



Twentyfour7.

Wärtsilä Stakeholder Magazine

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FUTU
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Wärtsilä Stakeholder Magazine*

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DISCLAIMER

editorial



Future in the present

PEOPLE TALK ABOUT HITTING technological plateaus, referring to a time when technology will have evolved to its peak, and won't advance any further. From the invention of the automobile to the telephone and even computers, many experts have felt that that the limit has been reached, only for future inventions to prove them wrong time and again. And this holds doubly true even now.

The fact is that the level of technological advancement today is unprecedented in human history. Future technologies that we thought we wouldn't see in our lifetime are now closer than ever. We are already talking about sending manned spacecraft to Mars, mining asteroids for resources, using Artificial Intelligence to improve our lives, and growing human organs from stem cells, not to mention the hoverboard becoming reality. Back to the future!

At Wärtsilä, we understand that this relentless march of technology holds enormous potential.

Our purpose is to enable sustainable societies with smart technology, and that requires us to face the future head-on. By embracing technological innovations, we are shaping the future, helping develop solutions and services that help our customers stay at the top of their game.

Take for instance the use of robots, at our Central Distribution Centre in Kampen in the Netherlands, which holds the promise of optimising the flow of logistics. Or, our pioneering remote control test in ship operations, which demonstrated to the marine industry that autonomous vessel operations are a reality, not a distant dream.

But we are also mindful of putting our technological innovations to use for the larger good.

The World Economic Forum has stated that there is a pressing need to gather data at a greater frequency and variety to understand our oceans to the degree that we understand our land. Our story on this topic will shed light on how Wärtsilä can play a big role in using data for cleaning the seas.

In short, stories in this issue will help you understand how Wärtsilä perceives the future and seeks disruptive solutions and technologies that can change all our lives for the better.

The future is here. Don't hesitate to grab it.

Atte Palomäki

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Your shorter route to the gas age

COMBINED POWER PLANT
AND LNG INFRASTRUCTURE

REDUCE RISK BY GUARANTEED PRICE,
DELIVERY AND PERFORMANCE

WE TURN PROJECT
IDEAS INTO REALITY

INCREASE REVENUES
BY SHORTENING
PROJECT DEVELOPMENT
AND EPC LEAD TIME

REDUCE COSTS BY ADEQUATE
& STANDARDIZED SOLUTIONS

FROM IDEA TO SUCCESSFUL OPERATION

As a forerunner in gas and multi-fuel engines, fuel systems, technology and services, Wärtsilä participates in the global shift to gas also with LNG infrastructure projects. We focus especially on developing the small-scale LNG value chain together with our customers, offering technology both for liquefaction and regasification.

The bright side of the eclipse

ON 21 AUGUST, MILLIONS OF AMERICANS were out in the streets with their eyes glued to the sky to witness the country's first solar eclipse in 26 years. While being a spectacular sight, the eclipse caused a lot of concerns for the utilities. The celestial event stretching 70 miles wide from Oregon to South Carolina took one hour and 33 minutes to traverse the US. During that time, photovoltaic (PV) resources had to be removed due to the obscuration of the sun causing a sudden increase in load that would otherwise have been supplied by behind-the-meter PV generators.

The financial impact of the eclipse was unprecedented.

According to an analysis by Challenger, Gray & Christmas, the solar eclipse is estimated to have cost the American economy close to USD 700 million in productivity. The combined cost, in lost productivity, to states and metro areas directly in the path of the eclipse could be almost USD 200 million.

This holds a lesson for the entire world, where solar power is on the rise. Countries will have to be adequately prepared for different kinds of variations in power generation. The answer lies in coupling a solar PV park with a power plant that ensures a balance in generation and provides a quick response to fluctuations.

*around the globe

NEWS & ONLINE | GLOCAL WATCH | WORDS & NUMBERS | TRENDS & SCENARIOS | CORPORATE CITIZENSHIP

PHOTO: 123RF

News

TESTING REMOTE CONTROLLED VESSEL

Wärtsilä has taken an important step towards developing its Smart Marine capabilities by successfully testing the remote-control of ship operations. The testing, which involved driving a vessel through a sequence of manoeuvres using a combination of dynamic positioning (DP) and manual joystick control, was carried out on 21 August off the North Sea coast of Scotland, in collaboration with Gulfmark Offshore.

Although the test vessel was in the North Sea, the remote-control navigation was carried out from the Wärtsilä office located in San Diego, California, 8000 km away. The Highland Chieftain, an 80-metre platform supply vessel, was driven through various manoeuvres at both high and low speeds.

“One of the first and most critical hurdles to overcome along the path to the enablement of intelligent shipping is to develop efficient and reliable remote control and monitoring capabilities, taking factors such as bandwidth limitations and cyber security into consideration. This test provides a clear indication that we are well on the way to achieving this,” says **Andrea Morgante**, Head of Digital, Wärtsilä Marine Solutions.

It is anticipated that Wärtsilä’s development of successful remote access to ships will also enable virtual service solutions to customers in need of tuning or testing their DP systems. Furthermore, this solution will be used for other pilot projects, such as automated docking procedures.



EXCITEMENT
RESPECT AND TRUST



CARIBBEAN:

The Caribbean region was heavily affected by devastating hurricanes this autumn. In order to aid the restoration of power to Caribbean communities, Wärtsilä has made a donation of USD 50,000 to CARILEC, the association of Caribbean electric utilities. Wärtsilä Services has also been deployed in some of the affected islands to assist with restarting Wärtsilä-powered generating plants which fortunately did not suffer significant damages.

ENERGY
MAKE THINGS HAPPEN



NORWAY:

The installation of a hybrid energy system on board the Viking Princess was completed this October. The Norwegian vessel is now the first-ever offshore supply vessel in which batteries reduce the number of generators aboard the ship. The new energy storage solution will improve engine efficiency, generate fuel savings and reduce greenhouse gas emissions.

Wärtsilä
GLOBAL
WATCH



DO THINGS BETTER
EXCELLENCE

SINGAPORE:

Wärtsilä will provide a 2.4 MW/2.4MWh energy storage system test bed for Singapore’s Energy Market Authority (EMA), a statutory board under the Ministry of Trade and Industry of Singapore and SP Group, a leading energy utility company in Asia Pacific. The solution will incorporate GEMS software from Greensmith Energy, a Wärtsilä company. This test bed will be Singapore’s first utility-scale ESS, and the first such project in Asia for Wärtsilä and Greensmith. The plant is expected to be fully operational during the latter part of 2018.

SAVING WATER IN THE AGE OF DROUGHT

TEXT: SUKANYA SHANTHA PHOTO: 123RF

Water scarcity is a looming problem in many parts of the world, compounded by drought. To combat it, while researchers are working on cloud seeding projects, Wärtsilä too is doing its bit by introducing solutions – such as Flexicycle power plants – that consume less water.

IN LESS THAN A DECADE – by 2025 – nearly 75% of the world’s population is expected to live with limited water resources, a United Nations study has noted. Communities in the developing world and other regions that are already suffering from acute water scarcity are likely to bear the brunt of crushing droughts.

In anticipation, several government agencies and private companies have been working towards developing tools to mitigate some of the effects that water scarcity can cause. And for several decades now, scientists and researchers across the world have been working on ways to induce artificial rain. The technique involves seeding rain clouds with particles to precipitate rainfall, which can really benefit countries with dry weather conditions.

“The UAE, which is a very dry desert country, gets its drinking and irrigation water mainly from desalination of ocean water. The aim there is to increase rainfall,” says **Hannele Korhonen**, a researcher at the Finnish Meteorological Institute.

Korhonen and her colleagues at the institute have been working on a cloud-seeding project in the United Arab Emirates to identify the most efficient aerosols that can generate rainfall. Korhonen notes that nearly 50 countries have pursued some form of weather modification.

However, this technique is not always used to generate more rainfall. “There are various goals for such weather modification attempts which include hail prevention, enhancing rainfall, or avoiding rainfall,” which happened in the case of Beijing Olympics, Korhonen explains.

Companies have also been alive to this is-

sue. They have found ways to do business in regions that are drought-prone by developing techniques to conserve water. Wärtsilä, for instance, has been working on creating power-generating systems that consume various amounts of water. The Flexicycle™ power plants solution is based on gas, multi-fuel or liquid fuel internal combustion engines (ICEs) and a steam turbine combined cycle.

According to **Ville Kallioniemi**, the product manager at Wärtsilä Energy Solutions and also an expert in this technology, there are four common cooling methods for the Flexicycle™ product: raw water cooling (e.g., through sea water or river water), cooling tower, air-cooled condenser (ACC) and radiators. Out of these, radiators and ACC do not consume water in the cooling process.

“In layman’s terms, Wärtsilä’s dry Flexicycle means better efficiency, hence less fuel consumption; lower emissions and less use of water, so it can be installed in remote areas or deserts where water is an issue,” says **Muhammed Qasim Latif**, General Manager, Business Development, Energy Solutions, Wärtsilä Saudi Arabia.

Latif has worked with several customers that use the dry Flexicycle product, especially in arid regions. He says the users benefit as the system’s water consumption is economical.

“We know that this reduces the consumption



of water by over 90% as it’s a closed system, whereas earlier options that cooled with the help of cooling towers required huge quantity of water,” he explains.

Kallioniemi stresses the importance of educating customers about the benefits of this technology. This is in part because water consumption is critical for many areas where Wärtsilä does business. In the latest improvement in the dry Flexicycle technology, the company uses a heat exchanger for blowdown cooling, instead of a batch of cold water. The next logical step would be to reduce the amount of boiler blowdown, notes Kallioniemi.

So far, water has been a key ingredient in producing energy. But there is hope that such techniques are likely to gain wider acceptance as water becomes a critical resource over the next decade.

[WORDS & NUMBERS]

USEFUL DEFINITIONS AND NUMBERS OF INTEREST.

EDGE COMPUTING

means moving computation and data processing closer to the user – the “edge” of the network. Compared with traditional cloud computing, this reduces the communication bandwidth needed and eliminates the latency between sensors and the cloud, which is crucial for autonomous vehicles and other robotic technologies.

EUI (ENERGY USE INTENSITY)

is a unit of measurement that describes how much energy a building uses. EUI represents the energy consumed by a building relative to its size.

8,000,000 tonnes

of plastic waste is estimated to enter the oceans each year from land. Most of the waste comprises everyday items such as bottles, wrappers, straws and bags.

[TRENDS & SCENARIOS]

FUTURE PERSPECTIVES.



The app that tracks pollution

Worried about the pollution around you? A device called **Flow**, connected to a mobile app, will give you information throughout the day, along with tips on how

to avoid badly polluted areas. Flow tracks particulate matter, nitrogen dioxide, ozone, volatile organic compounds (VOCs), temperature, and humidity.

The more people use the device – clipped to a bag, bike or stroller – the more information there is about the air quality in different parts of the city. The device, innovated

by a company called Flow Labs, is now out for pre-orders and will roll out in 2018. For those living in big polluted cities, it’s time to place your order!



Baker at Koptigei Cooperative pulling out freshly baked bread.

Sparkling Solar Entrepreneurship in East Africa

[CORPORATE CITIZENSHIP]

Where accessible energy is in short supply, it is tough to meet the challenges of day-to-day living, let alone run a small business. But a Wärtsilä-sponsored project running in rural Kenya and Tanzania, GoSol.org, is providing a clean, off-the-grid solution to help local entrepreneurs – and communities – thrive.

TEXT: STEVE ROMAN PHOTO: GOSOL.ORG

DAVID CHEPKWONE SLIDES A TRAY of freshly-baked loaves out of the oven, admiring its golden-brown perfection. “Mainly we are producing breads, muffin cakes and snacks,” he says. Chepkwone is the head baker at the Koptige Bakery, a community-owned business in the town of Tinderet in rural western Kenya. Sales are booming, he says. Demand is high. In spring 2016, the business switched from primarily using its old electric oven, which is connected to an unreliable and costly power supply, in favor of a SOL5, the first of two next-generation solar-powered ovens the bakery received under the auspices of GoSol.org. Koptige was one of the initial pilots in the project, which used advanced solar tech to incubate and support businesses in parts of Kenya and Tanzania where electricity supply is typically cost-prohibitive, spotty, or more often, non-existent. In the case of the bakery, the weak power connection meant expanding the business was impossible, since frequent power cuts put batches in jeopardy.

Though the bakery still uses its electric oven, the solar oven has boosted production and lowered costs, allowing Koptige to reach more customers. After one year of successful use, GoSol.org installed the second solar oven to increase production further still. In an interview posted on GoSol.org’s YouTube channel, Chepkwone shifts from baker to businessman mode, rattling off the increased profit figures and explaining how the newfound money is being reinvested into fertiliser and financial support for the community’s schoolchildren. “As soon as [David] saw he could bake for free, he totally got it. He really understood all of the implications of the tech, for themselves as well as for the region,” says **Eerik Wissenz**, chairman and co-founder of Solar Fire Concentration, the Finnish-based company behind GoSol and the developer of the technology that powers it. **THAT TECHNOLOGY IS THE SOL5** ovens and roasters, which employ a 5m² array of mirrors to concentrate

sunlight. They’re powerful enough to bake 30 200g loaves in 45 minutes or roast 20 kg of peanuts in 3.5 hours. Partnering with World Vision in Kenya and Global Resource Alliance in Tanzania, GoSol.org has initiated 10 pilots thus far, providing the SOL5 to rural collectives engaged in businesses such as baking, peanut roasting and fish dehydrating – businesses that depend on heat. “Making heat with electricity is not a good use of electricity where electricity is scarce,” Wissenz explains. That scarcity is certainly evident in western Kenya, where electrification rates were estimated at 22% for rural businesses and 5% for rural households in a recent study by the University of California, Berkeley. Where electricity isn’t available, the situation can be worse. Wood and charcoal fill the gap, creating problems ranging from deforestation and pollution to unhealthy smoke exposure, to women spending hours each day collecting firewood. The switch to solar thermal obviously alleviates these problems, but also gives the businesses a space to grow. “It generates income, which promotes development. Everybody wins when poverty is alleviated,” Wissenz says. It was this development-through-entrepreneurship aspect of GoSol.org that attracted Wärtsilä to the project, according to **Jukka-Pekka Niemi**, Marketing Manager, Digital at Wärtsilä Energy Solutions. “We were looking for a project where we could help [East African] societies, in addition to building grid-strengthening power plants,” he says. “GoSol is helping micro-entrepreneurs. We found that very fitting with Wärtsilä’s vision because when you help entrepreneurs, you make businesses grow and then societies evolve as well.”

