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WÄRTSILÄ TECHNICAL JOURNAL

in detail

issue no. 01 2018

COVER STORY

TESTING THE LIMITS
Wärtsilä's newest engine and its ground-breaking new design

22 page

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WÄRTSILÄ HEADS TO A SMART AND SUSTAINABLE FUTURE

Many industries are embracing connectivity and collaboration – including at sea. Wärtsilä's Smart Marine Ecosystem vision is to make shipping intelligent by connecting smart vessels with smart ports. Although the future is always somewhat unmapped, the direction is clear. Hence, Wärtsilä recently acquired Transas, a global market leader in marine navigation solutions.

Wärtsilä is taking concrete and tangible steps towards smart shipping, and the acquisition is in line with our Smart Marine Ecosystem vision and strategy. Our product portfolio is the biggest in the marine industry, and now the solutions we can offer with Transas will further increase the cost-efficiency and eco-friendliness of our customers' vessels.

Taking the environment into account is not just words on paper for Wärtsilä. In this issue, you can read how Wärtsilä's Voyage Emission Reduction (VER) (page 24) system helps reduce volatile organic compound emissions on vessels. On a Very Large Crude Carrier, the system can prevent the loss of up to 270 tonnes of cargo a week, all the while helping protect the environment from potentially harmful emissions. It makes financial sense, too: the solution spells potential annual savings of up to USD 2 million.

Things like the aforementioned acquisition as well as VER are perfect fits for our overall purpose: enabling sustainable societies with smart technology. Smart and sustainable often go hand in hand, complementing instead of contradicting each other.

Wärtsilä's approach acknowledges players of all shapes and sizes, and the Smart Marine Ecosystem is keen to invite new innovations on board. As part of our digital transformation, we've established a new venture model, including a programme called SparkUp Challenge.

The theme of the first round was marine technology, and at the end of February, 2 out of 11 finalists were announced as winners after a day full of pitching (page 48). SparkUp Challenge is one of the building blocks of Wärtsilä's ecosystem as well as a key contributor to our Smart Marine vision. The next challenge will revolve around Smart Energy, again looking to bring together smart and sustainable business opportunities.

In the world of rapidly evolving technology, the only constant is change. At Wärtsilä, we're at the forefront of digital transformation in the marine and energy industries – but we can't do it alone. In order to build a complete ecosystem, we need a network of partners and collaborators. Together, we can not only serve our customers better, but also better the world by looking after our shared environment and giving it the care it deserves.

Ilari Kallio
Director, Digitalisation
Wärtsilä Marine Power Solutions
Editor-in-Chief of In Detail

MAKING WAVES

A new breed of eco-friendly tugs is helping improve sustainability.

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The perfect backup fuel?

Natural gas, which has a small footprint, may be the right choice when a large amount of fuel is needed.

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A design process based on modularisation will increase efficiency, reduce production time and improve reliability.

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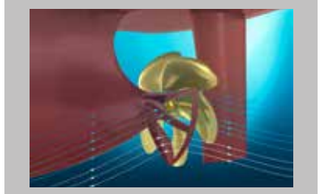

Taking propulsion to the next level

Wärtsilä's EnergoFlow reduces rotational losses in propulsion systems, boosting efficiency.

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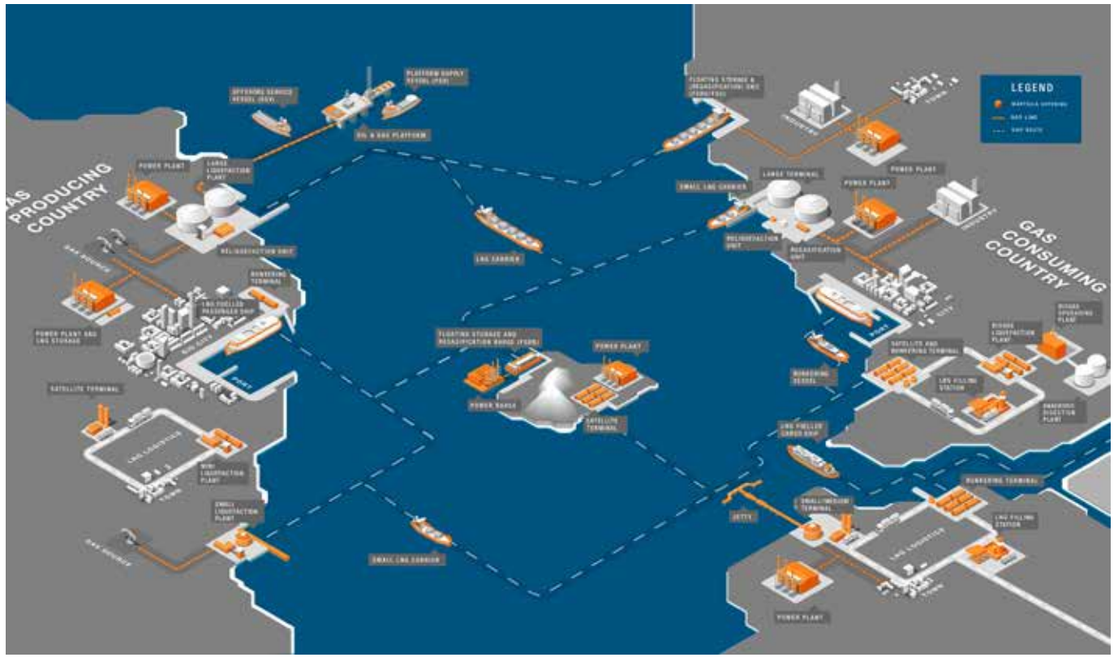

LNG terminals – land-based vs. floating storage and regasification technology

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One often reads or hears people say that floating storage and regasification units (FSRUs) are more economical solutions compared to land-based terminals. What is the basis for such a statement? Is it accurate? To answer that question, one needs a short history lesson to understand the past.

History

Floating storage and regasification units (FSRUs) as a concept were developed in 2005, driven by the need for a fast delivery LNG storage and regasification solution. The first FSRU was not a new-built unit but a conversion of an existing LNG carrier (LNGC) by a shipyard. The concept was a success, and more projects were developed. These first FSRU projects had a short delivery time in comparison with land-based terminals, which was the main driver. Simultaneously land-based terminals were built for long-term operations.

Looking at the installed FSRUs today, most of them have a good reason for being developed: some are political, while some are based on location, schedule, public safety or environmental constraints. These factors have been the determining factors for the selection of FSRUs versus land-based LNG terminals. So, can one say that FSRUs compete with land-based solutions? No, not really; they are more a complement to each other, since the projects are very different. The values FSRUs bring to the LNG value chain are not the same that land-based terminals do. (Figure 1)

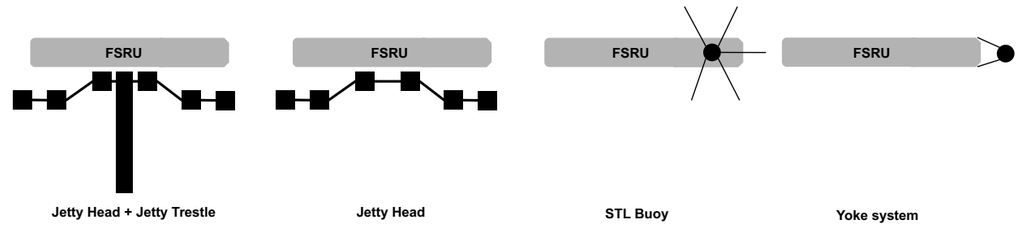


Fig. 1 - LNG terminal comparison. Historical concepts (mooring systems and layouts).

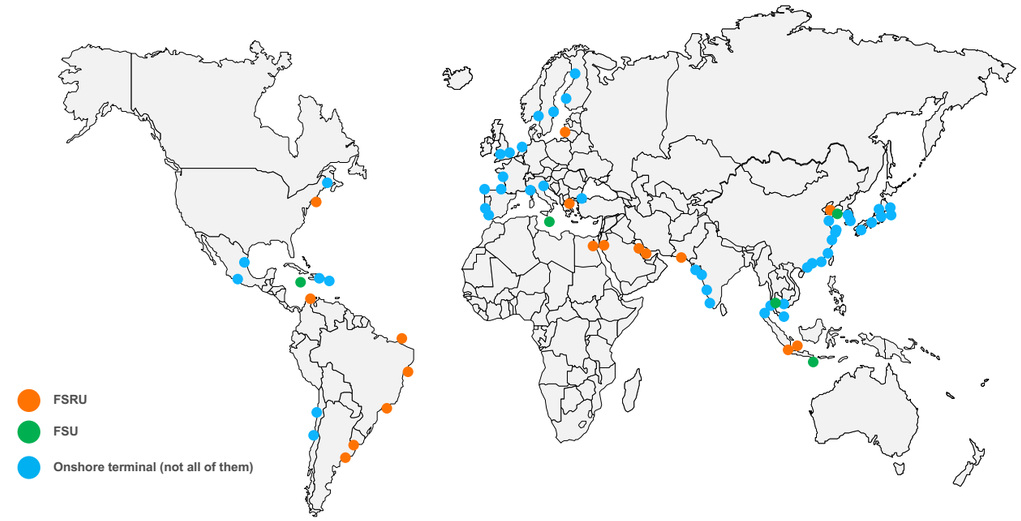


Fig. 2 - LNG terminals worldwide.

The FSRU concept

The most common concept for FSRUs is mooring at shore (> 60% have jetty + access trestle). This is the conventional FSRU and commonly referred to when comparing with land-based terminals. There are also concepts that use other kinds of mooring technology. These are, generally, more expensive systems that are used where conventional jetty structures are impractical to construct or are not permitted.

In general, land-based LNG terminals are more multifunctional terminals, since they also have LNG onshore. These functionalities might be reloading of LNG feeders, bunkering of vessels and LNG tanker truck loading systems, which may be of importance in certain markets and infrastructure systems. The majority of the FSRUs are also located onshore, so the functionalities given could be adapted also to the FSRUs if there was a need for modifications in the existing infrastructure. The most common FSRU concepts are single-purpose terminals with a national pipeline gas supply or large-scale power generation.

That said, developing a project with FSRU technology limits one to a fixed storage volume and send-out volumes suitable for a national pipeline. However, flexibility can be achieved if there is a possibility of sharing the units with multiple locations when there are seasonal send-out needs. (Figure 2)

CAPEX vs. OPEX

What favours floating solutions is the upfront investment, unlike the case in a land-based solution. Financing is key to success when comparing with the use of chartered units where it will be on OPEX.

Currently (March 2018), the charter rate for an FSRU is USD 80,000–120,000 per day depending on time charter period, location and size. This easily adds up to MUSD 29.2–47.5 on an annual basis. This is for the charter, e.g., the FSRU, insurance, crew and maintenance, and on top of this

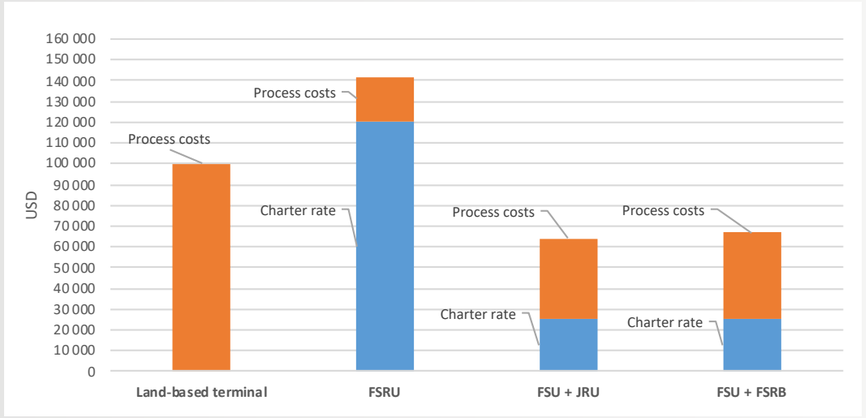


Fig. 3 - Daily equivalent costs.

come the regasification costs. Depending on regasification technology (sea water / glycol or steam system) and capacity, we need to add another USD 15,000–25,000 per day for a 300–500 MMSCFD send-out regasification system.

During the last few years, another comparable system, a floating storage unit (FSU), has been used in several projects.

These units are equipped only for storage. The regasification system is installed either on a jetty, on a separate floating storage regasification barge (FSRB) or on a land-based terminal. The fact that idle LNGCs are available in the market now enables faster delivery of these projects. However, conventional LNGCs (also known as "old ladies") are currently based on charter rates of USD 25,000–40,000 per day, and when it comes time to replace the LNGC, there's no telling what the charter rate would be. (Figure 3)

When constructing a land-based terminal, one does not have any charter costs for storage and regasification, since the costs of this functionality are part of the CAPEX cost of the terminal.

The cost of an engineering, procurement and construction (EPC) project of course depends on many parameters, everything from send-out capacity and storage size to location (bathymetry and met-ocean conditions). Assuming a typical location representing a majority of the FSRUs, e.g., on shore at a jetty head, we can compare the CAPEX and OPEX costs of floating versus land-based LNG terminals.

Studying the CAPEX and OPEX (see Figure 4) shows the cumulative cost over a 20-year period (assumed project lifetime) with various technologies. As can be seen from the graph, the breakeven is about six to seven years for FSRUs versus land-based terminals. (Figure 4)

What is interesting is combining an FSU (and also using the FSU as a carrier) with an FSRB that is used as a buffer storage while the FSU is on voyage. This is a good concept, since you have the regasification on board the FSRB and the concept is easily deployable for other locations. This can also be used as an intermediate solution during the construction of a permanent asset.

By adding a small power plant to the concept, we conveniently solve the boil-off gas management during low send-out periods or seasonal periods by generating electricity for the grid. The waste heat from the power plant cooling system can be used for LNG evaporation, e.g., increasing the overall efficiency of the installation. (Figure 5)

How to select technology

How does one make the selection for an LNG terminal technology? In general, one can say if the project lifetime is more than 10 years, it is more economical to use a land-based solution. Other selection criteria would be the need for fuel diversity, permanent asset and operational availability/reliability and financing.

The storage volumes and regasification volumes of land-based solutions can also more easily be expanded if needed, with the assumption that land area will be available.

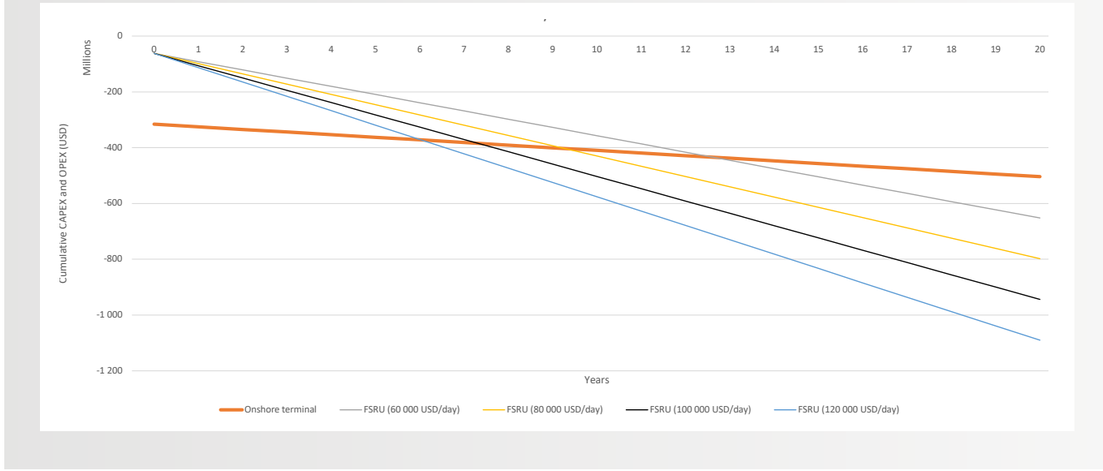


Fig. 4 - Lifecycle cost comparison of FSRU, FSU and land-based terminal.

