtsilä has made a statement of intent in the industry: "The efficiency and start-up times of our Wärtsilä 34SG and Wärtsilä 31SG engines make them very attractive to the customer," says Tolonen.

Wärtsilä 31: Setting world records

The Dresden plant relies on eight new Wärtsilä 31SG engines, which are even more powerful and efficient than their 34SG counterparts. In fact, the Wärtsilä 31 ranks in the Guinness Book of Records as the world's most efficient 4-stroke diesel engine. Hence, the 31SG represents a natural evolution, taking this efficiency to the next level. "This represents our most advanced engine, and delivers an output in the range of 12 MW," explains Tolonen.

The efficiency of the Wärtsilä 31SG engine helps reduce the cost of fuel. Wärtsilä guarantees operational reliability and efficiency of the engine, backed up with expert advice on optimising power plant operation and maintenance. Guidance on equipment performance and operations monitoring ensures a high performance level and maximised uptime for the plant.

Plus, the use of flexible power from Wärtsilä enables an increase in the level of renewable energy on the German grid as part of Energiewende. "The grid relies on a stable flow of energy," explains Tolonen. "When there's a limited amount of renewable energy online, that's not a problem. But greater levels of renewables mean fluctuations in supply. That's why Germany also needs highly flexible and dispatchable power generation that can respond in minutes and provide the energy that's needed."

The combination of flexibility and CHP opens up a new operational regime for these plants. Contrary to traditional CHP plants that mainly run in baseload mode when heat is most required, these plants will only run when the electricity market price is high, i.e., when there is fluctuation or lack of renewable power.

By decoupling electricity generation from heat generation with heat storage, the generated heat that is not directly consumed can be time-shifted for later use. This new operating mode will allow more renewable energy to penetrate the power system while still delivering heat to consumers.

Other advantages of Wärtsilä's technology include the fact that its engines are built in modules and can be readily scaled up to meet the needs of customers, such as at the KMW plant. There, Wärtsilä also has a 15-year Guaranteed Asset Performance agreement. For Dresden's local utility DREWAG, Wärtsilä will maintain the new 92 MW CHP plant under a Guaranteed Asset Performance agreement for 10 years, with the option to extend for a further five.

A bright future in renewables

CHP isn't the only technology that Wärtsilä is developing to help Germany move towards a 100% renewable energy economy: it's also working on energy storage systems and hybrids combined with energy management systems. In fact, Wärtsilä's energy management system software, GEMS, is among the most advanced in the world, using artificial intelligence and big data to control and balance multiple energy assets, including energy storage, renewables, and engine power plants.

CHP looks set to play a critical role in the future, even though greater levels of renewable energy are always coming online. Ultimately, Tolonen envisages a future where synthetic liquid and gaseous fuels generated through 'Power-to-X' technology are used to power CHP plants, developing a zero emission future power system.

But whatever the future holds, there's no doubt that as Germany makes the transition to a carbon-neutral energy system, Wärtsilä will continue to play a key role in the CHP market. ●



Introducing Wärtsilä 31DF – the most efficient multi-fuel engine for flexible and reliable power generation

AUTHOR: Isabelle Kliger

In the highly competitive electricity generation market, flexibility and efficiency are two of the key competitive advantages for power companies. As these companies seek to set themselves apart from the competition, Wärtsilä has responded by launching the most efficient multi-fuel engine for flexible and reliable power generation – Wärtsilä 31DF.

When power generation is distributed across a variety of different energy sources, the stability and resilience of the energy system increases. Distributed flexible power generation and the use of a multi-fuel solution to increase system-level resilience creates energy security in the event of issues caused by natural disasters or problems in the fuel logistics chain, politics or prices.

“A power plant that runs on multi-fuel engines is quicker to start up and has the flexibility to run on multiple fuel types, thereby securing access to energy regardless of what happens in the world,” says Jani Mäkinen, Product Manager, W3X Gensets. “Importantly, operators using Wärtsilä’s highly efficient engines also stand to benefit from reduced fuel costs and improved environmental performance.”

Already used in a number of applications in the shipping industry, Wärtsilä has now launched to the energy market the Wärtsilä 31DF, a multi-fuel engine version of the Wärtsilä 31 engine family in its 20-cylinder version providing an 11 MW output per unit. It is ideally suited for customers looking to gradually transition to gas-powered operations, especially in geographic locations where pipeline gas or LNG deliveries are not yet available or sufficiently secure to justify an out-and-out switch, meaning that provision for liquid fuel operation is omitted and the plant is fully optimised for gas-only operation.

“In this day and age, fuel security is a top priority and, in many places, the cost and availability of gas can still vary quite a bit,” continues Mäkinen, explaining that the Wärtsilä 31DF engine has been specially developed for customers who want to start operating on gaseous fuels or who intend

to do so in the near future, but are not yet ready to commit to it exclusively.

“When using flexible multi-fuel engines, you can rest assured you will never be forced to switch off the lights, even if something unforeseen were to occur in the fuel supply chain – Wärtsilä 31DF is capable of instantly switching fuels to a back-up liquid fuel without any disturbance in the electrical output,” he adds.

Huge potential for island nations and isolated power systems

The flexibility offered by multi-fuel engines makes the Wärtsilä 31DF engine ideal for use in isolated power systems, typically power plants that operate independently of the countrywide electricity network, such as islands in remote locations and major off-grid power consumers such as mines.

“We foresee huge potential for the Wärtsilä 31DF in island nations such as Indonesia, the Philippines, and Caribbean islands, where power systems are typically isolated and separate from large national grids,” says Mäkinen.

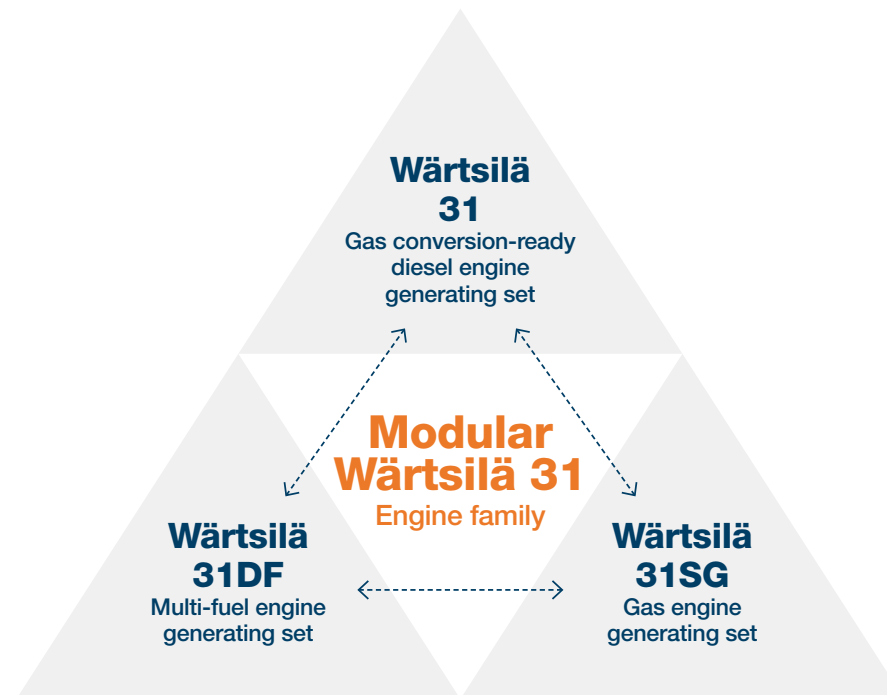
The Wärtsilä 31DF engine has a wide load range with high part-load efficiency. Its two-stage turbocharging enables more energy to be recovered from the exhaust gases, resulting in significantly enhanced engine efficiency.

In addition, customers who choose the Wärtsilä 31DF engine also stand to benefit from outstanding operational flexibility, as it takes only two minutes to go from start command to full load. It is also able to switch over from liquid fuel to gas and vice versa seamlessly during engine operation.

Third member of the Wärtsilä 31 engine genset family

The latest addition is the third piece of the Wärtsilä 31 engine generating set puzzle, which comprises the original Wärtsilä 31, a gas-conversion-ready diesel engine generating set, and the Wärtsilä 31SG, a spark-ignited pure gas engine generating set, launched to the energy market in 2017.

One of the most state-of-the-art features of the Wärtsilä 31 engine family is its



modular design, which makes it 100% future proof. Each of the three engine types can easily be converted to support one fuel type or another, preparing customers to adapt to all possible eventualities, regardless of the type of fuel that is available to the customer now or in the future.

Mäkinen explains: “Say a customer buys a Wärtsilä 31 today because they operate in a region where gas is not available, but they still want to start producing electricity using only liquid fuel. Two years from now, they may have access to some gas but, due to uncertainties in supply and price, they cannot rely on it fully, so they may decide to convert the engine to a Wärtsilä 31DF. A couple more years down the line, when they are ready to operate fully on LNG, they can convert the engine to an LNG-powered Wärtsilä 31SG.”

What’s more, there is no difference in performance between a product that has been converted and one that was built for purpose from the outset.

“There is no compromise whatsoever if you invest in one product with a view to converting it,” continues Mäkinen. “The beauty of the modular design is that it’s easy to remove a module and replace it with another with no compromise on power output or efficiency. This is why modularity has been such a central feature of this product family since day one.”

Wärtsilä’s modular power plant design also helps minimise downtime and lost output. Units can be converted one after another while the plant continues operating at full capacity throughout the conversion time.

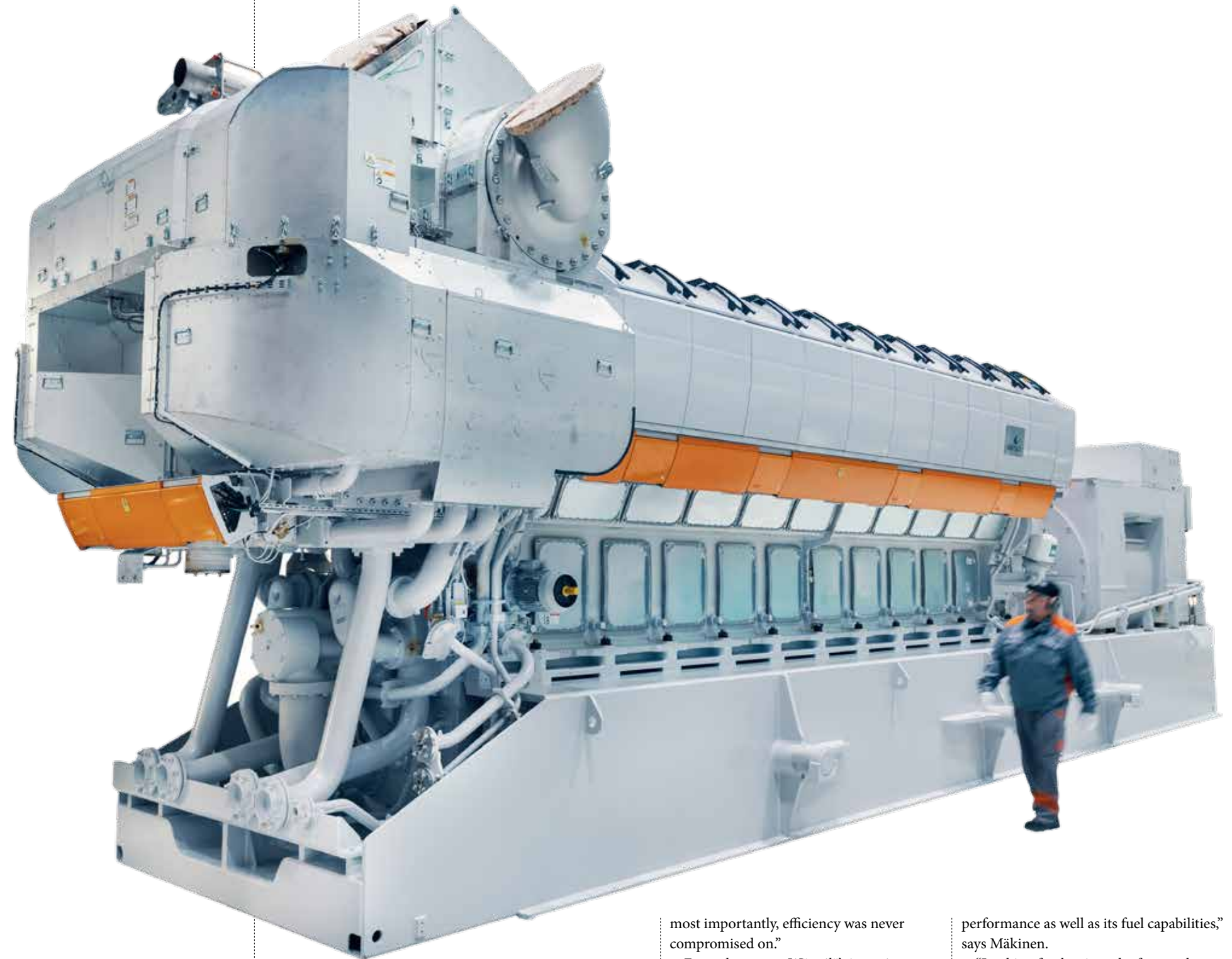
Dual-fuel power plant market leader with total offering

Over the years, Wärtsilä has established itself as a global frontrunner in dual-fuel power plant technology. Its capacity is unrivalled, offering everything from engine deliveries and installation to full Engineering, Procurement and Construction (EPC) setup and lifecycle services. In the last three decades, the company has delivered equipment and know-how to 205 dual-fuel power plants across 47 different countries around the world.

Customers also stand to benefit from Wärtsilä’s complete lifecycle approach for optimising the efficiency and performance of a power plant. All of Wärtsilä’s lifecycle solutions can be customised to suit the power plant’s operating profile and respond to the needs of the power plant owner and operator in the most efficient way possible. The solutions provide guaranteed operational reliability and efficiency, and performance guarantees are agreed upon on measured data.