[COLUMN]

Putting the pieces together

SELDOM DO YOU SEE technology and opportunity coming together in a way that can positively disrupt the marine industry, but the time is ripe for that to happen. After a period of stress where contracting levels fell to historical lows, the marine sector is finally beginning to look up. And while this is a good start, we must help this recovery by using innovative technology to radically improve efficiencies. This is what we are striving for with our new Smart Marine vision, which aims to use intelligent development to create smart solutions for an integrated marine ecosystem.

DIGITALISATION AND AUTOMATION will play a big role in this. Wärtsilä already has the biggest product portfolio in the marine industry and by combining this with digital aspects, we can help our customers improve their businesses. The benefits will be two-fold. First, it will help reduce fuel costs and emissions, making shipping more environment-friendly. And second, it will use technology to support safer and more efficient operations of vessels. In doing this, we help meet Wärtsilä’s larger purpose, which is ‘enabling sustainable societies with smart technology’. As part of this strategy, we are constantly looking at improving the different pieces of the marine ecosystem puzzle, figuring out how we can improve the movement of the vessel from point A to point B to point C. At the same time, our goal is to ensure that all these pieces are improvements by themselves. Our Wärtsilä HY product is a case in point. We have combined engines with batteries and with our software to create the most efficient hybrid model in the marine industry. Besides this, we also provide other solutions like induction charging to reduce the port time for battery-powered and hybrid vessels. If you add these separate solutions together, you will see how we have helped our customers optimise operations across the board.

WHILE WORK ON THE NEW STRATEGY has already begun, it is clear that this is not something which can be implemented, all at once. This has to be done step-by-step, in close collaboration with our partners and customers. And at the same time, our focus must be on continuous innovation, both in our existing product lines and in the development of new ones. Wärtsilä’s long history is filled with examples of how we have successfully disrupted the industry and so change is nothing new to us. This is why I feel this new strategy is both a big development and a continuation. We have done it before and we can do it again.

ROGER HOLM
President, Wärtsilä Marine Solutions

WE AIM TO
CREATE SMART
SOLUTIONS FOR
AN INTEGRATED
MARINE
ECOSYSTEM.



PHOTO: DANIELE MATTIOLI

OPEN FOR BUSINESS

Mexico has transitioned its closed and state-run energy sector into a vibrant market that is fully open to competition. Private investments are pouring in and the future looks bright. How did this happen and what does this mean for the Mexican economy?

Four years ago Mexico was in a big fix. Oil production was sharply declining and inefficiencies in electricity supply were driving costs higher despite its being one of the largest oil and gas producers in the world. Simultaneously, energy demand was rising.

Mexico needed to have more energy security while decreasing the high price of electricity, which was expensive to the public and dragged on the country's competitiveness. The only way to do that was to create a competitive retail and wholesale market. But that required massive changes in both legislation and investments.

So the government ushered in Reforma Energética or Energy Reform, to fully open the sector to competition. This move marked the beginning of the end of seven decades of monopolies by state-run Petróleos Mexicanos (PEMEX) and the Comisión Federal de Electricidad (CFE). PEMEX was the sole oil and gas producer in the country and CFE was in charge of everything to do with electricity – from generation, transmission and distribution to power dispatching.

Soon CFE was legally unbundled into six companies generating power, one transmission company, one distribution-company, one basic energy supplier, and four

affiliated companies. And CENACE, an independent body, was set up to create and run Mexico's wholesale electricity market where private companies as well as the various CFE companies could compete with each another.

"This is a very significant transformation that will definitively drive better quality, service, offerings and reduced prices for the consumers while increasing the national development and competitiveness of Mexico," says Dr. **Raul Carral**, Business Development Manager, Mexico, Central America and the Spanish-Speaking Caribbean, Wärtsilä Energy Solutions.

The oil and gas sector, too, was opened up to private investments and new technologies, leaving PEMEX to focus resources and expertise on a narrower range of projects while retaining the national ownership of hydrocarbon resources.

THE POWER OF CHANGE

Since then, more than 100 companies with different backgrounds and nationalities have shown interest in Mexico's oil and gas sector, and 69 of 123 oil blocks have been awarded to new companies.

"THIS TRANSFORMATION
WILL DRIVE BETTER QUALITY,
SERVICE, OFFERINGS AND
REDUCED PRICES FOR
CONSUMERS."

“MEXICO IS A HIGH- POTENTIAL MARKET FOR RENEWABLE ENERGIES.”

The demand for electricity is on a steep rise in Mexico.

Power auctions organised by CENACE have successfully placed over 6 GW in just three rounds. According to PRODESEN, Mexico's National Electric System Development Programme, the country's gross power generation was 319,364 GWh, or 3.2% more than 2015, maintaining the same proportion of conventional (79.7%) and clean technologies (20.3%).

“Thanks to new technologies and the improvement of current ones, the MW production cost has seen an impressive drop in the last few years, and this trend is expected to continue,” says **Yves Hayaux du Tilly**, Partner at Mexican Law firm Nader, Hayaux & Goebel.

A few months ago, President Peña Nieto stated that energy reforms have already led to the creation of 120 new companies with committed investments of USD 80 billion in the oil, gas and electricity sectors in Mexico.

PRODESEN, in its 2017 report, stated that Mexico will require investments of USD 110 billion over the next 15 years for power-related infrastructure projects. Of this, 81% would be required for generation projects, 11% for transmission projects, and 8% for distribution projects. It also estimates that USD 29.5 billion will be required for the installation of new generation plants within the first five years.

This is crucial because the Secretaría de Energía (SENER) estimates that about 137 generation units, totalling 15,814 MW (nearly 16 GW), are slated for retirement between 2017 and 2031. Approximately 70% of those retirements are conventional thermal units, and the largest number of retirements will occur between 2018 and 2020 (approximately 5500 MW).

BUILDING A BRIGHT FUTURE

In that scenario, Mexico will have to add 56 GW of new capacity between now and 2031. The target is to make clean energy account for 38.2% of its total power generation by 2031 from the current 20%.

“Mexico is a high-potential market for renewable energies in hydraulic, solar, wind, geothermal, biomass and waste-to-energy. There have been several renewable energy tenders launched and there are several wind and solar farms established,” says Heidi Virta, Commercial Counsellor, Finpro, Mexico

As Mexico's energy landscape changes, it is also bringing in a new set of challenges. For instance, more renewable power leads to more intermittent supply that does not match the demand all of the time. So how can Mexico meet these ambitious targets while ensuring increased reliability as well as lower prices?

“More flexible power is the right solution for this problem. And this is where Wärtsilä, the leader in flexible power worldwide, can bring in great value. In fact, we already have significant projects in our pipeline that look into adding flexible power into the Mexican grid,” explains Dr. Carral.

Mexico's switch to becoming a fully competitive energy market could pay off. It is the largest Latin American economy registering a positive growth and the second-largest Latin American market for capital inflows. Experts predict that apart from political shocks, there's no stopping this growth engine. ●

WÄRTSILÄ IN MEXICO

Wärtsilä in Mexico was established in 1993. It has been continuously operating in the country now for more than 24 years. It offers solutions to the industrial, marine and power plants sectors throughout Mexico. The power plants delivered by the company, located in seven regions across the country, have a combined capacity of 503 MW.



BETTER DATA HEALTHIER OCEANS

Knowledge is power when it comes to improving ocean health, yet only a tiny fraction of our marine and coastal areas are comprehensively monitored. Luckily, new technologies, approaches and players – including ‘citizen scientists’ and private sector supporters – are lining up to help fill this ocean data chasm.

“WE ALWAYS SAY
YOU CAN’T MANAGE
WHAT YOU CAN’T
MEASURE.”

With the livelihoods of an estimated three billion people dependent on the oceans, it’s no surprise that issues like climate change, habitat loss and other alarming ocean health trends are quickly rising to the top of the global agenda. But gaining a clear picture of what’s happening in the oceans is easier said than done. Less than five percent of the oceans are effectively monitored, according to observations published by the World Economic Forum, leaving “a pressing need to gather data at higher frequency, quality and variety” in order to set adequate ocean health management policies.

This line from data to policy is well understood by researchers working on the Ocean Health Index (OHI), a collaborative framework to evaluate ocean ecosystems that was set up by the University of California, Santa Barbara’s National Center for Ecological Analysis and Synthesis (NCEAS) and Conservation International. The OHI’s scope goes far beyond traditional oceanography and marine science, drawing on more than a hundred databases to include human factors such as population and economics into its assessments.

Julia Stewart Lowndes, PhD, is an NCEAS marine researcher who works on the index as a project scientist. For her and her colleagues, the need for more data is clear.

“We always say you can’t manage what you can’t measure,” says Lowndes. Though satellite information from NASA and data from NOAA are available for areas throughout the globe, she explained, they’re just a starting point. It’s vital to have in-water samplings over time. “That’s really good both for validating the satellite records and for seeing how different parts of the ocean are changing at different rates.”

Advances in technology are showing promise in filling in the gaps. Biologists are benefiting from improved animal tags, better remote vehicles and the exciting new field of environmental DNA. A start-up near San Francisco has developed Saildrones, unmanned vehicles that make months-long voyages to remote ocean areas and send data to NOAA in real time.

CAN OCEAN HEALTH BENEFIT FROM DIGITISATION?

The move towards digitisation is opening opportunities for private sector involvement. Eniram, the Wärtsilä-owned company focused on advanced data solutions, oversees the real-time remote monitoring of about 300 ships for Wärtsilä’s customers. Along with information on engine performance, fuel consumption and the like, onboard sensors collect and transmit data related to ocean conditions such as weather, currents, depths and seawater temperatures as these ships crisscross the globe.



Melvin Mathews, Director Maritime at Eniram, believes this data can and should – with customers’ permission – be anonymised and shared with researchers to add to the body of ocean data being collected.

“There is a lot of information we’re getting that could be useful. This information, when analysed over time, can show changes in measurements so we can actually track progress. We can put our finger on what’s getting worse,” says Mathews.

He adds that he would like to see information sharing not only from the ships Wärtsilä monitors, but also from the roughly 2000 to 3000 ships that use similar advanced data platforms.

“If the information is there, why not share?” he asks. “This is not only an obligation, but a responsibility of the private sector. It needs to be part of protecting and preserving the oceans.”

INTERPRETING THE DATA

In a similar fashion, technology has now created another non-traditional source for ocean data. A us-based non-profit has developed Smartfin, a surfboard fin packed with low-cost sensors that measure multiple ocean parameters and transmit the data to the Scripps Institution of Oceanography in San Diego for analysis. Smartfin founder **Andrew Stern** says it could be particularly useful in monitoring conditions around coral reefs and pinpointing potential trouble spots that could benefit from active intervention.

Stern’s goal is to distribute Smartfin on a loan basis to thousands of surfers, effectively turning them into citizen scientists. “I hope to really build an energised, empowered community around Smartfin,” he notes. “I think it’s going to engage surfers and the general public in science in a cool way that’s more accessible. It will lead to far more people claiming a voice around climate.”

New levels of innovation and participation are certainly encouraging signs for ocean data collection efforts. Lowndes notes, however, that data-gathering itself is just one piece of the ocean health puzzle. It’s critical, she says, that the data be freely available and properly managed, and that researchers share their analyses.

“As technology keeps advancing and it gets easier and cheaper to collect more and more data, it’s important to think about who has access to that data and the analyses that are done with that data. And I think these things go hand-in-hand, especially if we want to translate that data into knowledge and management action,” she says.

Clearly, gaining the necessary insights into our marine and coastal ecosystems is a demanding task, but heightened collaboration and new ideas could bridge the data gap, giving new hope for healing the oceans. ●

The global shipping industry has come of age with more automation, game-changing technologies and the Internet of Things. But embarking on this voyage has also made it a prime target for unforeseen, invisible and highly destructive cyber attacks. Find out what's at stake and how the industry can safely sail against this tide.