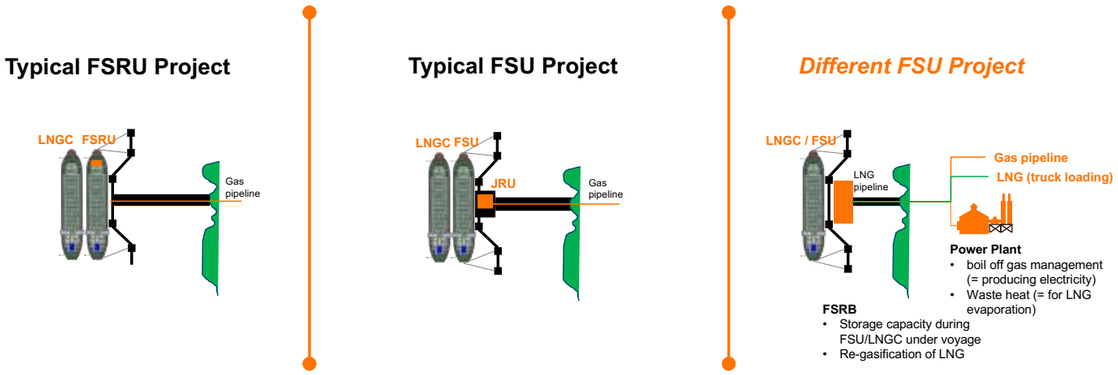
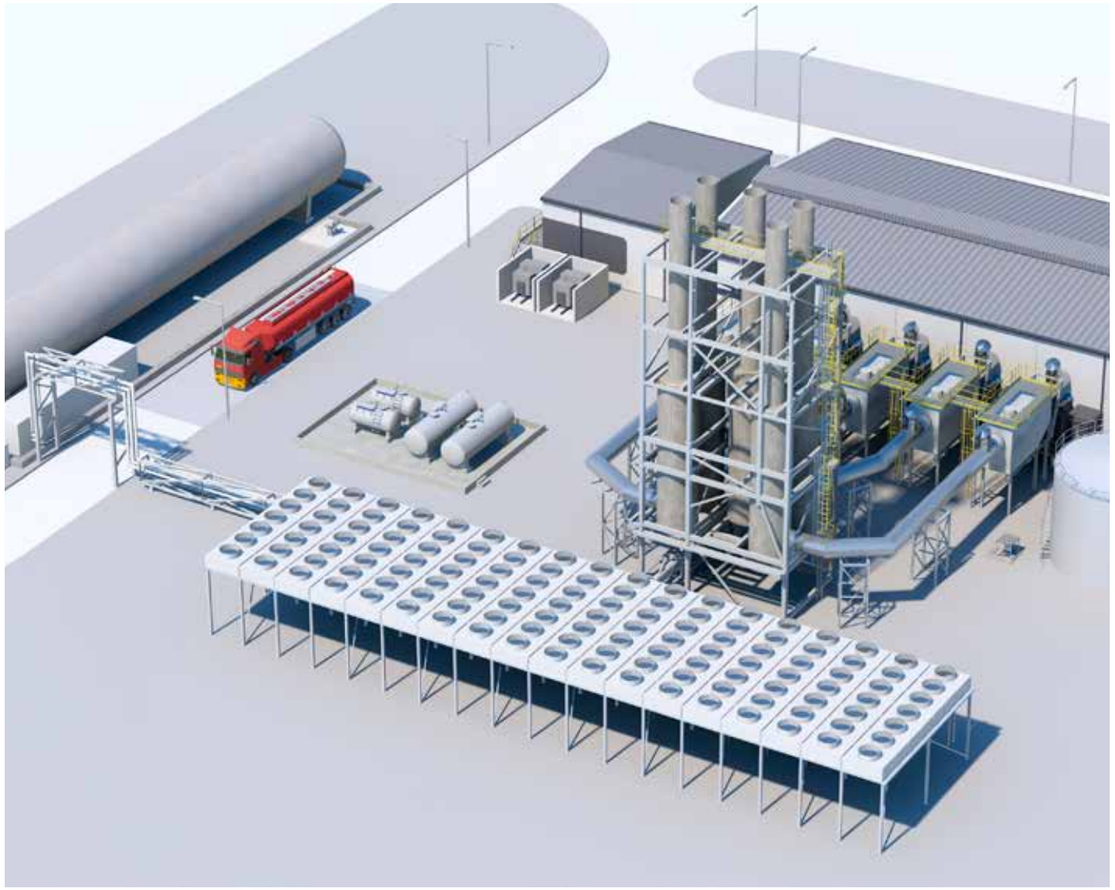


Fig. 5 - Concepts.



Natural gas takes the role as backup fuel

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The market for energy production, using gas, is ever growing. More customers want to go for a pure gas engine for varied reasons – environmental, legislative or even political. With this change, though, comes the need for a reliable and affordable backup solution using gas fuels. This article will focus on the different ways in which natural gas can be used to ensure production of power in power plants.

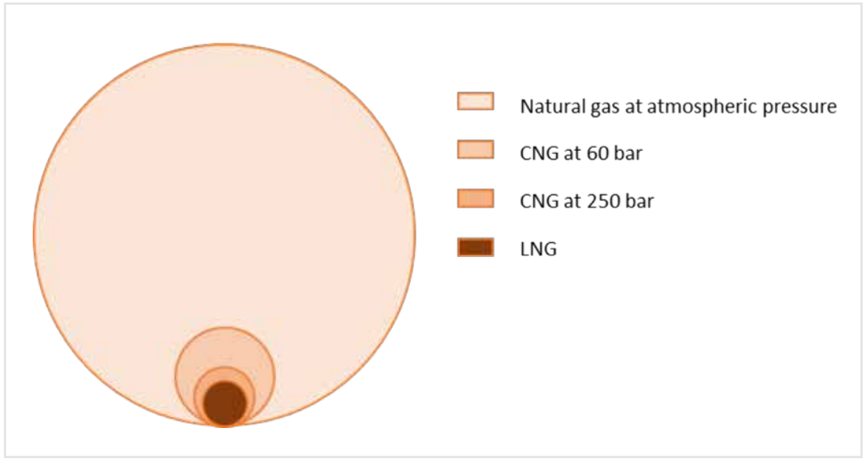

Fig. 1 - The relative volumes of one unit of natural gas in different states.

The choices available for storing natural gas are limited, particularly for small-scale solutions. We either need to compress the gas to compressed natural gas (CNG) or liquefy to liquefied natural gas (LNG). For large-scale solutions, on the other hand, there are other solutions available. Pumping gas in under bedrock or salt formations is a case in point. If we do not produce gas on site, we can get the gas to site in three different ways: by truck, ship or pipeline, or using a combination of the three.

If you intend to connect your power plant to a gas pipeline, you must answer two simple questions:

1. Can you always get gas from the pipeline at an attractive price?
2. Can you get the required volume you need?

Many pipelines are struggling to cope with high demand. This often leads to price spikes or shortages of gas during certain periods, which could further lead to costly outages or expensive power production.

When evaluating the backup options for a power plant the main focus should be on location. It is crucial to ask where the power plant is located in relation to a gas or LNG source and how it can be accessed.

If the plant is located inland, there is no point considering bringing the gas in by ship. If the plant is connected by good roads and at a short distance from an CNG/LNG plant, the easiest way to get gas is by using a truck loading system that supplies CNG/LNG. If the plant is located far away both from the coastline and its closest CNG/LNG facility, other means should be considered.

Using pipeline gas to create onsite storage can be an efficient way of ensuring gas availability and evening out spikes in supply.

Then comes the question: high pressure or low temperature, or in abbreviations: CNG or LNG?

Finding the optimal solution

When designing a CNG system, the pressure is the main point to consider. High pressures give a small storage volume but incur high costs in compressors and storage tanks. While safety measures from different pressures vary, legislations adds some limitations too. This has to be taken into account and optimised to see what is the optimal point in the equation.

It is good to note that the needed amount of backup fuel decides the feasibility of CNG.

If a large amount of fuel is needed and smaller footprint is attractive, LNG might be a better solution. Installing liquefaction equipment and LNG storage on site can give a reliable backup with a lot of flexibility. If short outages of pipeline gas are expected and the time between these are long, the capacity of the liquefaction system can be small (and cost-efficient) and the storage can be bigger to give a longer backup time.

Figure 1 shows the relative volume of gas in different storage solutions. The figure shows the little space LNG takes compared with uncompressed natural gas. The volume requirement for a CNG system at 60 bar is already significantly smaller.

In order to show the difference between the solutions, let's look at a case study.

One power plant, a 100 MW peaking plant that runs five hours per day, is located on an island with limited infrastructure and no LNG available. It uses a pipeline with a limited gas volume. The pipeline gas cannot be used during peak hours of the day. However, the volume during off-peaking is sufficient for a larger offtake. This means two of the five hours it runs, the gas supply from the pipeline is not enough. A small backup storage for short-term storage is needed. The only acceptable solution is to use pipeline gas during off-peak hours and turn it into CNG or LNG for storage.

The most expensive equipment on CNG plants is the storage tanks and the most expensive part of a small-scale LNG plant is the liquefaction. The volume of gas needed to be stored for the backup operation cannot

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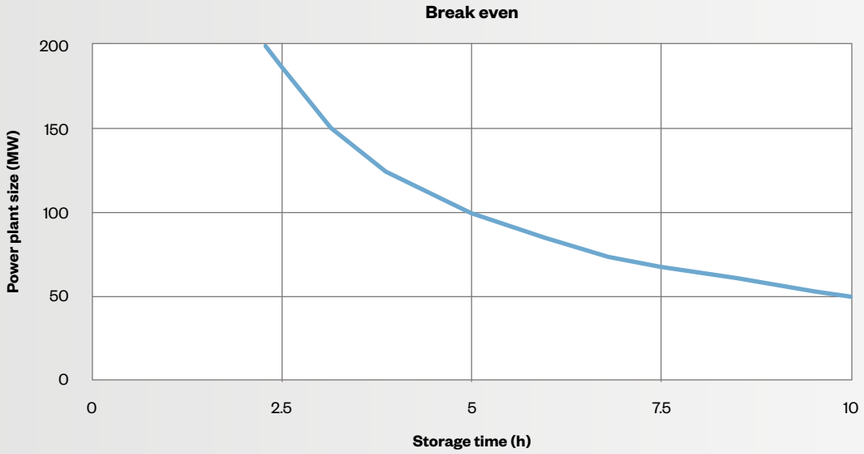

Fig. 2 - Break-even point for investments between the CNG and LNG solutions, where the solution is favourable for CNG on the right and LNG on the left.

be changed, so the possibility to affect the size of the LNG system is limited. The size of the CNG plant can be affected by using higher pressure.

A comparison was made to find a break-even between the investments of the two solutions. The off-take from the pipeline into the storage solution and the filling of the system is continuous. The system gets filled in a week. The total number of hours of backup power is presented in Figure 2.

The graph shows that, for example, when building a 100 MW power plant it is more cost efficient to build a compressor station and a CNG storage facility as long as no more than five hours of backup is needed. If, however, the assumption is that the gas pipeline will have outages of more than that it is more cost-efficient to use a liquefaction process and have LNG storage.

In Figure 3, a price split between the two different solutions can be found. The case is for a 100 MW power plant at the break-even point (five hours of backup power needed per week). It can be read from the figure that the major cost for this size of LNG plant is the liquefaction system, but with the simpler system of the CNG plant, storage accounts for the major cost. The cost for the regasification system for the LNG system and the pressure reduction unit in the CNG case are relatively close in cost.

The example location explained above did not have the possibility to get LNG delivered to site. A comparison with the same system with the opportunity of getting LNG supplied by truck is included in Figure 3. The advantage to the liquefaction on site is that the production of LNG is much cheaper, and the storage costs are much lower when compared to the CNG case. In this case the main components in the system are a truck loading station to receive LNG, an LNG tank for storage and a regasification system for restoring the liquid to gas.

Money matters

The CAPEX difference between producing gas backup on-site and bringing LNG to site is large. The limitation with the latter solution is that the plant is dependent on getting fuel delivered to site. This has to be timed and planned, and the fuel has to be bought from an LNG plant. The OPEX of this solution is commonly higher than those of both the CNG and the LNG case, as the LNG has to be contracted and transported to the site.

The same comparison could be done to trucking CNG to the site, or using ships for LNG or CNG transport. The CNG trucking and shipping is, in certain areas, a widespread and tested technology, and in other areas it is virtually non-existent. The optimal solution is based on the availability of these products.

The case study presented only gives a snapshot of the situation of one case in a specific region. The case will be very different if we do the same exercise for another area, another off-taker or a different filling time for the project. If the footprint can be larger on site, the equation could be different: if the price for storage changes, the preference moves again towards CNG.

In the end, what backup solution is needed depends entirely on the on-site conditions. The first question to address is the size of the backup. Is the storage supposed to be for one hour, one day or one week? The possibility of bringing LNG to site is the second question: where can it be sourced and how will it be delivered to site? If the distances are long, or the prices for transportation are high, it might not be a feasible solution to rely on fuel being transported to site. If it comes down to producing backup fuel on-site, the possibilities need to be weighed against each other: is compression the most cost-efficient way or is it liquefaction?

For a way to start, please see Table 1. The key questions that need to be answered are given with examples of what the answers could be. Every aspect has to be reviewed to reach an optimal solution, and this is not always an easy task. The answers are not always clear and they might even change during the project development. The sure thing is that solutions exist (in abundance) and at least one solution is possible for each power plant.

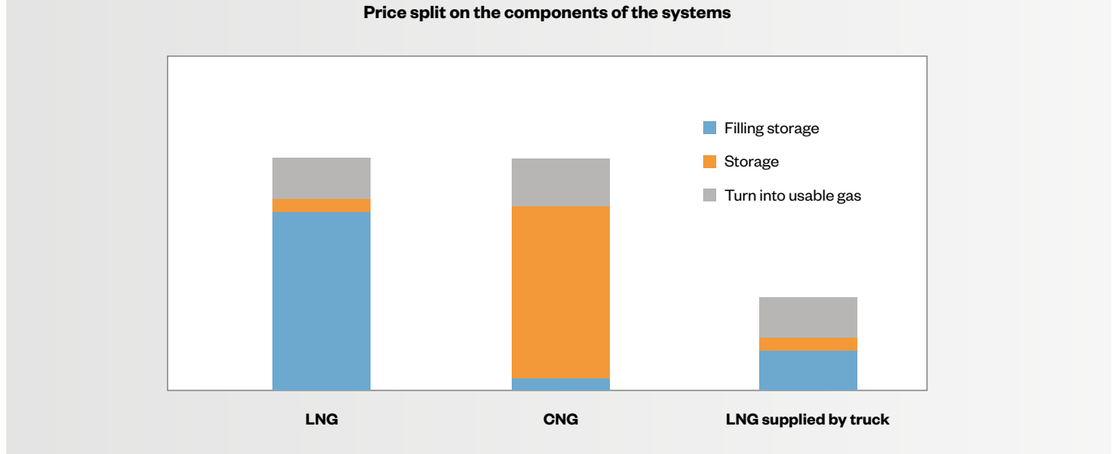

Fig. 3 - A rough price split between the different solutions for a 100 MW power plant at the break-even point as well as a comparison to the cost of a system supplied by LNG trucks. (Note that this is a simplified study without considering the limitations of the systems in question.)

Questions	WHY do you need backup?	FOR HOW LONG do you need the backup?	WHEN are you going to use the backup fuel?	HOW can you acquire the fuel?	WHAT are your restrictions?
Possible answers	Unstable gas grid Price fluctuations in grid Emission and backup requirements in legislation	2 hours 2 days 2 weeks	Every day Every week Every month	Compress to CNG at site Liquefy to LNG at site Bring CNG or LNG to site by truck or ship	No coastal access Limited space available on site LNG/CNG availability low

Table 1 - Where to start when figuring out the backup system for your gas-pipeline-connected Wärtsilä power plant.

Next-generation energy storage systems

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What is driving the growth of energy storage? How can operators derive maximum returns on their investments, and what are the challenges they should be prepared for? We answer these questions and more in our analysis.

The Energy Storage Systems (ESS) market is witnessing a boom.

This spurt in growth can be attributed to price declines in energy storage technology as well as an increased need for storage due to global deployment of renewables generation. Most importantly, energy storage has become a conventional, grid-reliable resource.

The Aliso Canyon crisis in California shows why. In 2015, a major leak in the Aliso Canyon natural-gas storage facility in Southern California led to a high likelihood of power outages for the grid.

In the following year, leading energy storage vendors deployed three lithium-ion (Li-ion) battery-based systems with a total capacity of 70 MW / 280 MWh to compensate for the power capacity shortage owing to the Aliso Canyon leak.

Upon the successful completion of the projects, the commissioner for California Public Utilities, Michael Picker, said, "I was stunned at the ability of batteries and the battery industry's ability to meet our needs. This was something I didn't expect to see until 2020. Here it is in 2017, and it's already in the ground."

Estimates suggest that the ESS market is expected to touch USD 7 billion by the year 2025 against USD 1.5 billion in the year 2016, registering almost a five-fold growth.

One major barrier to growth comes from the risk associated with financing. While ESS solutions are tailored to operate for 10 years or longer, investors demand the solutions to deliver over their lifetime to accomplish considerable returns. The absence of meaningful data related to the long-term performance of grid-scale ESS coupled with uncertain markets for ESS leads to challenges of revenue forecasting. Owners of energy storage systems will thus have to 'future-proof' their deployments to maximise their return on investments (ROIs).

