



Twentyfour7.

Wärtsilä Stakeholder Magazine

→ 01.2016

LNG
SPECIAL
ISSUE



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Wärtsilä Stakeholder Magazine*

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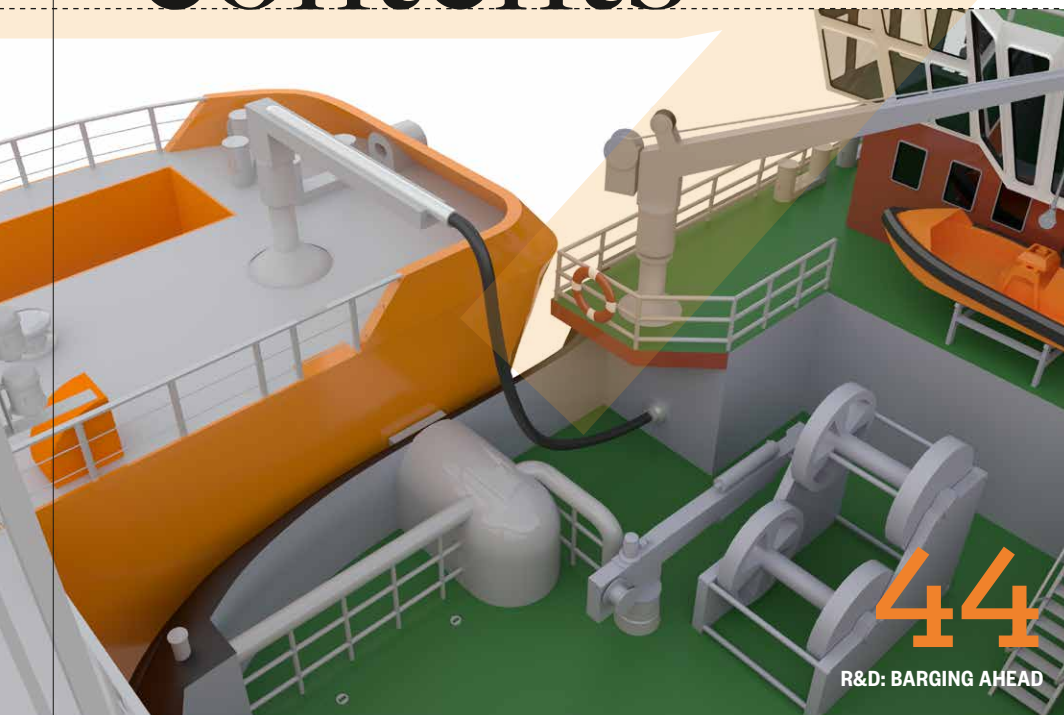
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1834 - 2014 and beyond.

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DISCLAIMER



Why we don't have the blues about going green

WHEN THE OIL PRICES took a tumble last year, the competitive edge of gas fell with it. The IEA's promise of a 'golden era for gas' became more muted, yet the opportunities with LNG still far outweigh the current challenges.

No other fuel can compete with gas' environmental credentials. Name the greenhouse gas – NO_x, SO_x, CO₂ – and LNG offers significant reductions.

With emission-control areas now in force in the Baltic and along the North American coasts, many customers simply cannot afford to opt out. Possible expansion of emission-control areas would add further impetus for customers considering conversion.

In spite of the low price differential with oil, the conversion to gas is well under way. A recent issue of *The Economist* pointed out that LNG is set to soon overtake iron ore as the most traded commodity in the world, second only to oil. In parallel, other, even dirtier fuels such as coal are dying a slow death. Just recently, Norway's investment fund divested all its coal assets. All things considered, LNG has never looked better.

Gas already generates 22% of the world's electricity, and one should mention that Wärtsilä's quick-start gas engines are a natural companion to fickle renewables.

It's also worth noting that supply has never been more bountiful. Australia is set to rival Qatar as the number one producer in a few years, with LNG terminals coming online. The US too is scheduled to start exporting in early 2016.

Supply means little, however, without the infrastructure to put LNG to use. With our technology, Wärtsilä can help customers along the entire value chain of LNG, from start to finish: liquefaction, cargo handling, regasification, terminal construction, and electricity production.

Importantly, our product portfolio can help smaller consumers join the importers' club. Lithuania is a good example, thanks in large part to Wärtsilä's regasification units aboard the carrier the *Independence*.

All in all, we remain committed to LNG's future. With our acquisition of Hamworthy a few years back, Wärtsilä positioned itself as an unrivalled expert on LNG.

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PROJECT EXECUTION
AND COMMISSIONING

ASSET MANAGEMENT
AND MAINTENANCE

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EVALUATIONS, CONSTRUCTABILITY
REVIEWS AND SAFETY STUDIES

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EVALUATE POTENTIAL
CONTRACTORS

CONCEPTUAL
DESIGN, FEASIBILITY
STUDIES AND FEED

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Read more at www.wartsila.com/WartsilaMobileLNG

EMENT AND
AGREEMENTS

**YOUR SHORTER & QUICKER ROUTE
TO COMMERCIAL OPERATIONS
AFTER 18 MONTHS**

ARRANGE FOR
OPERATION,
MAINTENANCE
AND TRAINING

**PROJECT MIGHT
BE READY AFTER
26 MONTHS**

BIDDING PROCESS, SUPPLIER
SELECTION AND DELIVERY
CONTRACT(S)

MANAGE
CONSTRUCTION OF
POWER PLANT AND
LNG TERMINAL

EASILY THE BEST

power generation.



[SNAPSHOT]



around the

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

'You need to believe'

PHOTO: iSTOCK/TYPHOONSKI

WHICH COMES FIRST? LNG vessels or the infrastructure to support them?

"We have seen many times that as soon as a consumer needs a certain amount of LNG, someone builds up a supply chain to support them – that's indisputable," says Wärtsilä's **Tomas Aminoff**, Director, Vessel Integration.

Supply and demand will reinforce each other going forward, he adds, as small- to mid-scale installations enter the market.

"Over time we'll see more of these installations," Aminoff says. "I believe this will also be a driver for demand."

In Europe, large import terminals have not in the past been well prepared to accommodate small-scale activities.

"They're playing in a different league; everything from capacity to the size of the pipes is just too large," Aminoff says.

The situation is changing, however, with more terminals preparing to accommodate smaller bunkering vessels. A main

globe

driver, not least in Europe, are emissions controls. Clean LNG vessels could one day dominate the waterways on the Rhine River (pictured), and facilities in Antwerp and Rotterdam will make sure they're not running on empty tanks.

"Rotterdam, which supplies gas for utilities, has already adapted to supply bunkering vessels," Aminoff points out. "It does require some investments, and you need to be able to justify your investments. You need to believe."

News

HIGH FIVE

In October 2015, Wärtsilä launched the Marine Mastermind open innovation contest to find new and unique digital services for the marine industry. The contest attracted both existing companies and aspiring entrepreneurs from around the globe.

From 47 applications, the Marine Mastermind team narrowed their selection down to five lucky finalists:

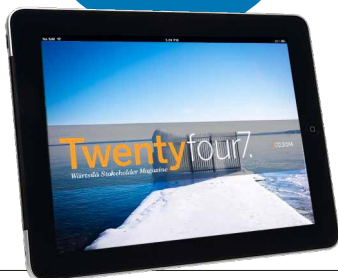
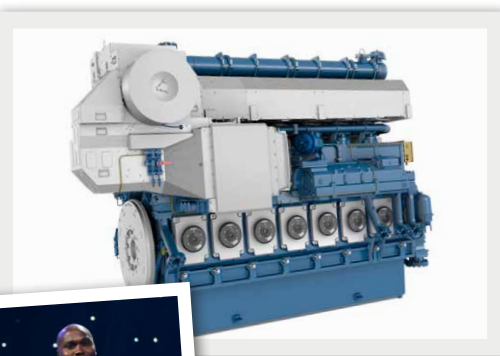
- Fibersail (Portugal) – a structural shape monitoring system
- Marina Ahoy (Estonia) – a management and sales tool for leisure marinas, also with potential for the industrial shipping segment
- Al-Marine, Aikumo Oy (Finland) – data analytics products and tools based on a patented machine learning technology
- Smart spectral sensors, Spectral Engines Oy (Finland) – a measurement sensor technology
- SeaEnergy PLC (UK) – a meta-heuristic modelling process to reduce the levelised cost of energy

The finalists came to Helsinki on 18 February to present their ideas to the jury and compete for the prize of a 30-day, agile "Lean Innovation Lab" product or service development sprint, worth EUR 50,000 and supported by Wärtsilä experts and Shift Actions Oy. Read more about the finalists and the jury on the Marine Mastermind webpage:

www.wartsila.com/marinemastermind

The Marine Mastermind winner will be announced at Digital Ship 2016 in Copenhagen on 5 April.