SAILING IN UNCHARTED TERRITORY

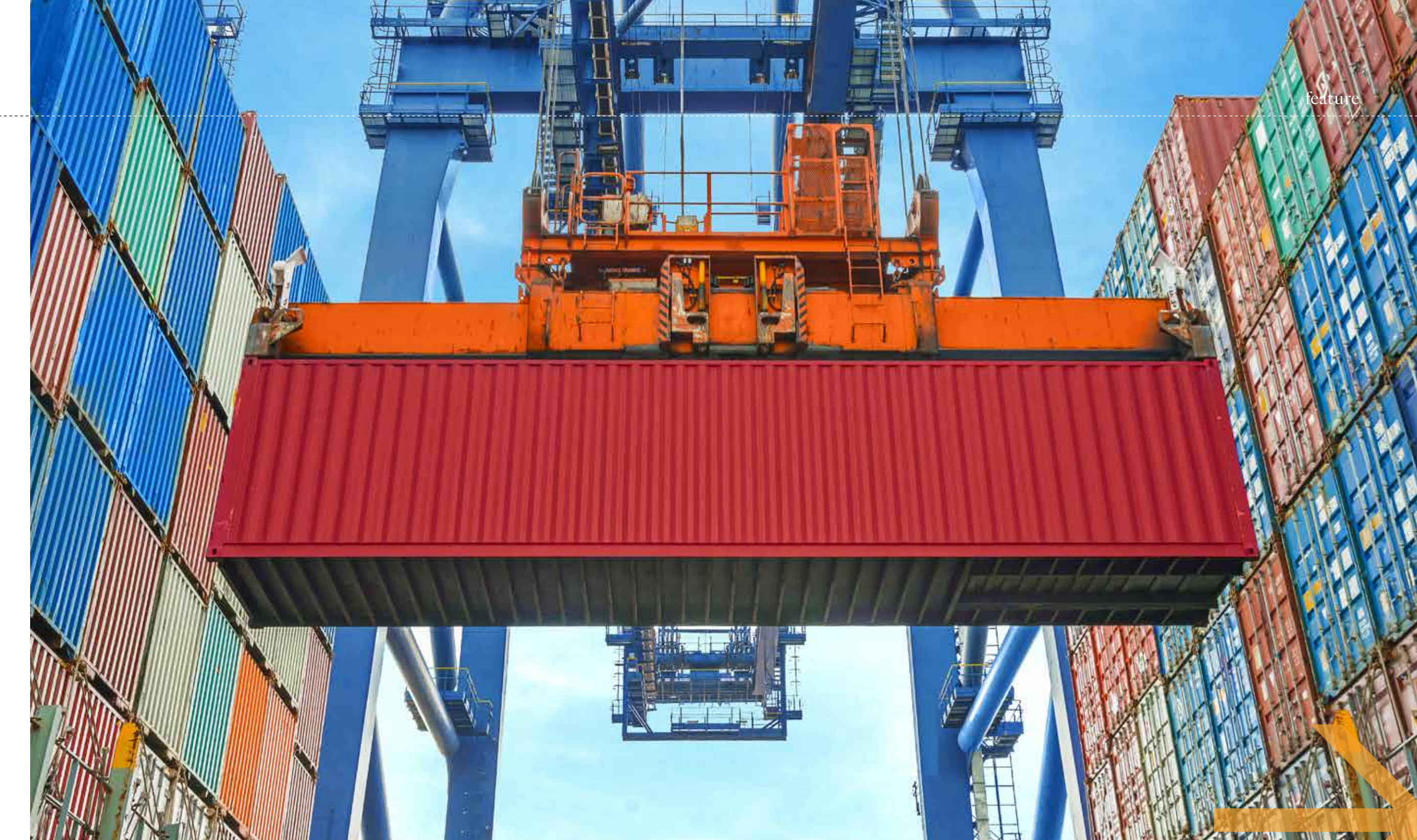
“THE CONTAINER INDUSTRY IS A SECTOR THAT REQUIRES ENORMOUS LEVELS OF DATA EXCHANGES.”

Spoofing, jamming, phishing, malware and ransomware are not terms that were associated with the maritime and shipping sector until recently. But reality has changed and so has the game. Physical attacks are passé and it's the day and age of cyber criminals who are targeting critical infrastructure sectors like maritime and shipping to cause maximum damage.

According to a 2016 survey by IHS Markit & BIMCO, 65 of 300 industry players said that they were victims of cyber attacks such as malware, phishing and theft of credentials, among others. The attacks led to financial losses and loss of corporate data and affected the functionality of shipborne systems and IT systems. BIMCO's report points out that the vulnerabilities on board ships include outdated or unpatched software, unsegregated networks, lack of access control to computers and networks, lack of cyber security and safety policies, lack of intrusion detection, obsolete operating systems and low-quality hardware used to construct networks.

“We consider the cruise line industry to be at particular risk due to the number of individuals boarding these ships all requiring connectivity. The container industry is also a sector that requires enormous levels of electronics data exchanges which could be vulnerable without network protection measures in place,” says **Phil Tinsley**, Manager – Maritime Security, BIMCO.

Apart from vessels or ships, the sector is a primary target for cyber attackers because it is critical for the development of economies and global trade. The shipping industry accounts for almost 90% of the world's trade by volume and contributes



USD 360 billion or 5% of the total world trade in freight rates annually. It is complex in structure and involves many players.

“The transportation chain of the maritime industry is complex and diverse. You have actors from product and service providers, shipyards, charterers, operators and owners to technology providers such as satellite connectors. In this kind of environment all parties are not necessarily aligned in their interests to protect different segments,” says **Kim Eklund**, Director – Cyber-as-a-Service, Wärtsilä.

UNDER ATTACK

The industry is also an easy target for cyber-attacks because it has many fixed and mobile assets spread across jurisdictions

and territories. An attack could not only lead to financial losses and breach of IT systems, but also cause damage to assets such as vessels, containers, offshore oil and gas platforms, unmanned undersea vehicles, drones, port infrastructure, navigation aids, undersea cables and pipelines, communications systems (onshore, ship-to-shore and satellite), port industrial control systems (ICS) etc.

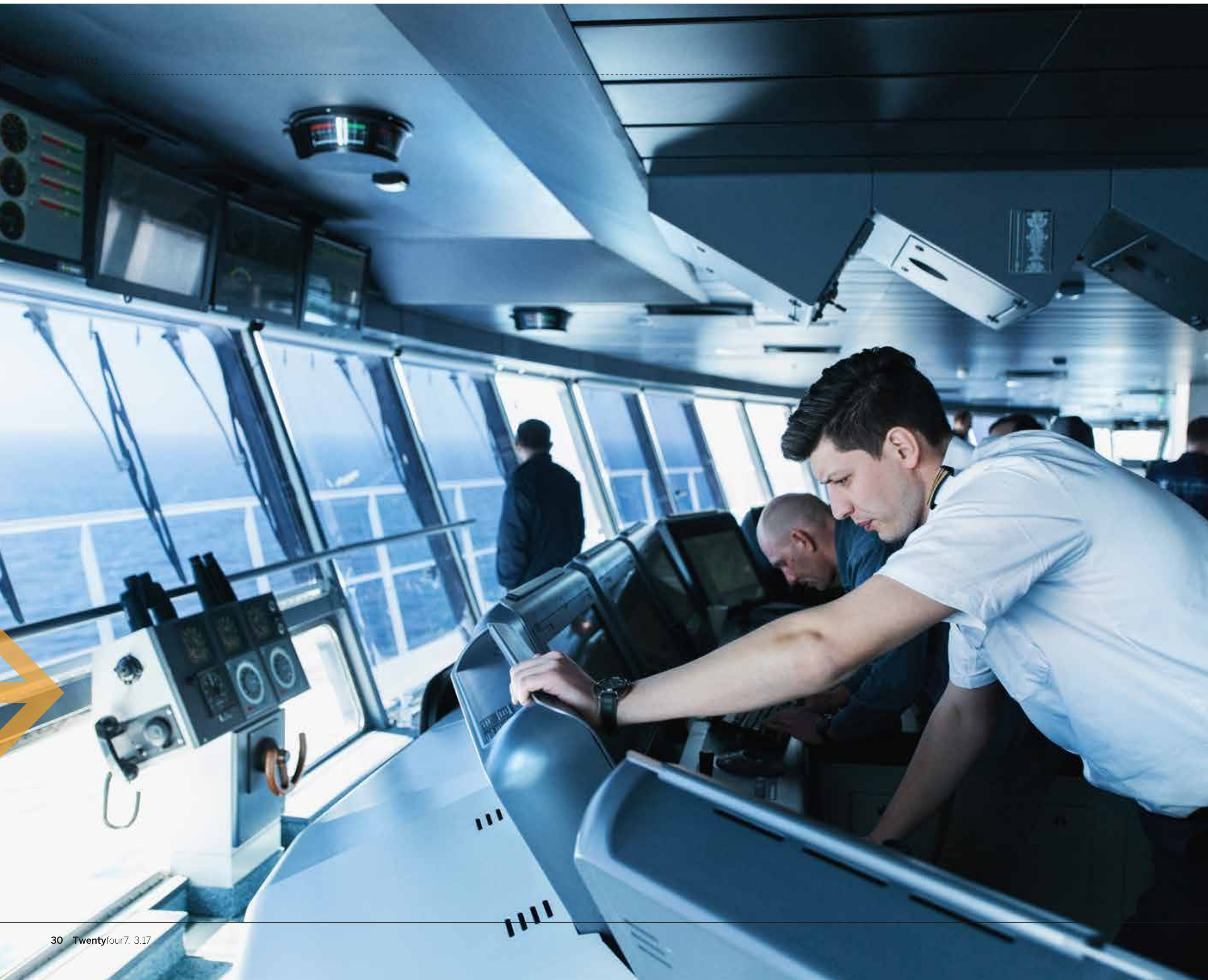
Lior Frenkel, CEO, Waterfall Securities explains, “If ships travel near, through or to zones of active conflict, state-sponsored cyber sabotage is a real possibility. Worst-case consequences include physical damage to the vessel, cargo, crew members, passengers and the environment.”

For instance, in April last year, South Korea is said to have

made almost 280 vessels return to port after experiencing problems with their navigation systems.

Other examples include an attack on the port of Oakland targeting its administrative site; ongoing and repeated attacks on the vessels of a global shipping company where pirates would board and locate specific high-value crates by a bar code and steal them; and attacks on the bunkering sector by impersonating sellers and requesting for payments into a scammer accounts.

“The intrinsically global nature of the supply chain, diversity of stakeholders and complexity of operational activities present a very challenging backdrop for security professionals in the shipping industry to work against,” says **Peter Broadhurst**, Senior Vice President, Inmarsat.



“IT IS INCREASINGLY
IMPORTANT TO
RECOGNISE THE
VALUE OF HAVING AN
INFORMED, TRAINED
AND RESPONSIBLE
WORKFORCE.”

THE WEAK LINK

Experts say that most of the cyber attacks in the shipping industry happen because of human error. According to Future-nautics' Crew Connectivity 2015 survey, only 12% of crew had received any form of cyber security training and only 43% of crew were aware of any cyber-safe policy or cyber hygiene guidelines provided by their company for personal web browsing or the use of removable media (usb memory sticks, etc.). Some 43% of crew reported that they had sailed on a vessel that had become infected with a virus or malware.

“The greatest vulnerability to any system is normally the user. It is therefore increasingly important to recognise the value of having an informed, trained and responsible workforce when it comes to cyber threats,” says **Selina Singh**, Senior Consultant (Maritime) at NYA International.

FUTURE-PROOF SHIPPING

As systems get more complex and ships become smarter due to technological advancements, every area of operation is exposed to cyber risks. Companies like Wärtsilä understand this and are offering turnkey marine solutions such as cybersecurity patching services to their customers in order to manage the entire life cycle of their industrial control systems.

“The whole approach is geared around the increasing onset of the maritime equivalent of the Internet of Things (IoT). We all acknowledge that we are in a global, more integrated network, and a more automated network overall. But at the same time, this brings with it an increase in risks because it also increases opportunities and vulnerabilities to those who would exploit them,” says **Andrew Ross**, Director, Cyber Assurance, Wärtsilä.

That's a good approach to have because in the days ahead, the threats will only grow and get more destructive in nature. So the best way for the industry to sail smoothly is to become 'future proof.' ●

STRONG DEVELOPMENT IN ORDER INTAKE

Wärtsilä's net sales increased by 7% to EUR 3,477 million in the period January–September, while profitability was solid at 10.0%. Order intake continued to develop well, thanks to good demand for Wärtsilä's energy solutions, a favourable vessel contracting mix and the healthy interest for long-term service agreements in both of our end markets.

STEADY DEVELOPMENT IN SERVICE MARKETS

The overall demand in the service markets was steady in January–September. Marine service activity favoured the cruise segment, while the offshore segment remained challenging. Activity among merchant customers stabilised at a low level in the third quarter. The demand for power plant related service activities was solid. Net sales from the Services business was stable at EUR 1,561 million, while order intake increased by 13% to EUR 1,834 million thanks to the increasing demand for long-term agreements in both the marine and energy markets. Received orders during the third quarter included a maintenance agreement with GasLog LNG Services, covering eight LNG carriers operating on Wärtsilä dual-fuel engines.

POWER GENERATION MARKETS SHIFTING TOWARDS FLEXIBLE TECHNOLOGIES

The demand for Wärtsilä's energy solutions has been on a good level through the review period. Electricity demand in the emerging markets continued to increase, particularly in Asia, and the growing share of intermittent renewable power sources in several developed markets supported interest in flexible generation capacity. The role of storage technology and hybrid solutions, including solar generation, is increasingly being discussed globally. The 25% growth in Energy Solutions' order intake supported market share development, which increased from 12% to 14% in the natural gas and liquid fuel

power plants of up to 500 MW during the twelve months ending in June. Ordering activity was strongest in Asia, where received orders included several equipment deliveries to Indonesia and Bangladesh.