Limited track record

The energy storage database by the U.S. Department of Energy (DOE) lists only 14 grid-scale ESS projects, globally, that have an operating history of at least 10 full years. The average operational lifetime of grid-scale battery energy storage systems stands at four years and nine months.

This is perhaps because a large number of the systems have been operated as pilot projects to test a host of applications rather than running as full-scale mission-critical resources similar to the present-day systems. In addition, vendors roll out new energy storage products every 12–18 months, which means that past performance may not serve as an indication of future results.

Among ESS projects that have been operational for multiple years, the track record is mixed. To bolster the progress of grid-scale storage, the DOE invested in a nascent project in the ERCOT market to showcase the capability of advanced lead-acid battery technology to offer renewable firming and frequency regulation. The DOE's objective was to procure technical and economic data from the project to gear up for future deployments.

Upon its installation, the operators found that the most profitable application for ESS was Fast-Responding Regulation Service (FRRS), a pilot program in ERCOT crafted to take advantage of the capability of fast-responding resources, like ESS, to alleviate grid frequency deviations.

Unfortunately, advanced lead-acid batteries turned out to be an unfavourable option for the case and the ERCOT ESS witnessed extreme degradation, which required replacement years before the expected end of the system's lifetime.

Revenue uncertainty

Additionally, many of the vital electricity market services which ESS offers are garnered via short-term contracts.

Other important services are procured on a complete merchant basis via day-ahead bidding. This is in contrast to solar and wind asset investments, which typically generate stable revenue for investors via long-term power purchase agreements. ESS projects often generate revenue via ancillary services as well as capacity markets, which often do not come with long-term contracts.

The market value and procurement mechanism for these market services will change in unknown ways over the life of the ESS asset.

Faced with a limited track record of the ESS installation base along with revenue uncertainty, the only option for an ESS owner to mitigate risk is to future-proof existing ESS investments to plan for future changes.

What does future-proofing entail?

A crucial step towards future-proofing ESS involves deploying technology as well as project engineering that primarily focuses on scalability.

ESS projects can be future-proofed by:
1) installing a flexible controls architecture,
2) planning the right way for battery

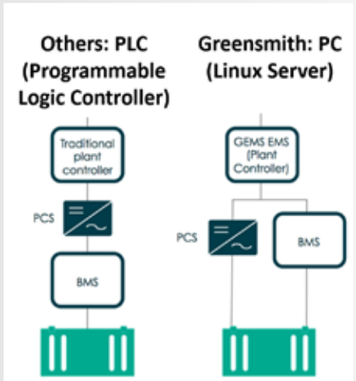

Fig. 1 - The PC-based approach communicates directly with PCS controller and BMS to abstract all technology characteristics and enable technology-neutral architecture.

capacity augmentation, and 3) tracking ongoing operation with a flexible warranty.

Let's start with architecture. There are two control architectures for ESS Energy Management Systems (EMSs): PLC-based and PC-based.

A programmable logic controller (PLC) is as a hardened industrial computer, designed originally for assembly lines. PLCs are 'hard' systems that are programmed to cater to specific tasks. They are programmed to accept limited inputs and outputs to achieve the task.

Modifications are possible, but they take significant time and effort and typically require an engineer onsite for months at a time. This makes the cost of PLC modification relatively high.

A personal computer (PC)-based controller is built on multi-purpose industrial servers and is controlled by software. (Figure 1)

PC-based architecture aids complex operation and optimisation and enables updates to be delivered quicker and at reduced costs. (Table 1)

The Greensmith Energy Management System's control platform, for example, is crafted with a modular and technology-neutral architecture. This means the same controls platform can be used with any inverter technology and battery with minimum configuration.

A flexible control platform also allows flexibility to be embedded in ESS design through a battery augmentation plan. Battery augmentation involves leaving sufficient space at site for extra battery racks, and scheming cable and wiring trays for the future state of the system where some battery racks could be moved and additional racks added.

The challenge with battery augmentation is that old and new battery racks cannot be wired in parallel to the same inverter bus. If vintages are mixed, the newer battery racks are at risk of an overcurrent fault. A correct battery augmentation plan keeps new and old batteries separate, and with the management of new and old battery banks as separate systems. This management requires a flexible energy management system that can co-optimize distinct assets, which is feasible with a PC-based EMS. (Figure 2)

Finally, the battery warranty must be maintained despite any changes in operation profile. Li-ion battery warranties are complex. Warranty terms often include: energy throughput, peak charge/discharge rate, average charge/discharge rate, average temperature, maximum temperature across measurement points, etc. In addition, the battery management system (BMS) does not record these values.

Without an understanding of battery degradation, battery owners cannot determine if it will be more advantageous to chase additional revenue, or rest the batteries to minimize degradation. The only way for system owners to make informed decisions is to track all revenue and

Capabilities enabled with a flexible PC-based architecture	Example Greensmith deployment		
	Date	Location	Description
Repurposing of existing ESS asset	2011	California	50 kW ESS sold from initial owner to secondary owner and repurposed for new use case with remote software update
Dual battery operation	2015	Virginia	60 kW ESS (50 kW flow + 10 kW electrochemical), unified control platform
Co-optimization of multiple generation assets	2015	Puerto Rico	1 MW ESS + 2 MW solar, unified control platform
Flexible augmentation plans (one controller optimizing the output of batteries with different vintages and performance characteristics)	2016	California	20 MW, augmentation pre-planned for 2021

Table 1 - Case studies demonstrating the capability of a PC-based architecture.

Original installation
Hypothetical system of 4 inverter banks, each with 3 battery racks at date of installation.

Battery rack-based augmentation
Under rack-based augmentation, a new battery rack is added at the end of battery banks.

Inverter-based augmentation
Under inverter-based augmentation, old racks from Inverter 1 are redistributed to banks behind Inverters 2, 3 & 4. All new racks are in one bank feeding Inverter 1.

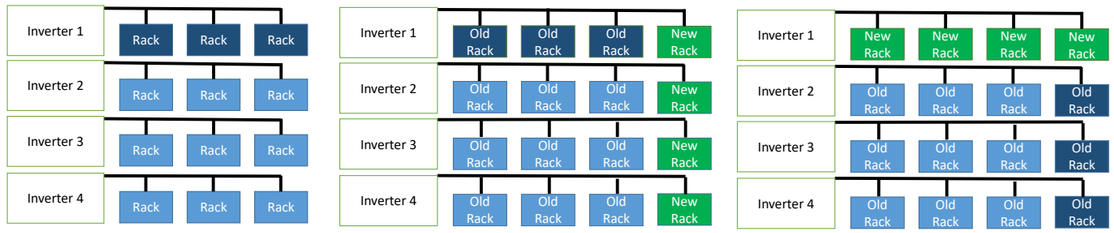

Fig. 2 - Hypothetical augmentation scenarios. The charts assume a central inverter design, which is representative of most operating energy storage systems.

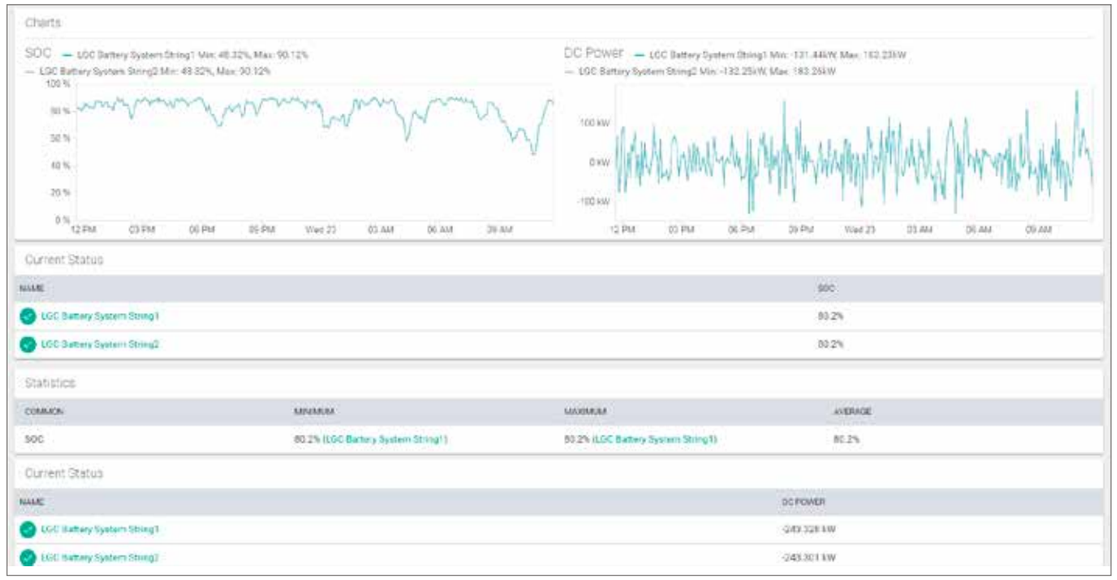

Fig. 3 - GEMS dashboard tracks values associated with warranty compliance; provides analytics as well as full data export capability (csv).

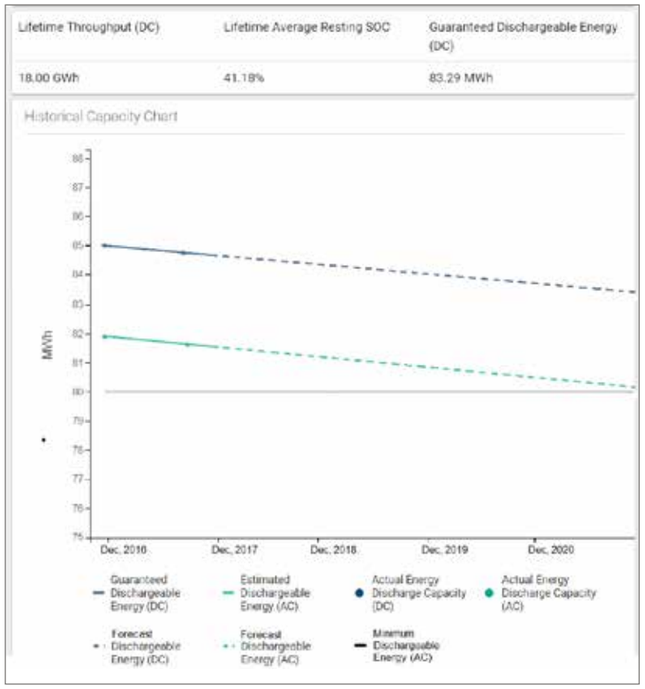

Fig. 4 - GEMS Analytics Dashboard showing forecasted battery capacity warranty based on battery usage scenario.

Fig. 5 - 20 MW / 80 MWh ESS in California with planned augmentation and flexible warranty.

battery health values using dashboards and analytics. These are core functions of the GEMS platform. (Figure 3)

Case study of ESS future-proofing

ESS projects designed by Greensmith for the California market provide an example of future-proofing. ESS projects in California provide the state with a capacity service known as Resource Adequacy (RA). For energy resources that are limited such as ESS, RA contracts need to have four hours of discharge duration at rated capacity.

As part of Greensmith's future-proofed ESS offering for California, GEMS tracks the warranted capacity of the batteries and displays trend values over time. At the same time, Greensmith designs for flexibility with a planned inverter-based augmentation in the middle of the system's expected lifetime. If the owner chooses to run the system more aggressively for more revenue, this augmentation can occur sooner with more batteries augmented. Likewise, if the owner chooses to run the system less aggressively due to unattractive market conditions, the augmentation can be delayed or even skipped to reduce cost as much as possible. By tracking the battery's flexible warranty, GEMS enables the system owner to make tradeoff decisions for various market conditions (Figure 4). This future-proofed offering was deployed as part of a 20 MW / 80 MWh project in 2016. (Figure 5)

This flexible approach provides an ESS owner with more confidence that merchant revenue is attainable, which boosts returns and allows for competitive bidding in RA tenders.

Conclusion

ESS owners must plan to future-proof energy storage to take advantage of revenue streams that are not contracted. These revenue streams are uncertain, so a flexible system design is necessary to be confident that the revenue streams are attainable. In California, the risk includes merchant market revenue, which augments revenue from a bilateral capacity contract. Storage owners who do not consider extra merchant revenue in their operational strategy will not be able to compete in tenders for long-term contracted revenue.

Greensmith has focused on crafting a software technology and an engineering philosophy with scalability and flexibility in mind. Regardless of the changes that come to battery storage technology or energy storage market earnings, its solutions will be armed with the flexibility to achieve maximum results for storage operators. That's the future.

Read the entire white paper here: https://www.wartsila.com/energy/learning-center/downloads/white-papers/future-proofing-energy-storage.

Photo: 123RF

Bright prospects for Wärtsilä's solar energy strategy

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The power industry is undergoing a global transformation. Wärtsilä is leading this change with its growing focus on solar photo-voltaic (PV) power solutions.

In a review of the renewables market in 2016, the International Energy Agency, Bloomberg and many others declared that solar will lead the charge of power generation capacity expansion in the next decades, far surpassing wind, hydro and any form of thermal power generation. The bullish forecasts were attributed to buoyed competitiveness in the sector driven by falling technology costs and lower prices.

The very same year, Wärtsilä launched its solar power strategy by introducing utility-scale solar photo-voltaic (PV) solutions. The offering comprises utility scale solar PV plants with a capacity of 10 MW and more, as well as hybrid power plants featuring solar PV systems coupled with internal combustion engines or energy storage.

Solar project in Burkina Faso harnesses advantages of hybrid logic

Wärtsilä moved quickly to implement the strategy, announcing its first solar power project in Jordan that year. The venture involved modifying an existing 250 MW engine power plant with 16 Wärtsilä 50DF engines delivered in 2014, and complementing it with a solar power plant of 52 MW peak capacity.

This was only the beginning. In March 2017, Wärtsilä announced that it had secured a turnkey delivery of 15 MW solar PV plant in Burkina Faso. This also is a hybrid facility featuring a solar power plant constructed alongside an existing 57 MW engine power plant powered by fuel oil. Both operate in a synchronised fashion to create the largest hybrid (engine-solar) of its kind in the world.

The new solar hybrid plant configuration maximises the utilisation of renewable energy at the Essakane mine.

The inauguration of the world's largest Solar Hybrid power plant was attended by representatives from Iamgold and Wärtsilä, as well as the President of Burkina Faso, Mr. Roch Marc Christian Kaboré.

The project was undertaken for Essakane Solar SAS, a company with majority ownership by global independent power producer EREN Renewable Energy (EREN, 90%) and by development partner African Energy Management Platform (AEMP, 10%).

As the operator of the plant, Essakane Solar sells the energy generated to IAMGOLD's Essakane mine. The off-grid gold mine lies 350 kilometres northeast of the Burkina Faso capital, Ouagadougou, and produces approximately 400,000 ounces of gold annually.

Wärtsilä's hybrid plant offers many advantages, particularly for off-grid facilities such as the Essakane mine. Cloudy skies can obscure the sun and reduce the output of a solar unit by up to 80% within a minute. When skies go dark, engines can immediately kick in and compensate for the loss of energy-producing sunlight by automatically boosting by dozens of megawatts per minute if needed. Internal combustion engines are still the only technology capable of providing such a high level of flexibility and responsiveness to power generation.

Moreover, the ability to synchronise and optimise the use of engines and solar power could see a reduction in fuel consumption at the mine by roughly six million litres per annum as well as an annual decrease in CO_2 emissions of some 18,500 tons.

Utility-scale solar PV plants in pipeline

Solar PV represented one third of all the power generation capacity increase globally in 2017, with close to 100 GW added in 2017 out of total of around 300 GW. This was more than any other power generation technology.

This development is expected to strengthen in the next decades, thanks to solar becoming a cheaper way of producing energy than any coal or gas-fired technologies.

Many emerging economies are now prioritising access to clean and reliable power as the bedrock for sustainable social and economic growth. At the same time, developed markets are also prospecting for alternative energy solutions and operational flexibility. These dual trends have opened up new opportunities for Wärtsilä to develop its expertise and footprint in the solar PV market.

The deals Wärtsilä has secured so far are just the tip of the iceberg in what it sees as a rich, renewable energy market. It is increasingly providing solutions for utilities, IPPs and industrial customers in Africa, the Middle-East, Latin America and South East Asia. Rapid growth in the solar sector spells a bright future for the power industry.