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on iPad
as well as online at
www.twentyfour7magazine.com

EXCITEMENT
RESPECT AND TRUST

NORWAY:

The 100th Wärtsilä 34DF dual-fuel marine engine will be delivered from the factory in early 2016. This delivery represents part of an order for three new escort tugs being built for Norwegian operator Østensjø Rederi. The engine's fuel flexibility is a major contributor to the industry's move into the gas age. "Within its power range, the Wärtsilä 34DF has become the workhorse of the marine industry, thanks to its superior reliability and lower operating costs. It is a highly efficient engine that is also making a notable contribution to environmental compliance," says Lars Anderson, Vice President, Wärtsilä Marine Solutions.

ENERGY
MAKE THINGS HAPPEN

Wärtsilä GLOBAL WATCH

FINLAND:

Atte Palomäki from Wärtsilä and a representative of Finnish organisation Crisis Management Initiative, Laura Seppälä, gave a special Sports Philanthropist award 'Charitable act in Sports' to Wilson Kipketer at the Finnish Sports Gala in Helsinki on 12 January 2016. Kipketer is known as the long-time world record holder and winner of several world championships in the 800-meter run. After his sports career, Kipketer, who is originally from Kenya, established his own foundation with the aim to help street children in the Kenyan capital, Nairobi, and has been an active member of the Peace and Sport foundation for 10 years. The award of USD10,000, donated by Wärtsilä, will go to the charity of his choice.

DO THINGS BETTER
EXCELLENCE

USA:

On Friday 29th January, the LNG fuelling facility in Port Fourchon, Louisiana, USA officially began operations when the OSV "Harvey Energy" fuelled up with 40,000 gallons of LNG from the shore-based facility. The Wärtsilä control system for Port Fourchon, the first LNG marine fuelling facility in the US, enables the entire fuelling process to be fully controlled from the control room onboard the Harvey Energy class platform supply vessels, thus making the fuelling far more efficient and safer than would be otherwise possible. Read more online at twentyfour7magazine.com.

[WORDS & NUMBERS]

USEFUL DEFINITIONS AND NUMBERS OF INTEREST.

SINGAPORE SLInG

Not just a cocktail, but a new LNG trading hub. Currently, only 5% of the LNG trade in Asia takes place on the spot market, but the new Singapore SLInG index is an attempt to establish a regional gas trading hub.

AL BARARI

The name of a new luxury eco community in Dubai means simply "The Wilderness" in Arabic. *Twentyfour7* spoke with its chief garden designer, Kamelia bin Zaal, who last year became the first Emirati to compete in the prestigious Chelsea Garden Show in London. Read more on pages 46–51.

2500 MW

An FSRU can have a sendout capacity corresponding to electrical power of 2500 MW, similar to that of a nuclear power plant, points out **Reidar Strande**, Director Midstream, Wärtsilä Gas Solutions, about Floating Storage and Regasification Units (FSRUs) fitted on carriers that offer new customers rapid access to LNG. Read more on page 14.

AUSTRALIA FEEDS INTO BUYERS' MARKET SHIFT

TEXT: ELIZABETH DUPONT PHOTO: CHEVRON CORPORATION

Lower LNG demand and prices in the world's biggest buyers – Japan, South Korea and China – have made LNG all the more attractive for the market's newest buyers and those looking to diversify their supplies, such as the European Union.

THE SLOWDOWN IN NORTHEAST Asian appetite for LNG comes just as new liquefaction plants in Australia start to push the country into the top producer's spot, ahead of Qatar, and as Pakistan, Egypt, Jordan, Lithuania, Poland and others enter the LNG market with newly installed receiving terminals.

This means that while Australian projects continue to meet Northeast Asian demand, mostly under long-term contracts signed years ago, supplies from new plants in the US, Africa and elsewhere will be free to go to the new buyers.

Europe is paying particularly close attention to the changing market, and positioning itself to reap those benefits. The European Commission will unveil a new LNG and gas storage strategy in February spelling out a plan for increasing the bloc's LNG imports and reducing its reliance on Russian gas.

To highlight the opportunities in the market, the Commission points to new supplies coming from Australia, as well as the US, Mozambique, North Africa and elsewhere, and the new price parity between Europe and Asia.

LNG buyers have much more bargaining power now than they did before oil prices started to slide in late 2014. At the time, LNG sellers were touting a seemingly endless growth in demand, and their plans to meet that demand.

But the oil slump has gradually dragged oil-indexed LNG prices down with it, and caused economic slowdowns that have consequently weighed on demand. Japanese spot prices have fallen from spikes of USD 20/MMBtu in the winter of 2013-2014, to USD 7-8/MMBtu in late 2015 and USD 5.60/MMBtu in January 2016.

Meanwhile, LNG supply continued to rise, by

4 million tonnes to 250 million tonnes in 2015, as three new Australian projects offset the loss of Yemeni LNG supply, according to the consultancy Wood Mackenzie.

With four more due to start producing LNG between now and about 2019, Australia's liquefaction capacity is expected to grow to 86.4 million tonnes per annum, from 24.1 million tonnes in 2014.

Queensland Curtis LNG, Australia Pacific LNG and Gladstone LNG are the first in the world to liquefy coal seam gas, and had to build thousands of onshore wells and long pipelines to complete the project. They will be followed by Gorgon and Wheatstone, on the west coast, Iohthys, in the north, and the offshore Prelude Floating LNG plant.

When their developers approved the projects for construction between about 2009 and 2011, they expected to sell most, if not all, of the gas to Japan, South Korea and China.

But demand in all three countries suddenly dropped last year, for a combination of reasons, according to Wood Mackenzie. Japan's demand declined by 4 percent to 85 million tonnes, as the two Sendai nuclear reactors returned online, while South Korea's demand fell by 8 percent to 34 million tonnes, because of lower power demand and increased nuclear and coal-fired supply. Chinese demand inched up by 1 percent to 19.5 million tonnes, which marked a significant slowdown from years of double-digit growth.

As a result, LNG has turned into a buyers' market that favors the flexibility and low prices buyers have long demanded, over the fixed terms and pricey oil-indexed contracts that exporters have resisted in the past.

Buyers that have contracts for too much LNG are expected to renegotiate with their suppliers to make the contracts more flexible and allow them to resell the cargoes to other markets, or get lower prices. Sellers, faced with an unattractive market, will have little choice but to give in.

India's Petronet LNG succeeded in renegotiating its contract with Qatar's RasGas at the beginning of this year for a daily price of around USD 5/MMBtu from 1 January, down from USD 12.5/MMBtu up to the end of 2015. It's now renegotiating its contract with ExxonMobil for LNG from Australia's Gorgon plant.

Meanwhile, sellers in the US have also started to prepare for the opportunity to send more cargoes into Europe by securing import capacity there. Shell signed an agreement for secondary capacity from RWE at the GATE terminal in the Netherlands, and Kogas and Cheniere Energy each signed put-option deals, buying import capacity, in Europe.



[TRENDS & SCENARIOS]

FUTURE PERSPECTIVES.



Digital LNG

LNG took a step into the future last year when a key LNG actor teamed up with Accenture to use predictive data to improve production.

The Australian company Woodside, which has a wide portfolio of LNG facilities, will use real-time data to manage its assets. "Through predictive analytics we are enabling

our people to access extensive analytical insights," **Shaun Gregory**, Woodside senior vice president strategy, science and technology, said in a statement.