The result of many years of R&D work

Developed from scratch in-house, the Wärtsilä 31 engine generating set family is the accumulation of all the experience and expertise Wärtsilä has built up over the years. It contains state-of-the-art features developed over the course of more



than a decade of dedicated research and development work.

“Throughout the development of this groundbreaking product, we remained firmly focused on the future and the expectations our customers will have in the years to come,” Mäkinen says. “Perhaps

most importantly, efficiency was never compromised on.”

From the outset, Wärtsilä’s intention was always to develop a family of products that would offer unparalleled efficiency and that could gradually be optimised for a multitude of fuel capabilities.

Future-proof product

“From now on, Wärtsilä will continue to develop the Wärtsilä 31 range into the future. In the years to come, we will further enhance its efficiency, output and dynamic

performance as well as its fuel capabilities,” says Mäkinen.

“Looking further into the future, there is every reason to believe that we will adapt this engine family for an even wider range of fuel options, including synthetic fuels and a variety of renewable power generation alternatives. This is why we call it a truly future-proof product,” he concludes.

The Wärtsilä 31DF engine was launched at POWERGEN Asia in September 2019 and deliveries are set to begin in 2020. ●



Photo: 123RF

Renewable energy gathers pace in the U.S.

AUTHOR: Lara McCoy

Even as the current administration in the United States works to shore up the American coal industry, renewable energy continues to increase its share in the U.S. electricity market. The falling cost of the technology, combined with strong economic growth, is encouraging individual consumers, utilities and corporations alike to increasingly turn to solar and wind sources for their energy needs.

The percentage of renewables in U.S. electricity production has grown steadily over the past 10 years, data from the Energy Information Agency shows. In 2008, 9% of the total U.S. electricity generation came from renewable sources; by 2017, that number had doubled.

This growth has been driven by a combination of strong economic growth and federal government support. Production Tax Credits, in place since 1992, have

encouraged electricity producers to increase their amount of energy generated from renewable sources. Although the tax credits are expected to expire at the end of 2019, the benefit applies to a plant's first 10 years of production, so companies still have a significant incentive to invest in renewable technologies.

"The costs of renewable energy systems make them attractive and often the outright winner on price alone now, let

alone their environmental benefits," says Daniel Kammen, a professor in the energy and resources group at the University of California, Berkeley.

Kammen adds, however: "energy markets are easily manipulated," and notes some tactics that could discourage utilities from investing in renewables. "These include weakening interconnection or carbon credit rules, and inhibiting state-level public utility commissions from seeing the full benefits of renewable energy," Kammen says.

With federal policies in question, the drive for expanding renewable energy production has shifted to the states.

By the end of 2018, 29 states and the District of Columbia had enacted renewable portfolio standards, which require electricity suppliers to provide a set percentage of their electricity from renewable sources.

According to a survey from Berkeley Lab, these standards will be responsible for around one-third of U.S. renewable energy growth in the future. Promotion of renewables at the state level continues to be pushed by more liberal-leaning jurisdictions, primarily California, New Jersey and Washington, D.C. In January, Washington increased its renewable portfolio target to 100% by 2030; California and Hawaii both plan to be carbon-neutral by 2045.

Renewable energy expansion is also taking place in more conservative states. For instance, one-fifth of the energy consumed in Nebraska comes from renewable sources, and renewable sources account for one-third of the energy consumed in Montana, which has the U.S.'s largest recoverable coal reserves.

Not just government policies

Apart from government regulation, the share of renewables in the U.S. electricity market is growing because it makes economic sense. Matti Rautkivi, Business Development Director at Wärtsilä Energy Business, says the government subsidies helped jump-start the industry by creating the conditions for a competitive environment, but today companies do not need to rely on these policies. "We see utilities adding more and more renewables in their generation mixes. Not because of politics or regulation, but because it makes financial sense," says Rautkivi.

Technology also has allowed individual consumers and small businesses to create their own renewable electricity systems using photovoltaic cells for some of their electricity. Although this market is still very small, the percentage of individuals using small-scale solar photovoltaic systems is expected to increase by 44% over the next two years, according to the Energy Information Agency.

"There are still some regulatory barriers that slow down this development, but when those are removed we start to see more and more household, commercial and industrial level installations. For these decentralised systems, it is not only the cost of energy that is driving this but also the avoided transmission fees and taxes," Rautkivi says.

Kammen also sees potential for growth in small-scale storage options.

"Energy storage is a fast-growing, dynamic sector that can turn renewables into baseload renewables," Kammen says. "This is particularly exciting because currently energy storage is coming down the cost curve as fast as solar ever has."

Even though the sector looks strong, some experts worry about the future expansion of the industry. In 2018, for the first time in five years, renewables did not make up the majority of added electricity capacity, according to a report by the Energy Information Agency. Nevertheless, Kammen says clean energy will continue to make strides because the economic benefits are clear. ●



Photo: 123RF

The Philippines' outreach for renewable energy

AUTHOR: David J. Cord

The Philippines is making a major push to develop renewable energy. While the country has natural advantages for the development of renewables in addition to pro-renewables governmental policies, Wärtsilä's flexible energy solutions are the missing link to enable the fulfilment of this ambitious plan.

The Philippines is facing a significant energy challenge. The demand for energy is increasing drastically, but the country has some of the highest energy prices in Southeast Asia. This disparity stems from the way the Philippines produces energy. In 2017, coal and oil accounted for 27% and 34%, respectively, of its primary energy.

Moreover, much of this was imported: only 51% of the country's energy mix was from domestic sources.

Yet the Philippines has an ambitious plan to sustainably increase and improve its energy supply. The Department of Energy's power development plan aims to increase energy capacity while simultaneously

making it more economical, flexible and less polluting.

"Investing in renewable energy to power the future is one of the flagship programmes of the government," explains Mylene C. Capongcol, Director of the Renewable Energy Management Bureau at the Department of Energy in the Philippines.

"The rapid deployment of renewable energy has been driven by a wide range of objectives, which include advancing economic development, improving energy security, enhancing energy access, catalysing rural development and job creation, and mitigating climate change. Altogether, these drivers can be described as the pursuit of sustainable development."

To meet its renewable energy goals, the government is recommending more investment in renewable energy

technologies and providing incentives for developers.

Use your advantages

The Philippines has some natural advantages for the development of renewables. Like Iceland, the Philippines is in a geologically active part of the world and the country has developed geothermal energy since the late 1970s. The country's rivers and mountains are perfect for hydropower, and the country is also a feasible place for solar and wind generation. Most importantly, there is a strong focus on renewables from decision-makers.

"The Philippines' Renewable Energy Act was deemed the first in Southeast Asia to provide comprehensive legislation on renewable energy," Capongcol says. "The primary goal is to achieve energy self-reliance through the accelerated exploration and development of renewable energy sources."

The Philippines offers fiscal and non-fiscal incentives to promote renewables, such as feed-in tariffs during early days and net metering, most recently a mandatory requirement for producers to carry a minimum share of renewables and the option for customers to purchase renewable energy.

Cheap solar, expensive coal

The results are impressive: as of March 2018, the DOE had awarded 880 renewable energy contracts with another 192 applications pending. The long-term plans are even more impressive, with a tripling of renewable energy capacity to 15,304 MW in 2030. Renewables would make up at least 35% of supply if this goal is reached. So, the

Philippines is clearly on the path towards a 100% renewable future.

Market forces are also helping to promote renewables. The cost of electricity generated from solar and wind has plunged in recent years. Additionally, the Philippines has added a hefty tax on imported coal, making renewables the cheapest source of electricity already today.

"New baseload coal or combined-cycle power plants are not any more feasible with current electricity market prices," says Ville Rimali, Business Development Manager with Wärtsilä Philippines. "Already solar is the cheapest in many cases. Wholesale prices have gone down and the price trend remains downward, which challenges baseload generation."

Adaptability is the key

Yet issues remain. One is the mismatch between demand and how renewable energy is supplied. The Philippines' sophisticated modelling can predict demand for energy quite accurately, yet forecasting the energy generated by wind and solar is difficult. Moreover, wind blows when it blows, not when energy is needed. This requires much more flexibility built into the system.

"Wärtsilä can help provide balancing power solutions, which give more flexibility in the power system," Rimali explains. "In this new era of power generation, you need flexible power plants which can start up in minutes. We will also see more energy storage capacity already this year. Luckily the Department of Energy and private players in the energy sector know that the world is changing and they have renewed their power development plans to reflect this new reality." ●



Engines and battery energy storage are fully integrated into one power plant solution, the Engine+ Hybrid.

“These can lead to greater renewable penetration in the system because engines and energy storage are the most flexible generation assets that exist. When you add more renewables in power systems, variability increases. Engines and storage are needed to bring in more flexibility and enable this transition,” he adds.

Energy & intelligence

Software plays a critical role in the Engine+ Hybrid system. GEMS leverages machine learning and sophisticated forecasting to predict operational conditions and optimally dispatch and control the resource mix while ensuring stability and reliability. It helps save engine running hours and maintenance costs and ensures optimal operations.

Here is how GEMS helps improve the efficiency of engine power plants by hybridising them:

Assume that a power plant with a load of 40 MW has five engines of 10 MW each. To ensure continuity in power supply in the event that one engine trips, the operator typically has to run all five engines at 8 MW output (80% load) rather than run four of them at full capacity. In this case, the fifth engine accumulates unnecessary running hours, resulting in higher maintenance costs. It also results in lower operational efficiency because the engines are running at less than full capacity.

In contrast, the Engine+ Hybrid model allows the operator to service the 40 MW load with just four engines running at full capacity and batteries for spinning reserve replacement.

Speed is of the essence in the Engine+ Hybrid solution. In the event an engine is tripped, the battery provides the power generation lost while the stand-by engine is automatically started by GEMS. Once

Future-proofing power investments

AUTHOR: Payal Bhattar

In a world driven by hyper-connectivity, power companies need to keep pace with rising energy demand while being environmentally friendly. Wärtsilä's energy system integration solution 'Engine+ Hybrid' is an affordable, efficient, speedy, and reliable way to move towards a 100% renewable energy future using both old and new generation units.

20 **in detail**

In August 2018, Hungary's Sinergy Kft, a subsidiary of ALTEO group, began participating in the country's electricity market by providing frequency and secondary regulation to the national grid. The unit already had three Wärtsilä 34SG engines running on natural gas and was additionally powered by a Wärtsilä 6MW/4MWh Battery Energy Storage System (BESS).

The unit was Hungary's first energy storage installation, and it helped ALTEO increase its revenues and participate in the electricity trading market. It was also Wärtsilä's first integrated Engine+ Hybrid installation with Greensmith Energy's Management System (GEMS) (Greensmith Energy is a Wärtsilä technology). Alejandro Schnakofsky, Director of

Product Management, Energy Storage and Optimisation, Wärtsilä Energy Business, describes the system, which pairs a battery with a production unit to maximise efficiency and minimise fuel consumption, as similar to a hybrid car. He notes that technology plays an important part in the unit.

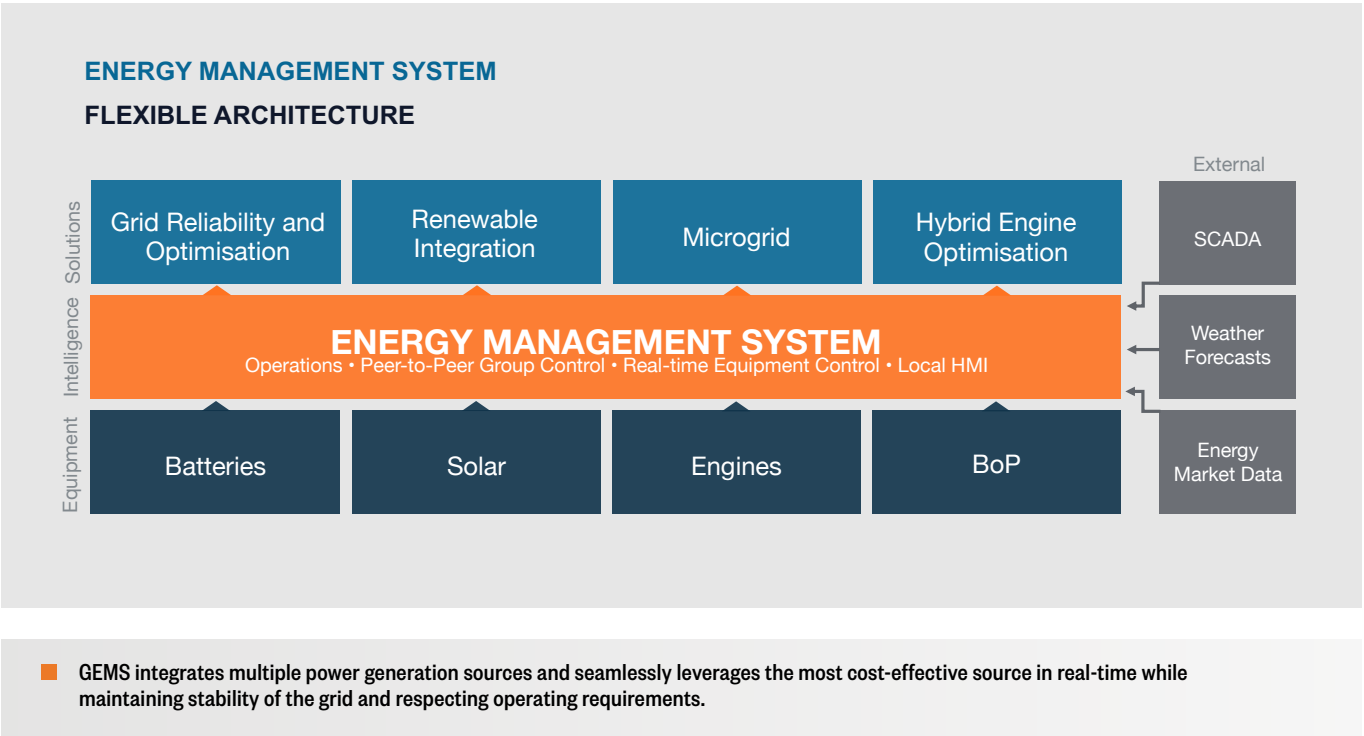
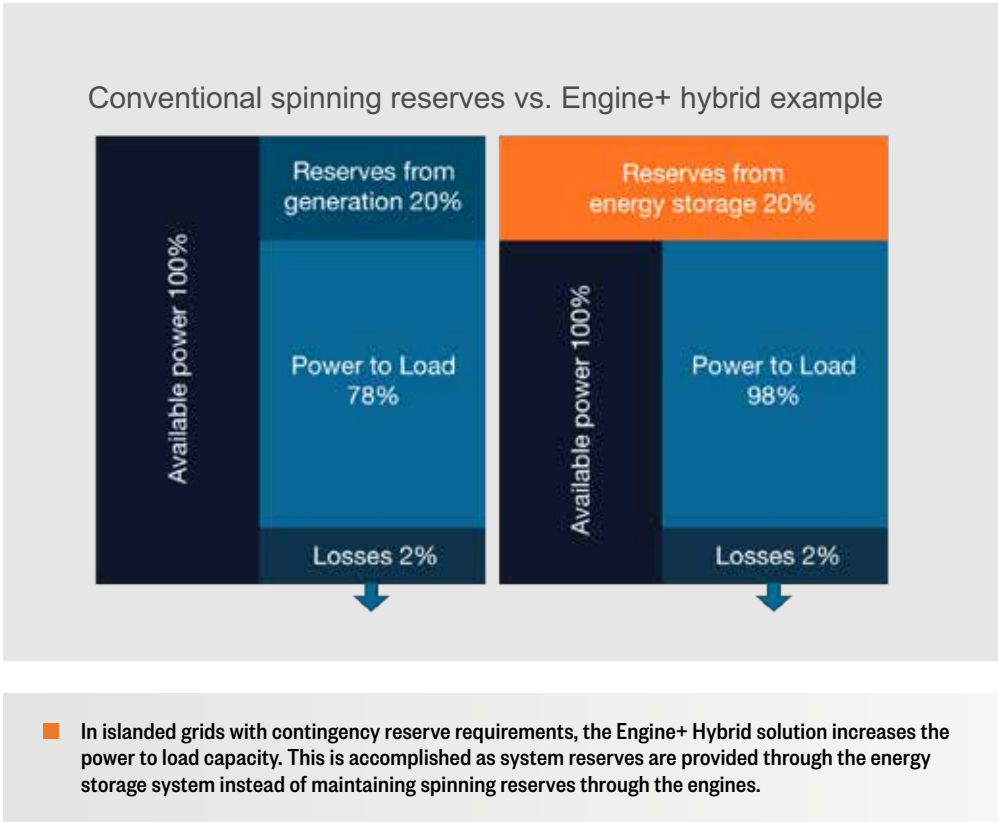
“Apart from hardware components, software plays a pivotal role in enabling this solution. GEMS leverages artificial intelligence – AI – forecasting and system condition learning to orchestrate energy resources in the power plant on a real-time basis,” he says.