[ENERGY / IN DETAIL]

Wärtsilä 31SG, the world's most efficient 4-stroke engine

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In the price-sensitive field of electrical power generation, efficiency and flexibility are the hottest commodities. Wärtsilä's newest engine marks a step change in both, delivering an industry-leading efficiency of over 50 percent. The secret to its success is a ground-breaking new design, conceived entirely from scratch, that makes it tough enough to withstand the heavy mechanical loading associated with two-stage turbocharging.

The internal combustion engine has been through a lot since its advent roughly 200 years ago. It's fascinating to consider that, despite all the advancements made through decades of tinkering and tweaking, this 18th-century concept continues to be the basis of so much power production today. And the consensus is that there are still more avenues for design improvement that simply need to be worked out and tested.

It was with this thinking, six years ago, that engineers at Wärtsilä set out to do something that is quite rare among manufacturers of large engines. Rather than improving an existing design, they started from a completely blank slate to develop a new engine family that would be considerably more efficient than anything that had come before.

The result: Wärtsilä 31, available in diesel, dual-fuel and pure gas variants. Recently introduced is the spark-ignited Wärtsilä 31SG, the 20-cylinder version which produces 12 MW of power. When the first Wärtsilä 20V31SG rolled off the production lines last year, it became the world's most efficient simple-cycle internal combustion engine ever built.

The Wärtsilä 31SG's defining feature is its ability to reach efficiencies surpassing 50% – a milestone within the industry. By comparison, simple-cycle gas turbines typically have an efficiency of around 40%. Wärtsilä's existing generating sets had already far surpassed that mark, but this new engine widens the gap even further, representing a significant cost savings potential for power producers, as well as lower emissions.

Efficiency under pressure

Designing a new engine entirely from the bottom up gave Wärtsilä's engineers the unique opportunity to examine all of the various factors that contribute to engine efficiency, making improvements in each to achieve the most possible gain. Combustion quality, heat and flow loss prevention, and internal friction were among the issues exhaustively explored and addressed to their fullest.

The most critical advance in the Wärtsilä 31SG, however, was an engine structure designed expressly to accommodate two-stage turbocharging. While the considerable boost in efficiency associated with two-stage turbocharging was well known – the industry had already been experimenting with it for quite some time – no existing engines were capable of taking full advantage of the effect. They simply could not stand up to the loading and strain that results from the step change in firing pressure. To overcome this, engineers gave Wärtsilä 31SG's entire engine structure a very robust design with an unprecedented break mean effective pressure (BMEP) of 30 bars.

Naturally, having a design that incorporates efficiency-boosting concepts is one thing while bringing a new engine to life is another. Development of the Wärtsilä 31SG was a long and complex process that involved extensive computer simulation, testing on a single-cylinder experimental engine then testing on a number of multi-cylinder engines. All this was carried out to guarantee that the efficiency gains would be realized and that the final product would meet the highest standards of reliability.

Flexibility for today's power needs

A fundamental advantage of the Wärtsilä 31SG is its flexibility – its ability to start up quickly and maintain high efficiency throughout the entire load range.

This is extremely important in today's power generation landscape, where the aggressive growth of renewable sources has triggered a disruptive change. Conventional baseload is disappearing as power generators take on the new role of intermittently backing up the grid when the output from renewables dips. This shift represents a huge challenge for plant owners. Combined cycle power plants cannot cope with the daily starts, stops, and continuously changing load patterns that are becoming the new norm.

An internal combustion engine, on the other hand, is just the right tool for the job thanks to its dramatically more flexible operating profile. Needless to say, engineers wanted to push the Wärtsilä 31SG's flexibility to the cutting edge.

A major contributor to the engine's increased flexibility is its completely redesigned valve actuation method. The new design replaced the mechanical, rocker arm-driven valve mechanism of previous models with a hydraulic system, similar to those used in the car industry. This feature allows very smooth and precise control of valve timing to ensure that the fuel-air ratio in the cylinder is optimised at all times. It's in this way that the engine can take maximum advantage of the boost provided by two-stage turbocharging, specifically so on partial loads.

Optimised engine parameters and adjustable inlet valve timing combined with electronic ignition timing result in fewer unburned hydrocarbons and thus vastly improved efficiency and lower emissions irrespective of the load. An added bonus of the hydraulic valve actuation concept is that there's no need for valve clearance adjustment.

The level of flexibility found in the Wärtsilä 31SG is hard to overstate. The engine can be continuously operated at 10% load and can reach full load within as little as two minutes of the start command.

Total control

Automation is a key element of any modern gas engine, underpinning efficiency, safety and flexibility, but there are particular requirements for a machine as advanced and complex as the Wärtsilä 31SG. With 20 cylinders each firing six times per second and so many variables coming into play, the ability to easily harmonise and control every aspect of the operation is absolutely vital. Accurate, cylinder-specific control algorithms are essential for a gas engine operating with firing pressures this high.

For this reason, as part of the development of this engine, Wärtsilä went to great lengths to create a next-generation automation system, which is integrated into the engine itself. The system was built entirely in-house based on new hardware and software.

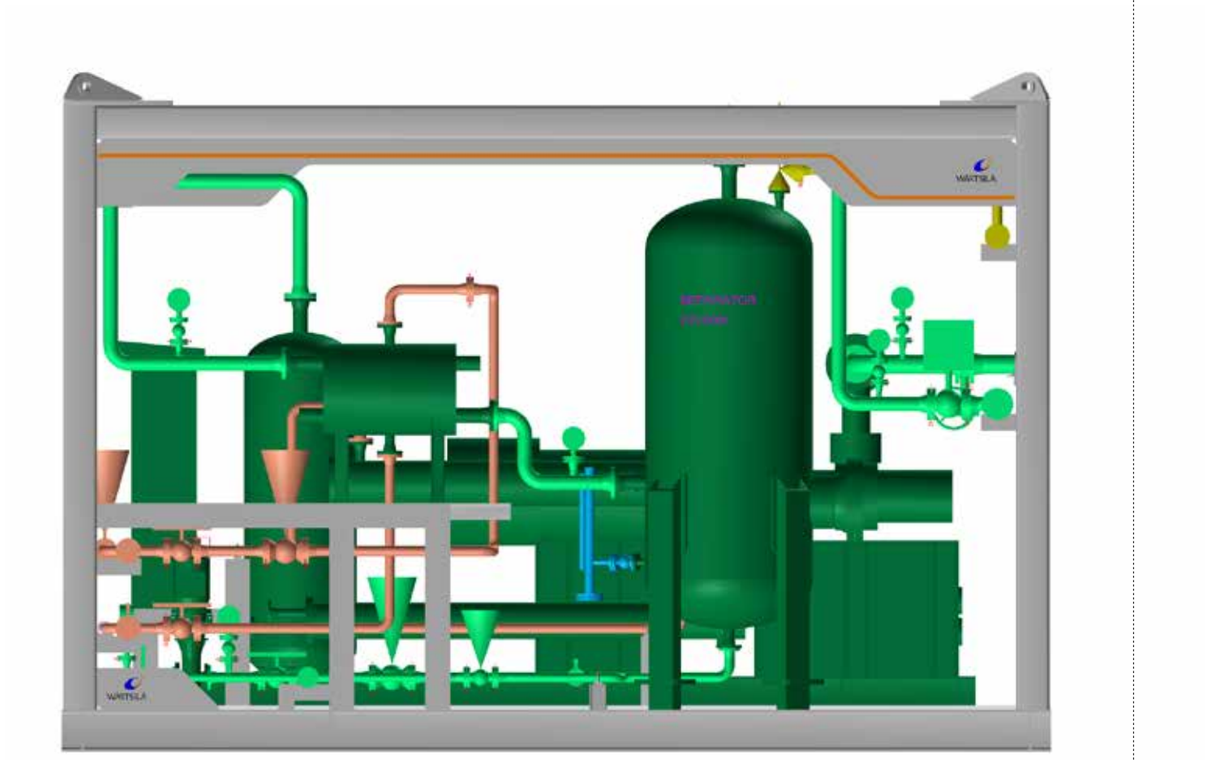
The engine automation system is distinctive for its wide implementation of digital controls, which regulate valve timing, gas admission, ignition, coolant temperature and various aspects of the turbocharging. It's this high degree of automation that allows the Wärtsilä 31SG to account for differences in fuel as well as run at various loads without compromising efficiency.

The new automation hardware is modular and integrated. All sensors are connected directly to the control ports, without going through connectors or junction boxes – a change that reduces the likelihood of faults. The equipment was also subject to rigorous vibration and heat testing to ensure that it would stand up to the difficult environment of an engine room, further boosting reliability.

The long view

The advantage of a more efficient engine like the Wärtsilä 31SG is obvious at times when fuel prices are relatively high. Yet interest in the engine has been strong in all of our markets, despite the fact that gas prices in certain regions are fairly advantageous at the moment. Today's investors recognise that an engine of this type is a long-term investment and that fuel prices can fluctuate radically from year to year, from decade to decade. These investors take a holistic approach, seeking both the lower lifecycle costs associated with prolonged maintenance intervals, and a buffer against potential shifts in the fuel markets.

On a more general scale, the world is likely to see a dramatic reduction in fossil fuel-burning power generation in the coming decades. This change will come about not only because of higher fuel prices, but also from political pressure leading to legal limits on emissions. The solutions that survive the test of time will be those that are most flexible and efficient. In both these categories, the Wärtsilä 31SG has a clear advantage. This is an engine built for the future.



VER fuel version skid showing the 2 stage compressor along with condenser and separator.

Wärtsilä Voyage Emission Reduction system turns emissions into fuel

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Wärtsilä has developed a groundbreaking new system that allows oil tankers to return potentially harmful volatile organic compound (VOC) emissions to the cargo tank, reducing cargo losses by up to 80%. The new Voyage Emission Reduction (VER) system is available in two versions – one for conventional oil tankers and another for LNG-fuelled tankers.

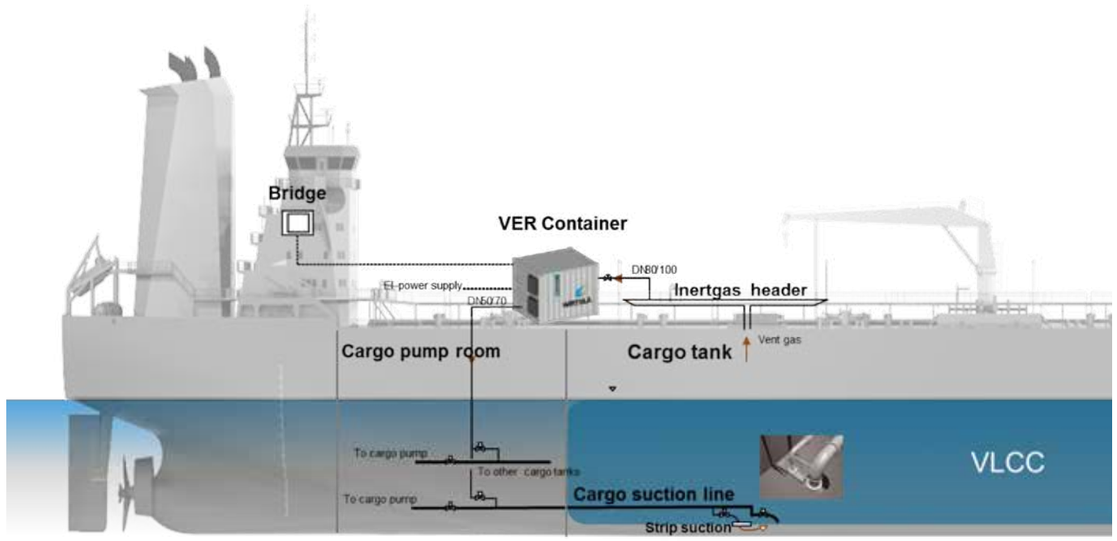


Fig. 1 - System overview – VER re-absorption version.

An oil tanker emits on average 0.085% of its contained cargo every week. This may not sound like much, but if you take a 320,000 deadweight tonnage (DWT) Very Large Crude Carrier (VLCC) as an example, this apparently small amount actually adds up to 270 tonnes of lost cargo every week. Take it a step further and look at an entire year and you will end up with a massive 5400 tonnes of lost cargo, assuming that the VLCC operates laden voyages for 20 weeks every year.

However, with Wärtsilä's cutting-edge Voyage Emission Reduction (VER) system, it will be possible to make losses like this a thing of the past. The groundbreaking system allows up to 96% of the VOC that is typically lost as boil-off to be converted back into fuel. On a conventional VLCC, the VOC emissions will go back into the cargo tank, while tankers powered by Liquefied Natural Gas (LNG) will be able to convert the VOC into fuel for use during the voyage. Both systems represent a unique, game-changing opportunity to increase revenues while, at the same time, significantly reducing the vessel's environmental impact.

VER re-absorption version – for conventional VLCCs

The version of the VER that has been designed for conventional VLCCs is based on a straightforward technology: a simple plug-in unit captures the VOC that would otherwise be lost and recirculates it back into the cargo tanks. In doing so, it prevents the loss of up to 270 tonnes of cargo a week, while, at the same time, protecting the environment from these potentially harmful emissions. (Figure 1)

VOC emissions from cargo tanks contain both methane and non-methane hydrocarbons. Considering the example of the VLCC that operates 20 weeks of laden voyages and loses 5400 tonnes of cargo in the form of VOC each year, this translates to the equivalent of up to 20,000 tonnes of CO_2 per year. With the Wärtsilä VER, 80% of that VOC is re-absorbed, thereby reducing local pollution by 80%.

A VLCC that re-absorbs 80% of the 5400 tonnes of cargo that would otherwise have been lost will be able to deliver an extra 4320 tonnes of cargo each year. This is equivalent to 27,700 barrels of oil, which, in turn, represents a huge amount of money – USD 1.9 million to be precise, based on present-day oil prices. Considering that a re-absorption version Wärtsilä VER costs around USD 1.2 million to install, the

[MARINE / IN DETAIL]

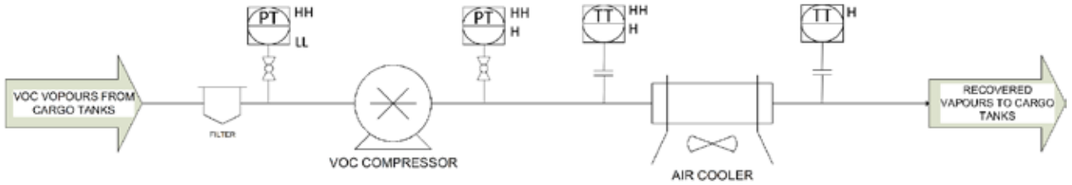


Fig. 2 - Re-absorption process flow diagram.

return on investment is excellent, equating to a payback time of a little more than six months.

The Wärtsilä VER re-absorption version is likely to be of particular interest to the global oil majors. Most fleet operators own the ships but not the cargo, but when an oil company owns the entire value chain, including a fleet of, say, 40 vessels, the opportunity to recover more than 4000 tonnes of oil a year would translate into a total saving of more than 160,000 tonnes of oil per annum, or USD 77 million worth of oil.

How does the VER re-absorption version work?

The Wärtsilä VER has been designed for easy installation, operation and maintenance. It comes in two versions; either with a capacity of up to 400m³/h (tankers up to 160 kTDW), or up to 800m³/h (tankers up to 320 kTDW). Both versions are delivered in a container that includes all the equipment needed to run the system. The only utility the ship needs to provide is electrical power.

The container is connected to the cargo tank vent line to allow the inlet of vapour and to the cargo stripping line to enable the VOC to be returned to the cargo tanks. The stripping pipe inlet on one or more of the tanks needs to be fitted with a simple installation for gas absorption, in order for the gas to be distributed for re-absorption into the cargo. (Figure 2)

Operation is automatic and no manual intervention is required. The plant operates within a fixed cargo tank pressure range and stops automatically at low pressure, while an automatic vent is activated at high pressure. As far as service and maintenance goes, routine maintenance will typically be carried out after the compressor and glycol pump have accumulated 5000 running hours. Standard maintenance includes changing the inlet filter and applying lube oil to the system.

Innovative features

The Wärtsilä VER re-absorption version contains innovative features that combine to make it a simple plug-and-play solution.

Firstly, the rotary vane compressor on the VER is glycol-cooled with oil lubrication. Its oil consumption amounts to less than 0.5 l/day of operation. It has an air-cooled electrical motor with a power requirement of 35/46 kW. It also has an air-cooled heat exchanger that serves three purposes: firstly it cools the compressed VOC to an air temperature of + 5°C, secondly it cools the glycol and, last but not least, it creates ventilation for the container. The VER system also comes with auxiliary equipment such as a glycol pump, inlet filter and re-absorption units for three or four cargo tanks. (Figure 3)

Easy operation

What makes the Wärtsilä VER re-absorption version even more unique is that it is so user-friendly. The automatic system includes a control panel that monitors the plant and sets off an alarm in the event low levels of lubrication oil, of low levels of glycol, high temperature in the gas outlet, low suction pressure, or high bearing temperature on the motor and compressor. Lube oil can be filled up from outside of the container and levels can easily be monitored using the gauges on the outside of the container.