MARINE SOLUTIONS DEVELOPMENT SUPPORTED BY FAVOURABLE VESSEL CONTRACTING MIX

During January–September, 690 contracts for new vessels were registered as compared to 634 during the corresponding period in the previous year. Despite slightly improved market conditions in the merchant segment, large order books and scheduled newbuilding deliveries continue to limit utilisation levels and rates. Contracting activity continued to be on a good level in the cruise, ferry and Ro-Ro segments, while gas carrier contracting has improved from very weak levels in the previous year. Marine Solutions' order intake increased by 8%

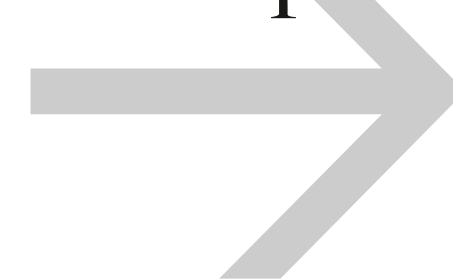
to EUR 1,112 million in the review period January–September, supported in particular by the cruise and gas carrier segments.

OUTLOOK FOR 2017

Looking ahead, Wärtsilä anticipates demand by business area to develop as follows: The service demand outlook remains solid with growth opportunities in selected regions and segments. The outlook for Energy Solutions is good thanks to increasing electricity demand in the emerging markets and the global shift towards renewable energy sources, which will support the need for distributed, flexible, gas-fired power generation. Demand is expected to be solid in Marine Solutions. Despite good order intake growth, the marine market environment remains challenging, as the merchant, gas carrier, and offshore segments continue to suffer from overcapacity and slow trade growth. ●

THE OUTLOOK FOR ENERGY SOLUTIONS IS GOOD THANKS TO INCREASING ELECTRICITY DEMAND IN THE EMERGING MARKETS.





DRIVING THE TRANSITION

Switching to renewable sources of power may be the future, but the need to improve the energy efficiency of existing power systems cannot be ignored. Wärtsilä's Guaranteed Asset Performance programme is one way to make that possible.

“AS THE WORLD TRANSITIONS TO CLEAN ENERGY, EFFICIENCY CAN MAKE THE TRANSITION CHEAPER AND FASTER.”

From Sweden to Germany, to India, China and even Kenya, many countries are switching to wind and solar power, vowing to be almost entirely powered by renewables in order to rein in emissions and ensure sustainability.

However, even as the renewable energy signals the rise of a new world order, governments and energy experts are no longer viewing the adoption of clean and renewable power in isolation. And that's because of challenges like energy intermittency, power wastage and varying adoption rates, which prevent renewable energy from reaching its full potential.

Which is why, in order to accelerate the path to meeting emissions targets, an equal focus is now being placed on another key element – achieving energy efficiency.

“As the world transitions to clean energy, efficiency can make the transition cheaper, faster and more beneficial across all sectors of our economies. Yet energy efficiency is far from fulfilling its potential,” **Fatih Birol**, Executive Director, International Energy Agency (IEA), said in a 2016 energy efficiency report. “Globally, two-thirds of the economic potential remains untapped. 70% of the world's energy use takes place outside of any efficiency performance requirements.”

A WIN-WIN SOLUTION

Improving the energy efficiency of existing power systems can have significant social and economic benefits.

“Customers can achieve cost savings via lower fuel consumption and also reduce the use of spare parts owing to a lower risk of breakdowns,” explains **Markus Åbrant**, General Manager, Energy Agreements (South Europe & Africa) at Wärtsilä. “Emission reductions can also be achieved through constant follow-ups on engine and equipment performance and also through predictive maintenance whenever required.”

In fact, in IEA member countries that have been following energy efficiency improvements since 2000, greenhouse gas emissions from fossil fuel consumption declined by 1.5 gigatonnes. In monetary terms, this translated to a whopping USD 540 billion in energy savings in 2015.

It's no wonder then that economies around the world are now tightening energy efficiency regulations.

The EU, for instance, voted for a legally binding increase in its energy efficiency target of 40% by the year 2030. China, too, is seeking to reduce its carbon emissions by 18% from 2015 levels with the help of efficiency improvements.

So, what's the best way to achieve energy efficiency?

“Continuous development of technology, efficient ways of working, that is, right actions at the right time throughout the life cycle of a power plant, as well as employing the correct mix of renewables and conventionally produced energy,” declares Åbrant.

One way to improve energy efficiency is through data-driven maintenance and life cycle upgrades, such as Wärtsilä's Guaranteed Asset Performance programme, which is used by companies to maintain their equipment.

“We collect current operational data via digital services on different levels and analyse it,” explains Åbrant. “Then we suggest preventive actions that will allow the customer to achieve

performance targets in terms of e.g., heat rate, availability and output for respective installation. This is something that make long-term costs more predictable for our customers.”

THE MANY PATHS TO ENERGY EFFICIENCY

In addition to this, Wärtsilä also supports daily operations by employing dedicated operational management for each installation, backed up by several expertise centres. Fleets are also continuously optimised through the use of operation and maintenance plans.

“By maintaining the equipment according to OEM schedules and bulletins, performing maintenance at the right time and for example replacing components with new technology whenever available, we are safeguarding the efficient operation of an installation in an environmentally friendly way,” says Åbrant.

But that’s just one part of the picture. There are multiple ways to improve energy efficiency, and Wärtsilä, for instance, has successfully executed a number of these in different projects. One such method is through a power plant lifecycle upgrade.

In Limbe, in Cameroon, Wärtsilä rehabilitated and upgraded a power plant within a span of seven months to help it regain its original capacity of 80 mw. Not only did this extend the life cycle of the power plant, it also helped reduce costs.

Another way to upgrade energy efficiency is through complete conversion, such as at the Shanghai Electric Power Plant (SEP) in Malta.

The Delimara power plant 3 operated by SEP at Malta is crucial as it is the only plant that provides power to both Malta and its neighbouring islands. Previously run on heavy fuel oil (HFO), eight Delimara plants were converted by Wärtsilä to run on natural gas, with the primary aim of reducing the cost of electricity production.

“Our power plant will benefit from a lower heat rate for the engines, increased efficiency, higher power output capacity and lower emissions. This means reduced operational costs, says **Tan Qing**, Project Manager at Shanghai Electric Power Limited, speaking about the Delimara 3 conversion.

Upgrading turbochargers can also improve overall energy efficiency. Typically, the replacement of turbochargers usually takes place in 50,000-hour intervals and requires major work to be carried out. Wärtsilä’s solutions, however, allow customers to simply exchange the turbocharger instead of replacing it, guaranteeing a reduction in fuel consumption of up to 4%.

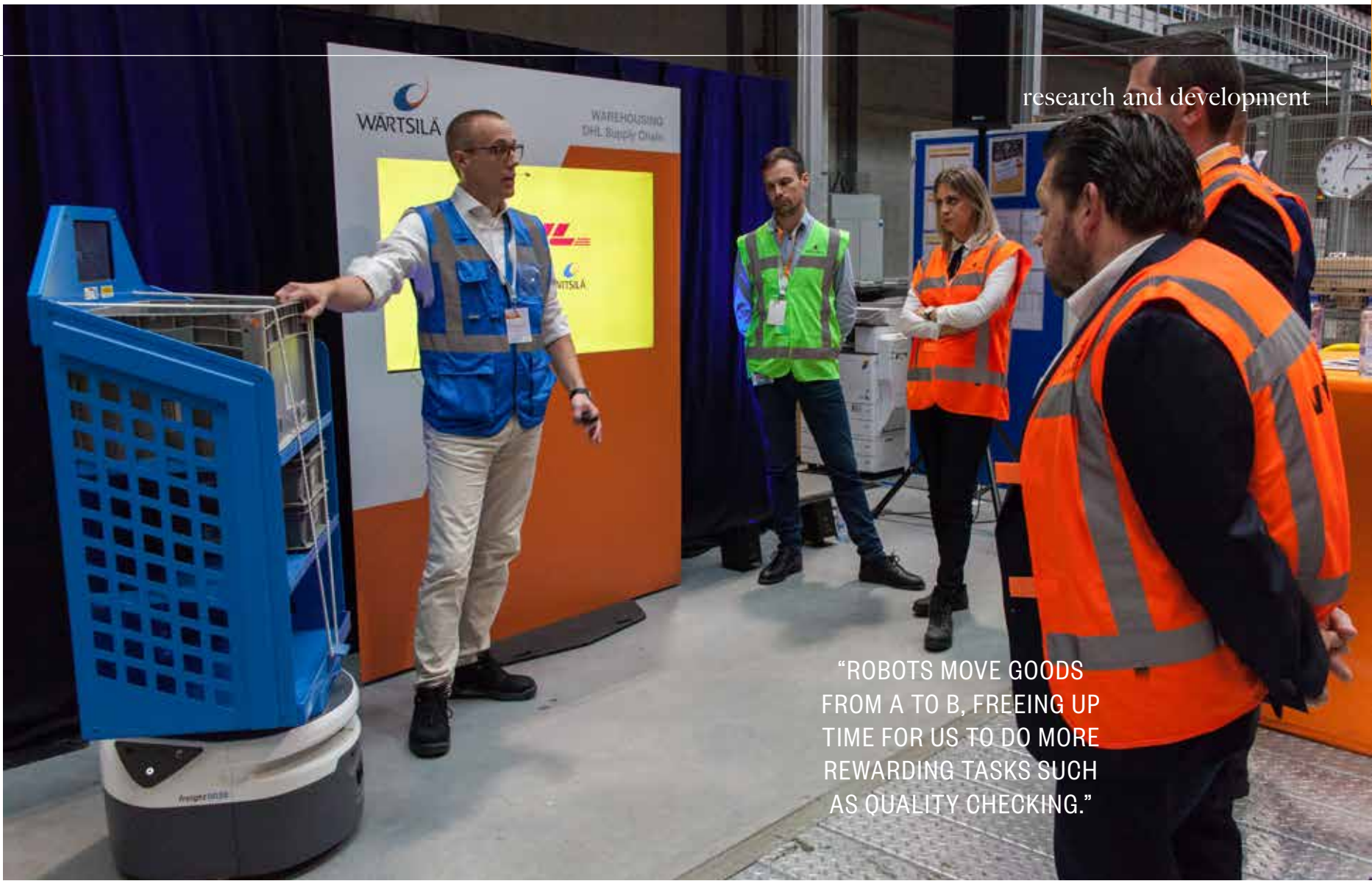
In order to obtain maximum energy efficiency, a mix of component upgrades as well as constant maintenance is considered the way ahead. Here, the upgrade will result in short-term improvement, while the right type of maintenance will help reach mid and long-term improvement.

“Both upgradation and maintenance, in combination, will be by far the best solution to improving energy efficiency throughout the plant lifecycle,” concludes Åbrant. ●

“BOTH UPGRADATION AND MAINTENANCE WILL BE BY FAR THE BEST SOLUTION.”

LOGISTICS WITHOUT BOUNDARIES

The highly automated warehouse in Kampen, the Netherlands, features the latest technologies, including robots, used in optimising logistics flow.



research and development

“ROBOTS MOVE GOODS FROM A TO B, FREEING UP TIME FOR US TO DO MORE REWARDING TASKS SUCH AS QUALITY CHECKING.”

An orange robot crane zoomed towards a group of Wärsilä's customers. They were standing in the 20-metre high, fully automated so-called High Bay area in the Central Distribution Centre. It picked a wooden pallet off the orange racks and returned at a speed of 11 kilometres an hour.

“That's impressive,” commented one of the visitors, wearing an orange safety vest and safety shoes. He had joined others from companies around the globe for the technology group's customer event, named ‘Powering the supply chain – Logistics without boundaries’.

As they walked through the highly automated warehouse, they were passed by a yellow-vested forklift-driver on one side and grey plastic boxes moving along a conveyor belt on the other. During this Gemba walk – a Japanese term meaning ‘the real place, the real thing, the real people’ – the visitors, divided into small groups, learned more about transportation, warehousing, parts supply and quality assurance.

DIGITALISATION'S SOFT SIDE

“It starts with communicating and understanding each other,” said **Rob Scharff**, Global Purchasing &

Logistics manager from Stolt Tankers B.V. in Rotterdam, who attended the event with a few colleagues. “It's only logical that we look together at how to improve processes.” He added that while digitalisation can make things faster, it's important that people develop alongside it.

According to him, in the coming years it will become increasingly important to know in advance which products are needed when and where, so the right goods are available immediately, while still keeping supplies limited. “It would be brilliant if Wärsilä could predict how long their engines can run and when to buy new parts.”

Wärsilä's director of Global Logistics Services, **Christian Rönnholm**, mentioned that the company implements condition-based maintenance, providing maintenance to engines and other machines at certain intervals: “This shows in advance when something needs to be replaced, which increases reliability.” Wärsilä also recently invested significantly in its global spare parts availability and regional presence. “When the goods are located closer to the customer with optimised inventories and flexible delivery points, we can deliver them faster,” he says. In the coming years, regional centres will be established in new locations.

SMART SENSORS

The Central Distribution Centre, which opened in 2010, has a floor space of 37,000 m². It covers the entire material flow from order intake to delivery. Altogether, there are 120 Wärsilä and 210 partner-company employees who work here. Around 27 million pieces are in stock with more than 83,500 unique parts. Last year, over 100,000 deliveries were shipped from here to more than 180 different countries.

The visitors entered a climate-controlled area (always 20° C), where high-tech equipment, such as a large coordinate measuring machine, is used to check part quality and numbers. “I always say, quality is not a department, but an attitude,” one of the employees in a light green vest said.