Cutting curtail

The Engine+ Hybrid solution replaces the traditional system of relying on

spinning reserves to cover sudden changes in generation or load that produce inefficiency. The innovative GEMS platform enables producers to configure or reconfigure power plants with an optimal resource mix and help them achieve a wide range of goals, including increasing reliability, optimising operating costs and reducing environmental impact.

“Engine+ Hybrid explores the capabilities and possibilities of energy storage. It is just one application, but it is like a jack-of-all-trades that does many things at one time. Through this solution, we have touched upon several things, like spinning reserves, frequency regulation and voltage control,” says Risto Paldanius, Business Development, Energy Storage and Optimisation, Wärtsilä Energy Business.



the engine is up to speed and synced to the grid, GEMS automatically phases out the battery and slots the engine in, resulting in a full recovery of the system and avoiding a blackout.

“It is only through the orchestration offered by GEMS that this complex operation is possible. It controls the entire system from batteries and engines to renewable generation,” Schnakofsky explains.

Enabling 100% renewables

Schnakofsky says systems like these are critical to integrating a higher percentage of renewables in power generation.

“A world with 100% renewables is only possible with flexible and firm generation,” he says. “Flexible engine power plants that can provide power in minutes will be pivotal to enable high levels of renewable energy penetration. This means engine power plants that can start and stop fast while maintaining a high operational efficiency will be in high demand to materialise a more sustainable energy system.”

One example of how such a system has

improved efficiency can be found on the small Caribbean island of Bonaire. Local energy provider ContourGlobal Bonaire has a 25 MW power plant that generates energy using both engines (15 MW) and wind (11 MW). Until last year, this plant was generating between 12-15 MW, with loads peaking at around 18 MW during the summer. ContourGlobal was reported to be “curtailing wind because its engines were needed to provide additional spinning reserve for wind and also for sudden increases of electricity demand.”

Late last year, Wärtsilä began integrating a 6 MW energy storage system in this plant. Its Engine+ Hybrid solution included batteries and intelligent inverters along with access to GEMS for primary and secondary grid controls while integrating multiple power generation assets including existing wind, solar and storage capacities. By June 2019, the first phase of integration was complete, and the island no longer had to curtail wind resources.

Also thanks to the solution, renewable energy penetration has almost doubled, and the system is prepared for additional

capacity to accommodate peak demand during tourist season.

Maximum efficiency, minimum costs

“We are hybridising engine power plants with energy storage even in cases where the engines may not be supplied by us but by competitors. Our solution is perfectly suited for island microgrids and remote industrial self-generation sites such as mines and cement factories,” says Paldanius.

“Typically, the fuel cost in these places is quite expensive. What makes Engine+ Hybrid attractive for these users is the fact that it increases power system efficiency i.e. utilises less fuel. There are cost savings also on maintenance and additionally lower emissions. These all are attractive attributes for short payback times on investments,” he adds.

Engine+ Hybrid is a smart investment that helps power producers future-proof their assets and businesses. It is a next-generation solution that uses current technology in the quest to make a 100% renewable energy future a reality. Locations like Hungary and Bonaire are already realising the system’s potential. ●

A powerful solution with global applications.

The diagram shows a world map with five circular images highlighting different market segments: Industrial EPPs, Island Grids, Modernising EPPs, Growing EPPs, and New EPPs.

■ The Engine+ Hybrid solution is applicable in a number of different market segments. The solution can be provided for new builds as well as being retrofitted into any existing power plant.



■ Usage of LNG can help meet the IMO 2030 and 2050 greenhouse gas emissions targets.

Who's afraid of the sulphur cap?

AUTHOR: Sami Anteroinen

As the IMO's Global Sulphur Cap 2020 approaches, time is running out for marine industry players to make changes. What can be done?

The International Maritime Organization's (IMO) Global Sulphur Cap 2020 regulations specify that every vessel must adhere to strict sulphur emissions limits by 1 January 2020. As this date looms closer, marine industry players are finalising their game plans on how to cope with the sulphur cap.

Continuous engine operation on

low-sulphur fuels is one viable option to comply with the sulphur-related emission regulations. Another is to install an exhaust gas cleaning system, known as a scrubber. A third opportunity involves moving from fuel oil engines to gas, such as LNG.

Sangram Kishore Nanda, General Manager, Product Engineering at Wärtsilä, says that right now, customers are seeming to opt for compliant low-sulphur liquid fuels, at least for the short term, as this is the easiest option not demanding a significant investment.

"It is a difficult choice for the customers,

as a number of factors – such as a ship's age, size, trading route, charter condition, fuel price, crew competence and many more – need to be considered in the business case for an investment," Nanda says.

According to Nanda, customers with ships having a remaining lifetime of 10 years or more may consider greenhouse gas emissions reduction targets as part of their investment and opt for converting engines to gas. Wärtsilä sees LNG as a key transition fuel towards meeting IMO 2030 and 2050 greenhouse gas emissions targets.

"In such cases, using LNG as a fuel becomes very attractive. An exhaust gas cleaning system may be attractive in the medium-term from an opex perspective," he says. This scenario is indeed materialising as 2020 approaches, given the current return on investment and the fuel spread.

Karl-Johan Nixholm, General Manager, Technical Services, Medium and Small Bore Engines at Wärtsilä, agrees that many marine operators are choosing scrubbers as a good medium-term option.

"When it comes to alternatives, exhaust gas cleaning (scrubbers) are the most popular option, since they work with high-sulphur heavy fuel oil (HFO), are easy to operate and have the lowest total lifecycle cost," Nixholm says. He adds that as of 2020, there will be more than 2,000 vessels equipped with scrubbers.

Controlling all the variables

Often the challenge when switching from HFO to low-sulphur fuels is that installations designed to run on HFO require upgrades in order to maintain fuel viscosity, temperature and circulation flows at specified levels.

Nixholm points out that ensuring proper control of the fuel temperature, and viscosity is crucial throughout the conversion process.

"In many cases, in order to achieve this, it may be required to do some modifications to the auxiliary systems and engines," Nixholm says.

If this is not possible – and normal recommendations for fuel injection viscosity cannot be reached when operating with low-viscosity fuel, if for example fuel cooling is not available – various operational and/or equipment deteriorations may occur. Among these are cavitation corrosion on fuel pump and fuel system parts, power loss, and uncontrolled fuel rack control.

"In general, the set-up of the installation has to be checked case by case," says Nixholm, specifically discussing the challenges that involve making four-stroke engines sulphur cap compliant.



■ Installation of a scrubber.

The external fuel system alone holds three key concerns: fuel oil feed pumps, which may not be suitable for operation on low-viscosity fuel; separators, which may require changes depending on the fuel type used; and fuel oil cooler, which may be required for low-viscosity fuel to keep the injection viscosity and temperature within the recommended range.

With regard to the four-stroke engine itself, the issues range from possibly having to overhaul fuel injection equipment to adjusting propulsion control or even changing exhaust valves.

Combating leaks

On the two-stroke low-speed engines' side, Nanda lists leakage and premature wear



■ Marine Diesel Fuel Cooler Unit.

and tear on the components, as the biggest concerns involved in switching to low-sulphur fuel.

“Low-viscosity fuel leads to a higher leakage rate in the injection equipment, which can result in engine starting difficulties or slowdown due to insufficient pressure in the fuel injection system. Furthermore, the high leakage rate needs to be handled by the drain fuel system.”

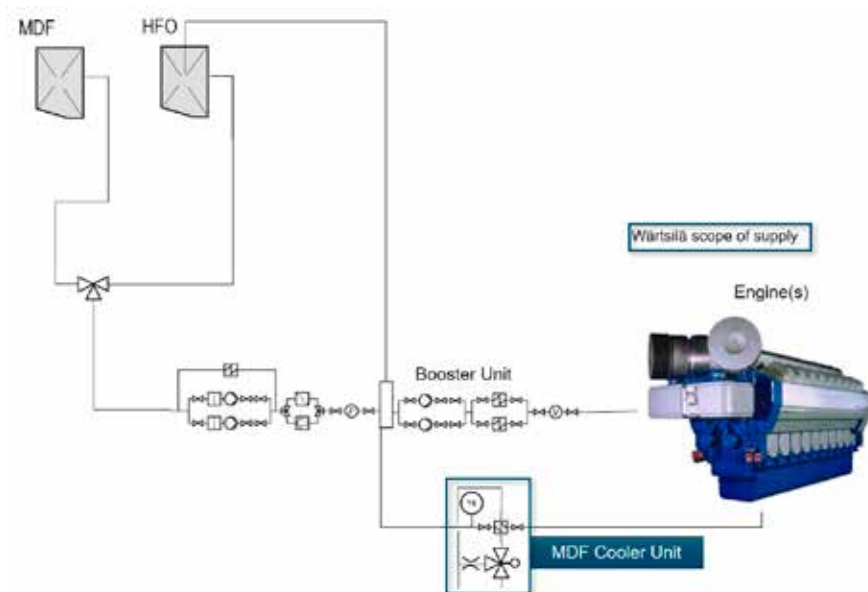
Nanda points out that injection systems in recent decades were designed for continuous operation on residual fuels, with operation on low-viscosity fuels limited to a few hours during shop tests and major overhauls.

“In today’s operating environment, engines switch over to gas oil when entering Emission Control Areas (ECA) or zones where local emissions legislation is in force. Continuous operation of two-stroke main engines on distillates may result in components wearing out earlier compared with operating on residual fuels,” Nanda says.

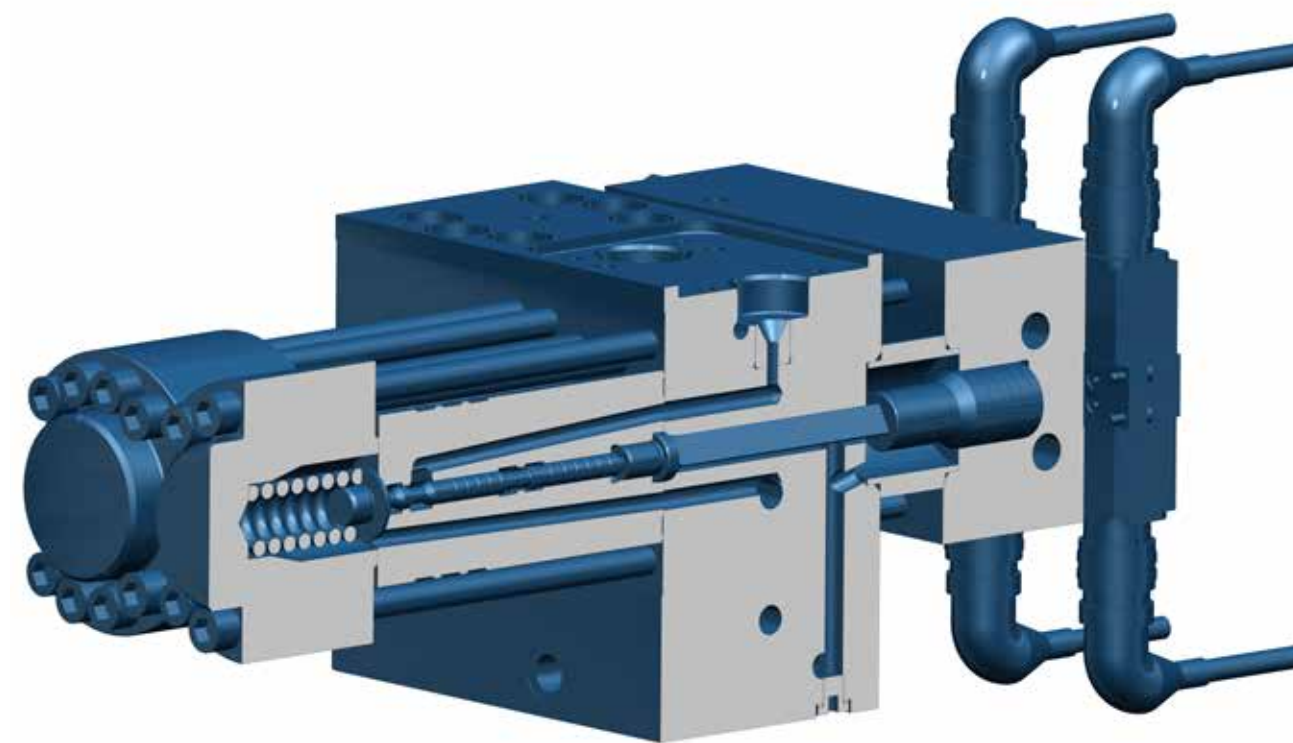
Furthermore, it is recommended to check the condition of the Injection Control Units (ICUs) to evaluate their capability to operate on distillates.