1. VOC cooler / Glycol cooler
2. Glycol tank
3. Glycol pump
4. Inlet filter
5. Lube oil tank
6. VOC compressor

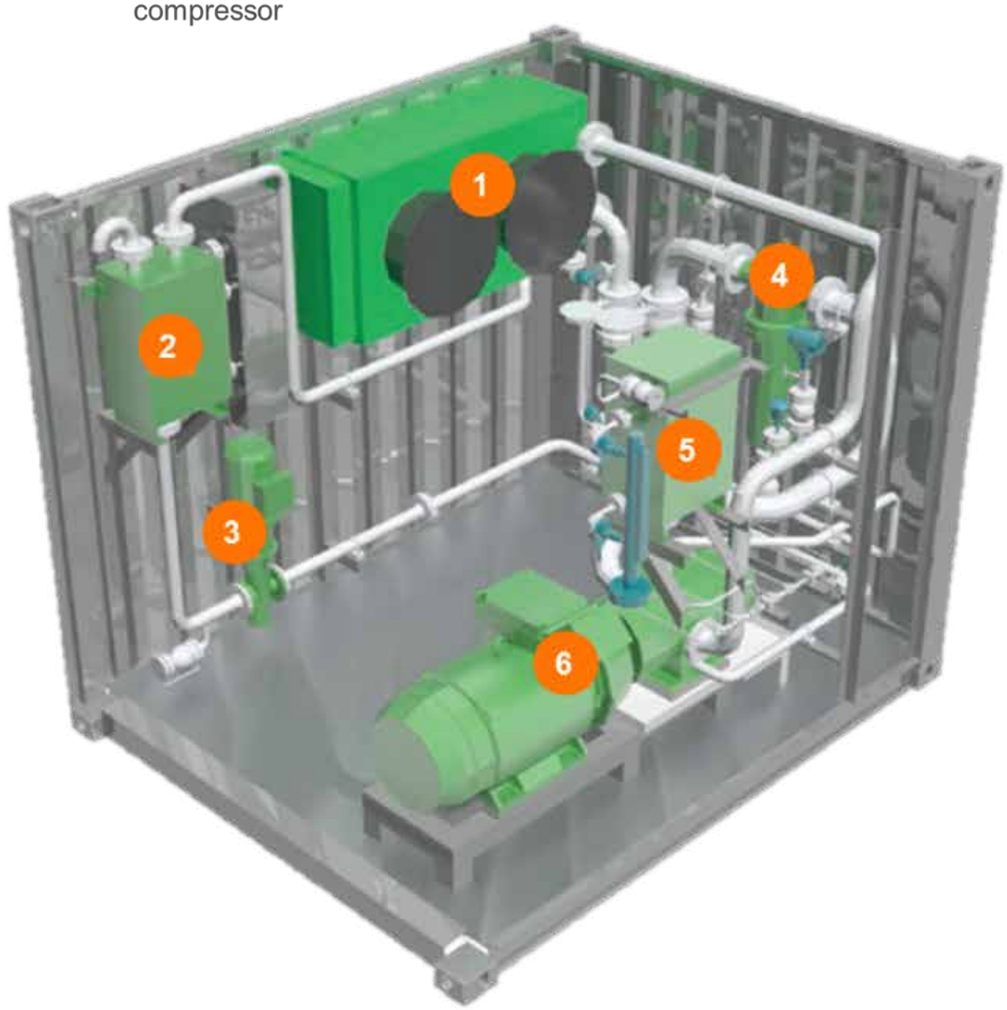


Fig. 3 - Typical fully equipped container – VER re-absorption version.

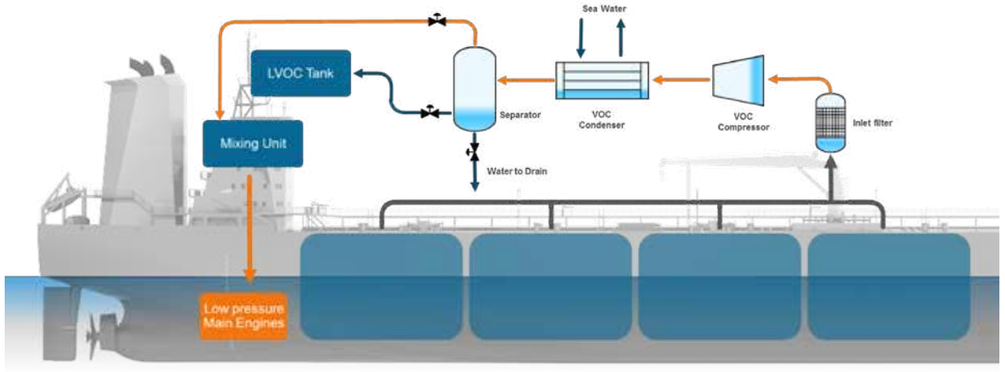


Fig. 4 - SIMPLE PROCESS – fuel gas mixing with SVOC and LNG.

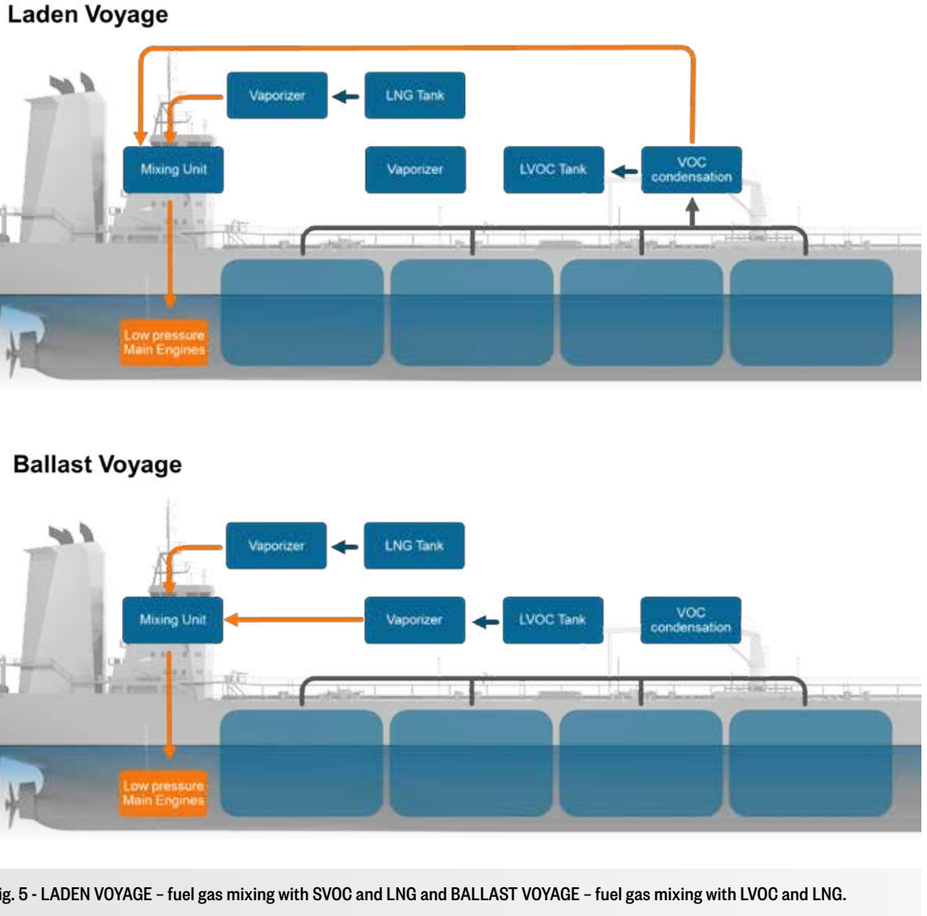


Fig. 5 - LADEN VOYAGE – fuel gas mixing with SVOC and LNG and BALLAST VOYAGE – fuel gas mixing with LVOC and LNG.

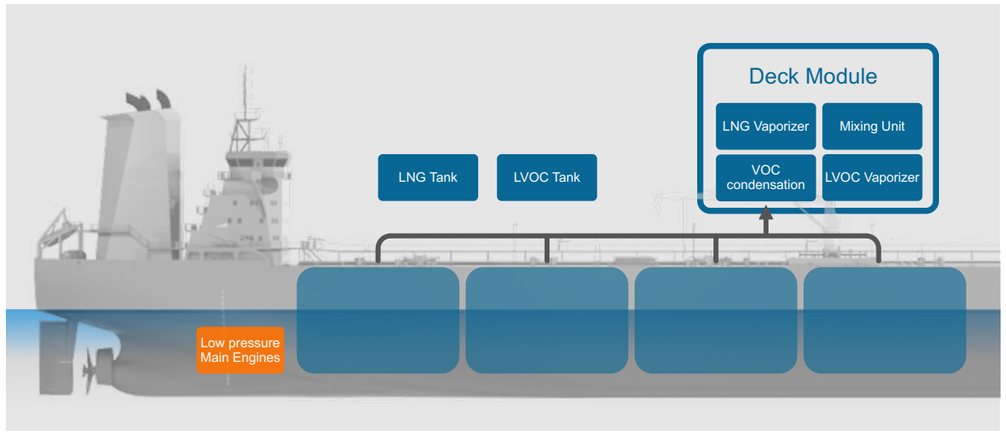


Fig. 6 - VER equipment can be located in a deck module with the LNG heater / vaporizer skid.

VER fuel version – for LNG-fuelled VLCCs

The fuel version of the Wärtsilä VER is designed especially for VLCCs operating on LNG. While the existing LNG-fuelled VLCC fleet is extremely small – with only 20 vessels on order at the present time – there is every indication that this market will only continue to grow going forward. With the IMO's 2020 sulphur cap regulation coming into effect in less than two years' time, the market is in urgent need of a fuel alternative that will enable it to comply with new requirements, and LNG is quickly emerging as one of the most viable solutions. As a result, demand for LNG across all shipping segments is expected to increase significantly in the coming years.

The Wärtsilä VER fuel version is based on a patent-pending recovery and mixing technology. The technology has already been thoroughly tested at Wärtsilä's test facilities for both four-stroke and two-stroke engines and is currently being installed on North Sea shuttle tankers at Samsung Heavy Industries (SHI). Tests have demonstrated that the VER fuel version is able to deliver savings of up to 20% for LNG-fuelled fuel tankers by mixing VOC with LNG fuel, enabling the vessel to operate on the mixture.

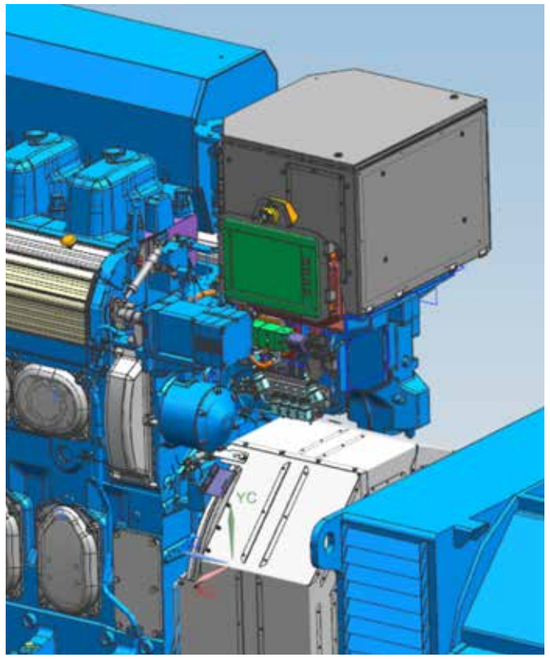
How does the fuel version VER work?

One of the features that make this system unique is its ability to reduce fuel consumption during both laden and ballast voyages. The recovery and mixing system on the Wärtsilä VER fuel version consists of an inlet filter, a VOC compressor, a VOC condenser, a separator, an LVOC tank and a mixing unit. In short, the system works by compressing the VOC to a pressure of 16 barg for two-stroke or eight barg for four-stroke engines. (Figure 4)

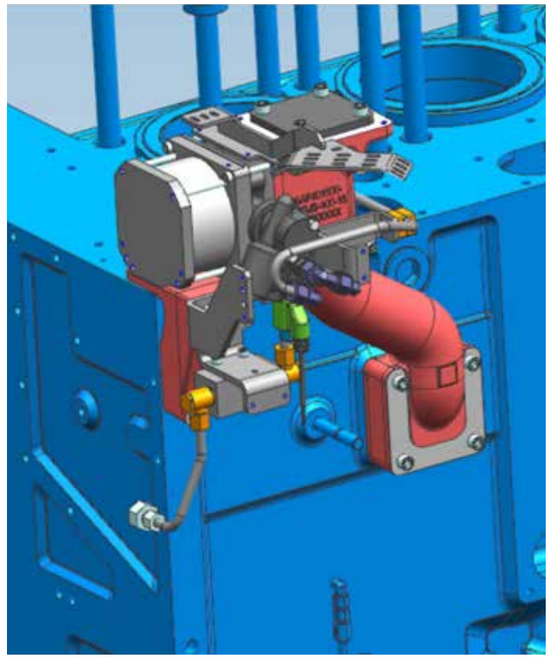
After compression, a sea water cooler reduces the temperature of the compressed VOC and consequently some of the VOC condenses and can be stored in a tank for use during the ballast voyage. During the Laden Voyage the non-condensed VOC (SVOC) is mixed with LNG fuel and used in the engines. During the ballast voyage, liquid VOC, collected during the laden voyage, is vaporised, mixed with LNG and used in the engines. The fuel mixing system continuously controls the mixing ratio between VOC and LNG in order to maintain the correct methane number (MN). (Figure 5)

In addition to the VER plant itself, a small deckhouse containing all the fuel-related equipment, such as the VOC plant, VOC vaporiser, LNG heater and vaporiser skid, and mixing valve unit, needs to be installed. In addition, an LVOC tank and LNG tank will need to be installed on deck. (Figure 6)

The Wärtsilä VER fuel version will be available in two sizes: a smaller version for up to 160,000 DWT and a larger version for 160,000 to 320,000 DWT.



New automation system including a touch screen display.



New wastegate with hydraulic actuator.

Wärtsilä 20 – Small changes, big results

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We revisit a classic, making it better and more efficient than ever before. The upgraded Wärtsilä 20 engine comes with a host of new features, making it a great choice for marine vessels.

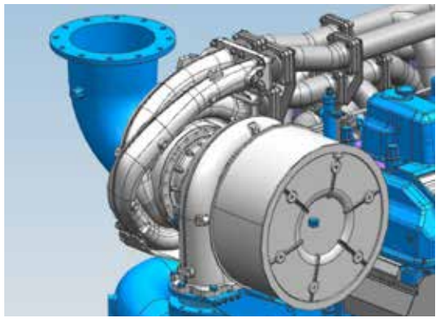
In the world of big diesel engines and generators, everyone wants more bang for the buck.

But there are only two ways to get higher output from an engine. The first is to increase the firing pressure at a fixed rotational speed, which usually is not possible without extensive redesign of many parts. The second method, and the most economical, is to increase the rotations-per-minute (rpm) of the engine at a fixed firing pressure.

In December 2017, Wärtsilä announced an upgraded version of its popular Wärtsilä 20 diesel engine which does just this – increases maximum rpms from 1000 to 1200 for mechanical propulsion engines and from 900 to 1200 for 60Hz generating sets, for instance. It is an example of doing more with less.

This technology is passed over from the already established Wärtsilä 20DF (dual-fuel) engine, which has been running at this speed from the introduction in 2011, without any issues.

With an increased cylinder output of 220 kW at 1200 rpms, the upgraded engine is a high-value-added proposition for the yards building merchant ships, and ultimately ship owners looking for lighter and more compact engine configurations to achieve higher payloads with almost the same low fuel consumption.



New KBB turbocharger version ST5 EP (8L20).

	900 rpm	1000 rpm	1200 rpm
4L20	740 kW	800 kW	N/A
6L20	1110 kW	1200 kW	1320 kW
8L20	1480 kW	1600 kW	1760 kW
9L20	1665 kW	1800 kW	1980 kW

Because the upgraded Wärtsilä 20 engine is a refinement of an existing engine, there is also a high level of spare parts compatibility. In addition, maintenance procedures remain unchanged, a welcome development for everyone.

What's new?