Local media pointed to the tumble in oil prices pressing the gas industry to become smarter in order to stay competitive.

"It has really helped [Woodside] with their decision-making," **Paul Carthy**, managing director of Accenture's energy industry group, told ComputerWeekly.com. "It has allowed them to predict issues days, weeks and months in advance – which was the real thing they've wanted to focus on."

[INNOVATION]

THE VALUE OF EXPEDIENCY

Regasifying and storing LNG offshore has allowed customers to import gas without committing to land-based infrastructure. The option also speeds up access to vast amounts of energy.

“WÄRTSILÄ FOCUSES ON COMPLETING THE LNG value chain,” says **Timo Koponen**, Vice President, Flow and Gas Solutions, Wärtsilä. “It’s basically creating an alternative to pipeline gas. The whole logic of the Floating Storage and Regasification Units (FSRUs) is to provide a floating receiving terminal that has a regasification plant on board, plus LNG storage tanks.”

The end users vary, from industrial clients connected to smaller FSRUs – essentially an LNG carrier equipped by the addition of on-board storage and regas facilities – to large utilities.

Last year, Hyundai Heavy Industries (HHI) ordered Wärtsilä seawater/propane based regasification modules for two FSRU customers, Höegh LNG and Gazprom.

A bait for all types of consumers is expediency.

“It’s just a more flexible and faster way to get the gas imported,” Koponen points out. “It allows new importers and that’s why it has become popular, it’s a faster way to kick off gas imports, and it is in many cases much easier to build offshore and not invest in expensive and very bureaucratic onshore terminals, plus the vessel can be deployed to another location. It’s not tied to land forever.”

And there’s the question of size. Part of marketing the idea of FSRUs to customers has been

about communicating how much energy they store, underlines **Reidar Strande**, Director Midstream, Wärtsilä Gas Solutions, because not everyone truly understands how much energy LNG contains. Each of these FSRUs has a sendout capacity corresponding to electrical power of 2500 MW, similar to that of a nuclear power plant. “When you go from gas to LNG, you increase the energy content per unit volume by a factor of 600, so you’re bringing enormous amounts of energy with you,” he says.

And then there’s the question of speed. It isn’t simply a question of a lot of energy, but of a lot of energy delivered very quickly. “An FSRU new-build takes on average three years to build, a retrofit maybe two,” Strande says. “Compare that to the timescale of setting up other plants – buying the land, getting the permit.”

IN SOME PLACES, FSRUS can also add competition to the energy market. Wärtsilä and Hyundai Heavy Industry delivered an FSRU christened the Independence to Lithuania a few years ago. Once the two 170,000 m³ storage capacity vessels were in place, the country eventually saw Russian pipeline gas become cheaper.

And while on the topic of Lithuania, it’s worth noting that technically it’s an ideal

customer for a very specific Wärtsilä technology because of the grim winters.

“[Other FSRUs] use only seawater to provide heat for vaporisation, but this runs the risk of frozen seawater clogging the heat exchangers,” explains **Kenneth Engblom**, Director, Business Development LNG, Wärtsilä. “Instead, Wärtsilä uses propane and seawater in a cascade loop to warm the LNG.”

Other technologies also offer ways to deal with the cold, but often at great fuel cost. Wärtsilä can thus bring down the price tag of regasifying in colder climates.

So cheaper, faster, bigger... a final advantage to FSRUs is the fact that they can be moved. “They are typically leased over a 10- to 15-year contract,” Strande explains. “Which brings down the capital expenditure compared to a project on land.” ●

IT ISN’T SIMPLY A QUESTION OF A LOT OF ENERGY, BUT OF A LOT OF ENERGY DELIVERED VERY QUICKLY.

TEXT: CAMPBELL BLACK PHOTO: WÄRTSILÄ

Want to keep in shape? We'll help.

AN INCREASING NUMBER OF VESSELS run on gas today – from ferries, LNG carriers and offshore supply vessels to special vessels, like dredgers and tugs. Yet, many operators experience challenges in finding the expertise to operate a vessel running on gas. Faced with advances in technology, in combination with generally smaller crews onboard, operators can turn to Wärtsilä remote support services for help to run the vessel efficiently with the equipment available onboard.

Time is money, and safety is paramount. A crew loading or unloading gas, for example, has only a few hours to overcome any obstacles in port during such a critical operation. They need to know that we will support them come rain or shine. That holds true also during the voyage so we now perform services on board, too. For our customers, who always look for new ways to increase fleet use and optimise their operations, this feature is of huge benefit.

As well as being available 24/7, we know that efficiency is a deal-breaker for our customers. To meet their needs for efficiency, Wärtsilä has optimised its maintenance programme and updated related services. We tailor our maintenance to the state of the equipment, looking at how the ideal running conditions will affect both the efficiency of the engine and how long its components will last. With dynamic maintenance planning, we can keep the engine running for as long as it is still worthwhile to do so. As efficiency degrades with wear and tear, one reaches a point where inefficiency costs more than the maintenance; we'll keep the engine in the best possible shape for as long as it is needed.

TAGE KLOCKARS

General Manager, Marine Agreements

CUSTOMERS
NEED TO KNOW
THAT WE WILL
SUPPORT THEM
COME RAIN OR
SHINE.

PHOTO: WÄRTSILÄ



TEXT & PHOTO: ANN TÖRNKVIST

THE ISLAND OF **THE STUBBORN**

Being an innovator costs money, but long-term dedication to LNG and cutting-edge technology give Norwegian shipowners Eidesvik a green and commercial edge that could expand beyond the oil-rich swell of the North Sea.

REPORTAGE

[AFRICA | AMERICAS | ASIA | EUROPE | OCEANIA]

reportage





Jan-Fredrik Meling
(above) at Eidesvik
headquarters, which
houses models of the
company's fleet (right).



“WE CAN REDUCE COSTS FOR OUR CUSTOMERS AND AT THE SAME TIME REDUCE EMISSIONS.”

“**S**ee that ferry – do you want to guess how old it is? When it was built?” says **Lauritz Eidesvik**, as he gazes down on the inlet far below one of his family firm’s vessels.

“1994?”

Eidesvik shakes his head. The ferry chugs past the giant hull of the Viking Poseidon and heads towards the small island community on Bømlo, where the company Eidesvik has been based for almost more than three decades.

“1975,” the communications & strategy vice president informs us, peering down from the helicopter pad, whose yellow outline echoes the ringed buoys of the small island community’s salmon farms, floating just a stone’s throw away from the vessel’s hull.

The unassuming passenger ferry and the ships Eidesvik owns may be worlds apart – it’s not just size but function – but the question of vessel life and ship turnover rate will resurface in conversation with the company’s CEO, **Jan-Fredrik Meling**. He will argue that the ship turnover rate is one of the things holding Norway back in its fight against emissions. While the government can rightly state that emissions from offshore supply vessels have been reduced – although the size of the fleet has also grown – ships live for decades, which means that failure to support innovative technology in the present has repercussions decades into the future.

Back on the ship, Lauritz sets off into the innards of the crewless subsea vessel, docked at home between assignments. Silent corridors with few signs of life add to the cinematic calm of an empty ship. For the uninitiated, its content is the stuff of sci-fi movies. In the hold, an off-duty ROV that has been further under the surface of the ocean than perhaps Captain Nemo himself. The outline of the moon pool, which allows the ROV’s journey straight through the hull on its 3,000 metre descent, lies closed.

“The only depth limitation really for the ROV is the length of the cable,” Eidesvik explains. Later, on passing by the door to the mess room, where a large jar of pickles is eerily illuminated in the gloom, he adds, “If you don’t have good cooks on board, you’re setting yourself up for mutiny.”

While the Viking Poseidon rests, the remainder of the Eidesvik fleet is busy at work – 10 PSVs, five subsea and nine seismic vessels in total. Among the PSVs, it’s not just the norm-breaking Viking Energy, the first platform supply vessel (PSV) in the world to run on LNG, but also the newest additions. They include the Viking Lady, the product of a cooperation with Wärtsilä and Norwegian classification society DNV that saw the development of a hybrid energy system.