He was showing the visitors a small yellow device and telling them about a pilot they were running with five of these ‘smart sensors’, which can measure



temperature, humidity and light. “We send them along with shipments to customers who are experiencing difficulties.” For instance, a customer in India wasn't satisfied with the quality of the parts they received. The sensors soon made clear that the road from the airport to the customer was very bumpy. Double packaging is now being used to resolve the problem.

ROBOTS AND DRONES

Further along, the visitors were passed by a small blue robot carrying grey boxes. “We've recently started using these,” said **Bob van Turnhout**, site manager at logistics company DHL, one of Wärsilä's partners, which operates a significant part of the warehouse activities. “The robots move the goods from A to B, freeing up time for us to do more rewarding tasks such as quality checking.”

“A day like this is a great opportunity to hear what our customers need,” van Turnhout said, also mentioning his appreciation that Wärsilä had involved its partners. “Now we can show them the complete chain.”

The group reached the other side of the warehouse, next to the loading bays from which around 35 trucks

depart each day. Here, staff from transportation partner CEVA logistics told the visitors about the future of transport, which will involve innovations such as wind energy and platooning, with single-driver truck convoys.

In addition to the Gemba walks, the visitors could attend several presentations about Wärsilä's innovations during the day and join a boat trip on the river IJssel in the evening. There was plenty of time for their questions.

YEARLY EVENT

“An event like this is new to the global logistics business,” said Rönnholm. “We like to be closer to our customers, so we can serve them better, and we're also proud to show them what we can do.”

“It was time to open the doors of Wärsilä Global Logistics Services to receive feedback directly from our customers,” said **Joe Lunday**, General Manager at Parts Coordination Management, who helped organise the day. “This event will not only help us modify and explore opportunities to improve today's services but it will also aid in the development of future initiatives, ensuring our investments are supporting a path that our customers will value for years to come.”

The *E*-naissance woman

Futurist K D Adamson's predictions for the maritime industry are being discussed at the IMO. She says the future isn't somewhere we go; it is something we create. For shipping, this means its position "at the heart of the value and supply chain" might not be a given for much longer.



“IF YOU GIVE PEOPLE
IDEAS, YOU GIVE THEM
THE PERMISSION TO
THINK DIFFERENTLY.”

KD Adamson originally comes from advertising and strategic brand development, but her increasing work with technology and scenario planning led naturally towards futurism. Her special interest in the blue domain, maritime, and shipping industry is, in part, due to her familiarity with that world – her father was an officer in the Royal Navy, her husband is a naval architect by training and has run several maritime technology companies – and because she saw a big problem on the industry’s horizon.

“Shipping sits at the heart of multiple value and supply chains, but several years ago there was a huge gap between what maritime and shipping was doing when it came to digital transformation and what other industries were doing. Shipping wasn’t moving fast enough,” she says.

For a long time, there have been no real competitors to shipping. But now, among other examples, China is investing in railways and the new Silk Road, while the race is on to build the first Elon Musk-inspired Hyperloop. Competition is on its way and shipping is falling behind.

Those might sound like harsh words, but Adamson loves the maritime industry. “I’ve worked across every industry you can name, but I always have great fun with shipping people, they’re very straightforward and I kinda like that.”

Yet the maritime industry didn’t unanimously love her back when she began spelling out what digital disruption was going to look like for shipping, via the *Futurenavics Maritime* quarterly journal four years ago.

But it came as no surprise to Adamson – in fact it meant she was doing her job. “If you give people ideas, you give them the permission to think differently,” she says.

So while her ideas were once called ‘ludicrous’, her predictions for the maritime industry are now being discussed by the IMO.

“Take autonomous ships, a key topic in our first issue. The industry said it was ludicrous. If you mentioned crew-less

ships, everyone threw rotten tomatoes at you,” she says with a heartfelt and dry laugh. “But here we are three years later and it’s basically mainstream and the IMO have said, ‘Yeah we’re gonna do this.’”

THE DIGITAL TIDE

Adamson noticed a change in attitude in the third quarter of 2016. Shipping has always been a cyclical industry, but this downturn was proving so long that the maritime industry was worried.

“I noticed subtle changes from boardrooms in the maritime industry last year. It was partly driven by letting go of the idea that ‘We just need to hold on, this is a cyclical downturn but it’s OK, because we always come out the other side’. And then last year the mood shifted, when people started to really feel and fear that they weren’t seeing any light at the end of the tunnel,” she says.

Therefore, she argues, it’s essential that shipping learns the lessons of other industries which have been hit by digital disruption, but failed to keep up. For example, the publishing industry made the mistake of focussing on the struggle between e-books and physical books, and missed the boat. “Then Amazon came along and created a platform that connected the creators of content with the consumers of content and basically ate the publishers’ lunch,” she says.

There are countless other examples proving that consumers themselves will use digital services before companies do. While record companies were busy viewing the internet with scepticism, listeners started sharing, or stealing, music online. The same happened to the film industry. Crucially, digital developments made this all possible.

“It’s wrong to focus on the book or the ship or even the CD, it’s actually about business models,” Adamson says.

She is not only aware of shipping’s digital potential, but recognises shipping’s many challenges. In a recent article titled



K D Adamson believes the shipping industry hasn’t moved fast enough to meet the current challenges.

“THE FUTURE ISN’T SOMEWHERE WE GO, IT’S SOMETHING WE CREATE.”

‘Regvolution’ she tackles the issue of regulation – often cited by ship operators as their biggest problem.

“The first thing to realise is that regulation isn’t going to be the remit of regulators any longer,” she wrote. “Digital products, services and assets are different. The legacy paradigm of one all-powerful regulator can’t cope. What are required are new ownership ecosystems. Around vessels these are going to include owners, third-party managers, lenders, insurers, charterers, equipment manufacturers, connectivity suppliers, service providers, flag, class and port state control. In some cases, those ecosystems will also include the end-consumer.”

BACK TO THE FUTURE

Adamson has made it her mission to identify how the future will impact the lives and expectations of people and businesses, whilst equipping them with the information, insight and appetite to fully participate in its creation. As she says, “The future isn’t somewhere we go, it’s something we create,” but to do so requires some context for the huge changes we face.

As a result she likens our times to the Renaissance. “There’s an awful lot of parallels between that period and what we are seeing now, with global mega trends, changes in mind-sets, technological developments and the focus on the individual,” she says. “This time round it’s being accelerated by the exponential growth of information-enabled technologies, which is why I refer to it as the ‘e-naissance’, the second Renaissance and the birth of the exponential age.”

A writer and novelist, Adamson is also a sci-fi fan and has been since childhood. “Take *Back to the Future Part II*. Like all the other teenagers at that time I thought ‘Wow, I want a hover board!’ Everyone wanted a hover board. It’s taken 30 years, but now we’ve got them. Sci-fi movies spread ideas, they implant alternative scenarios of what’s possible in people’s minds, they drive people forward.”

Back to the Future, however, is easy-to-digest popular culture. There are bleaker films that have made an impression on Adamson, not least *Blade Runner*.

“That film introduces the kind of ethical questions we’re going to have to deal with as a society very soon, because the androids have feelings too,” she says, embarking on a 10-minute conversation about favourite scenes from the film. Finally, she notes that the most problematic thing about *Blade Runner*’s vision of the future is that it’s so depressing.

“That’s a problem, I think, because sci-fi films are increasingly painting the future as a choice between dystopia or utopia. The truth is that the future will most likely be a bit of both.” ●



Adamson has made it her mission to identify how the future will affect people and businesses.

TIMELINE OF THE FUTURE

WHAT WILL THE WORLD LOOK LIKE IN THE COMING DECADES?
WE TOOK A LOOK AT SOME OF THE PREDICTIONS FOR THE FUTURE.

2020s

- Telepathy and teleportation will become possible. It will take another 20 years until they are fully commercialised, though.
- Intel will develop brain implants that can control devices via brain waves.
- Autonomous shipping will go commercial.
- The SpaceX Interplanetary Transport System will send the first set of people to Mars.

2030s

- The world will switch to 100% renewable energy.
- Europe will become the centre of production for thin-film solar PV.
- Over 30% of all cities in the US will operate their electric utilities as micro grids.
- China will become the world's most important cruise market with 10 million cruise passengers.

2040s

- Workplaces will transform into ecologically friendly co-working spaces, equipped with robotic helpers and 4D teleconferences.
- In the absence of radical improvements, computer chips will need more electricity than what global energy production can deliver.
- Half of all the new cars sold will be autonomous.

2050s

- More plastic in the ocean than fish.
- China and India will be the two largest economies, followed by the United States.
- With appliances directly linked to energy distribution systems, energy pricing will be real-time and based on supply and demand.

2070s

- 23 out of 25 biggest megacities in the world will be located in Asia and Africa.
- The ozone layer is fully recovered.
- More than 100,000 people live on the Moon.

Solar energy has led the growing popularity of sustainable renewable energy sources for some time. Wärtsilä has tracked the trend to develop solar and hybrid solutions complemented by a new operation and maintenance services offering – and is now poised to become a global energy systems integrator.

SUNNY SIDE UP



In 2016, the renewables sector saw new investments in solar energy rise to USD 113.7 billion globally, reflecting a record 75 GW increase in capacity from 2015 – for the first time outstripping year-on-year growth in all other renewable technologies*.

Riding the wave of the renewable energy surge, Wärtsilä began delivering turnkey utility-scale solar photovoltaic power plants as well as hybrid engine-solar PV power plants in 2016 as part of its Energy Solutions renewable strategy. It followed up with the launch of a Wärtsilä operation and maintenance (O&M) solution in 2017.

The O&M solution helps guarantee performance of customers' solar power plants, maximise the productive lifetime and ROI of their assets, and enhance the predictability of plants' lifecycle costs.

"The customer has the chance to focus on their core business – to produce and sell energy – while Wärtsilä can support with operations and maintenance of the power assets, such as guaranteeing performance and covering scheduled maintenance or the risk of unplanned

maintenance," says **Kim Lindqvist**, Wärtsilä's Manager for Solutions Development, Services.

SIGNING ON THE DOTTED LINE

In April 2017, Wärtsilä concluded its first agreement for a Wärtsilä O&M solution with solar power operator Essakane Solar SAS, the local subsidiary of Paris-based EREN Renewable Energy. The agreement covers a 15 MW DC (~12 MW AC) solar PV plant used to power the Essakane gold mine in Burkina Faso.

The Essakane solar farm complements the existing thermal facility that powers the mine with engines also supplied by Wärtsilä, creating a hybrid power plant that will cut fuel costs, decrease overall energy costs and reduce greenhouse gas emissions to moderate the facility's social and environmental footprint.

"In this case, the solar PV plant is close to the mine, where environmental plus logistical conditions are harsh and there may also be a great deal of dust and this kind of solution is the key maximising power production,"

explains **Francesco Fonda**, Wärtsilä's Area Sales Manager, Power Plants Agreements for Southern Europe and Africa.

The Essakane solar PV plant will deploy upwards of 100,000 solar panels. These solar panels must be kept clean and the equipment must be checked regularly and maintained to operate at peak efficiency. Additionally, the overall performance of the equipment can naturally fall if it is not constantly cared for, making maintenance a high priority for plant owners.

Wärtsilä's O&M solution is therefore a timely service for operators, eager to recoup installation and maintenance costs and maximise the utilisation, reliability and production of their solar PV plants.

CONTINUED STRONG SERVICE AS ENERGY SYSTEMS INTEGRATOR

As part of this solution, Wärtsilä will deliver a host of services including mobilization, daily operation activities, preventive maintenance, coordination and support for the thermal plant crew, as well as scheduled and corrective maintenance for the equipment covered by the scope of the solution.

"In general, a solar O&M solution offering can be quite differentiated from region to region, and from customer type to type. In that respect, it is important to understand the customer's needs and be very flexible in tailoring the

offering. Strong remote support is crucial and our Expertise Centres ensure that we are always on top of plant performance. Then, having qualified people on site will complete the solution, ensuring we are always ready to act. This solution will assure the top-quality service that our customers expect from Wärtsilä," Fonda adds.

Wärtsilä already has a strong presence in the African market and is looking to leverage growth potential to sell more solar PV plants with Wärtsilä Operation and management solutions. It is also keen to take on a new role as a systems integrator supplying energy management systems that include solar and engine power as well as energy storage systems, both as retrofits and as new assets.