“If the ICUs need to be overhauled to ensure efficient engine operation and reduced maintenance costs, the latest ICU technology – which is more robust and exhibits improved leakage behaviour under multi-fuel operation – can be installed during remanufacturing of ICUs or, in the case of larger-bore RT-flex engines, as a retrofit,” Nanda explains.

He is also recommending that customers take proactive action – such as making a thorough assessment of the main engine condition (Wärtsilä Health Check), as well as increasing the onboard inventory of safety parts and special repair kits – in order to ensure continued operation in case of



■ Technical concept – Continuous LFO operation.



■ Injection Control Unit: Fuel leakage and TBO.

damage to fuel injection components due to contaminated fuel or in case of accelerated wear.

Finally, he adds that since a variety of fuels in terms of density, viscosity and combustion characteristics is to be expected, installation of an automatic closed loop injection control system such as Wärtsilä Intelligent Combustion Control, or installation of Wärtsilä FAST Nozzles, is highly recommended in order to optimise fuel injection and combustion.

Get all the facts

In order to facilitate a smooth transition to sulphur cap compliance, Wärtsilä has been providing technical support for customers and performing technical audits and surveys onboard where such have been requested.

“Also, we have performed fuel and cooling system designs, installation and commissioning supervision,” Nixholm says.

According to Nixholm, Wärtsilä is well equipped to support all possible solutions in order to meet sulphur cap compliance. “Wärtsilä has been providing this support for many years already: we issued the first

edition of our Low Sulphur Guideline for the customers back in 2005.”

This document, which has been updated over the years, gives a solid overview for most of the four-stroke portfolio, he adds. Nevertheless, only recently has the guideline become a real ‘bestseller’.

“For sure, we are now contacted more frequently as the deadline closes in,” Nixholm notes.

Operation support department standing by

Wärtsilä has recently published a Business White Paper on operating two-stroke main engines in compliance with the sulphur cap regulations, in order to guide and inform customers during their decision-making process.

In addition, technical bulletin RT-229, ‘Operation Guidance to the Global Sulphur Cap 2020’, was released in August 2019 to offer assistance. Wärtsilä’s Technical Services also is available 24/7 to support customers, Nanda says.

“A Remote Operation Support (ROS) solution is also available for installation, with which the ship crew can communicate

with the specialised team in the ROS centre in real time and get support to resolve the issue, in order to avoid equipment downtime and experts’ attendance onboard a vessel,” Nanda says, adding that this solution also enables a review of historical data for recommendations.

Diminishing alternatives

Despite lengthy discussions leading up to the transition, there may still be issues that many have not considered regarding meeting compliance and the sulphur cap.

Nixholm worries that customers may not be taking into consideration the time needed to carry out some of these options. He says that, as the finish line grows closer, the number of possibilities that can be successfully implemented before 1 January declines. In many cases, these options are limited due to delivery time.

Overall, however, Nixholm and Nanda are of the opinion that most marine players won’t have problems in meeting compliance.

“Provided they are up to speed with all the information available on managing compliance,” Nanda adds. ●



Illustration: Ponant - Stirling Design International

■ Le Commandant Charcot.

ship. It will also put its second LNG vessel, the Costa Smeralda, into operation this summer. There are now about 20 new LNG-fuelled cruise ships on order, with all the major cruise companies – Carnival, MSC, Disney, Royal Caribbean and TUI – betting big on the technology.

“We are talking about 50% of the normal order book for cruise ships in a year,” says Piero Zoglia, who leads the business development team for Wärtsilä LNG Fuel Gas Supply Systems. “All the players are focusing 50% on LNG fuel.”

The tipping point

Zoglia believes the arrival of cruise operators marks the tipping point for the fuel, as port operators and fuel suppliers will now be forced to extend bunkering facilities in dozens of new ports.

LNG has, in the past, been seen as suitable for ships on repetitive routes in seas with strict emissions controls, and not for vessels like cruise ships, which can be sent to another hemisphere at short notice. But improving bunkering availability, and the arrival of the first global sulphur cap next year, has made the fuel look more attractive. Vessels running on heavy fuel oil now need to install scrubber systems or pay a premium for low-sulphur fuel, improving the economics of LNG.

When France’s Compagnie du Ponant ordered Le Commandant Charcot, a specialist ship that will take sightseers on luxury expeditions to the North Pole, around Greenland, through the Bering Strait and to the penguin colonies of Antarctica, it opted for Wärtsilä’s LNG dual-fuel engines.

“They are sailing in the North Sea and the Baltic Sea, and that’s a nitrogen oxide emission control area (NECA), so they have two options: low-sulphur MDO or LNG,”

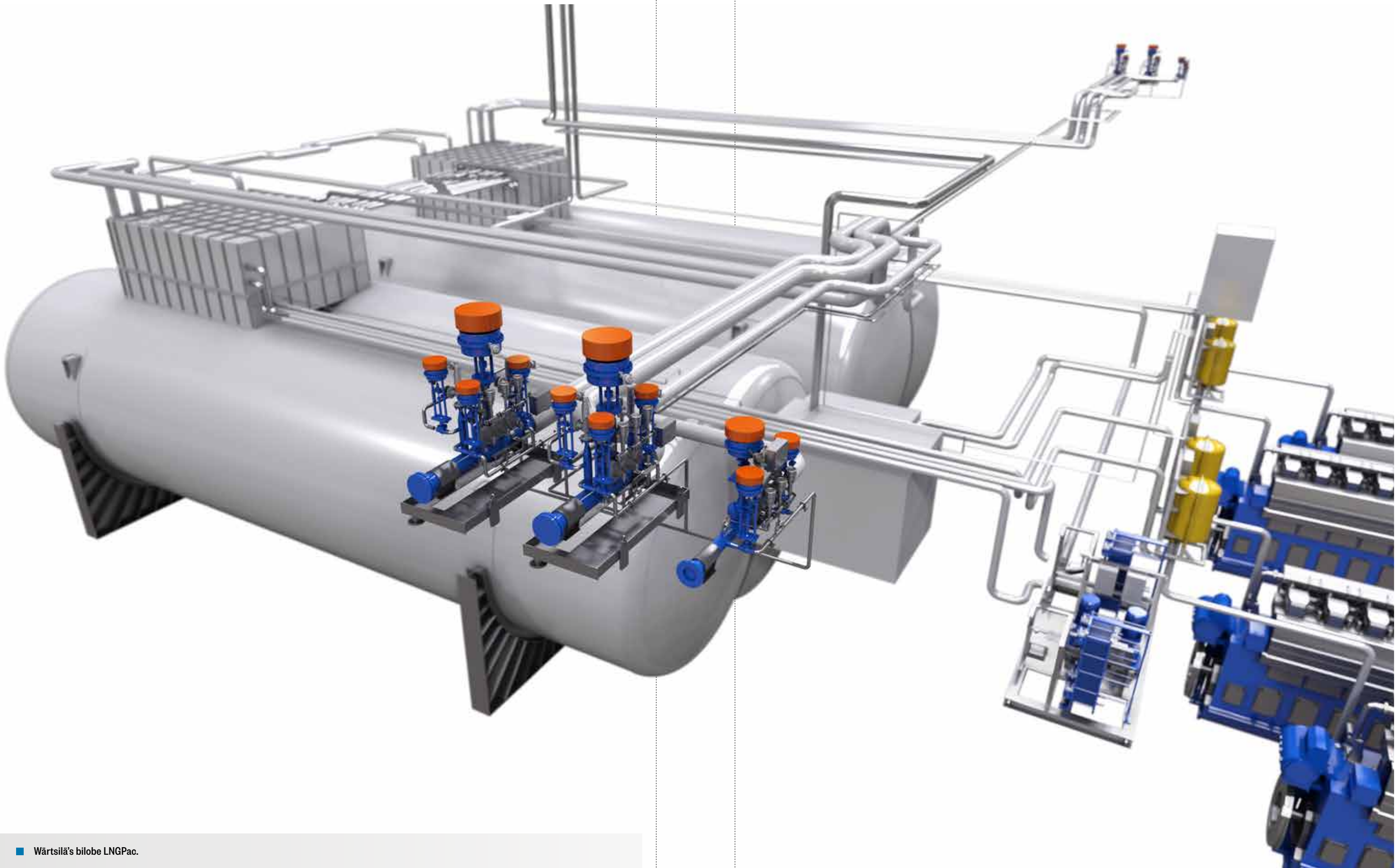
Cruise ships herald the age of LNG fuel

AUTHOR: Richard Orange

This year will see the first LNG-fuelled cruise ships come into service, and there are many more on order. Find out how Wärtsilä Gas Solutions are playing a key role in meeting the industry’s high demands for space efficiency, safety, and sustainability.

Very few still see LNG as a novelty, and there is nothing new about a cruise ship. But until this year, the two have never been combined.

This is about to change. In December, Carnival Cruise Line took delivery of AIDAnova, the first LNG-powered cruise



■ Wärtsilä's bilobe LNGPac.



Illustration: Ponant - Stirling Design International

says Zoglia. “The fuel price is attractive, and you also save on maintenance costs because the engines are running on cleaner fuel.” The IMO has committed to developing a ban on HFO, thereby making it no longer a realistic option for new projects in Arctic cruise.

Towards clean alternatives

But economics is not the only or even the main driver of the decision. The impacts of climate change are nowhere more visible than at the North and South Pole, where ships will be operating.

Public concern over environmental pollution affects the cruise industry more than any other sector. “They have to be

clean. It is not only a matter of the rules and regulations, but also a question of image,” explains Zoglia. “They have to go into ports at tourist destinations and in these ports, you don’t want to have smoke emissions.”

With LNG there is no smoke at all. Switching from fuel oil to LNG cuts sulphur emissions to zero, particulate emissions by 98%, NO_x emissions by 85% and greenhouse gas emissions by approximately 12-17%. It should, therefore, be no surprise that the fuel is attractive.

Tailor-made solutions

The cruise ships currently on order are the first to be fuelled by LNG, meaning

companies like Wärtsilä are having to work hard to meet entirely new demands.

“It is very complex, very difficult, with very demanding customers,” says Zoglia. “There’s not one project that is like what anyone has done before.”

LNG’s lower fuel density means that an LNG vessel typically requires twice as much tank space as one fuelled by diesel. Standard cylindrical tanks compound the problem, as they fill only about 40% of the rectangular space needed to house them.

This is a particular problem for cruise vessels, Zoglia points out: “In a cruise ship, every cubic metre you lose might be a cabin you give away.”

Wärtsilä worked with the French engineering company GTT to develop a membrane tank for the icebreaking cruise ship Le Commandant Charcot, which could be fitted to the shape of the hull. As much as 75% of the space was used for fuel storage. It is a technology that has been used on LNG carriers, but never before on a cruise vessel.

Safety first and foremost

On another project, Wärtsilä supplied Bilobe Type C tanks, which use 60% of the available space for gas storage. Again, Wärtsilä is the first to supply this technology to a cruise ship. Because bilobe tanks are pressure tanks made of stainless steel, they

are one of the best technologies from a safety perspective.

Cruise ships have some of the strictest safety standards in the industry, and Wärtsilä has built triple redundancy into the LNG systems it has supplied. This means having two LNG tank systems working in parallel and ready to take full control in case of a single failure. Even if both fail, the diesel used as pilot fuel in the engines is stored in sufficient quantities, so that the engines can switch to diesel and bring the vessel back to the nearest port.

“For a cruise ship that’s particularly important because passengers don’t care if there is a technical problem on board; they

have paid for the ticket and the cruise must go on,” says Zoglia. “Safety and reliability are of utmost importance on board these ships. They are the top priorities.”

Every year between now and 2026 (at least) will see new LNG-fuelled cruise ships hit the market, and their operators are lobbying hard to bring bunkering to all their key ports. At the same time, oil and gas companies will order LNG bunkering ships which will make LNG refuelling much more flexible.

With the arrival of the cruise giants, it is time to stop talking about LNG’s ‘chicken-and-egg conundrum’. The fuel has come of age. ●



Getting smart with navigation

AUTHOR: Sarah Hudson

In a world of connectivity, why shouldn't the maritime industry be reaping the benefits of optimised navigation? Introducing Wärtsilä's Navi-Planner – a system set to revolutionise the industry, one smart voyage at a time.

On land, technology has completely redefined our day-to-day activities, paving the way for disruptive business models from

banking to travel. From smartphones to the connected car, we live in a digital world. Yet shipping has arguably been slow to capitalise on these possibilities.