“When we started out with LNG, we never foresaw that it would lead us to batteries,” says Meling, a sincere and strict man with strong opinions on what needs to be done to reach a cleaner future, when we return to Eidesvik headquarters. “The future to a great extent will relate to how we manage energy, and how we store it. I envision tankers stacked with batteries charged from renewable energy sources heading to where they’re needed, the empty batteries acting as ballast as the ships return.”

But to understand where Eidesvik is heading, it’s important to look back to 1999 when the company first started talking about building a vessel fuelled with LNG. “DNV and the Norwegian Maritime Directorate’s attitude back then was very much ‘It’s impossible, it’s against the rules, you’re bothering us,’” Meling says. “They’re much better now.”

What he sees as a lack of foresight on the part of the authorities, not to mention the politicians, pops up repeatedly in the conversation with Meling, who has made his opinions known in public many times before. What irks him the most is the wishful thinking about a one-off solution, rather than incremental work towards less hydrocarbon reliance.

“I don’t come across as the absolute optimist when it comes to the authorities’ ability to tackle climate change. We burn fuel, that has limitations, and there are limited resources. It must make sense to utilise that fuel as efficiently as possible,” he says, underlining the tried and tested efficiency gains with LNG engines. “To be a little bit cynical, we aren’t doing this to save the world, we’re in business, but we believe that we can reduce costs for our customers and at the same time reduce emissions.”

A recent hiccup, however, has been the drop in oil prices, which has put oil on an even footing with gas, thus reducing financial incentives to convert. The current situation has dampened, but not killed, Meling’s gas enthusiasm. Today, five of Eidesvik’s 24 ships run on LNG. That’s almost half of the entire LNG-fuelled fleet of Norwegian PSVs in the North Sea. The small proportion bothers him. “Has LNG been a success in Norway? No, I don’t think so. But for us at Eidesvik it has been a success. It gives us a competitive edge and could allow us to extend globally, but if you look at the PSVs that have been built in Norway since, let’s take 2013, I don’t know how many PSVs have been built...”

“Three hundred plus,” Lauritz interjects.

“Yes, at least, and 11 of them are fuelled with LNG. Until a year ago, ship owners still ordered vessels fuelled by diesel, and those ships will operate for at least 30 years.”

“THIRTEEN YEARS AGO THE
AUTHORITIES SAID THE
TECHNOLOGY ON BOARD THE
VIKING ENERGY WAS
IMPOSSIBLE TO BUILD. BUT
PEOPLE ON THIS ISLAND ARE
STUBBORN.”

The decades-old
local ferry passes the
enormous subsea vessel.



Meling would like more political meddling, not less, pointing out that if you build an offshore rig, everything down to the toilet paper is regulated, but very few regulations exist for the logistics side of things.

Political initiatives have existed and worked in the past. Eidesvik's original LNG work benefitted from a NO_x reduction fund set up in the 1990s. NO_x is more a quality-of-life question, however, rather than a climate one. On the day that Meling and Lauritz meet us, the local Stavanger newspaper carried an article about residents' irritation over emissions from PSVs in the harbour. A harried official countered that people had to stop putting damp wood in their fireplaces, which also added to the haze.

"It's the same in Bergen," Meling points out. "We proposed years ago to build a floating, LNG-powered power plant to allow the PSVs to plug in rather than generate their own electricity with their engines and we got a research grant, but in the end the kilowatt-hour price acted as a deterrent," he remembers. "The problem is that we in Norway are so used to low energy prices – four times lower than a German electricity bill – that the local government balked at the costs. Had we proposed this in, say, Hamburg, no one would have batted an eyelid at the price. The project came to nothing, yet Bergen's land-based infrastructure cannot support these vessels. So nothing has happened."

Despite all the resistance, Eidesvik never gave up on LNG, ploughing huge amounts of money into its development work. As Meling and Lauritz trace the technological developments from the Viking Energy 13 years ago to the now seven-year-old Viking Lady, the island community outside the office panorama windows awakens; children make their way to school, cars head towards the 40-year-old ferry.

"You know, 13 years ago the authorities said the technology on board the Viking Energy was impossible to build. But

people on this island are stubborn," Meling says as Lauritz, an island native, nods in agreement.

While the Viking Lady is busy running errands for Total's Leif Eriksson platform, the Viking Energy just got its contract renewed for two years with Statoil, not least because Eidesvik upgraded it with a hybrid energy system based on the original battery pack developed for the Lady.

"We couldn't have done this without Wärtsilä," Meling says, adding, however, that he'd like to see more freestanding innovation from all marine suppliers. He offers a parallel to automotive. "BMW doesn't wait for a customer to ask if they can have a solution. BMW tells the customer what they want."

"I'm not an engineer, nor have I been a sailor, but I was really shocked that the captain on the bridge hasn't got a clue what kind of consumption he has. Yet since the early '90s you could sit in a car and see on the dashboard that if you keep driving like you're driving now you will consume X per mile. Then it becomes a sport to keep it down," says Meling, wishing for similar solutions at sea.

The company also noticed early on that their captains had wildly different ideas of how to run the ships in the most environmentally friendly way. It's an issue that Eidesvik has attempted to address as part of its Eidesvik Energy Efficiency Programme (EEEP).

"On one of our vessels, our two captains – there's one per shift – had totally different opinions about what economy speed meant," he offers as an example. "One thought it was to keep a constant speed of 10 knots; the other captain thought economy speed was to keep the speed that was optimal to reduce the consumption. If he had windswell or a current, he didn't care if he went down to eight knots."

The solution was to introduce a company definition of economy speed, including notes on how to plan the voyage. If a ship lingers too long in an oil platform's 500-metre security zone,



'BATTERIES NOW FACE A SIMILAR IMAGE PROBLEM TO WHAT LNG DID TEN YEARS AGO'

INGE SKAAR, WÄRTSILÄ SHIP DESIGN NAVAL ARCHITECTURE DIRECTOR, LOOKS BACK TEN YEARS TO THE BIRTH OF LNG IN THE OFFSHORE INDUSTRY.

Eidesvik was responding to a Statoil PSV tender and offered two designs, one diesel and one LNG. At the time, there were LNG-fuelled ferries but nothing in offshore. The Norwegian Maritime Directorate were very sceptical, they literally told us to go home and do something else – because there were no rules. But Eidesvik didn't take no for an answer.

They started to dig into the idea. First off was finding new suppliers, get a holding tank for LNG, then finding engine suppliers that could use LNG as a fuel.

Classifications society DNV did a lot of risk analysis, looking at different accident scenarios and what would happen. We had to prove to oil companies like Statoil, but also to the government, that this was safe. We did a lot of lobbying towards the politicians so there was pressure from that side also. It was quite an exciting period.

The LNG vessel was designed very safely. The technology was so new that there were special requirements on board for the first LNG PSVs. We had to put in two engine rooms, and the LNG engine room had to be separated from the auxiliary systems.

We usually push air into the engine room to overpressurise it, but, in this system, we had to suck it out – so if there was a gas leak it would be sucked out of the ship immediately. We designed an underpressurised engine room. It was a bit complicated, because it was an unusual way of doing things that wasn't normal back then, compared to industry standards. Another challenge, when the vessel was built, was the lack of training courses for the cold. So DNV, Wärtsilä and Eidesvik had to develop new learning materials for the crews.

Today, with a proven safety track record and advances

in technology, we no longer have to separate the engine rooms nor keep LNG separate from the auxiliary systems.

People trust LNG much more today. At that time, the vessels couldn't use LNG for dynamic positioning near the rig, or in the harbour, or for anything requiring manoeuvring. People were concerned that running on LNG was too unstable and too unsafe, but as soon as the vessel was delivered, this was disproved immediately. Today, they can run on LNG only, as long as they have two engines running in the 500-metre safety zone around the oil rig.

Today the same challenges exist for batteries. Wärtsilä and others in the industry are discussing with the owners and DNV how batteries can be used safely and how to get them to accept that batteries can be used as a replacement for one of the engines. ●



"You know, 13 years ago the authorities said the technology on board the Viking Energy was impossible to build. But people on this island are stubborn," says Lauritz Eidesvik.