"You have the flexibility with a focus on providing green energy, but with the hybrids you still get stability in case of low sunshine levels when you still need to maintain energy production. Storage is a solution for short-term peaks, but if you want to sustain capacity then other sources are needed. So having these hybrids with all three systems provides a lot of flexibility," concludes Lindqvist. ●

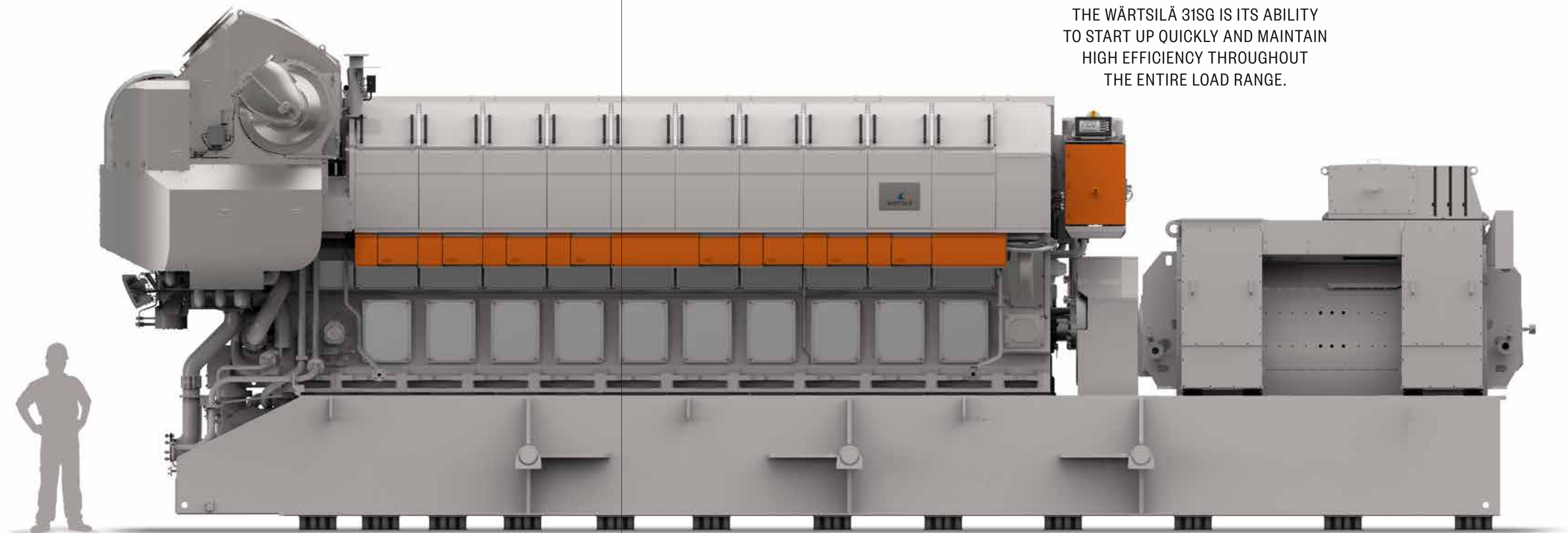
* Frankfurt School – UNEP Collaborating Centre for Climate and Sustainable Energy Finance, *Global Trends in Renewable Energy Investment 2017*, April 2017. Web. 12 May 2017. www.fs-unep-centre.org

“WITH HYBRIDS, YOU GET STABILITY IN CASE OF LOW SUNSHINE LEVELS WHEN YOU STILL NEED TO MAINTAIN ENERGY PRODUCTION.”

WORLD'S MOST EFFICIENT 4-STROKE ENGINE

In the price-sensitive field of electrical power generation, efficiency and flexibility are the hottest commodities. Wärtsilä 31SG marks a step change in both and delivers an industry-leading efficiency of over 50 percent.





A FUNDAMENTAL ADVANTAGE OF THE WÄRTSILÄ 31SG IS ITS ABILITY TO START UP QUICKLY AND MAINTAIN HIGH EFFICIENCY THROUGHOUT THE ENTIRE LOAD RANGE.

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 that Wärtsilä engineers 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 is Wärtsilä 31, available in diesel, dual-fuel and pure gas variants. The last of these 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 this year, it became the world's most efficient 4-stroke engine ever built.

EFFICIENCY UNDER PRESSURE

The most critical advance in the Wärtsilä 31SG 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 but bringing a new engine to life is another. The development of the Wärtsilä 31SG was a long and complex process that involved extensive computer simulation, testing on a single-cylinder experimental engine then several years of lab testing on a number of multi-cylinder engines. All this was carried out to guarantee that the efficiency gains would be realised 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 – the 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 high efficiency 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. The engine can be continuously operated at 10 percent 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 engine automation 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 is this high degree of automation, combined with the implemented technologies, which allows the Wärtsilä 31SG to account for differences in fuel as well as run at various loads without compromising efficiency.

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.

THE ENGINE AUTOMATION
SYSTEM WAS BUILT
ENTIRELY IN-HOUSE BASED
ON NEW HARDWARE AND
SOFTWARE.

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. ●

**CHUGGING
ALONG!**
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Twentyfour7.
in detail

CHUGGING ALONG!

► **TEXT:** RONAK KOTECCHA **PHOTO:** 123RF

EXCITING TIMES FOR the tugboat industry are here! Technological ideas and advances are unlocking new opportunities for economics and operations of a business that is just as aware of environment conservation as it is of safety and profitability. So here’s how the industry is striking this fine balance.

Tugboats are having their day in the sun. Today, there are more tugs operating worldwide than at any time in the past. Interestingly, Asia is emerging as the powerhouse for tug construction. Tugs made in Asia are being marketed in Europe, West Africa and Latin America, highlighting how highly tug operators value Asian construction.

Meanwhile, increased trade volumes are poised to drive revenue growth and benefit the industry operators. Reason? Consistent increases in water transport industries in the past five years.

Demand for navigational services has been steady over the past half-decade, and a rebound in the global economy has only helped it rise.

“Increase in trade flows, the need to manoeuvre even larger vessels in confined spaces, expansion of port and terminal activities and an increase of operating responsibilities all drive the current tug fleet expansion,” explains **Edgar Snelders**, General Manager Product Platform Thrusters, Wärtsilä.

The tugboat industry has done well to wake up to these opportunities. It is upgrading its offering to match expectations and changing demands. Last year the industry ushered in several new, higher-horsepower tugboats. A 2016 tugboat market report by Marcon International Inc. states that there has been a definite shift in the second-hand tug market over the last few years with newer boats out of Southeast Asia and the Far East being offered for sale.

Steve Dougal, Managing Director of Century Marine Services Limited – a UK-based international

shipbroking company engaged in the sale, purchase and valuation of tugs, barges, offshore and all other specialist vessels, points out that this is the best time to buy tugs.

“New-building prices have fallen as the shipyards compete for work,” Dougal explains, adding that a new-build tug now costs less than the same vessel built five years ago. A blessing in disguise!

THE BALANCING ACT

And why not? After all, the market is exceptionally price-conscious, and the industry is fast dispensing cost-effective and environmentally efficient options these days. Leaner crews, compact tugs, new cost-effective forms of power such as hybrid and LNG, and increased automation are becoming commonplace.

Needless to say, new technology plays a major factor in the fleet replacement exercises, especially with regard to lower crew and fuel costs. The

Wärtsilä Steerable Thruster (wst), for instance, has been developed to fulfil the latest operating demands for tugs, river- and sea-going and various offshore support vessels. Designed and validated following a rigorous engineering process, the thruster family from Wärtsilä is marked by high overall efficiency, manoeuvring capability, reliability and advanced system integration.

“The newly developed Wärtsilä steerable thruster series is versatile, has outstanding hydrodynamic performance and can be tailored to comply with specific vessel requirements,” Snelders points out, adding that these are the features that allow a tug and its crew to deliver the highest performance in assisting, towing or repositioning a vessel.

The use of greener harbour tugs is also becoming more important to both contractors and authorities. Thanks to new emission rules, the expansion of Emission Control Areas (ECAs), stricter local

regulations, and public opinion, the need for sustainability is more pronounced now than ever. The industry has taken the stringent environment and safety regulations in its stride and complied seamlessly.

THE LIVE WIRE

But Dougal stresses the fact that while the industry has stabilised, there are certain time-inflicted evils that are familiar pressure points. Simply put, when there is a boom, global shipping demand spikes and the industry experiences growth. This creates a ripple effect and there is surge in demand for tugboats resulting in more traction in tugboat sales. However, like any commodity market, price and service influence the sales.

For starters, some existing operators with high-cost tugs (built 2005-2012) are facing greater competition from operators with new tugs costing less than older tugs. Dougal adds that “the downward

pressure on harbour towage rates by linear companies is a pain point.”

Apart from this, there are other factors such as heightened volatility in the world price of oil that effects the operators.

But the industry is learning to adapt to change. “New propulsion solutions for tugs help operators address the challenges they face. For instance, the Wärtsilä HY equipment combines emission-free propulsion when in ‘green mode’ with the availability of maximum power when in ship assist operation,” Snelders weighs in.

Companies like Wärtsilä, are betting on cutting-edge technology and innovation to help them steer forward. Additionally, they are creating robust maintenance strategies that will give their offerings the desired boost to stay ahead of the curve. Only time will tell what the future holds in store for these tiny yet mighty tugboats! ●



AUTOMATING OPERIM

► TEXT: DAVID SMITH ILLUSTRATION: WÄRTSILÄ

WÄRTSILÄ GAS SOLUTIONS' Operim has been monitoring its LNG cargo and reliquefaction plants on LNG carriers since 2011, but its new automated system is taking analysis to a new level of speed and accuracy.

Wärtsilä Gas Solutions (wgs) has introduced a technologically advanced model of its Operim solution to monitor the performance of its liquefied natural gas (LNG) cargo and reliquefaction plants on ships carrying liquefied petroleum gas (LPG) and LNG. The process captures data from the components of a ship's plant every five minutes and sends off a file to wgs' home base near Oslo, in Norway, for automated analysis.

With previous versions, Operim has demonstrated its usefulness in optimising plant performance with simple calculation methods and manual data sampling methods. wgs is now working with key customers to develop and implement the next version of Operim, which uses advanced steady-state process simulators – normally used as an engineering tool to design the plant – to analyse the plant's operations.

“Process simulators, have been used for decades in the marine industry, but the novelty is to use this engineering tool to verify the sound operation of the plant. This is done by connecting the simulator to the data feed, allowing proprietary knowledge to be applied also in the operational phase,” says **Torgeir Paulsen**, wgs General Manager, Aftermarket Business Unit.

VITAL MONITORING

Monitoring assets is vital for ships carrying liquid gas. The complex array of piping, processes, valves, compressors and instruments in a wgs plant keeps the liquid gas at the right temperature and pressure. For LNG this is -161°C and for LPG it is -43.8°C for propane, and between -0.5 and -10.4 for other types of

gas. The plants capture the boiled-off gas that inevitably escapes when heat comes in from the outside and re-condense it into liquid. Without this safeguard, a large LNG carrier would lose up to six tonnes an hour of cargo on a journey from Qatar to Japan.

Using a process simulator is a more sophisticated method than the Operim version it replaces. “With the process simulator we can even obtain virtual readings from non-existing instruments, or help the operator assess whether the onboard readings are within the correct range for current operating conditions. Recent improvements to technology make it much easier now to automate the process of capturing data, either by connecting to the ship's integrated control system (ICS) through the ship's computer, or through a small wgs computer. It's being trialled on LPG, but will be equally relevant for LNG and most of our other products.”

REAL-TIME FEEDBACK

The more basic ‘manual approach’ for LNG plants meant engineers at the wgs home base near Oslo had to stop work on developing new plants to cast an eye over Operim data. Now they need to be called in only when data flags up a pressure point. And there are many advantages for wgs customers, too, Paulsen says. “Automation is cost-effective and provides a lot more data than before. The biggest advantage is the speed – customers get close to real-time feedback on their processes.”

Automated analysis can help customers improve the efficiency of their organisations by uncovering the requirement for more training. The crew could

“THE BIGGEST ADVANTAGE IS THE SPEED – CUSTOMERS GET CLOSE TO REAL-TIME FEEDBACK ON THEIR PROCESSES.”

even use data from their own ship as part of the training, which would be more like an interactive workshop than old-fashioned classroom tutoring. “The shorter your feedback loop is, the faster you learn,” Paulsen points out.

Ideally, data flags up issues before they even arise and ship owners take preventative measures. “The feedback loop is much faster and more instructive so it's more likely to result in deep-rooted changes to the entire structure of the organisation. Ship operators become aware of how to run a plant more economically, more efficiently, and in an environmentally friendly way,” he adds.

The next stage in the refinement of the Operim solution is asking customers how they want the wgs data analysis to be presented to them as well as how wgs can best help them raise performance standards. wgs is in close discussions with key customers to develop Operim monitoring procedures that best serve their needs. One trial project underway with a major LPG operator, for example, assesses the data on the cargo and the reliquefaction plants to give early warnings of technical issues, in addition to improving training procedures and developing more precise fleet maintenance goals.

Operim promises to set new benchmarks. ●



SMART POWER GENERATION FOR DATA CENTERS

► TEXT: ADAM RAJEWSKI ILLUSTRATION: ADOBE STOCK

DID YOU KNOW large data centers consume power equivalent to an average-sized town? They need a reliable and affordable power supply to ensure uninterrupted functioning, 24/7. The answer lies in modern gas-fired engines. This new solution is a game changer.

The phenomenal use of information technology has made data centers an indispensable part of modern day business needs, as they store an enormous volume of data that is generated on a daily basis. Every data center thus needs an extremely reliable and affordable power supply to ensure uninterrupted functioning, 24/7.

The traditional mode of power supply, which involves a combination of grid electricity and diesel generators, has its own drawbacks in the form of unstable power prices and high local emissions.

But what if these emergency power generation facilities helped in revenue generation? Can a back-up power supply facility become the primary source of power supply? And can this be achieved using cleaner forms of energy? The answer to all of these is a big YES. Our white paper – Smart Power Generation for data centers – substantiates that the solution lies in modern gas-fired engines.

MODERN GAS-FIRED ENGINES

To understand how gas-fired engines are changing the dynamics of emergency power back-up mechanism for data centers, one needs to understand the functional requirements of an emergency back-up system. They are:

- **Very rapid automatic start-up:** Data centers use Uninterruptible Power Supply (UPS) systems based on electrochemical batteries. They are typically dimensioned to last a couple of minutes and are very expensive.

- **Modularity of capacity:** A good emergency power supply system needs spare capacity in a separate independent generator set, sufficient to cover the capacity lost due to maintenance or isolated failure.

- **Ability to run on locally stored fuel:** The facility needs some locally stored fuel to ensure an uninterrupted supply for a certain amount of time until the external power supply can be restored.