Like its predecessor, the new Wärtsilä 20, which will take two years to develop (all versions), can be used as an auxiliary engine to produce electricity on board, as a generation set for electrical propulsion, or for direct mechanical propulsion. In theory, all Wärtsilä 20 engines can be upgraded to the new performance parameters.

The original Wärtsilä 20 is a four-stroke diesel engine that can be run on light fuel oil (LFO) and heavy fuel oil (HFO). The engine can switch from LFO to HFO and vice versa without power interruption at any engine operational load. The Wärtsilä 20 has proven robustness and reliability, with over 6000 engines delivered since it was introduced to the market in the early 1990s.

The Wärtsilä 20 is especially suitable for the 1.3-2.0 MW merchant auxiliary fleet segment. It is also the perfect fit as the main propulsor in smaller ships including fishing, tugs and offshore and support vessels, and covers the lower power range within the Wärtsilä diesel engine family. The engine is fully compliant with the IMO Tier II exhaust emissions regulations set out in Annex VI of the MARPOL 73/78 convention. Also IMO Tier III compliance is possible together with a Wärtsilä NOR NOx reducer and associated equipment.

The new Wärtsilä 20 engine was officially launched at the Marintec conference and exhibition in Shanghai, China on 5–8 December, 2017.

Following is a breakdown of some of the Wärtsilä 20 new developments:

First of all, the new engine is denominated with the 'E' suffix indicating (as in Wärtsilä 20E and Wärtsilä Auxpac 20E) its (alphabetic, and other) evolution over previous models, with both models achieving a 10% higher output at 1200 rpms but still based on the classic Wärtsilä 20 engine design. The intention is for the Wärtsilä Auxpac 20E to replace the former Wärtsilä Auxpac 20D3/D4 as an auxiliary generator set which is, for Wärtsilä internally, an enormous reduction in complexity and spare parts handling, a cost which is naturally and eventually passed on to the customer.

The higher cylinder output will be available in 6-, 8- and 9-cylinder configurations, and due to the new automation system (UNIC 2) including a new main cabinet, now equipped with a touch screen display, will be somewhat longer (30.3 cm–37.2 cm) than previous models and will weigh between 9.3 and 11.6 tonnes.

Most of the new engine components are based on the earlier Wärtsilä 20 diesel engine with a few tweaks.

The red thread

Both new engines – Wärtsilä 20 and Wärtsilä Auxpac 20 – have a Wärtsilä UNIC engine control/automation system, which is designed for the harshest environments and includes an engine-mounted control panel showing the engine's operational data – temperature, pressure, hours, etc. – on an LED touch screen. The important thing here is that the available information is the same for the user, who will not notice any difference, but the design is improved for Wärtsilä and the interface is simpler.

As far as the actual engine block, cylinder heads and camshaft are concerned, a few new flanges and connecting holes have been machined in to allow for cooling pipes. A new injection system was also installed across the whole Wärtsilä 20 range.

The key to tweaking additional rpms and capacity on the upgraded Wärtsilä 20 stems from the turbocharger and compressor aspects where a new cooling pipe arrangement is needed to reduce the internal temperatures of the turbocharger.

Another major improvement comes in the form of a new AWG (Air Waste Gate) valve, which previously was a pneumatic system and not very accurate. The new Lisk valve is a hydraulic set-up (borrowed from the high-speed engine industry) which has improved functionality. It will also yield a longer lifespan.

Other improvements include a new cable rail for the electrical equipment, new piston rings, a new injection pump and valve.

Commonalities between the old and new engine exist because the basic design of the whole engine remains untouched.

It is also possible to retrofit a diesel into a dual-fuel unit. In these cases, required changes include pistons, piston rings, cylinder heads (with injectors and valves), camshaft and electrical equipment including brackets.

Wärtsilä's new retractable thruster is an improvement across all parameters

AUTHOR: **Vincent Klous,** Product Development Manager, Propulsion, Wärtsilä Marine Solutions
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The WST-24R thruster, with its eight-degree tilted propeller shaft configuration, delivers 23% more effective thrust than its predecessor, uses less fuel and takes up less space on board.

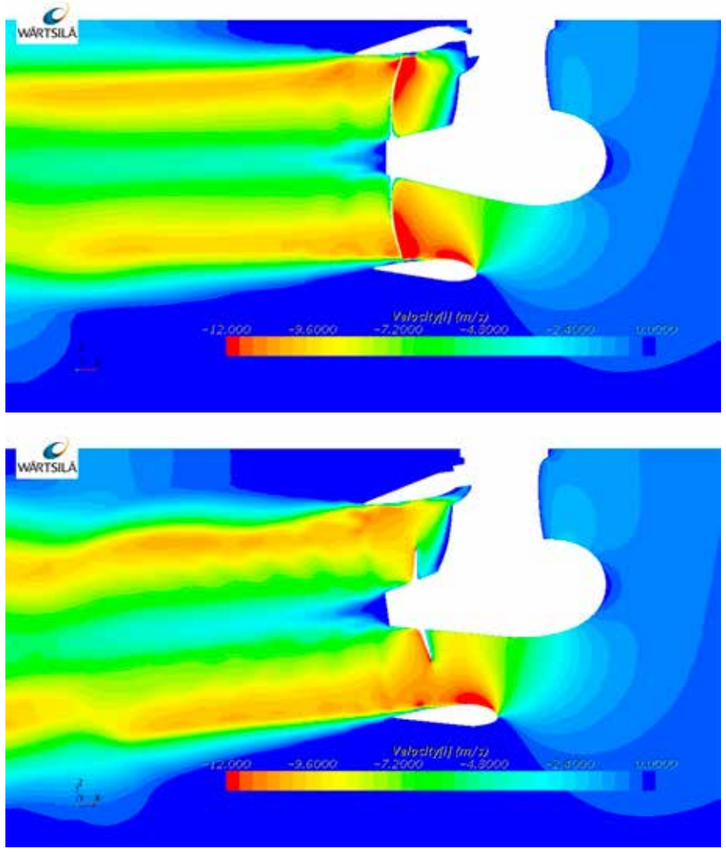


Fig. 1 - These images show the difference between how the thruster stream interacts with the hull depending on whether a conventional thruster or a tilted thruster is installed.

Five years ago, Wärtsilä embarked on a complete renewal of its entire thruster portfolio, with dynamic positioning applications built around a more hydrodynamically efficient eight-degree tilted gearbox. The process, which started with the launch of the WST drilling series, moved to the next stage last December with the official launch of the WST-24R, the world's first retractable thruster with a tilted gearbox and electric steering and retraction.

Like its predecessor, the LMT-FS1510, the WST-24R has been developed for vessels that require the safety of dynamic positioning while operating on offshore sites, but also need to be able to retract them en route. It has a power rating of 2400 kW, the same as with the LMT-FS1510, making it an ideal choice for vessels such as shuttle tankers, and offshore support and construction vessels.

The new design has been developed over a period of more than 18 months by a team at Wärtsilä Marine's Technology and Services Center in Drunen, and is an improvement on the LMT-FS1510 across all parameters. Effective thrust has been increased by 23% compared to a conventional unit with a 90-degree gearbox and a tilted nozzle, lowering fuel consumption and operational cost while also improving the vessel's dynamic positioning performance.

The lean design means fewer components, which translates into lower maintenance costs, safer and simpler installation, less space taken up on the vessel, and a reduced risk of oil leaking to the environment.

Complete redesign

Since the redesign began at the start of 2016, Wärtsilä's team has kept in close contact with ship owners and yards, to make sure that the product meets their requirements for a retractable thruster. This has pushed the team to significantly alter the design focus, making ease of installation, serviceability and maintenance as much a priority as performance.

With a conventional thruster (with a 90-degree gearbox) such as the LMT-FS1510, the downward deflection of the jet is not

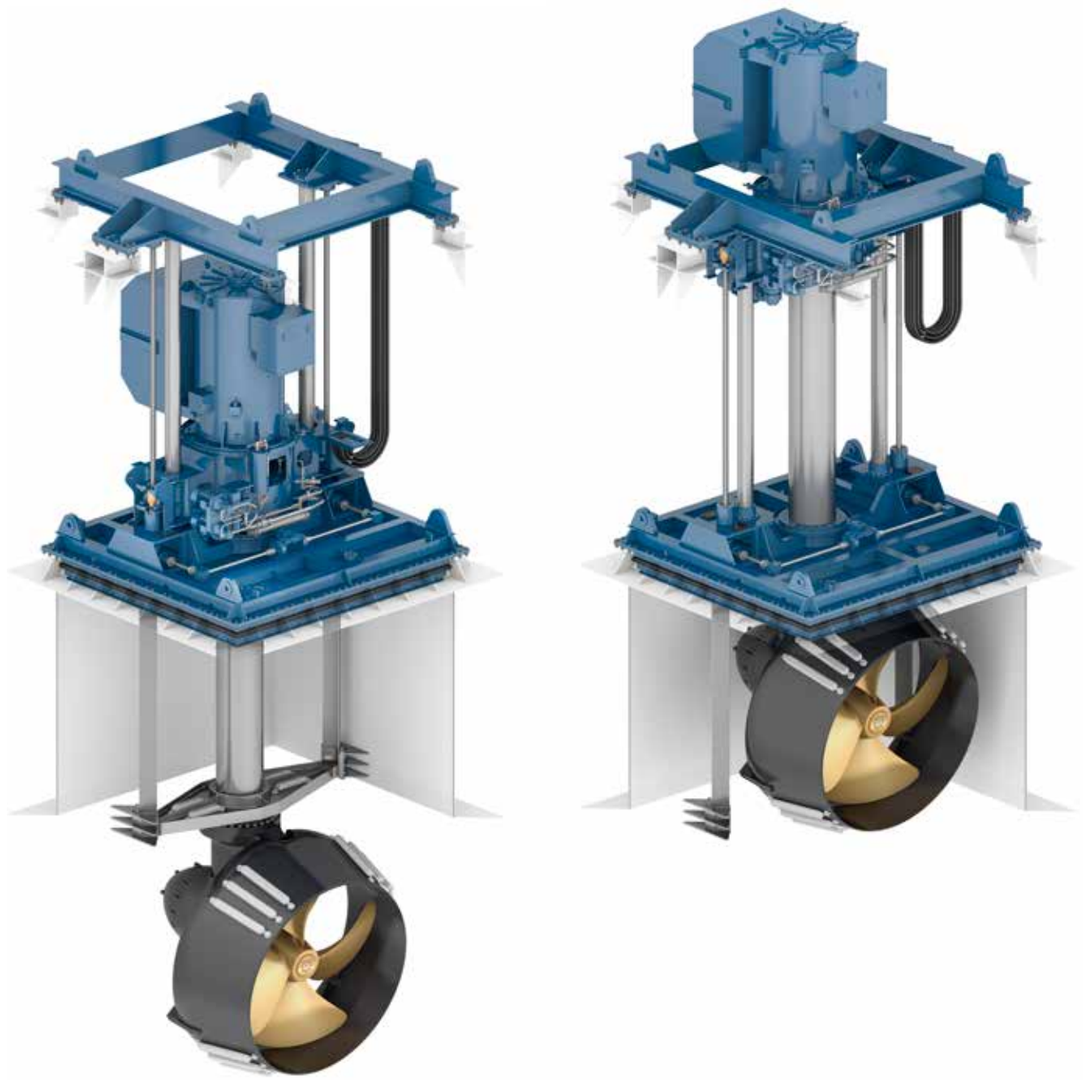


Fig. 2 - The Wärtsilä WST-24R thruster offers more effective thrust than comparable conventional thrusters.

enough to stop the stream from the thruster hitting the bottom of the ship, causing high interaction losses between the thruster and the adjacent hull. A nozzle tilted five degrees counteracts this to some extent, but the effective thrust is still significantly reduced.

On the other hand, in the WST-24R as with Warstila's drilling steerable thruster family, the complete pod, shaft line, propeller and nozzle is tilted by eight degrees. This is the tilt angle that research indicates is enough to deflect the jet downward sufficiently to clear the hull without significantly reducing horizontal thrust. (Figure 1)

Typically, in a shuttle tanker or pipe-laying vessel, two to three retractable thrusters will operate alongside two to three main steerable thrusters and between one and two tunnel thrusters.

In this configuration there is a further risk of thruster–to-thruster interaction.

The eight-degree tilt also combats this by deflecting the jet to reduce 'forbidden zones' where thrusters cannot operate without blowing into other thrusters.

Simply adding a tilted gearbox to the existing LMT-FS1510 design would have significantly increased the amount of space taken up on board by the thruster unit, because the additional angle implies a longer retraction length.

To prevent this, Wärtsilä redesigned the entire thruster, including the inboard parts, to make the system more compact. The hydraulic retraction and steering mechanisms used on the LMT-FS1510 have been replaced by a more lightweight and compact electric system.

A significant amount of space on board has been freed up by the decision to use a single drive cabinet to control the three electric motors used for steering and retraction. When a thruster is being retracted, there is no need to steer it, and when a vessel is being steered, there is no need to retract, making a second drive redundant.

Switching to electric systems also eliminates the risk of hydraulic fluids leaking, causing marine pollution and an unsafe slippery workspace for crew, and makes the set-up easier to maintain.

The WST-24R can be delivered with a 2600mm or 2800mm propeller rather than the 2500mm propeller used on the LMT-FS1510, reducing the power density.

Combined with improvements to the hydrodynamic shape of the propeller gearbox and nozzle, the WST-24R generates 10% more unit thrust with the same power even without the improvements in hull-thruster interaction. (Figure 2)

New patent application for retraction mechanism

The push to develop a more compact retraction system led the Drunen team to develop, and then file a patent for, a new mechanism for retracting the thruster using tension-loaded spindles.

The new mechanism has allowed the diameter of the spindles to be reduced from 330mm to 80mm to lift the same load. Because the spindles are self-locking, the new design also eliminates the need to apply external locking hooks when the thruster is retracted.

The new mechanism keeps the spindles used to retract the thruster permanently loaded under tension regardless the direction of the forces acting on the spindles. This prevents the spindles from buckling; subsequently a thinner spindle can be used for the same load. (Figure 3)

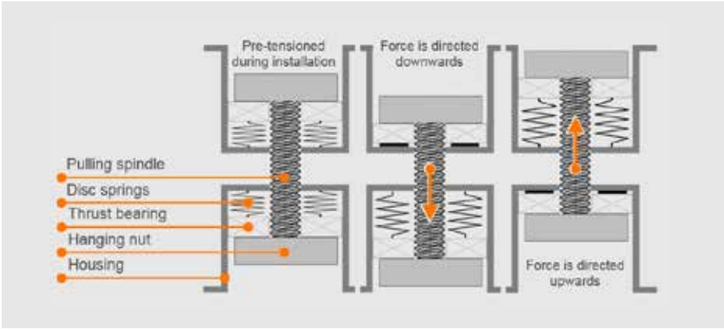


Fig. 3 - WST-24R new spindle retraction system.

Single seal

The WST-24R uses a single, specially shaped seal developed for Wärtsilä by a leading manufacturer to protect both the steering and retraction mechanisms. This means that the thruster has one less oil-to-sea interface than the LMT-FS1510, with its two seals, reducing the risk of oil leaking into the environment.

The WST-24R's seal is essentially a rotary seal that has also been made suitable for linear motions by incorporating elements of hydraulic cylinder seals.

It is a significant improvement on both the stuffing box seals used for the LMT-FS1510 retraction mechanism and lip seals for steering.

The old stuffing box seals in particular were difficult to make completely tight, always leading to water leaking inboard. The new seal is designed sturdier and tighter, reducing water ingress inboard to an absolute minimum during operation.

Easy installation and maintenance

The thruster's streamlined, plug-and-play design means that it can be installed on vessels as a single package, taking less time and using less labour.

The thruster has been designed to be sent to yards in a single delivery, with each unit pre-assembled and pre-aligned at Wärtsilä's factory. The thrusters are then installed and levelled at the yard, with alignment checked using a 3D laser scanner.

The thruster can also be delivered as inboard demountable unit, effectively avoiding the costs and risks associated with dry docking.

The unit is also equipped with an additional inflatable seal which is activated when the thruster is retracted, preventing any water entering inboard. The inflatable seal also allows the combined retraction / steering seals to be serviced inboard without the need to dry dock.

The composite steering support bearing for the tilted gearbox is also designed to be serviceable by divers in water.

Conclusions

The additional challenge implied by installing an eight-degree tilted gearbox has pushed the development team working on the WST-24R to carry out an even more complete redesign than that carried out on the rest of the renewed steerable thruster portfolio.

One month after launch, Wärtsilä is already close to entering an exclusivity agreement with a major ship owner, showing that the unit's increased operational performance, reduced cost of installation and easier maintenance is likely to make it a popular choice for years to come.