"ON THE WAY TO THE GREEN SOCIETY, IT'S IMPORTANT TO SUPPORT INDUSTRIES THAT CAN REDUCE EMISSIONS BY 10 PERCENT, OR 15 PERCENT."



where it has to have two engines running, HQ will call and tell them to pull further out, switch off an engine, and relax until they get a docking slot.

Such initiatives reduce fuel use. And then there are the years of operational data that the company has fastidiously been collecting on its vessels, which allows Eidesvik to tell its customers with certainty what the fuel costs will be.

Eidesvik has even discussed whether to pay for the fuel itself in the future, with the customer buying the company's service in a package deal, because that way Eidesvik captains would have a vested interest in keeping the consumption down and keeping within a preset fuel budget.

It's always, after all, about the budget, Meling underlines. His candour extends to the company's customers, not least when it comes to the environment. Adopting green technology has to make business sense, otherwise why bother? There's a paradox at play, of course, that green technology should be a priority for the very industry that extracts the hydrocarbons that humans are over-consuming to their own detriment. Such paradoxes are inescapable in Norway, which a few generations ago was a country of fishermen and farmers. Last year, one in three new car purchases was a hybrid car; yet the country's petro kroner allowed the prosperity to afford such fancy cars in the first place.

Meling is well aware of such ironies. And given the state of

the things, the only option is a gradual weaning off hydrocarbons, he says.

"You don't get rid of emissions overnight," he says. "Some political parties don't think that gas is the solution. They think that the solution is the green society without any hydrocarbon fuels, which is fine maybe in 20 or 30 years but on the way there it's important to support industries that can reduce emissions by 10 percent, or 15 percent."

Eidesvik will own a ship by 2020 that uses 50% less fuel than its ships do today – that's the company's aim. But the journey there didn't begin today when Meling sat down at a conference table and strung the words together into one bold statement. The journey began in 1999 when Eidesvik first started thinking about LNG and drafted Wärtsilä in to help. Incremental and long-term change, that's where the solution lies.

"Technological development is an evolution –

it needs failures on the way," he says, about to offer a parallel with popcultural appeal.

"We should never forget that it was not Apollo 1 that landed on the moon, it was Apollo 11." ●

The Viking Poseidon sports Eidesvik's signature red and orange.

“ADOPTING GREEN
TECHNOLOGY HAS TO
MAKE BUSINESS SENSE,
OTHERWISE WHY
BOTHER?”

A GENIUS WAY TO OPTIMISE ASSET PERFORMANCE

Wärtsilä is constantly looking for ways of helping its customers optimise their operations, in order to be more efficient and profitable. Now, thanks to new developments within digitalisation, there is a huge opportunity to provide services that are faster and simpler and deliver more value. Wärtsilä Genius Services is the latest step in this digital transformation.

Since the industrial revolution, most innovations within engineering have been linked to tangible, hardware-related developments. While improvements are still being made on the mechanical side, the greatest leaps are now being taken thanks to the rise of digital technologies. One such example is Wärtsilä Genius Services, a range of solutions that, in effect, transform digital bits into more efficient operations.

“At Wärtsilä, we don’t see digitalisation just as an add-on to our existing products,” says **Stefan Nygård**, General Manager of Product Management in Asset Performance Optimisation. “We view it as an opportunity to utilise the advantages of connectivity and data gathering to optimise our customers’ operations. Our goal is to use these advancements to deliver more value and enable customers’ business growth.”

Digitalisation is fundamentally changing the ways in which companies create value for their customers. It is also transforming the nature of maintenance services. The amount of data that can now be remotely collected from various sources is increasing incrementally and, as data analytics become more and more advanced, this information is proving more useful than ever.

THE OPPORTUNITIES OFFERED BY this trend are the foundation of Wärtsilä Genius Services. Wärtsilä Genius Services comprises of three product families: Optimise, Predict and Solve. All three are available to both the marine and power generation

markets. They are subscription services, sold separately or as part of agreements to new and existing Wärtsilä customers.

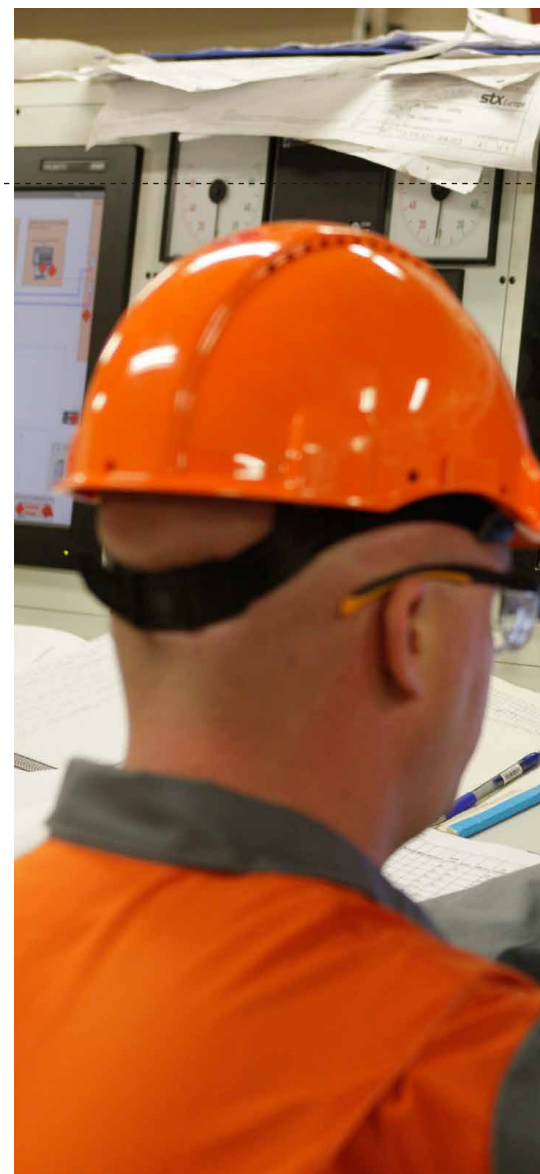
As most current customers will know, Wärtsilä has been carrying out condition based monitoring for some time but, as Stefan Nygård explains, Wärtsilä Genius Services will take performance monitoring to a completely new level.

“What Wärtsilä Genius Services offers is real-time information. Through digital sensors and the constant monitoring, collection and analysis of data, Wärtsilä customers will know about an issue and be able to prevent it before it happens,” he says.

BUT WHAT QUALIFIES WÄRTSILÄ to provide these services more effectively than anyone else? According to Stefan Nygård, the many decades of experience that Wärtsilä’s employees have in the marine and energy industries make them better equipped than anyone to make qualified predictions and decisions based on the collected data.

“Simply put, it’s our people and their expertise,” he adds. “Once the data has been collected, it’s up to our employees to analyse it and make recommendations. Our experience shows that the one thing that really makes the difference in this work is the combination of excellent analytics tool and experienced people.”

“Wärtsilä turns data into knowledge by combining the very latest technical capabilities of the digital age with an unrivalled level of human expertise,” he adds.





FACTS

WÄRTSILÄ GENIUS SERVICES IS AVAILABLE IN THREE PACKAGES: OPTIMISE, PREDICT AND SOLVE.

Optimise by Wärtsilä Genius Services is designed to increase the competitiveness and effectiveness of customer operations through real-time optimisation. This includes enabling ship and power plant operators to optimise their assets according to their operating profile and manage fuel and other costs more effectively.

Predict by Wärtsilä Genius Services improves customers' asset and business availability and predictability through lifecycle maintenance. For example, these solutions and services help customers to base their decisions on the actual operating condition of their equipment and increase revenue through more efficient usage of their fleet throughout its lifetime.