- **Technological maturity:** Finally, the requirement of maturity is natural for a system where reliability is of fundamental importance.

An internal combustion engine still remains the only solution capable of meeting the above-mentioned functional requirements. But such an engine does not have to run on diesel fuel anymore – especially when there is a cleaner and more economically effective alternative: natural gas. Compared with other fuel-based technologies used in the large-scale commercial power industry, gas engines meet all the features of a smart power backup system. It is fast to start, cheap to build and extremely flexible.

GAS ENGINES, COME OF AGE

But not long ago, gas-fired engines suffered a major drawback in terms of very delayed start-up timing – at times as high as 10 minutes. But recent years have seen huge progress on this front. Now these state-of-the-art gas engines can be started and brought to full power in considerably less than one minute from the starting order, ushering them into the world of emergency power supply.

THE FUTURE OF GAS-FIRED ENGINES IN DATA CENTERS HOLDS IMMENSE POTENTIAL.



Gas engines have also taken care of the issue of fuel storage. Recent years have seen emergence of small-scale affordable gas storage technologies, especially in the form of liquefied natural gas (LNG). As a matter of fact, small-scale LNG storage and regasification plants are so reliable and safe that they are currently being installed on passenger ships.

Clearly, modern gas engines hold enough power to become a potent alternative to diesel generators. Restricting carbon emissions is very important amid growing environmental concerns. And adopting gas engines is the need of the hour as natural gas is the cleanest of all fossil fuels. Using gas means less SO_x, NO_x and particles, as well as CO₂, which in turn means corporations can reduce their carbon footprint besides cutting cost.

This means operating the generating sets continuously instead of relying on electricity grids would have a positive effect on the carbon footprint of the data center.

That modern gas engines are the future of emergency power back-up systems has been established

beyond doubt. But gas engines are not merely futuristic alternatives to diesel generators. In fact, gas engines are the game changers – because they can go beyond emergencies.

Once an emergency power generation system is built using a solution that is neither legally nor technically restricted from operating beyond emergencies, there are two essential ways of using this capability: self-generation and merchant operation.

SELF-GENERATION MODEL

This model shifts the source of primary power from the electricity grid to the emergency power generation facility. If a data center has a power-generation facility that can be operated continuously on an inexpensive fuel with a low emission footprint, then it may very well be used as a primary source of power. This would make the local power plant the primary source of electricity, while the grid functions as a backup. This approach protects the data center operator from higher power costs and reduces carbon footprints too.

Data center operators can generate additional revenue since data centers do not operate on full design load. That time can be used to generate additional power and sell it to the electricity market along with the spare and redundant capacity of the power plant.

MERCHANT PLANT CONCEPT

Unlike the self-generation model, in this case the gas-fired power plant can be used only as an emergency back-up power source while operating independently as a merchant generating station co-existing with the data center and selling its production to external customers. In the event of any disruptions in the grid power supply, it would automatically switch to the emergency power supply mode. This might be a preferred approach for markets with high electricity costs.

With phenomenal advances in gas engine technology and the advent of LNG solutions, there is no denying that the future of gas-fired engines in data centers holds immense potential. ●

DECODING SMALL-SCALE LNG SUPPLY CONTRACTS

► **TEXT:** JOHN REINLUND **PHOTO:** WÄRTSILÄ, AGE FOTOSTOCK

AS THE WORLD transitions from liquid hydrocarbons to other fuels, liquefied natural gas (LNG) has the potential to reach several markets worldwide, despite its considerably small supplier base. Here's what you need to know about small-scale LNG supply contracts.



With a new fuel comes the question: What is a reasonable price to pay for it? Crude oil is traded globally on a scale that leads to a completely liquid market with transparent pricing. It is not difficult to contract heavy fuel oil (HFO) or light fuel oil (LFO) as there are benchmarks and multiple suppliers available. It is also feasible to transport these fuels fairly long distances. The picture is very different for small-scale LNG. In many parts of the world, there is only one supplier or, in the best-case scenario, a few. Furthermore, the prices published for conventional, large-scale LNG deliveries have very little use for someone interested in contracting smaller quantities.

But in order to understand small-scale LNG contracts, one has to have some knowledge about how large-scale LNG is contracted.

LNG prices have largely been linked to crude oil or a basket of oil products in Asia. They were initially linked to Brent oil in Europe, but are now increasingly moving towards hub prices following the increased liquidity of the NBP (United Kingdom) and TTF (Netherlands) gas hubs.

In North America, gas markets are hub-based,

with Henry Hub being the most well-known. When prices diverge between regions, arbitrage opportunities are created. This means excess large-scale LNG will go to the region that is willing to pay the highest price. There is currently, and for several years to come, a lot of uncommitted LNG production capacity, which has improved the bargaining position of buyers. This is leading to more variation in price indexation, more spot trading, shorter-term contracts (previously 25-year contracts were common) and destination flexibility: Free On Board (FOB) instead of Delivered Ex-Ship (DES).

Large buyers hedge their LNG prices by having a portfolio of contracts with different suppliers and pricing mechanisms. This is a luxury small-scale buyers do not have. If a small-scale buyer has only one supply contract, there is less room for error. Therefore, there are some clauses in an LNG sales agreement which small-scale buyers should pay extra attention to.

START DATE

As LNG sales agreements should be negotiated and signed before the construction of the facility,

ONE CHALLENGE WITH A LONG CONTRACT IS THAT THE QUANTITIES REQUIRED MAY CHANGE CONSIDERABLY.

assigning a realistic start date is of utmost importance. There should be a funnel where the start date of the contract is specified in an increasingly tighter time range as the facility comes closer to commissioning. Schedule slip could have serious financial consequences.

LOGISTICS

In large-scale LNG, the trend is towards increased destination flexibility. The buyers want FOB contracts instead of DES, so that they can divert cargoes to spot buyers in case they do not need them. This is not really applicable in the small-scale market, since LNG cannot be economically transported very far on small-scale carriers and there are few alternative customers. However, having the shipping component in one's own hands might save some money for the buyer, but FOB contracts would also require the buyer to assume responsibility for ship charters, insurance, boil-off gas and port costs. In some cases, DES contracts are advantageous if the supplier can utilise the same ship for other customers and share the costs. Those new to the market would be better off with a DES contract. But to shave off some hidden cost, considering FOB may be a good option.

CONTRACT LENGTH

The contract length is often determined by the financing needs of the parties as financial institutions require certain guarantees. The trend in large-scale LNG is towards shorter contracts and spot deliveries, but in small-scale LNG one wants to make sure that supply of fuel is guaranteed for a longer time. However, if one expects the number of suppliers in the region to increase, it might be a good idea to opt for a shorter contract, so that a new contract can be negotiated when the buyer's bargaining position is better.

ANNUAL CONTRACT QUANTITIES

One challenge with a long contract is that the quantities required may change considerably. Given the fact that the liquefaction facility wants to produce at a steady rate and there seldom, are other takers for a cargo, the seller wants to make sure that the buyer takes the cargoes that have been assigned to him. Also, the buyer wants to be certain that his fuel needs can be met. Therefore, the contract specifies an Annual Contract Quantity (ACQ). These clauses generally allow for some downward flexibility. The buyer has to pay for the cargoes whether he takes them

or not (Take-or-Pay), but the outstanding cargoes should be taken the following year, in addition to the normal ACQ. If the LNG supplier is the only source of fuel (meaning there are no alternative suppliers and alternative fuels cannot be used), it is also important to specify what happens in case of failure to deliver.

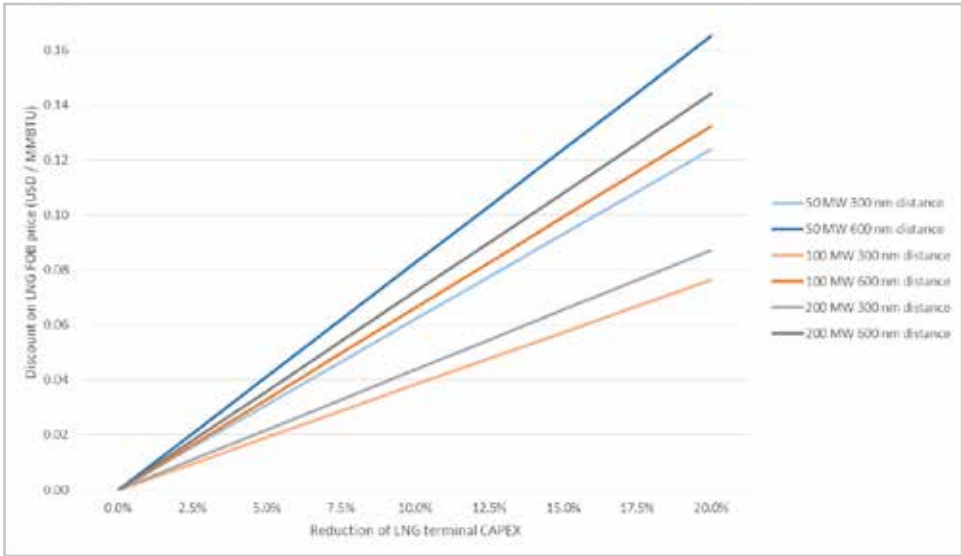
TIMING

The timing of negotiating an LNG sales agreement matters as these contracts contain a price review mechanism with the purpose of restoring the conditions of when the agreement was signed. The **base period** of an index is defined in the contract and constitutes the reference period for the price. The base period values will affect future prices, so it is important not to accept one that would result in a future disadvantage.

A **review period** for determining the index to be applied is also specified. Instead of choosing a particular day as reference point for the index, an average over a longer time period is chosen. The intention of this is to smoothen out peaks.

If the contract is increasingly disadvantageous to one of the parties of the contract, it should be

Discount on LNG FOB price compared with a reduction of LNG terminal CAPEX



WHAT CAN BE SEEN
IN REALITY IS THAT
SUPPLIERS OF SMALL-
SCALE LNG OFFER A
HUB OR OIL PRODUCTS
INDEX PLUS A FIXED
COMPONENT.

Differences between large-scale and small-scale LNG

| | Large-scale | Small-scale |
|---|---|---|
| Supply situation (near future) | Oversupply | Few alternatives for buyers |
| Contract duration | Trend towards shorter contracts and spot trading | Medium-term contracts |
| Pricing model | Trend towards market-based pricing | Indexed slightly below alternative fuels; or Cost+ from hub's price |
| Payment and delivery obligations | Take-or-pay for long-term and Cargo-by-Cargo for spot trading | Take-or-pay |
| Impact of logistical and port costs | Low-Medium | High |
| Buyer's pricing intelligence / experience | High | Low / none |

returned to equilibrium. The contract should state a **price adjustment frequency**. With a suitable frequency, the price is kept close to the market level.

PRICING MECHANISM

Price of LNG is obviously one of the most important points when negotiating an LNG sales contract. With few suppliers to choose from and a low level of experience among buyers, it is often the suppliers that have the upper hand in deciding the terms. The principles of a fair agreement should be that the price provides an acceptable return on investment for its facilities and operates at a reasonable profit. The seller wants the price to reflect the market value of the gas, while the buyer wants the price to mirror the price risk in the sales of their products or services (e.g., electricity).

Prices are linked to different indices in different parts of the world, and generally small-scale LNG is influenced by large-scale LNG. This is understandable

as LNG suppliers don't want to absorb the price risk of buying according to one index and sell according to another. But this is not necessarily in the interest of the buyer. Ideally, a consumer wants to make sure his fuel costs are lower than his competitor's. If the competitor is using HFO or LFO, this is the preferred index. For the buyer, it would be ideal if the price would be linked to a local index, but as they seldom have sufficient liquidity, the seller probably insists on an international index. It is common to use Brent crude as an index, which is beneficial since it is easy to hedge, but there is no guarantee that the price of crude oil and refined products cannot diverge in the future.

Other, more experimental indexing can be considered if the buyer, e.g., a dual-fuel power plant, can use other fuels. Then a different index can be chosen, e.g., Henry Hub or NBP, so that one can play with price differences and produce using the fuel that is currently most affordable. Such a strategy might,

however, be difficult to align with the Annual Contract Quantities.

What can be seen in reality is that suppliers of small-scale LNG offer a hub or oil products index plus a fixed component. The fixed component not only comprises the logistical costs in a DES contract, but also reduces the transparency of the pricing mechanism. By coincidence or not, the final price often ends up close to the cost of the competing fuel.

Even a minor discount on the LNG price has the same impact as reducing CAPEX spent on the LNG terminal by several million USD. While spending less on the LNG terminal will result in lower performance, reliability and perhaps safety, the properties of LNG will not change when lowering the price. The savings also remain more or less the same in both low- and high-price environments. Therefore, the LNG sales contract should be given considerable deliberation and if needed, an experienced consultant should be brought in to support negotiations. ●

TEXT: LÖTTA HEIKKERI PHOTO: STEPHAN KUHN

Diving deep

With the livelihoods of an estimated three billion people dependent on the oceans, it's no surprise that issues like climate change, habitat loss, and rising amounts of plastic in our seas are quickly rising to the top of the global agenda.

This year has been an important one for the oceans. Governments, corporations and organisations are taking concerted ac-

tion to make things better. While the United Nations held the first-ever conference on oceans, 80 European scientific experts from more than 25 institutions published the first Copernicus Marine Environment Monitoring Service Ocean State Report. Going forward, it is expected to be an annual report on the state and health of our oceans and seas. The project run by Wärtsilä and Seabin

Project has installed floating trash cans in marinas across the world.

The future of the oceans looks a little brighter.