[MARINE / IN DETAIL]

Eco-friendly tugs make a splash

AUTHOR: Ronak Kotecha

Wärtsilä's new family of environment-friendly tugs is here! It is based on the Wärtsilä HY concept, and draws inspiration from the company's proven LNG technology. We tell you how these innovative tug designs translate into improved efficiency.

"Wärtsilä's journey to provide environment-friendly tug designs started in 2014 when the liquefied natural gas (LNG) Eco Tug was introduced," remembers Joost Van Eijnatten, Manager Application Engineering, Propulsion, Wärtsilä Marine Solutions.

Tugs with LNG as fuel or with hybrid technology place higher demands on the design and on the integration of the different systems on board and this, he says, is typically where Wärtsilä can excel and add more value.

Interestingly, Wärtsilä has successfully delivered many proven dual-fuel and hybrid solutions for different vessel types, and the new eco-friendly tugs are an extension of this endeavour.

"With Wärtsilä's reputation in Asia as a formidable tug designer, the family of new eco-friendly HY Tugs drive in as a perfect vehicle to further strengthen our position in the market," says Ay Hwa Ngoh, Offshore & Specials Sales Manager in Wärtsilä's Ship Design.

These newly launched Wärtsilä HY Tug designs come in three different hull sizes, namely a 28m harbour tug with a 50t bollard pull, a 29.5m harbour tug and a 35m escort tug – both with a 75t bollard pull. The propulsion configuration is such that each design comes with the option to select either diesel mechanical hybrid or diesel electric hybrid propulsion, and the designs are able to cover a 40 to 90t bollard pull range with the appropriate Wärtsilä equipment modules.

A 'battery' of better solutions

Ngoh considers development of battery power as one of the fastest-evolving technologies for energy storage that has a huge leg up on safety size, and cost.

"Wärtsilä's constant technological development on engines, E&A and thrusters also provides further improvement to system efficiency," says Ngoh, adding that the new designs also bring flexibility and efficiency by using less engine power, which decreases emissions, fuel bills and the need for massive engine maintenance.

The company has found a perfect partner in its own thrusters. The Wärtsilä Steerable Thrusters (WSTs) have a large-diameter propeller to provide high performance propulsion with excellent hydrodynamics.

"They are reliable and easy to install, operate and maintain," points out Van Eijnatten, adding that the efficiency and low operational costs enabled by WST thrusters enhances environmental friendliness and overall economics of the new tugs.

And the new tugs have done well to find their place in the new scheme of things.

For starters, they have significantly reduced fuel consumption and associated CO_2 emissions as well as NO_x, SO_x and particle emissions. For the tug designs having LNG as fuel, the emissions are even lower. The Wärtsilä HY Tug features a zero-smoke design, meaning that no smoke is visible when the engines are started or running. When running fully electric on the batteries, there are no emissions at all. This zero-emission mode is especially useful when starting or idling at port or during transit and standby modes.

[MARINE / IN DETAIL]

What's more, the thrusters are equipped with seal monitoring, to monitor possible lubrication oil leakage to the seawater.

"While environmentally acceptable lubricant (EAL) can be used for lubrication of the thruster gears, bearings and seals, in the unlikely event of a spill, the oil does not harm the environment even in the case of a leakage," assures Van Eijnatten.

Operational performance

Operationally, the new tugs are not only modern and environment-friendly, but also optimised to provide the best performance.

Ngoh points out the practicability of the new tugs, which is due to its distinct design that is optimised for low hull resistance, high escort performance, good sea-keeping, safety and comfort for the crew. Some of the new features include the special wheelhouse design with improved 360-degree visibility for single-man operation, and introduction of side shoulders and semi enclosure for the bow winch for safety of the crew during towing operation. The designs also come with a unique and modern exterior outlook.

"The Wärtsilä HY Tug designs have been designed in close co-operation with the ABS, BV and Lloyds Register classification societies, and received Approval-in-Principle (AiP) certification," says Ngoh.

As the total solutions provider, Wärtsilä has the unique vantage point with its capability to produce these new tug designs with its unparalleled expertise and in-house resources.

It seems the decks are now clear for the dawn of a greener tomorrow with eco-friendly tugs leading the way.

Wärtsilä HY – a fully integrated hybrid power module

The standard mechanically driven configuration includes:

- Main engine with on/off clutch
- PTO/PTI on the gearbox (or in-line shaft generator/motor)
- Energy storage system
- DC link and power drives
- Energy Management System

The standard electrically driven configuration includes:

- Generating set
- Energy storage system
- DC link and power drives
- Energy Management System

Key benefits of Wärtsilä HY

- Guaranteed module performance
- Instant load taking capability
- No visible smoke under all normal conditions
- Green mode (zero emissions)
- Optimised plant dimensioning
- Built-in redundancy
- Reduced maintenance (less cylinder-hours, reduced stress to the components)
- Increased efficiency (lower fuel consumption, fewer emissions)
- Ship type optimised design and specific application tuning
- Wärtsilä is the single supplier

Modularisation hand in hand with manufacturability

AUTHOR: Tim Bird

The development of the new Wärtsilä 31 engine provided the perfect opportunity to exploit the benefits of modularisation and put the concept of Design for Manufacturability into practice.

The design and development of the Wärtsilä 31 engine have presented a great opportunity to implement a design process model based on a high level of modularisation. The wide range of benefits in doing so include maintained operational excellence during manufacturing, reductions in lead time and guaranteed reliability.

"Wärtsilä 31 is a product of modularisation, which means it is based on a different architecture from previous engine platforms," says Patrik Wägar, Product Director, Medium Bore Engines, Marine Solutions. "This enables a lot of benefits, although we need to be prepared to exploit and maintain them. This is key to enable a more flexible and less complex portfolio going forward."

Modular product architecture means breaking down the product into property-driven building blocks – modules – with defined interfaces. "It's a representation of a product family which consists of modules and its variants," explains Mika Yli-Salomäki, Senior Manager Platform Architecture, Technology, Engines, Marine Solutions.

"In addition to facilitating shorter lead times from configuration to order, modular product architecture makes it easier to fit customer needs and provide high-quality, accurately validated solutions, a faster introduction of new features, and easier upgrades and conversions."

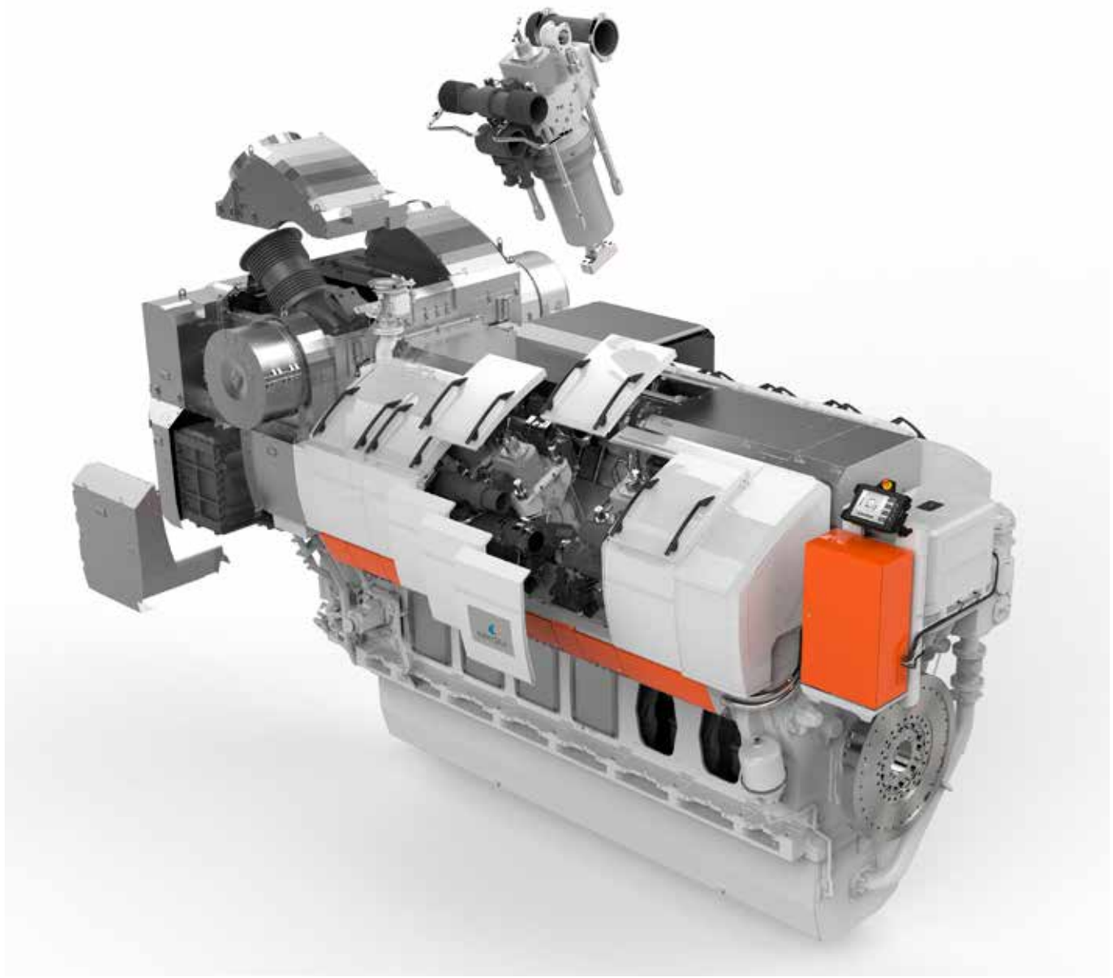
"During the Wärtsilä 31 engine development project we secured the involvement of manufacturing experts in the design process," says Juho Mäenpää, General Manager, Delivery Centre Vaasa Pilot Delivery Unit. "This model is what we now refer to as Design for Manufacturability (DFM), which in turn is part of our New Product Introduction process (NPI). In practice, DFM means that specific assembly and component manufacturing experts join the product development project at an early phase. They start to design how the product will be produced at the same time as the product designers are getting to work."

Faster process, better quality

Work is done at a component level by instructing the product designer to make component features in such a way that the parts are easy to produce, explains Mäenpää, eliminating the need to make technical compromises in production. If such compromises are necessary, they can be identified during the design phase. DFM also means the engine assembly structure is also developed in parallel and makes possible more extensive product preparation in the sub-assembly phase, thus speeding up the overall production process and increasing quality.

"From the point of view of DFM, when manufacturing structure and process are designed in parallel with the product, we can then also design and develop related production tooling," says Mäenpää. "The result is faster product ramp-up and fewer changes after production has started. All this is coordinated within the NPI process for each product development. DFM allows manufacturing experts to play a part in prototype production as well as in developing the manufacturing process."

When describing product design modularity in the context of DFM, Mäenpää likes the process to providing Lego bricks for manufacturing experts at an early stage. "First drafts for the assembly structure were made using these modules, even before the details were known of what parts each module would contain. While design modules were developed and product design



The Wärtsilä 31 is the most extensively validated engine ever released by Wärtsilä.

was progressing, we also had the chance to influence what those details might be, up to a point."

In general, products have traditionally been designed on the basis of performance and cost, with less focus on the manufacturing process, says Wägar. Modularisation combined with DFM makes Wärtsilä an industry leader.

"With the Wärtsilä 31 we have developed a product architecture that allows for smart modularisation whereby we can achieve more combinations using fewer variants or modules," says Wägar. "With modularisation, you can also proceed quite far with the assembly of an engine before deciding the fuel type or specific customer needs. You can add those modules that are relevant for the project towards the end of the assembly. This approach has many benefits, but it does require close cooperation with assembly line operators and suppliers."

More customer benefits

This combined approach also passes on direct customer benefits in terms of shorter lead time, faster maintenance and fewer components. Wägar expresses satisfaction both at this potential and the fact that the same approach will be taken in developing future new products. Room for improvement still exists, he believes, in improving external modularisation, in which engine interfaces with other products can be managed.

"Fewer component variants means volume synergies, while for the assembly process it means reduced risk and shortened lead time," says Wägar. "The core team around the new Wärtsilä 31 product has been accountable for enabling the concept, and we have also had external consultants included in the process. From any turnkey builder's point of view, it is a benefit to have pre-engineered and pre-validated components with standardised interfaces. It moves the installation and commission risk earlier into the supply chain and increases the chances for successful commissioning trials."

The supply chain will focus more and more on the entire process from design to user experience, and not just on the connection between companies. Wärtsilä's focus on operational excellence will also be sharpened, eliminating process waste and strengthening connectivity between the company and its suppliers.

"From sourcing to sales, everyone needs to understand the reasons for adopting modularisation and how to utilise the benefits with this knowledge," says Wägar. "Suppliers need to take more responsibility for delivering module variants instead of loose components, while quality processes need to be more closely aligned as well. It calls for stronger incorporation of sub-supplier processes into our own.

"We needed a new platform for further development," he says. "The Wärtsilä 32 engine has been with us for some time, and the previous latest output stage was introduced in 2012. The new Wärtsilä 31 broke the Guinness World Record in efficiency for any 4-stroke engine, in competition with much larger engines."

All in all, he says, it's the engine for the digital era, in the context of self-tuning engines, self-trouble-shooting and self-adaptation. Nine engines had been sold to marine installations as of September 2017, with references ranging from icebreakers to fishing vessels. The first delivery has been made, and the first engine is scheduled to become operational in spring 2018.

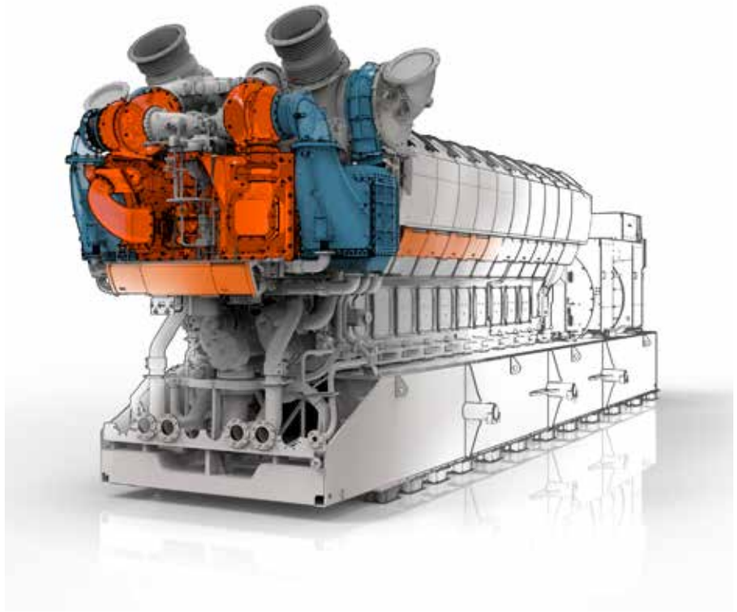
Speed of innovation and technology development will only accelerate in the future, Wägar believes. Past limitations to development have been largely eliminated, while Wärtsilä's success has always been in proportion to its focus on and investment in R&D, a factor that has delivered highly competitive products. Efficiency is always a top priority for the company, and energy efficiency has always been a key driver. The DFM approach will only serve to underline these factors.