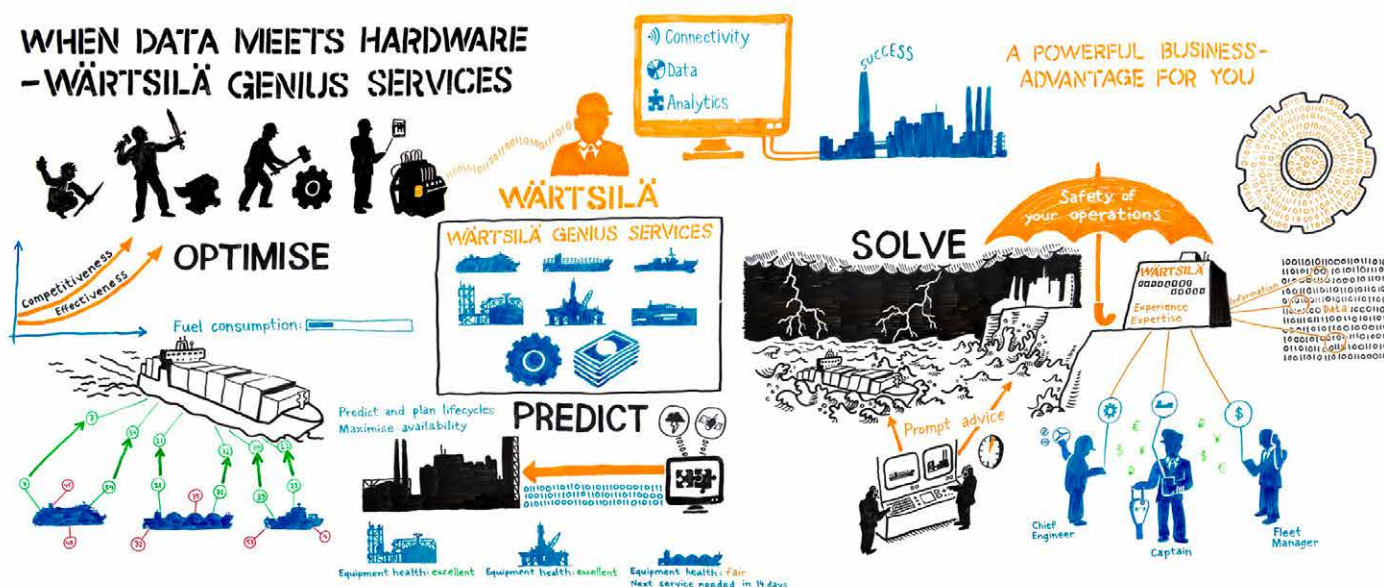
Solve by Wärtsilä Genius Services ensures the safety of customer operations and provides access to instant support whenever and wherever it is needed. It includes remote support services to ensure safe operations and offers customers 24/7 access to Wärtsilä's experts via its global service centres.

MOST WÄRTSILÄ CUSTOMERS run demanding operations that are based on extremely complex machinery. Machines like these are expensive to repair or replace and can also consume a lot of fuel. But their profitability can be maximised when they are operated intelligently – with a focus on reduced fuel consumption, optimum availability and a minimal risk of breakdowns. “Having the best vessel, engine, or equipment is only the start,” says Nygård. “To optimise the performance of your

assets, you need to start your engines at the right time, run them efficiently, predict internal and external events and act to resolve them at the right time. And when you have a problem, you need to solve it fast.

“Wärtsilä Genius Services is what enables you to do all that. It's how data meets hardware – delivering a powerful business advantage by enabling you to use your assets in the most intelligent way possible,” he concludes. ●

WHEN DATA MEETS HARDWARE – WÄRTSILÄ GENIUS SERVICES



TEXT: ANN TÖRNKVIST PHOTO: DARREN HAUCK

THE END OF THE LINE

The small town of Marquette in northernmost Michigan can rely on no one else for its energy needs. So when its coal units crept dangerously close to “mothball age”, the community decided to invest in dual-fuel technology from Wärtsilä.

feature





Paul Kitt, Executive Director of Marquette Board of Light and Power (MBLP), at the Frank J. Russell hydro plant in Marquette, Michigan.



"We had to take care of our own reliability," John Reynolds, MBLP Director of Generation, says.

"THEIR WINTERS CAN BE PRETTY BRUTAL, SO THEY NEED RELIABLE SERVICE."

An area of outstanding natural beauty, and a town that has grown from its iron-ore roots to such an idyllic place that an American news channel once included it in a Top 10 list of places to retire.

The French went by here in the 17th century. The area has attracted trappers since the 19th century, perhaps not only because of its wildlife, but because keeping warm just off Lake Superior was best achieved with fur.

Keeping warm is no less of an occupation today in the town of Marquette, Michigan, on the northern peninsula of the state, not far from Canada.

That's why the Marquette Board of Light and Power (MBLP) has ordered a 50 MW Smart Power Generation power plant from Wärtsilä, which will run dual-fuel engines primarily on natural gas.

The quick project turn-around – the plant will go online in early 2017 – and the technology's quick ramp-up were key in a town that has been forced to rethink its energy supply.

Marquette sits at the end of the line, not philosophically or poetically, but literally the end of the transmission line. Today, about 10% of the town's energy needs come from a major utility further south. The rest comes from its own generation, mostly coal, some hydro.

When the elected board of MBLP started to size up its aging coal units, its members knew that the community's self-reliance was under threat. Now was the time to act. "We're living on the ragged edge, and if we continue doing that we'll be like some other communities that go black for several hours a day," says **Paul Kitt**, MBLP Executive Director. "But that's unacceptable when it's minus 40 degrees Celsius."

Kitt compares the winter in Marquette to cities such as Finland's Tornio and Sweden's Haparanda, references that testify to his own Nordic heritage. When it's that cold, the power supply cannot fail. "The community hasn't known how close we were to crisis mode," he says, "because our utility, historically, hasn't cried and hasn't been alarmist about our problems. We've had a work ethic of getting a handle on them, and getting a solution."

As the existing units come close to retirement age, or "moth-ball age" as Kitt refers to it, MBLP started looking for options. Wärtsilä, with its Smart Power Generation, was up against two other bidders. Wärtsilä prevailed due to quick delivery times and the rapid ramp-up capacity. The latter is important if back-up transmission from the southern utility were to fail. "We needed quick-start generation in the event we were curtailed," says Kitt.

And, to complicate matters, the contract with the bigger utility down south may not be renewed in its current form, which underscores the need to invest in new local generation.

"We had to take care of our own reliability," **John Reynolds**, MBLP Director of Generation, says. "We couldn't depend on the outside world anymore."

At Wärtsilä, **Gary Groninger**, North America Business Development Manager, Energy Solutions, has felt sympathy with the town's plight from the very start. "They're right at the end of the transmission line because they're way up north, and they're really worried about not having electricity for their customers. Their winters can be pretty brutal, so they need reliable service."

It wasn't Wärtsilä, in the end, that was in for a tough sell.