This is changing with Wärtsilä's Navi-Planner – Smart Voyage Optimisation that all but obliterates manual labour when it comes to route planning. It's a solution that's targeted to the very specific needs of today's maritime industry, bridging the gap

between the latest technological offerings and the need for compliance with existing systems. Fully market-ready, it's set to take the shipping world by storm.

How does Navi-Planner work?

Wärtsilä's Navi-Planner takes into account metocean data, traffic patterns, and weather updates to prepare a safe and efficient route using one of the world's largest navigational

databases. That data is then available for the captain's finalisation and, most importantly, everything is cyber-secure and fully compatible with the ECDIS.

"Navigating a route is a mathematical problem with a whole load of variables that need to be gathered and collated, then factored into the equation," explains Christopher Schröder, Wärtsilä's Sales Director for Northern Europe.

At present, a navigator has to physically click through, setting and linking waypoints, matching them to charts, purchasing those charts and then manually uploading them. Humans are good at many things, but crunching large amounts of data is something computers excel at, and – unlike mere mortals – their capacity is only expanding.

Navi-Planner allows operators to transform real-time navigational data into an optimised route in a couple of clicks. Not only does it use all available data to streamline the route and reduce human error, it also frees up valuable crew time for other tasks.

Smart, under pressure

Under increasing pressure to compete on cost efficiency and environmental impact, shipping is feeling the strain. Across all areas of compliance, demands are tight and tightening. For the sake of the planet, as well as the bottom line, it is high time the industry had access to technology to help with the heavy lifting.

"Optimising a route is utterly crucial to all elements of improved performance and safety – not to mention environmental sustainability," Schröder says. "We need to embrace the reliable technology we now have to help this industry solve its problems."

Many self-sufficient but separate sensors and systems already exist on board vessels – such as depth sounders and weather sensors, to name a few. They are connected on the bridge but still require data to be manually transferred beyond it.

With Navi-Planner, such systems are directly connected to the ECDIS, so all data required to make optimal route decisions is already right where it needs to be. With better links from ship to shore, smart and timely joint decisions can be made.

Why is maritime playing catch-up?

According to Schröder, Navi-Planner represents such an essential leap forward that the most common feedback from customers is: "Why wasn't it invented earlier?"

It is a fair question. We've long been using technology to simplify our land and air travel and make it more efficient, so why haven't we been using it to harness onshore and offshore data to optimise sea routes?

"Part of the answer is that we need to find our own way," explains Schröder. "Our requirements are different, and the maritime industry has its own challenges."

The reality on ships is very different to experiences in our daily lives on land. In the scheme of things, even using electronic charting systems is a relatively recent advancement, and getting those systems to the point of IMO compliance has taken time. Until now, we didn't really have the technology to consider better ways of getting data into the ECDIS, Schröder says.

Also, while plenty of technological opportunities are now within grasp for the maritime industry, unlike on land, full connectivity may be close, but it is not there yet. In contrast, manual systems and paper charts have been relied upon for hundreds of years, so it is understandable that maritime might be a tad slower on the uptake.

That said, the future is officially here. The benefits of Smart Voyage Optimisation are clear, and it is hard to imagine it becoming anything but an industry norm.

What's the future of Navi-Planner?

The Wärtsilä Navi-Planner is a system with the capability to constantly evolve, so the best news is that customers won't be left behind as the technology improves.

The system is designed to seamlessly incorporate new information into route planning, so Smart Voyage Optimisation opportunities are endless. For example, Navi-Planner eventually will be capable of dynamically adjusting the route and speed of a vessel's port approach for a just-in-time arrival.

As the ability to connect, share data and communicate in real time penetrates further into the world of marine transportation, opportunities for smarter, safer and more sustainable operations will expand exponentially.

Wärtsilä's Navi-Planner is charting the way to a smarter future – time to get on board! ●



Illustration: DNV GL

Ultramax 2030: Next-generation shipping

AUTHOR: Payal Bhattar

Ship owners can now have vessels that that are affordable, compliant with the IMO's 2030 emission targets and have high operational efficiency. Meet the Ultramax 2030 65K DWT Bulk Carrier.

The all-new Ultramax 2030 65K DWT Bulk Carrier is a dream vessel that meets future emissions legislation while being optimised according to actual operating profiles both at sea and in port. This 200-metre ship has a range on LNG of about 13,600 nautical miles at service speed, which covers the

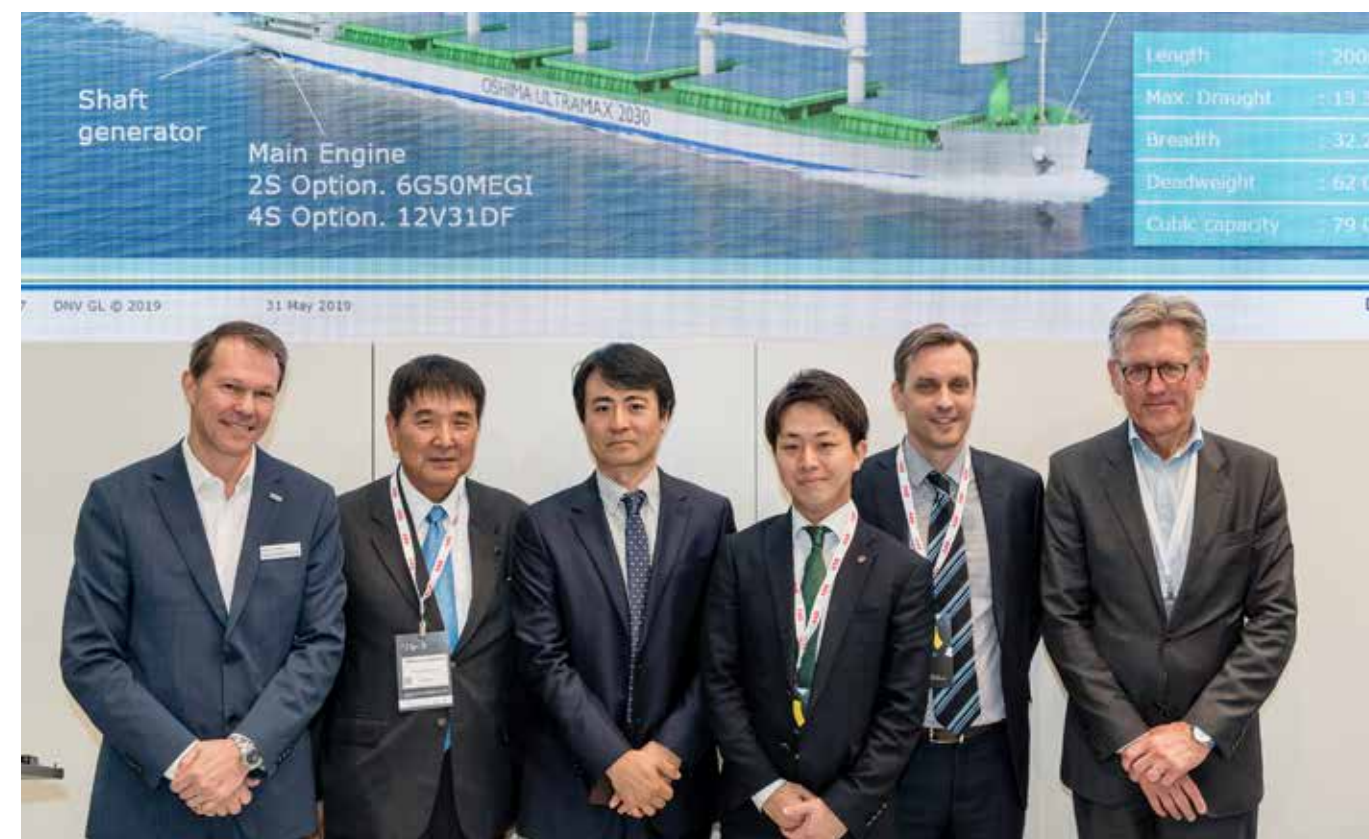
main trading patterns worldwide with the LNG bunkering infrastructure available today. It gives ship owners the comfort of having more than 20% lower operating expenses (opex) when compared with standard vessels operating today, and has an approximate payback time of 12 years compared with a standard vessel.

"Many ship owners have asked us how to reach the coming IMO regulations for reducing CO₂ emissions from shipping, so we thought of jointly demonstrating along with our business partners that even today,

with the current technologies available, it is possible to achieve that while keeping the return on investment (RoI) in mind," says Johnny Kackur, General Manager, Merchant & Gas Carrier Segment Sales, Wärtsilä Marine Solutions.

Maximising efficiency, minimising emissions

The Ultramax 2030 65K DWT Bulk Carrier has a 60-metre-tall hard sail made of glass fiber reinforced plastic (GRP) and comes in two options – a two-stroke LNG-fuelled option and a four-stroke LNG-fuelled



■ From left to right: Morten Løvstad, DNV GL, Vice President, Global Business Director – Bulk Carriers, Tatsuro Iwashita, Oshima Shipbuilding, Director, Deputy General Manager Design, Jaeouk Sun, DNV GL, Principal Engineer, Naoki Shigemura, Oshima Shipbuilding, General Manager, Oshima Europe, Johnny Kackur, Wärtsilä, General Manager, Segment Sales, Stein Thorsager, Wärtsilä, Director, Segment Sales.

version. Both options promise an Energy Efficiency Design Index (EEDI) of more than 46% compared to EEDI Phase 0, while maintaining a service speed of 14.5 knots. The four-stroke version utilises a controllable pitch propeller (CPP) to allow smaller installed power and still maintain manoeuvrability of the ship in adverse weather conditions without overloading the main engine. The lower installed power means not only savings in costs, but also that the main engine can be operated at higher engine loads at higher efficiency levels.

"There are now two options for the propulsion machinery," Kackur says. "The standard arrangement for Ultramax bulk carriers today is to utilise a two-stroke engine with an FPP (fixed pitch propeller), so therefore this is still an option. The second option with a Wärtsilä 12V31DF four-stroke main engine connected to a

CPP is not a standard arrangement, but it turned out to be a competitive alternative. Based on the analysis we did on the AIS data from Ultramax bulk carriers, we could see that actual operation is at a wide speed range with most of the operating hours at lower ship speeds with low engine loads. The Wärtsilä 31DF engine uses a two-stage turbocharger, which in addition to increasing the engine efficiency, also increases engine efficiency at part loads. The lower the ship speeds the more competitive the Wärtsilä 31DF engine option gets compared to the standard two-stroke engine option."

For both main engine options, shaft generators are used to cover the hotel load. Shaft generators run by the main engine offer superior efficiency compared with using small auxiliary gensets. While the shaft generator for the two-stroke option is a slow-speed generator installed on the

propeller shaft, the shaft generator for the four-stroke option is a high-speed generator connected through the reduction gearbox. The shaft generator for the four-stroke alternative can also be used in port, meaning it offers the possibility to install fewer auxiliary generators.

"Various alternative fuels were considered, but LNG is today the most developed alternative fuel widely available," Kackur says. "The use of LNG makes it possible to drastically reduce emission levels and comply with the coming emission legislations. We are fully aware that LNG may not be the fuel of choice for a zero-carbon future, but we cannot just sit and wait for a perfect solution to arrive. By using the best available technology already available we can make significant progress now."

The Ultramax 2030 65K DWT is powered by solar panels and batteries in order to produce energy in the most efficient



■ Overview of some of the technologies reviewed and evaluated for Ultramax 2030. Illustration: DNV GL.

manner. Almost all of the hatch cover area is covered with solar panels, which help to achieve higher efficiency levels. During waiting times, the carrier can operate in an eco-mode where the hotel load is minimised, so that most of the hotel load can be covered by the solar panels only. A battery is installed to reduce engine running hours and optimise and stabilise the engine loading levels, boosting the efficiency to even higher levels.

The voyage to Ultramax

Building this vessel was not easy. The process began late last year, when Wärtsilä embarked on a joint development project with Japanese ship builder Oshima and DNV GL, a Norwegian accredited registrar and classification society. The project aimed to build a next-generation ship that would set new standards for the maritime sector. This smart carrier had to go beyond merely complying with the International Maritime Organization's (IMO) goal of reducing

every ship's CO₂ emissions by at least 40% per tonne-mile by 2030 while being cost-friendly and performance-driven.

"Cargo carriers need to reduce emissions levels," Kackur explains. "Therefore, in addition to lowering emission levels during sailing, the idea was to significantly try and reduce emissions in port and during waiting, because Ultramax bulk carriers spend a surprisingly long time waiting."

The project involved assessing current market needs and investigating port infrastructure. The study required getting input from major ship owners, researching fleet profiles and conducting AIS analytics on about 850 vessels and ports.

Optimising knowledge from across the industry

Each partner involved in designing the Ultramax 2030 65K DWT Bulk Carrier had a crucial role based on their specific areas of expertise. Oshima, one of the best shipyards in the world for designing and building bulk

carriers, already had extensive R&D for achieving higher efficiency levels. Its current designs were used as a benchmark for the study conducted ahead of the Ultramax's creation. Several technology options were compared and evaluated, and ultimately, many of Oshima's own solutions, such as the hard-sail, were applied to the new ship.

DNV-GL, which has extensive experience in bulk carrier design, offered the project access to new innovative technologies and provided many important parameters, such as actual operating profiles for Ultramax bulk carriers and the most suitable solar panel technologies for this kind of ship.

Wärtsilä contributed world-class expertise in propulsion machineries, hybrid propulsion and alternative fuel system arrangements. There was a very broad range of technologies that were considered before arriving at the final selections. For instance, both single-skeg and twin-skeg hull designs were reviewed in order to explore possibilities for improving hull efficiencies



■ EEDI (Energy Efficiency Design Index) – CO₂ per tonne-mile.

according to actual operating profiles. Solar panels were chosen, and alternative fuels including LNG and hydrogen were shortlisted together with after-treatment units for conventional diesel engines.

"We had to make sensible choices because we were also equally focused on the payback time. So even though we saw benefits with some technologies, they had to make sense in terms of the cost," says Kackur.