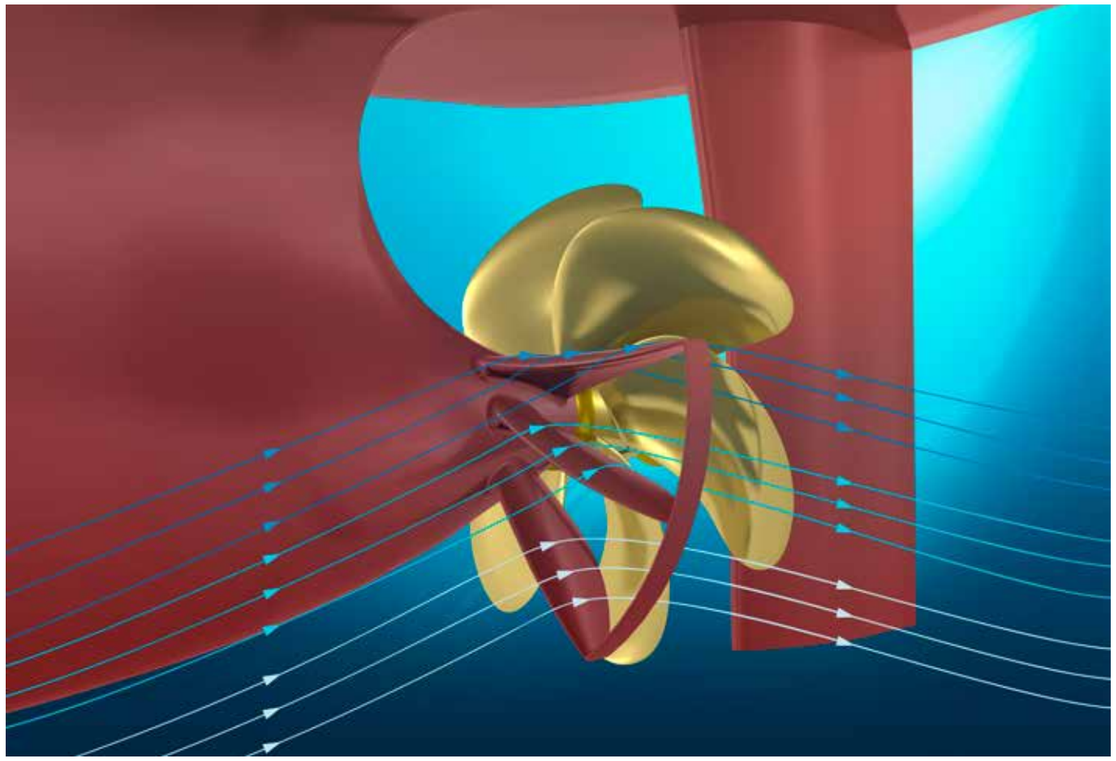
Accurate simulation

Accuracy of simulations in design is another asset, says Wägar. "As recently as five years ago, we were still surprised at the discrepancy between simulations and reality. These days we are surprised at how accurate our simulations have become. The capacity for accurate simulations is a major value for a company." Validation, to check that specifications meet customer needs, is also enhanced by DFM, and Wägar insists that the Wärtsilä 31 is the most extensively validated engine ever released by Wärtsilä. He sees the next step as creating a "digital twin" – a virtual engine that can be used to analyse and evaluate design and performance, without the need to construct a physical engine for these purposes.

"For other engine products on the drawing board, our DFM experiences with the Wärtsilä 31 help us develop our approach and processes to make sure we capture the synergies," Wägar continues. "We can upgrade existing products partly using concepts from the Wärtsilä 31 development, but the main gain is for the future. For other products in our portfolio apart from engines, the journey has started, and we see great benefits for ship builders and customers for having modularised products with fixed interfaces, offering shorter lead times, reduced risk and a higher degree of pre-engineering and testing before installation."

"This development has involved great co-operation across the organisational borders," says Mäenpää. "Many different segments of the company have been working together to develop and introduce a great engine – in fact, the best of its kind. This way of working will increase the level of information for all parties. Of course we need to continue this work and adhere closely to the new rules we have been creating, so that we can look back on many more projects with pride at this clear product modularity."



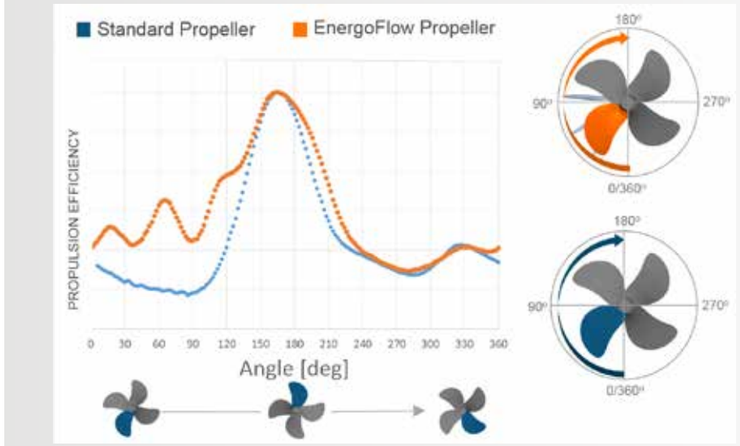


Wärtsilä EnergoFlow increases fuel efficiency by up to 10%.

Wärtsilä EnergoFlow boosts propulsion efficiency

AUTHOR: Steve Roman

Last year, Wärtsilä launched its latest energy-saving device for ship engines, a next-generation pre-swirl stator dubbed the Wärtsilä EnergoFlow. The innovative apparatus, available for both retrofits and new-builds, is already attracting attention with the substantial fuel savings it can yield – up to 10% in certain cases. The key to its propulsion-boosting power is how it controls the complex hydrodynamics upstream of the propeller.



Blade efficiency during one revolution of a 4-bladed propeller.

With cutting fuel costs such a high priority for ship operators, marine engineers are constantly looking for ways to squeeze the most propulsive power out of every bit of energy that goes into an engine. One way to do that is to dampen down the rotational losses that result from the way water flows into a ship's propeller blades.

Due to the shape of a typical ship's hull, the water leaving its aft flows steadily at a slight upward angle as it moves toward the propeller. At the downward stroke of the propeller, the 3 o'clock position when viewed from aft, this upward inflow angle is ideal since the blades are moving against it and can thus better accelerate the moving flow. On the opposite side of the propeller, however, both the water and the blade are moving upward, minimising the propeller's ability to push against the water and thereby weakening overall propulsion power.

This situation can best be compared to an airplane with head- or tailwind during takeoff. In case of a tailwind, the lift of the wings is reduced, thereby elongating takeoff distance.

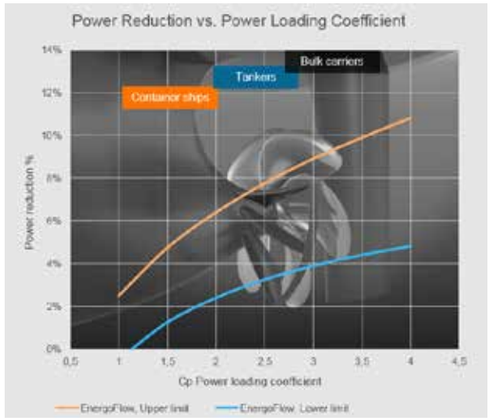
To counteract this effect, engineers over a decade ago began experimenting with the idea of a pre-swirl stator (PSS), a static structure consisting of multiple fins attached to the ship's hull that were designed to shift part of the wake downward for a better angle of attack. Though the basic theory behind the PSS was sound, early examples on the market couldn't effectively control the water's flow direction, and weak structural design left them prone to cracking or breaking off at the first sign of rough weather.

Designs soon improved, however, and the PSS eventually gained enough interest to be chosen for study by GRIP (Green Retrofitting through Improved Propulsion), an EU-funded research project carried out from 2011 to 2015 to investigate various energy-saving options in the marine market. Wärtsilä and the nine other European companies participating in GRIP put the PSS concept under their collective microscope and, after gaining a deeper understanding of the hydrodynamic principles involved, came up with a better working model. In sea trials on a bulk carrier, GRIP's PSS achieved a power savings of 7%.

Modelling the fins

To build on the successes of GRIP and develop the Wärtsilä EnergoFlow, Wärtsilä's engineers had to design a model with three fundamental traits: it had to be robust enough to withstand both long-term fatigue and the roughest weather, optimise the flow into the propeller to maximise propeller efficiency, and minimise viscous resistances. Also, applying a PSS can lead to additional hull and rudder resistance, which can result in considerably less net gain. This factor had to be addressed as well.

The fail-safe design of the Wärtsilä EnergoFlow was achieved by both taking into account fatigue – the low-level stresses that occur over the lifetime of a ship – and carefully studying the effects of peak load, or the maximum stresses that a ship might encounter once every 25 years. For the latter, Wärtsilä used a modelling technique that treated the Wärtsilä EnergoFlow's fins as if they were a propeller blade attached to the ship, then looked at the stress effects of various wave heights combined with the ship's vertical motion, sailing speed, pitch, roll and other factors. Once the requirements were fully understood, designers were able to adjust the fins' thickness, width, length and camber accordingly to create a product with a 25-year lifetime. They also added a ring, or arched segment that connects the fins



Power reduction vs. Power Loading coefficient.

Model tests carried out for validating the strength of the EnergoFlow.

at their tips, which serves to distribute the force that might act on any one fin under an extreme condition such as slamming, when the ship's aft repeatedly rises out of the water. Model tests carried out to measure forces in both normal and storm conditions found that the ring decreases the maximum occurring stress on each fin by about 40%.

For fine-tuning the pre-swirl flow and lowering viscous resistance, Wärtsilä relied on the latest CFD modelling to create its design. The result can be seen in the pronounced curvature of the fins in the Wärtsilä EnergoFlow.

But it's important to note that the Wärtsilä EnergoFlow concept is about more than the design of the stator itself, since it's the hydrodynamic interplay between the stator, the hull and the propeller that will ultimately determine how accurately the flow can be directed and how much viscous resistance will be added. Therefore, the positioning of the stator and the design of the propeller are critical parts of the package and are key elements in the power savings equation.

Custom-designing solutions

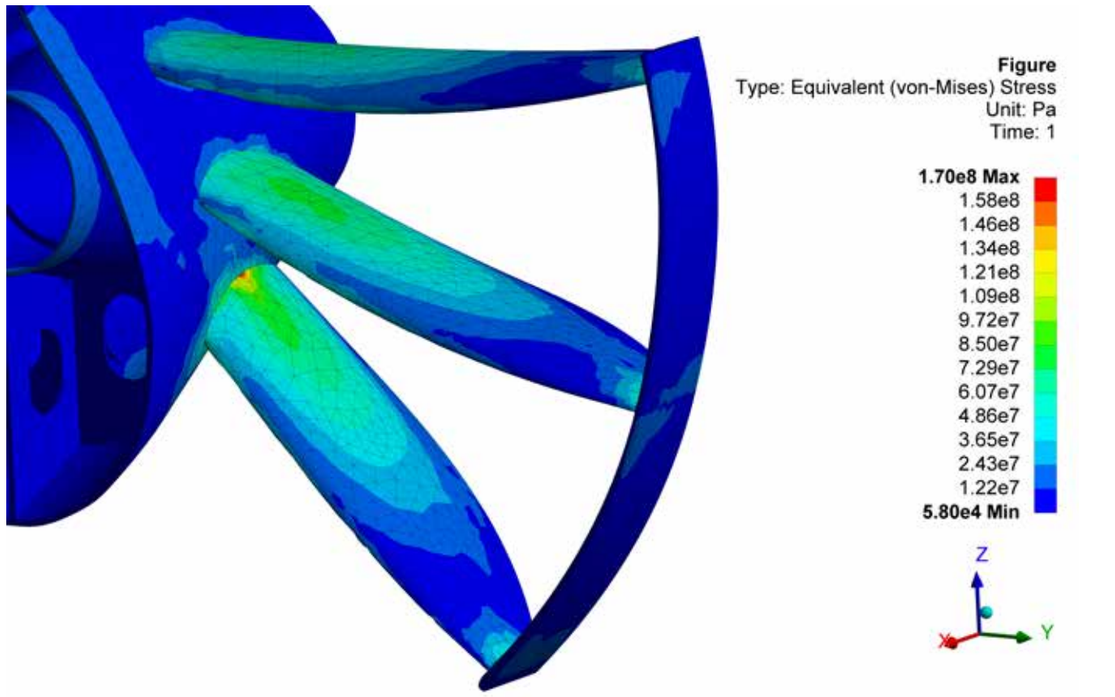
As every ship design and operating profile is unique, Wärtsilä assesses each one individually using CFD modelling to create a strategy for installing the Wärtsilä EnergoFlow. The stator itself is custom-designed for each case, with possible variations in the shape of the fins and, in some circumstances, even the number of fins when the typical three-fin approach isn't the best solution.

Hull integration must be carried out by a welded connection to the cast bossing or stern tube to ensure structural soundness. Sometimes this can result in limited options for optimizing the positioning of the stator relative to the propeller, but Wärtsilä engineers can usually find a solution even within these constraints.

The most crucial factor in the Wärtsilä EnergoFlow setup, however, is propeller pairing. The system works best when a ship's propeller is specifically designed to work with the PSS – a factor than can boost the power savings by up to 2%. Wärtsilä has the capability to modify an existing propeller by removing pieces at the trailing edge to give it a new pitch angle, but in cases where the resulting fuel savings would be large enough, it would make sense for a ship owner to invest in a new propeller.

Just how much power – and therefore fuel – savings can be achieved is again determined by the specifics of each case, but there are some generalities based on ship type. Bulk carriers, for instance, can see fuel savings in the 10% range. Container ships, which are already relatively efficient in propulsion terms, would still see a respectable 4% improvement, but this could also climb to 10% if a new propeller design for slow steaming applications is made. The savings figure for tankers falls roughly in the middle of the two.

Regardless of the ship type, the Wärtsilä EnergoFlow typically pays for itself within one to two years of operation. Given the high potential for savings and short payback times – not to mention the environmental benefits of burning less fuel – this could be a true game-changer for ship owners.



Stress distribution [Pa] of fins and stern structure for typical bulk carrier with reference load on the fins.

[FUTURE / IN DETAIL]

KNL Networks and Portcall.com were the winners of the first SparkUp Challenge.

SparkUp Challenge invites start-ups to innovate and co-create together with Wärtsilä

AUTHORS: Sofia Kilpikivi, Lotta Heikkeri, Anne Salomäki

Wärtsilä's SparkUp Challenge aims for the perfect match between the company's business and innovative start-ups.

The Wärtsilä SparkUp Challenge is an opportunity to shine a light on a newly discovered innovation or business idea that could disrupt a whole industry – if only it was found and developed further.

The goal of the challenge, launched at the Slush start-up event in November 2017, is to identify start-ups with the most promising ideas and partner them with industry experts. It is part of Wärtsilä's five-level Tiered Venturing Model.

"I believe this approach will help bring in new and fresh ways of thinking to help us with our work," notes Alid Dettke, Vice President, Open Innovation. Dettke compares the model to forming a relationship. First one gets to know the other, and step by step things might proceed to more and more serious levels.

"At Wärtsilä, we are looking for a special someone."

The first phase of the challenge focused on Wärtsilä's Smart Marine Vision. The company looked for innovative start-ups to develop ideas for the smart shipping value chain in collaboration with Wärtsilä. The winning team was promised an incubation period in Wärtsilä's Digital Acceleration Centres (DACs) in Helsinki or Singapore. These hubs are where projects are developed at unprecedented speeds, often in collaboration with start-ups and other partners.

The winning teams

The challenge, which attracted almost 150 entries, reached its peak at the end of February, when a full day of co-creation with Wärtsilä mentors and pitching led to the announcement of the winner of the very first SparkUp Challenge. A total of 11 pitches, mostly focusing on connectivity and green solutions, were of such high quality that the jury had difficulty deciding on just one out of the lot.

In the end, the task proved impossible. The jury decided to name not one but two winners: KNL Networks and Portcall.com. The first offers reliable data networks for ships, and the latter has developed a collaboration platform that logs incoming and outgoing ships in ports.

"I did not expect to win, with all these amazing participants," said Portcall.com's Bryan Bender after the announcement, brimming with excitement.

"This has been a great opportunity to work with Wärtsilä. I enjoyed the approach and the synergy we got."

KNL Networks' team called the SparkUp process amazing yet challenging.

"I really can't hide my smile," said Tomi Linden from KNL Networks after the win. "Wärtsilä's mind-set has changed. They are looking for a big impact – and fast."

Wärtsilä provides the winning teams with space and mentoring for up to six months, as well as a capital grant of EUR 50,000. Now, Portcall.com and KNL Networks face a collaboration period in the Digital Acceleration Centre, DAC. The projects, including an incubation phase and a go-to-market transformation, will culminate in a Demo Day later in 2018.

For Wärtsilä, the most important aspect of the challenge is the ability to connect the innovative solution to business. "We also look forward to moving on with the finalists and their projects," says Steffen Knodt, Director, Digital Ventures. "This is a learning process for all of us."

The future is, by default, a learning process. SparkUp Challenge is one way to prepare for it.

"You cannot shy away from the future," Dettke points out. "We must roll up our sleeves, embrace it boldly and grow with it."

The second SparkUp Challenge, focusing on Smart Energy, will be launched in the fall of 2018. The concept is set to become a key part of the strategy of building effective and fruitful long-term partnerships with start-ups.

"This is an amazing opportunity to co-create with us, and really accelerate the development of innovative digital services," adds Dettke.

Marco Ryan, Chief Digital Officer for Wärtsilä, holds a similar view. SparkUp Challenge along with the DAC concept accelerate Wärtsilä's digital transformation journey towards an 'as-a-service' smart technology company.

"We at Wärtsilä are renowned for spotting trends and innovation," he says. "The best results will happen, he says, when engineers, business people, data scientists and UX experts sit together and work collaboratively towards a common goal that meets the needs of our customers."