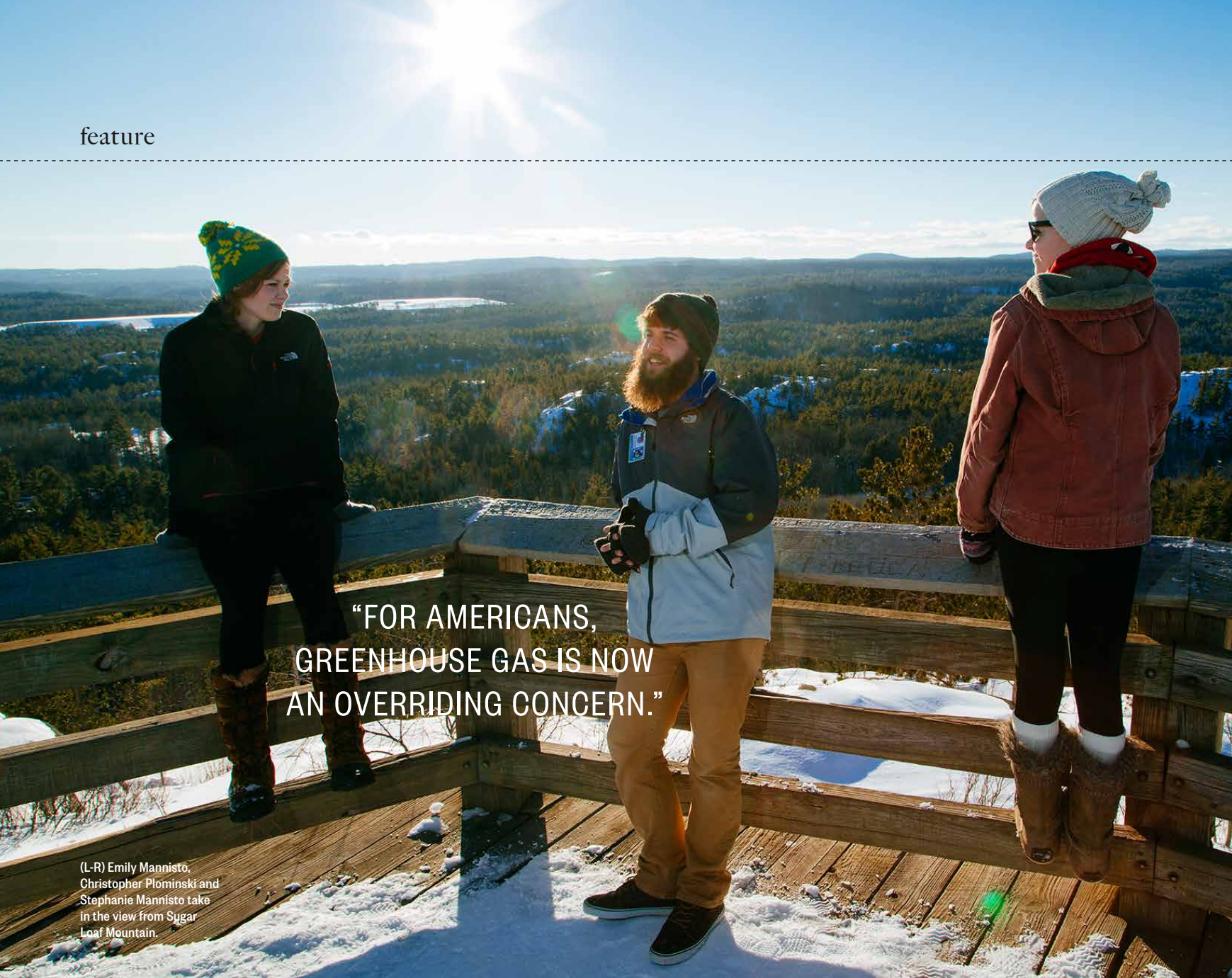


A view from the second floor of Doncker's, a famous restaurant in Marquette, Michigan, on the banks of Lake Superior.



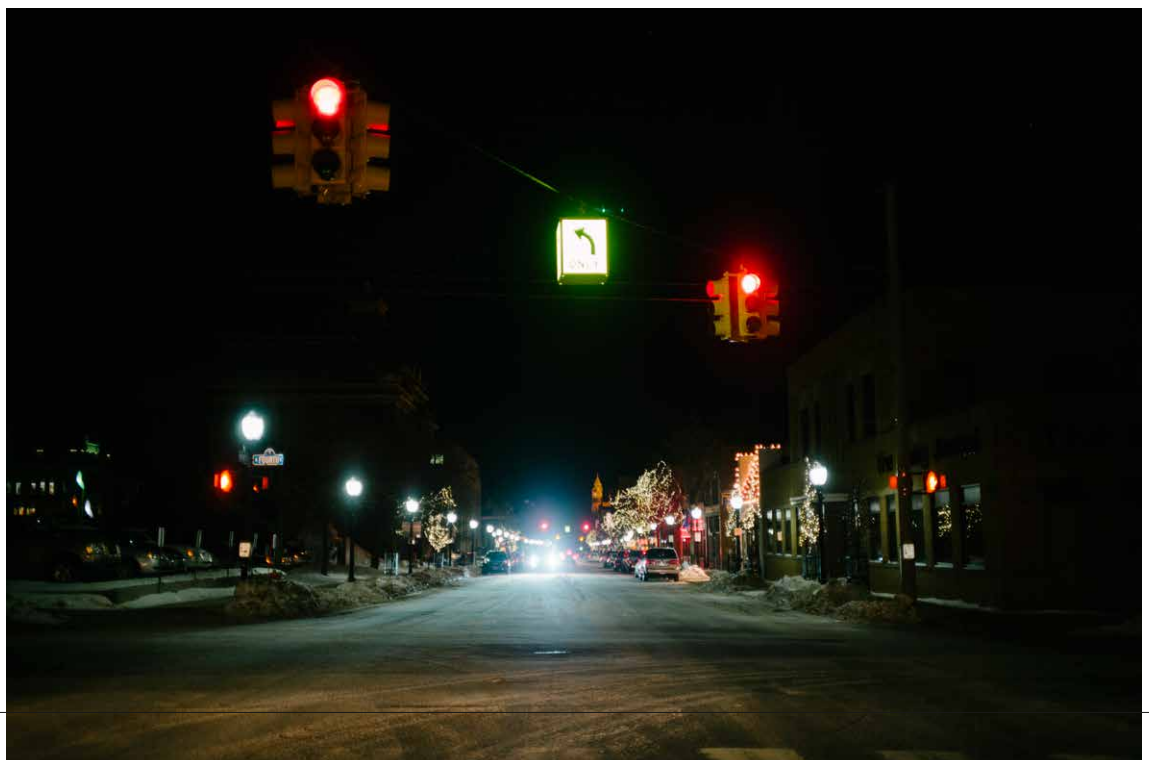
Luke Tikkanen rests after a bike ride in the grounds of James R. Smith Hydro Plant, which is open to the public.

Marc Himes clears the pavement outside the co-operative Zero Degrees Artist Gallery.



“FOR AMERICANS,
GREENHOUSE GAS IS NOW
AN OVERRIDING CONCERN.”

(L-R) Emily Mannisto,
Christopher Plominski and
Stephanie Mannisto take
in the view from Sugar
Loaf Mountain.



Cyclists enjoy the trails in the James R. Smith Hydro Plant grounds, which serve as a public park.



It was up to MBLP to sell the project to the community. Some residents wanted to bypass fossil fuels altogether, but many were persuaded by LNG's environmental credentials. This was an important sell, not least because environmental awareness has increased exponentially in the US in recent years, Groninger points out.

"It used to be there was no concern about CO₂ or greenhouse gas, but now that's an overriding concern," he says, noting that many Marquette residents had hoped to increase its use of renewables. Yet topography and the dense forests ruled out any significant potential for wind power, while the long winter days and overcast skies defined strict limits for solar.

"I don't think the general public understands yet that there's no easy way to store energy, that you have to use it when it's generated," Groninger adds.


In the end, after several community consultations, MBLP offered a win-win compromise in the shape of solar panels to be built next to the Wärtsilä units. "One of their selling points was that this would help integrate renewables in the area," Groninger says.

Tom Tourville, chairman of the elected MBLP board of directors, says much the same "The project not only provides a near-term reliable solution for firm backup power – it will secure our future energy needs for decades to come – it also provides a nice segue to introducing renewables."

With the question of gas versus renewables settled nicely, the board still had one issue to tackle. Some customers confused a pending 30% rate increase, which was a long time coming, with start-up costs to buy and install the new units. MBLP hadn't raised rates in several years, setting the community up for a shock.

"Our affordability has been second to none, so our customers are used to very low rates. I understand that some were surprised by the 30% rate increase, but once they understood the need for the project, they say 'Build!'" Reynolds says.

Marquette will see the units in place in the autumn of 2016, and online already in April 2017. The result will be a community that relies on a broad fuel mix. "With solar, hydro, natural gas and some light fuel oil for backup, we're going to have the best of both worlds," Kitts says. ●



“THE BUSINESS CASE
FOR FLEXIBILITY HAS
STARTED TO EMERGE.
INCREASINGLY WE CAN
SHOW THE INCENTIVES.”