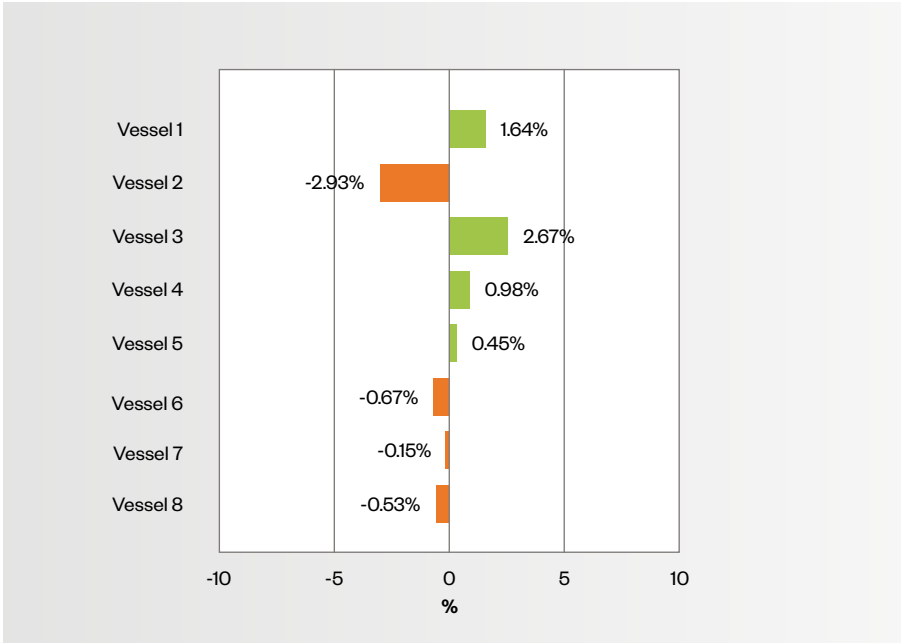
Future-proof shipping

These smart choices helped Wärtsilä, Oshima and DNV-GL design one of the smartest bulk carriers in the market. With legislation on emissions becoming increasingly stringent due to implications for climate change, ship owners, cargo owners and charterers need to make a shift to ecologically friendly vessels sooner than expected. With the new Ultramax 2030 65K DWT Bulk Carrier, the sector can take a giant leap towards zero-emission shipping. "Wärtsilä wants to play an active role in

the development of decarbonising shipping. This joint development is one step forward on this journey," Kackur says. "Wärtsilä cannot decarbonise shipping alone. If we, together with our business partners, actively work on developments to reduce emissions and improving efficiencies, we can achieve much more. Collaboration is the key to moving forward, and Wärtsilä will continue to take an active role in this development."

The Ultramax 2030 65K DWT Bulk Carrier is not the only joint project Wärtsilä is developing. The company is actively looking to cooperate on design evolution and innovation, working with partners that have complementary domain expertise and can bridge gaps in competencies. Collaborations like these can help overcome challenges and bring in new technologies to create world-class solutions.

After all, the best collaborations create something bigger than the sum of what each partner can create on their own. ●



Fleet performance dashboard: KPI trend indicator.

Smart Marine just got a little smarter

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With richer data and faster connectivity, the upgraded Operim system lays the groundwork for new business models as part of Wärtsilä's Smart Marine Ecosystem. With its unique packaging of hardware and subscription-based software, the new Operim demonstrates the company's commitment to upending traditional ways of doing business.

With the newly upgraded version of Operim, released at the Nor-Shipping trade fair in Oslo in June 2019, Wärtsilä shows that it is serious about anchoring itself in the domain of intelligent engineering.

The Operim system was first launched in 2011 to monitor the performance of Wärtsilä's LNG cargo and reliquefaction plants on ships. Operim, short for Operational Performance Improvement & Monitoring, lives up to its tagline: "Forget about optimisation – with Operim, it's always on."

Originally designed to monitor and optimise onboard gas plant performance with simple calculations and manual data sampling, the early Operim system, designed by Wärtsilä Gas Solutions, aimed to help crews optimally operate large reliquefaction plants, reduce their 6 MW power consumption and keep the associated environmental footprint to a minimum. The cargo handling system, with a reliquefaction plant at its core, plays a significant role in the efficient operation of gas cargo tankers.

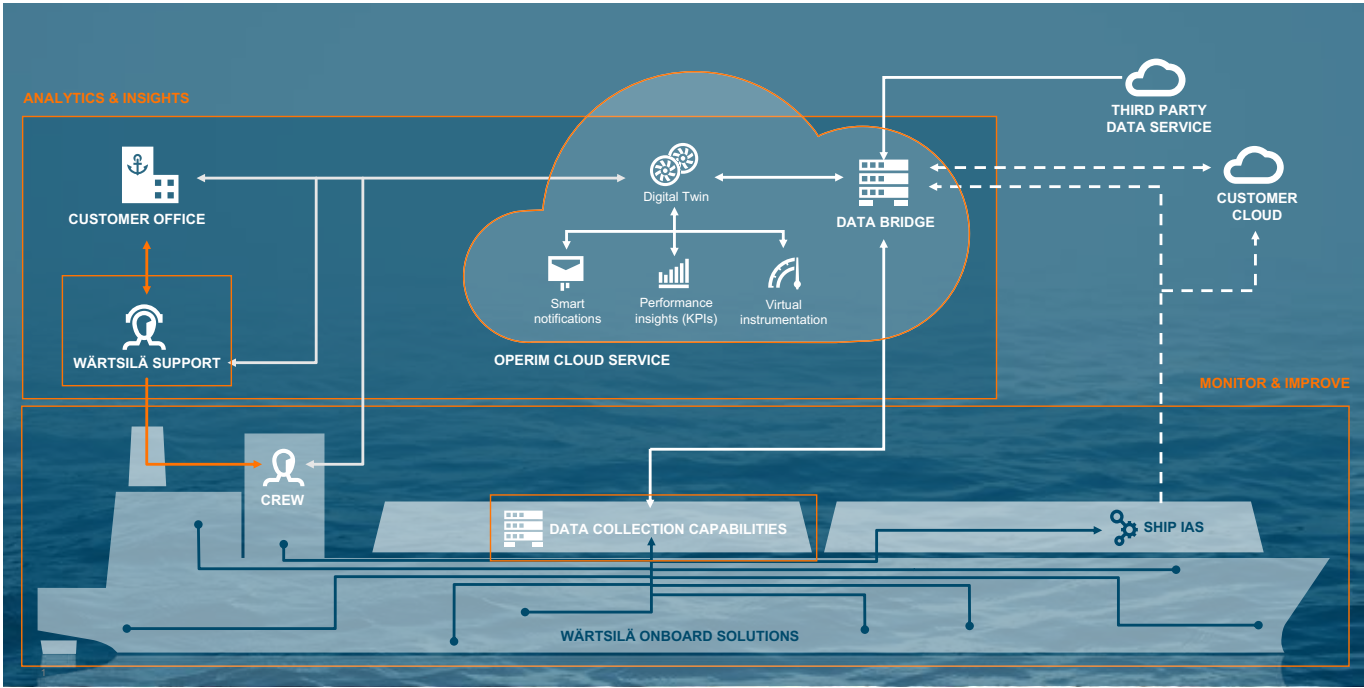
On a typical voyage from Qatar to Japan, for example, up to six tonnes of cargo per hour are managed by the reliquefaction process. Without careful operation and

consideration of the varying operating conditions throughout the voyage via Operim, efficient operation would be compromised. With ever-increasing financial pressures on ship owners and operators, the need for operational efficiency is higher than ever before, which is why Operim has been updated to utilise the latest technology to support our customers and help them meet their business challenges.

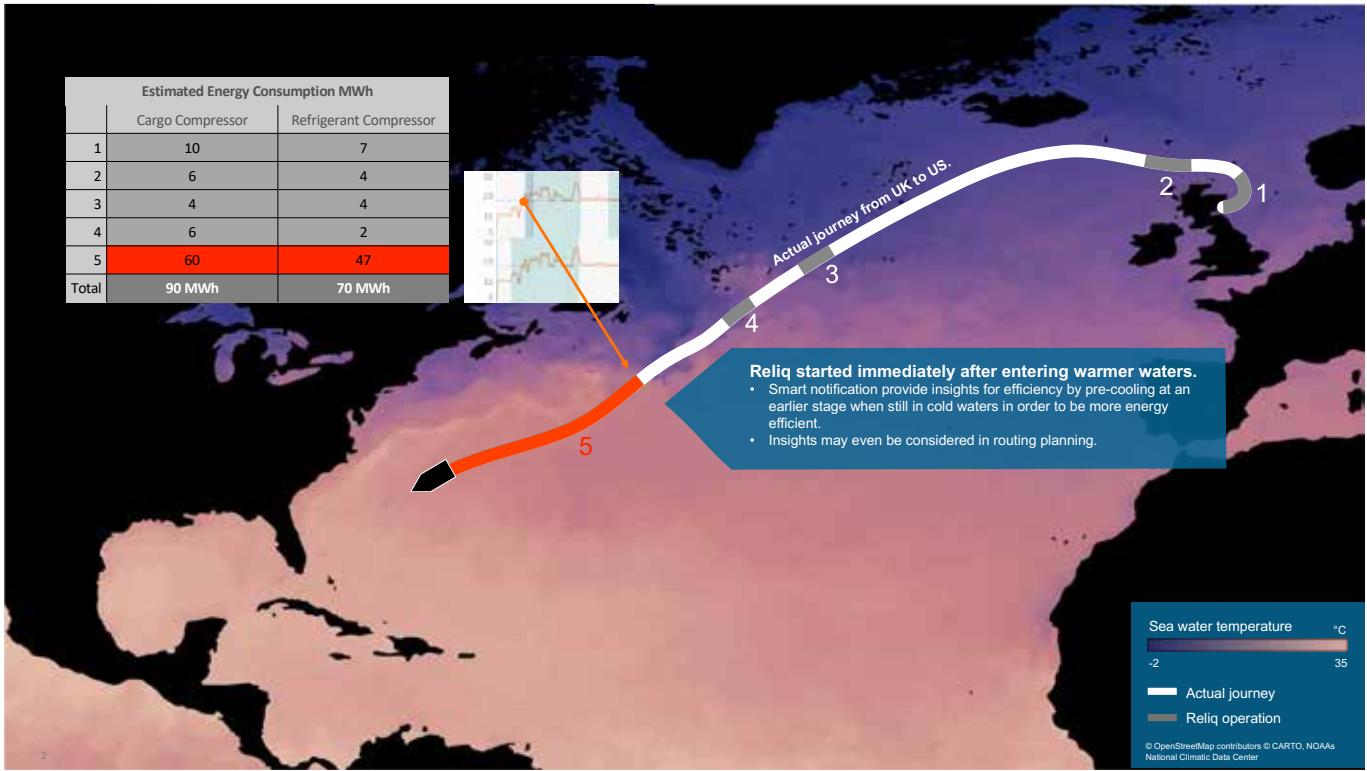
So what's new with Operim?

Thanks to the increased availability of rich and near real-time data and upgrades to web and software interfaces, the application areas of Operim have widened beyond just LPG and LNG reliquefaction plants. Recent upgrades include land-based biogas, fuel gas supply systems and waste and water treatment solutions. Other processing assets will follow. Based on the widespread application areas of Operim, Wärtsilä has enhanced its Smart Marine Ecosystem strategy and is quickly developing new business models to support it.

For owners and operators, Operim enables a slew of cost-saving operating performance improvements in a continuous



Operim: Digitally enabling physical devices for smarter performance.



Voyage report and operation insights with Operim.

and dynamic fashion. Vessels are only as efficient as the way they are operated, and with Operim, inefficiencies and profitability impairments of all types can be identified and rectified to reach optimal operational efficiencies. Operim can, in a nutshell, constantly provide advice and insights on how to adjust working parameters in accordance with sea and weather changes as well as monitor maintenance routines and early warnings.

Used properly, Operim can also make money for users via cost savings. There are frequent developments in environmental compliance for individual ships and entire fleets that have to be managed. That's just one of the many complex variables involved in running a fleet smoothly and efficiently while adjusting to different local conditions around the world. Operim helps synthesize all this data.

Additionally, as crews age and expertise and know-how are lost to attrition, newer

crews need – and, in fact, require – data-rich environments in order to make accurate, fact-based decisions onboard ships.

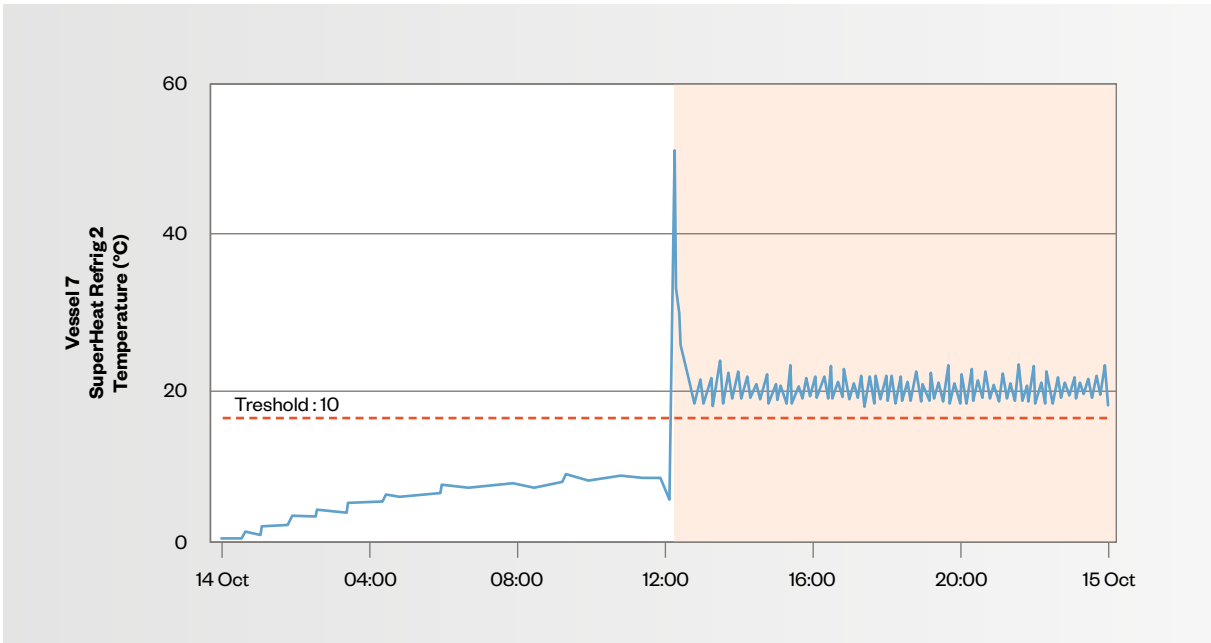
Digitally augmented and integrated with Operim

What really makes Operim a linchpin in Wärtsilä's Smart Marine Ecosystem is how it will become packaged and included in the sale of new physical hardware. In the foreseeable future, all of Wärtsilä's physical products could be digitally enabled this way as part of the brand promise. This is unique in the industry. It leverages Wärtsilä's broad portfolio and product heritage and is not easily replicated by new digital entrants to the market.