The photograph of a tiny shrimp resting on a sea anemone is taken by Stephan Kuhn, Vice President, Electrical & Automation Wärtsilä Marine Solutions. He is an avid diver and marine photographer.

*Sign off

AT YOUR SERVICE | CLASSIC | AMBITION | LITTLE ENGINEER | COLUMN

[AT YOUR SERVICE]

Rethinking the grid



“YOU CANNOT HAVE RENEWABLES WITHOUT ENERGY STORAGE, PERIOD.”

GREENSMITH ENERGY MANAGEMENT SYSTEMS – world’s top provider of advanced energy storage technology – is the newest member of the Wärtsilä family. We asked its Founder, President and CEO, **John G. Jung** the three important questions on everyone’s mind.

1 HOW EXACTLY WILL GREENSMITH ROUND OUT WÄRTSILÄ’S OFFERING?

Firstly, Wärtsilä will be able to offer the most advanced energy storage capability available, proven around the world through 70 successful deployments. Secondly, customers can expect to leverage the best software available that not only optimises energy storage but also enables seamless integration of other grid assets including thermal and renewable sources of generation, along with distribution networks and microgrids. Thirdly, customers can look forward to increasingly integrated power solutions and hybrids that reflect high-order thinking about the changing nature of the grid network.

2 WHY IS ENERGY STORAGE SO IMPORTANT FOR THE TRANSITION TO RENEWABLES?

You cannot have renewables without energy storage, period. While it’s great that renewables are replacing fossil fuels, the fact remains that they are limited in terms of when the wind blows and when the sun shines. This form of intermittency makes the grid more fragile. And the nice thing about energy storage is that it doesn’t care where the electrons come from – it just wants to do get more value from them.

3 WHAT IS THE ROLE OF GREENSMITH’S SOFTWARE IN THE BREAKTHROUGH OF CLEAN ENERGY?

Intelligent energy storage and advanced software is ideal for integrating with renewables to gain more value from ‘clean energy’ electrons. We already offer the most mature storage and energy integration software platform. We are talking about a platform that not only optimises energy storage, but all grid resources and the distribution network. We also offer big data and analytics that drive rule-based and automated decision-making across a stack of real-time applications and optimisation opportunities. In short, we offer the best in the business.

sign off

[CLASSIC]

The coolest flame

A spring-loaded toggling cam in the lid creates the Zippo’s instantly recognizable ‘click’ and ‘clunk’ sounds.

The windscreen chimney ensures that the flame won’t blow out, whether you’re lighting up a stogie or translating the curse on a mummy’s tomb.

The name originates from the inventor’s love of the newly coined term ‘zipper’. He decided ‘Zippo’ had a more modern ring.

Basic versions carry a suggested retail price of USD 14.95, but anyone with USD 11,893.95 to throw around can opt for the 18-karat solid gold model.

Many a wartime story tells of a Zippo stopping a bullet and saving a soldier’s life, though the lighters are not recommended as a replacement for actual body armour – or staying away from firefights.

ORIGIN

Of the countless ways to strike a light, none comes close to the rugged, bad-boy appeal of the **Zippo Windproof Lighter**. The sleek industrial design has remained virtually unchanged since Pennsylvania inventor George Blaisdell put the first Zippo on the market in 1933. More than 500 million have now been sold, thanks in part to generations of pop culture tough guys from the Marlboro Man to Indiana Jones.

TECHS & SPECS

Production
1933 – present

Inventor
George G. Blaisdell

Manufacturer
Zippo Manufacturing Company; Bradford, Pennsylvania, USA

Materials
Brass, stainless steel, wicking, flint, felt, rayon

[CULTURE WATCH]

[SCIENCE]



The age-old riddle of why yawning is contagious may have finally been cracked. A new study by the University of Nottingham in the UK attributes this form of echophenomena – involuntarily copying the actions or words of another – to a primitive response in the primary motor cortex, an area of the brain linked to empathy and group behavior. The researchers hope that the findings could lead to a deeper understanding of other echophenomena-related conditions such as epilepsy, dementia, autism and Tourette’s syndrome.

[LITERATURE]



Development of super-human AI is the Holy Grail of science, but what would its ramifications be for homo sapiens? In his new book, *Life 3.0: Being Human in the Age of Artificial Intelligence*, MIT physicist and Future of Life Institute founder **Max Tegmark** delves into the multi-faceted debate surrounding AI and presents some gripping, if speculative, scenarios for what an AI future could look like.

[TECHNOLOGY]



Chemists at the University of Amsterdam and Utrecht University are studying a novel way to wipe out our energy woes: In August, they published the first techno-economic analysis of converting used toilet paper into electricity. The two-step process involves gasification and high-temperature fuel cells. The team is flush with optimism for the method, as the levelised cost of the electricity it produces is comparable to that of residential photovoltaic installations.

TEXT: JAN TAZELAAR PHOTO: WÄRTSILÄ

"I SEARCHED FOR
UNIVERSAL MUSICAL
PATTERNS IN THE DIGITAL
ENGINE DATA."

sign off

See the
video on
[wartsila.com/
twentyfour7](https://wartsila.com/twentyfour7)

Can an engine sing?

When British sound architect Tom Middleton was given the data gathered from Wärtsilä's engine, he did what he does best – compose a song.

A modern-day engine provides a lot of information, in the form of data, about its functions. Generally, this data is used to monitor engine performance and predict maintenance needs. But it can be used to compose music, too.

This was proven earlier this year in Munich at Wärtsilä's Ignite Your Digital Heart event, where Wärtsilä internally kicked off its digital transformation journey with close to 500 employees, Digital Champions around the world. Data was one of the key themes in the event, where British 'sound architect' **Tom Middleton**, with the help of the participants, all Wärtsiläns, performed 'Hear the Data', an anthem based on Wärtsilä's engine data.

"The inspiring brief immediately ignited a fire of creative excitement," says Middleton, recalling the time when he was asked to take on the task.

He was provided a graph and logs which included a day of data. Middleton set to work on this unprecedented assignment. The challenge was to turn endless rows of numbers (like rpms, power output, exhaust gas temperature, and ambient barometric pressure) into something audible and meaningful.

TALENTED MACHINERY

Middleton is a famous British musician with a colourful resume. A trained graphic designer and classical musician, he developed a fascination for the limitless possibilities of electronic music very early on in life. Having produced hundreds of tracks, he has toured the world for many years as a DJ.

When he was approached to compose music from engine data, he had never heard of Wärtsilä. "I was deeply impressed by the brand's global reach and impressive impact," he recalls.

Middleton couldn't stop at writing a mere piece of music. "I spent many months experimenting and proposing numerous options for turning the data into music. In addition, I added light effects and interaction with the audience. Everybody was to participate in a way that would do justice to the overall theme of digital transformation."

What Wärtsilä eventually got was far more than they had bargained for. Middleton had found ways to compose enjoyable music from the rows of engine data.

Wärtsilä machinery turned out to be surprisingly talented. "Engine sounds formed rhythms and bass. Then I started to search for universal musical patterns in the digital engine data, and I found them. They translated beautifully into pentatonic melodies and harmonies, very pleasing to the ear."

THE HUMAN INPUT

In addition to performing the song at the event in Munich, Middleton added visual effects to the show and made the audience participate in two ways. First, he let them sing a text which everyone knows: 'la' from the solfeggio scale, incidentally the last syllable of Wärtsilä. And then, he had everybody give live input into the performance through 60 networked iPads.

"A clock provided the right in-cues, and every time someone hit an iPad, an orange dot on the screens would flash and another note would be added. The dots corresponded with global Wärtsilä locations."

Middleton personally directed the performance and also played additional parts, live, while indicating the pitch of the notes to sing. "There was no rehearsal time. A few seconds of explaining was all the audience needed to participate." The 'Wärtsilä Choir and iPad Orchestra' was a triumph and a delightful, appropriate coda to the event and segue into the after-dinner party at which Tom also played music.

One of Middleton's passions is the science of psychoacoustics, the study of how sound affects the way our mind and body work. This explains why he is a sought-after consultant with architectural firms and brands.

"You can use sound to modulate thoughts and emotions. My mission is to use my research to improve the lives of people. With the Hear the Data experience, I was able to communicate the use of digital data and integrated human input via music and light."

Well, at least in this case – mission accomplished. ●

GET READY TO
ACTIVATE
DATA ON YOUR
iPAD

[TRAVELLERS' GEAR]



Billed as next best thing to Star Trek's universal translator, the **Pilot translating earpiece** from Waverly Labs combines wireless tech with a sophisticated app to provide (mostly correct) person-to-person interpretation in real time. Available this fall, initially with Romance languages.



You never know what life will throw at you, but with the **FRĒ water-proof case** by LifeProof, you can at least be sure your iPhone or Galaxy will be safe and functional even under extreme conditions. Besides being shock-, dirt- and snow-proof, it's submersible up to 2 metres.

Long-haul flights no longer have to spell Travel Zombie Syndrome thanks to the **Travel Halo ergonomic pillow**. The lightweight (70g) cloth band includes strategically placed cushions to prevent head flop, while an eye mask blocks any intrusive light.



TEXT: STEVE ROMAN



[LITTLE ENGINEER]
Bots for tots

THE ROBOT INVASION IS UPON US! In case you missed the memo, semi-autonomous, electronic creatures are appearing everywhere these days, mowing lawns, cleaning carpets and delivering sushi. Meanwhile, toy stores have been absolutely inundated by DIY robot kits, which make building and programming just as much part of the experience as racing the contraptions around and confusing the cat.

Among the many kits on the market, the **Jimu AstroBot Kit** from UBTECH stands out for its functionality, educational value and overall coolness. The snap-together blocks can be configured to create three distinct, pre-designed characters: a humanoid, an anthropomorphic rover vehicle and a treaded mobile robot (think WALL-E) with a grabber arm. LED lights and a speaker add life to the finished product.

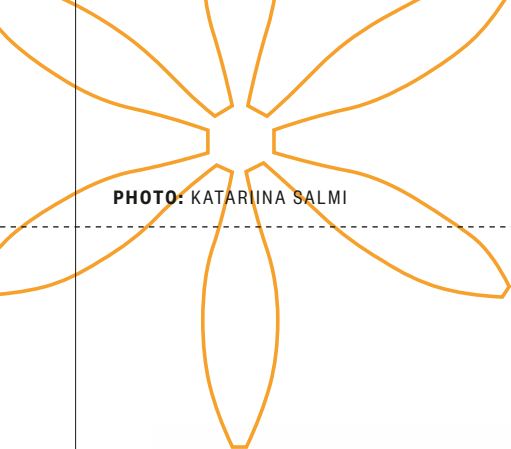
Assembling the 397-piece set, along with its servos, infrared sensor and other speciality com-

ponents, is easy thanks to a sophisticated app that provides step-by-step instructions with 360° views. Once the bot is built, it's ready to roll – or shamle – under the control of your tablet.

Here's where the geeky fun really begins. The AstroBot can be programmed via a record/play method, and the sequences of actions can be edited by dragging and dropping blocks in Jimu's Blockly coding module. It's this coding play that has made the kit a popular teaching tool in schools' STEM (science, technology, engineering and maths) programmes.

AstroBot is recommended for years 8 and up, though slightly younger kids have been able to handle it with grown-up help. In fact, the coolness of this kit pretty much guarantees that adult 'supervision', welcome or not, will be an unstoppable factor. Thankfully for parents, the robot doesn't come with a stun gun.

PHOTO: KATARINA SALMI



sign off

Changing the way we work

I REMEMBER THE DAYS of the typewriter. It was my first tool at work. I would type out a letter and then send it across to the receiver, via mail. It would take at least two to three days to reach the intended person. Now, technology has crunched the response time to a few minutes or even seconds, in some cases.

Change is definitely the only constant, yet it is often perceived as something difficult and unpleasant to adapt to. But I think otherwise. Most things come along naturally, with evolution. We didn't need change management to deal with the advent of mobile phone technology. We just adopted the new tools and changed our ways of working accordingly. I believe this is a positive circle, and that's why I prefer to talk about evolution, not revolution, when it comes to the future of work.

It is impossible to predict what work will look like in a decade or two. But what we know for certain is that job functions will be more versatile. There will be more ways of working than there are now. As more and more people work on ad hoc projects with cross-border teams while collaborating with clients, flexibility in work patterns (work anytime, from anywhere) will be the name of the game. This enables (as well as requires) individuals to keep learning new skills continuously. It'll be easiest for the kind of people who embrace this change and the opportunities it brings.

That said, organisations will continue to thrive, primarily because it is human nature for people to want to belong to a team. And as leaders, our job is to provide these teams with an environment they would love to work in. One way to do that is to ditch hierarchy in the ordinary sense of the word and opt for a chain of command that promotes swift and efficient decision-making. This in itself is a big incentive for teams to perform their best and take more responsibility.

In short, the leaders of the future will have to be enablers. They have to understand that the changes they are dealing with are affecting not only individuals and workplaces but also societies at large.

Change is always exciting. But more than that, it's energising to take the steps towards the future and make it reality.

Päivi Castrén
Executive Vice President, HR

Astonishing performance through synergies



WÄRTSILÄ CONNECTS THE DOTS

Wärtsilä marks a new milestone: Wärtsilä HY is the first integrated hybrid power module in the marine power industry. Its guaranteed superior performance is the result of combining Wärtsilä's leading expertise in both engine design and electrical and automation systems. Dedicated versions are offered for each vessel segment, enabling an unprecedented match between operational requirements and product features.

Find out more about Wärtsilä HY at www.wartsila.com