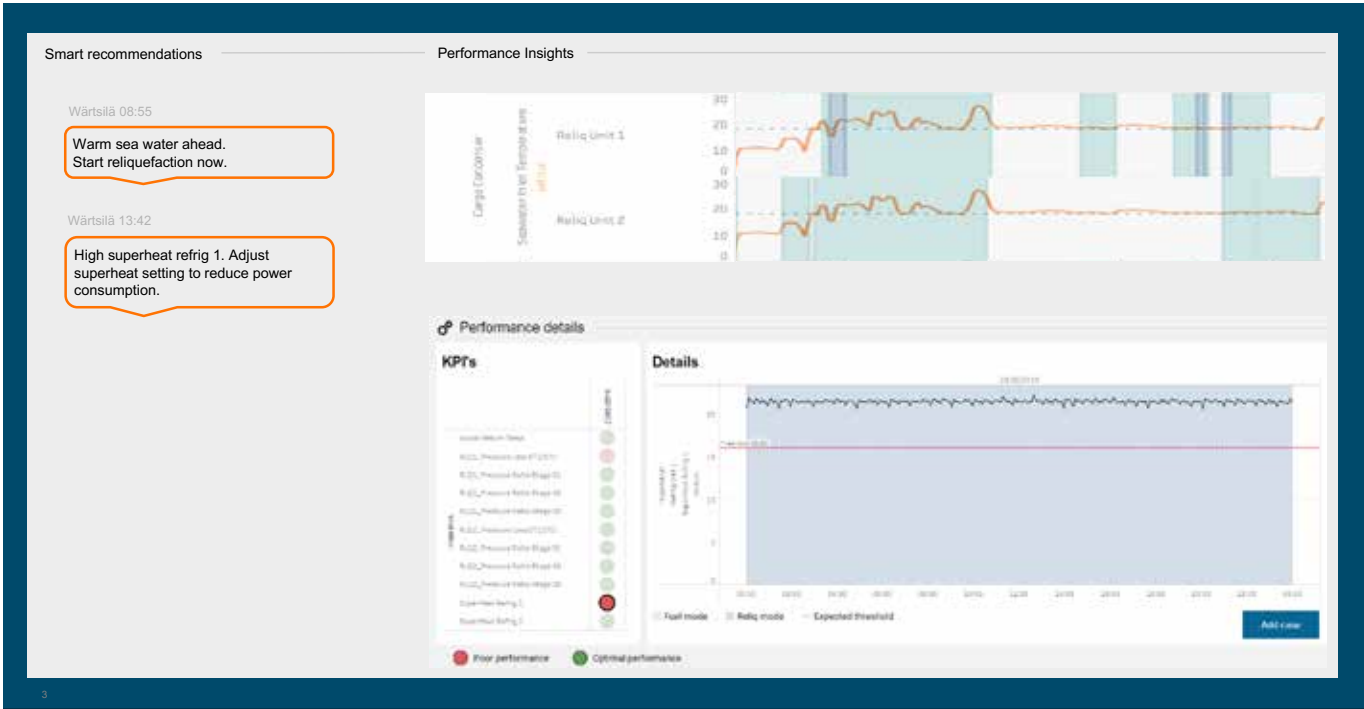
Additionally, Operim can be retrofitted to existing installations and made available via a Service Agreement, either stand-alone or, typically, as part of a broader Wärtsilä agreement. Wärtsilä's unique competitive advantage over pure software and data

companies working only in the virtual space is that the company has in-house at its disposal the engineers who designed the machinery and can offer support in the form of a live chat functionality backed up by real-life expertise. This level of product understanding and support on a web interface is not just unique, it also strengthens the connection between the customer and Wärtsilä.

Digitally augmenting the product starts by enabling data collection. This can be achieved in several ways, depending on the configuration of the vessel and customer preference, by installing dedicated Wärtsilä hardware or using the vessel Integrated Automated System (IAS) system. Additionally, if the customer already has data in a cloud system, this also can be utilised. Once the data is collected, it enters the Operim cloud service, which features Wärtsilä's digital twin of the product being monitored.



Analysing the process performance through Operim dashboards.



Operim: insights dashboard.

A digital twin

At the core of Operim is a digital ‘twin’, developed with the help of product engineers and data scientists. This twin allows the system to compare actual performance against optimal performance and ascertain areas for improvement.

These areas then can be visualised through dashboards in the form of KPIs and smart notifications for operators and crew members. They are accessible to the crew onboard the vessel as well as to the team onshore via a web-based dashboard hosted in the cloud, enabling the team members to use analytics and insight to monitor and improve the product performance.

From a user perspective, the interface is reliable and easy to use. A ship operator can easily access his fleet dashboard in the Operim system, which provides a near real-time overview of the operational health of the company’s vessels, clearly outlined in red and green with average KPI indicators visible in a separate window.

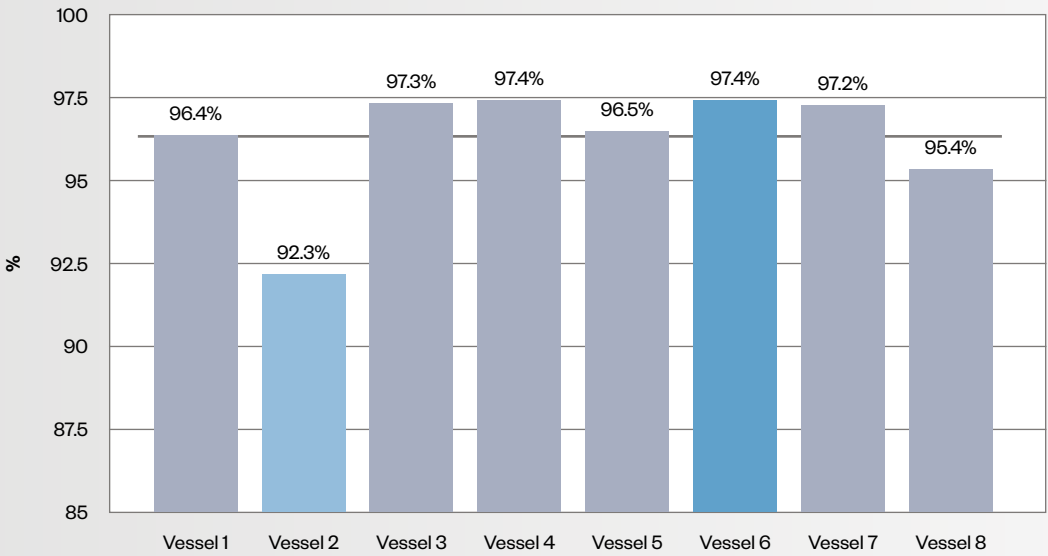
Voyage reporting

One concrete example of Operim’s usability is the voyage report and operation insight window inside the system.

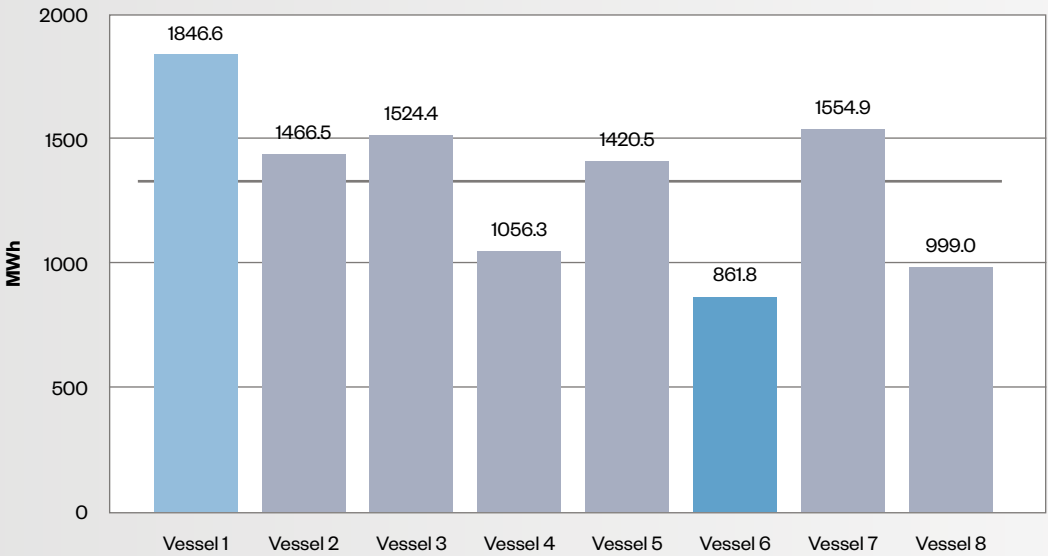
For example, think about a gas cargo ship travelling between the UK and the US in the cold waters of the North Atlantic. Considering the temperature of the ocean, Operim can alert the crew to the need to pre-cool cargo such as liquefied gas when in cooler waters instead of waiting until the ship reaches warmer waters and using energy to cool the cargo then. This kind of precision was nearly impossible in the past without a very experienced operator and could be based at best on a guesstimate of the ship’s position. Operim, however, can provide minute details about a vessel’s route and assist with planning adjustments depending on weather, current and water temperatures, to name just a few variables. The hope is that in the future, this functionality will lead to fuel savings based on different route positioning.

Future features will incorporate the automation of recommendations and utilise machine learning to complement the digital twin, providing richer insights. Operim also will be enabled to interact with other Wärtsilä systems, such as Wärtsilä Online, Expert Insights, and voyage planning solutions, allowing asset-specific optimisation to be considered in voyage planning.

Operim is central to Wärtsilä’s Smart Marine Ecosystem approach to creating greater levels of efficiency, safety and environmental sustainability as the maritime industry adjusts to meet the challenges of an emerging new era. ●



Operim leaderboards: learn how efficient the operation is across the fleet (KPIs).



Operim leaderboards: learn how the power consumption is across the fleet.



Sailing towards a carbon-neutral future

AUTHORS: **Fredrik Östman**, General Manager, Strategy & Business Development, Wärtsilä Marine Business
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Big changes are afoot in the shipping industry as a whole, and in marine propulsion generally, as the urgent need to find a path towards zero-emissions shipping confronts a dramatic projected increase in global shipping traffic by 2050. Shipping accounts for 90% of global trade, and while it is still the most efficient way to move goods, it also is responsible for 3% of the world's emissions, a figure that is projected to increase by as much as 250% by 2050 as demand grows.

To mitigate the environmental impact of this increase, the International Maritime

Organization (IMO) recently adopted a new strategy aimed at reducing greenhouse gases (GHG) from shipping by 50% by 2050 compared with 2008 levels. This comes on top of the previously established NO_x and SO_x caps that should be in place by 2020. The shipping industry needs to quickly explore new solutions to cut emissions.

The challenge is that there is no panacea yet that will create such a zero-emissions shipping ecosystem. Instead, available opportunities and acknowledged trends include large scale roll-outs of alternative fuels (fully electric ships and hydrogen fuel cells, as popularised in the media), and

increased digitalisation of the industry and the onboard utilization of wind and solar energy.

The industry perspective overall and Wärtsilä's in particular include exploring these opportunities while bearing in mind profitability, scalability, and urgency. It is increasingly understood that the internal combustion engine together with fossil (and later bio or synthetic) LNG provides an excellent platform for actually achieving the set emission targets for 2050 and beyond.

If the industry really wants to address emissions, the consensus is that the internal combustion engine still offers the most

realistic emissions-reduction potential. Additionally, this solution requires only existing infrastructure, minimising the amount of investment needed. Generally speaking, a de-fossilised future could take this path: LNG->bio-LNG->synthetic LNG, which would maximise the utilization of existing infrastructure.

The estimated cost of synthetic LNG in 2030 is on par with or lower than other alternative fuels, and this combined with the world's decade-long experience with marine LNG fuel makes it a safe and reliable bet. Bear in mind that other alternative fuels would take between 10 and 20 years to be accepted by marine classification societies, not to mention the time required to develop infrastructure and bunkering facilities.

Regardless of the potential of future fuels, the internal combustion engine still has the flexibility to burn most combustible substances. By burning LNG in a modern combustion engine, we can immediately reduce GHG emissions by 20-25% compared with a diesel engine. Methane leakage during production and combustion is still a challenge that negatively impacts the GHG footprint of using LNG, as it is 28 times more potent than CO₂. At the same time, this is an opportunity for the industry to improve, something Wärtsilä, Shell, and others have committed to doing.

Trends of the future

Recent efforts have successfully reduced local emissions of nitrogen, sulphur oxides and particle matter from ship engines across different regions of the world – a result of ongoing and increasingly stringent emission regulations by the IMO which began in the 1990s and continue to the present.

But GHG emissions are widely acknowledged as the primary source of global warming, with all their well-publicised consequences to the planet. Thus far, there has not been a large-scale industrialised solution to solving the emissions problem. In the short- and medium-term, there is no known single solution to the challenge. There is more potential for the long term, however.

There are currently four long-term technology trends that can help mitigate climate change.

- Alternative fuels using internal combustion engines

- Fully electric propulsion enabled by batteries, applicable mostly for smaller vessels
- Hydrogen-based operations using fuel cells
- Optimised vessel operation through digitalisation.

Alternative fuels using internal combustion engines

There is a plethora of fuels that can be used in marine engines. But with carbon-neutral biofuels, it's necessary to consider what renewable energy sources are used in the production to start with. Other critical aspects to consider in the selection of fuel for a new vessel are its availability and energy density. For fuels based on biomaterial, the main challenge is the local availability of sustainable feedstock. For most fuels, the current supply chain is unevenly developed and will require substantial investment to accommodate future needs.

Bio-LNG has a big advantage in that many different kinds of sustainable feedstocks can be used, from manure via sewage residue to forest residue and many other types of waste.

Fully electric propulsion enabled by batteries

There are many challenges in developing battery technology. First, capacity and cost are still not at a feasible level for the marine industry. In 2018, the first fully electric cargo ship was launched in China. It had a range of 80 kilometres after two hours of charging. This example demonstrates that battery operation for larger vessels today is mainly restricted to port areas for tugs and ferries, or for peak-shaving operations.

This is expected to remain true for the foreseeable future, meaning that other solutions are needed for the business of long-distance shipping, which also is responsible for the bulk of total shipping emissions.

Secondly, charging batteries is time-consuming and requires high charging power and related infrastructure to limit charging times. Another challenge with respect to emissions is that any pollution from the onshore generated electricity must be attributed to operating the vessel. Therefore, the electricity used should stem from hydro, solar and/or wind power to achieve zero emissions in a true sense.

Finally, many of the materials used to produce batteries are precious metals. Cobalt, an integral component of the lithium-ion battery, for example, is being hailed as the 'new gold', a cause for alarm since scarcity may create vulnerability in the supply chain. In addition, batteries are often categorised as hazardous, requiring special disposal procedures.

Hydrogen fuel cells

The almost too-good-to-be-true proposition of providing energy without emissions from hydrogen fuel cells is attracting the attention of the entire world. As renewable energy sources are already today the cheapest energy source in many places, hydrogen can be used and produced in a sustainable way.

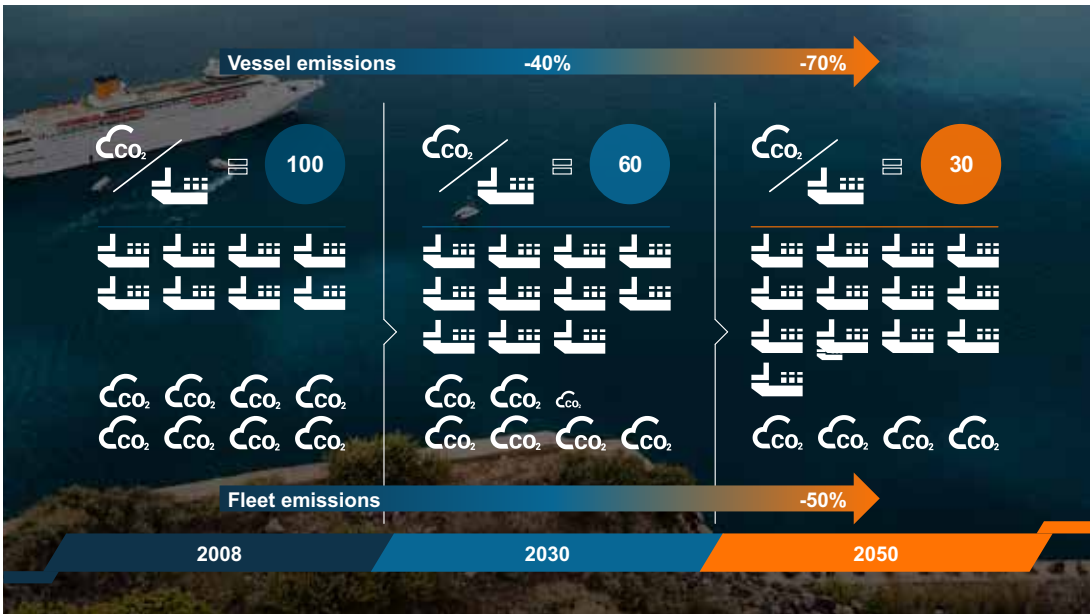
This great potential is offset by some serious challenges, however. As with other renewables, one of the main issues related to developing this fuel cell is cost. Significant progress has been made within the automotive industry that could eventually improve the feasibility of marine applications as well. However, recent developments in the automotive industry indicate a preference for batteries over fuel cells for most applications that could possibly curb further fuel cell development. As in the case of large-capacity batteries, the investment cost likely will plateau at a higher level than for automotive applications, due to the need for technology to mature and lower sales volumes.

The availability of hydrogen is another problem. Large-scale hydrogen production based on electrolysis demands large amounts of energy and has low total efficiency. This is perhaps the biggest challenge for hydrogen as a fuel itself, and for any other synthetic fuels based on hydrogen.

If renewable energy is available with even lower costs, the production of hydrogen is not the biggest challenge, unless the electrolysis is difficult to scale up. Another possibly bigger challenge involves the storage of hydrogen as fuel, as well as the operations of bunkering and transportation.

As a result, synthetic fuels are actually more attractive than H₂ and can be considered as a hydrogen carrier, when bound to CO₂ or N₂ in the form of CH₄ (methane) or NH₃ (ammonia).

Onboard hydrogen storage solutions pose another problem. High-energy-density hydrogen can be stored physically



■ The IMO 2050 challenge, which not only sets limits for ship-level emissions by 2030 and 2050, but also includes a whole-fleet emission limit by 2050.

as either gas or liquid. As a gas, it typically requires high-pressure tanks, while storage as a liquid requires cryogenic temperatures because the boiling point of hydrogen at one atmosphere is -253 degrees Celsius. Some applications centre around linking it with solids or within solids. Storing hydrogen in liquid form will require storage of the fuel below -253 °C, under normal pressure, which adds to the complexity.

The most probable use of hydrogen is as a component in producing synthetic fuels such as synthetic LNG, ammonia or methanol. However, large-scale adoption of the hydrogen fuel cell as a primary energy source is unlikely for many years to come and cannot be considered a solution for meeting the IMO 2050 GHG targets.

Optimised vessel operation through digitalisation

Shipping is by far the most cost-effective way to move goods around the world, and yet it is characterised by waste, pollution and a multitude of inefficiencies, all of which present opportunities. A major reason for these inefficiencies is the lack of transparency between the huge number of actors involved in shipping goods today. The complexity and lack of real-time communication create congestion in high-traffic areas, leading to

increased emissions, operational costs, and significant delays.

Eliminating this waste is the basis for Wärtsilä's Smart Marine Ecosystem. It focuses on connecting all agents and parties in the shipping industry to create the needed transparency and dynamics to optimise the complete logistic chain rather than sub-optimising the individual steps. This involves taking joint responsibility for operations, working together, ensuring that the right parties have access to the necessary information and can access it at the right time. Smart Marine is about understanding that ships are only one element within the complete logistics chain. Vessels have to interact with ports, and they, in turn, have to interact with land-based transportation modes, all the way to the end customer. In the end, the main driver for this development is the end customers' need for transparency, just-in-time arrival delivery and low costs.

Optimising the connections between these elements will reduce fuel consumption and the related emissions significantly for the whole logistics chain as well as reduce delays in the deliveries. Digitalisation will not by itself create zero-emission vessels, but it will significantly lower the energy needed for transporting goods.

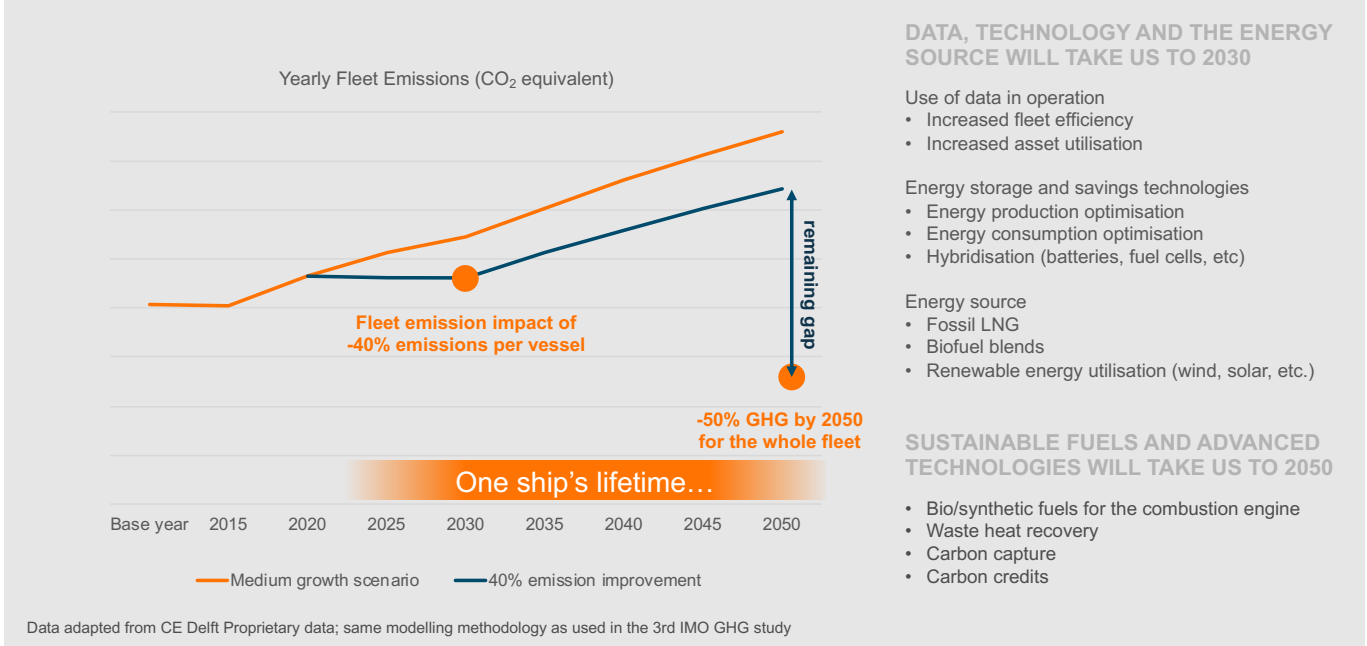
As the Smart Marine Ecosystem becomes

the industry's preeminent operating model, shared capacity will improve fill rates and reduce unit costs, big data analytics will optimise both operations and energy management, intelligent vessels will enable automated and optimised processes, and smart ports will deliver smoother and faster port operations.

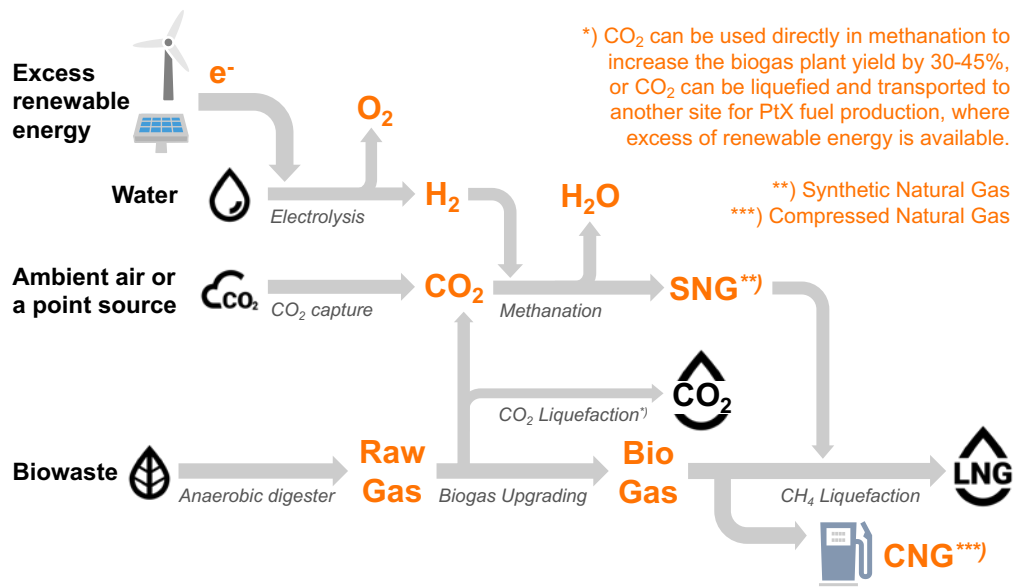
Conclusions

Despite the significant challenges, a road map towards zero-emissions shipping is beginning to crystallise. Already, sulphur, particle or black carbon emissions and NO_x emissions of a low-pressure engine are compliant with Tier III. But in order to reach the 2050 target set by the IMO, the industry must focus on rooting out inefficiencies, utilising onboard wind and solar power, increasing LNG investments globally, working on fuel flexibility for engines, and expanding capacity investments for biogas and synthetic fuels to be mixed with LNG.

To reach the targets of the Paris agreement and IMO 2050 we need to start acting *now* and today the only established fuel that takes us towards these goals is LNG. Fossil LNG is however only an intermediate fuel, and a parallel increase in production capacity for making bio-LNG and synthetic LNG using



■ A sustainable future requires cleaner fuels.



■ Multiple pathways towards sustainable LNG.

renewable energy sources is imperative as we recover waste/side streams from agriculture, the food industry, landfills and wastewater treatment and turn that into biogas or bio-LNG (LBG). In the future, there will be other fuels and technologies that will help us de-fossilise the shipping industry, such as

ammonia, methanol and fuel cells. However, today the combustion engine with LNG is the only way to put a real dent in GHG emissions. And the longer we wait, the bigger the challenge will become. We have the means, we know the goal, so the time to act is now.

To comply with the IMO targets, radical change is needed – both in vessel design and in power generation. However, the main challenge is fuel, and the related global investments in its production and infrastructure. ●