THE BIG BOYS

With decades of trusted cooperation with community-based utilities, Wärtsilä North America has expanded to target ‘the Big Boys’ on the market – large, profit-driven utilities for whom affordable natural gas creates opportunities. *Twentyfour7*. speaks with Matti Rautkivi, Origination, Americas, in Houston, Texas.

Can you give us a quick summary on gas in the United States?

At the moment, there’s so much excess gas at some locations they just want to get rid of it. We saw the first gas wave in the early 2000s. It then slowed in 2008 due to the financial crisis, but now again it’s speeding up.

And with fracking, the price of gas dropped significantly in the last couple of years, which has definitely boosted a new gas development. I’m pretty sure we’ll get more and more gas generation.

Will availability and pricing help open more big utilities’ eyes to gas?

Yes, but there are two other factors that are equally important. Coal plants are growing too old to use. I think we will still see some coal in operation in 2030, but the political risk and market risk to build new plants are very high, in particular with emissions requirements. Therefore utilities are looking at new types of plants.

That are presumably not just cleaner but more quick-start than coal?

Yes, which brings us to the second factor: renewables. Two-thirds of all new capacity in the United States comes from renewables at this point, but sun and wind are fickle. Big-scale utilities who have a lot of green energy in their portfolio are already running into these issues, which means they see the financial incentives to put flexible quick-start Wärtsilä units in.

Apart from the obvious – securing reliable supply – does it all make business sense?

People are ready to sign, and that’s definitely coming from the market because this is the land of capitalism, after all. Six years ago no one was talking about flexible power or balancing needs, but now everybody is looking for flexibility to cope with renewables and increasing price volatility.

Are there any detractors?

The business case for flexibility has just now started to emerge. There are some people still arguing it doesn’t make sense, but increasingly we can show the incentives.

Finally, what it’s in store for Wärtsilä in North America in the medium term?

We’ve enjoyed a very good relationship with cooperatively run and municipal utilities, who invest about 20% of all new capacity annually in the US. We’re typically talking 50 MW to 100 MW plants, but we have seen also larger than 200 MW plants. We already have their trust; they’re our bread and butter.

There are, additionally, some 200 larger utilities and independent power producers (IPPs) – the ‘Big Boys’, if you like – who invest in the remaining 80% of upcoming installed capacity, plants as large as 500 MW. That’s where we have focused our energy in the past few years, and it will bear fruit this year and next. ●

STALL OR ENTHRALL?

TEXT: CAMPBELL BLACK

Can LNG still enthrall investors as the go-to fuel of the future? Or has the development stalled?

Last year, classifications society DNV GL issued a word of warning: “Making the wrong fuel choice today can have major implications for the commercial performance of a ship over its lifetime, including tradability and the second-hand value.”

Zooming out, long gone is the ebullient LNG optimism of a few years ago, when the International Energy Agency predicted a golden age of gas, not least due to rising demand in Asia. Its heavy dependence on local pipeline infrastructure makes gas a region-based market in contrast to oil, whose markets are very intertwined across the world’s trading oceans. So while the future availability of LNG is not in question, gas remains regionally based, which means the rate of adoption will wax and wane from area to area.

The US, meanwhile, still rides high on its shale-gas boom, which makes supply a non-issue for regions with incumbent peak shaving plants best positioned to respond to immediate demand. These gas utilities can start, and some already have started, to supply the marine market easily and cheaply, thanks to existing storage, a sunk cost. Thus, they are finding a CAPEX-light enabling approach.

THE MARINE LNG FUEL market for North America is hurdling over another challenge. “The regulatory challenges were stark,” says **John Hatley**, Director, Market Shaping, Wärtsilä Marine Solutions, who credits both the US and Canadian Coast Guards with moving forward with rules on vessel design, safety, training and operational standards for LNG fuel.

At sea, the low oil prices have robbed gas of its competitive price edge. That threatens to affect demand, yet experts at Energy Insights earlier this year encouraged the industry not to let the current and near-term worries get in the way of planning for the future – demand might grow slowly but it won’t disappear.

At Wärtsilä, Hatley saw no cause for pessimism: “We’re at the start of a paradigm shift,” he said. “A few thousand years ago the shift was from oars to sail, two centuries ago sail to steam, a century ago steam to oil, and now it’s a new era for gas. These sorts of changes only happen once a century, so it’s a very exciting time.”

Whichever speed the transition ends up going at, a full-scale

switch to LNG would signal good news for the environment. Even though maritime shipping remains the most efficient way to transport goods, it still produced approximately 2.1% of greenhouse gas emissions in 2012, according to a tally by the World Shipping Council.

But what needs to happen for such a switch to take place? The European Commission released a report on LNG last year that called the emissions-controlled areas (ECA) the “major motivation” of stakeholders.

“On the other hand,” the report continued, “the higher equipment costs for engines and tanks are not offset by savings in fuel or operating expenses. Also, the lack of existing bunkering infrastructure for LNG is another quite important barrier.”

When it comes to infrastructure, all stakeholders agree. “To develop the maritime LNG market, we need to see more players develop more bunkering ships and barges,” said **Pierre Cotin**, Chief Strategy Development and Marketing Officer at Elengy, the operator of LNG receiving terminals in France.

“Every investment that is made in gas infrastructure and logistics will only make the change happen faster and faster,” said **Ilari Kallio**, Vice President, R&D, Engines, Wärtsilä.

INFRASTRUCTURE IS A QUESTION often picked apart by experts, not least at Wärtsilä, which is doing its bit to open up the value chain. Recognising that smaller consumers far from pipelines needed a medium-sized solution, Wärtsilä in 2015 launched Wärtsilä Mobile LNG Concept. It essentially brings LNG to shore, but no further, allowing for rapid deployment and the possibility to lift anchor if demand shifts to another market. The concept is the perfect fusion of Wärtsilä’s dual competencies, marine and energy solutions, which shows also LNG’s benefit for electricity consumers. With negligible NO_x and a significant reduction in CO₂, it’s also a much nicer fuel to burn in your figurative backyard.

Gas-fuelled electricity production has another, crucial, application – supporting the integration of renewables. Rapid ramp-up will be crucial across the world when the electrical grids incorporate more and more renewables. The transition to green energy cannot, in fact, be phased in seamlessly without a helping hand from fossil fuels. Which makes gas, at the moment, as clean as it gets. ●

SMALL IS THE NEW BLACK

The large-scale LNG carrier market appears to have reached saturation – at least in the short term – but the less developed small-scale market still represents plenty of opportunities. *Twentyfour7* examines when and under what circumstances it makes most sense to use a smaller gas carrier.

In spite of the severe impact of the recent collapse in energy prices, the long-term outlook for small-scale LNG shipping and bunkering remains positive. While operators may be hesitant to make major investments in large-scale vessels and terminals at the present time, **Alexandre Eykerman**, Director of Sales at Wärtsilä Marine Solutions, argues that small-scale LNG represents a less risky, more flexible alternative, and, perhaps most crucially, a market that is still growing.

“We’re entering the gas age, of that there is no longer any doubt,” he confirms. “What remains to be seen is how we will resolve the problems of supply and distribution.”

Eykerman explains that the infrastructure for distributing LNG is still limited, with existing LNG volumes mainly being traded towards large terminals, which, in turn, are linked to large utilities. These projects typically come with long-term contracts, which ensure the viability of the investment.

SMALL-SCALE TERMINALS IN DEMAND

However, there is also a strong business case for smaller-scale LNG terminals. The rationale for building a terminal of this kind may vary, from a lack of space to a limited energy demand or challenging geography. In restricted areas, such as islands in Indonesia or the Caribbean, for example, it is common to use small-scale LNG infrastructure to supply energy to remote or isolated regions. Where it is not feasible to build a pipeline, it often makes sense to install small- or medium-scale LNG instead.

One such example is Tornio terminal in Finland, which is under development and due to be up and running in early 2018. Wärtsilä has delivered a complete turnkey solution for the terminal, which will be the largest of its kind in the Nordic region. Providing a full range of LNG services, including storage in a 50,000 m³ tank, regasification, pipeline distribution, ship bunkering, transshipment and loading for redistribution, the Tornio terminal will supply LNG to customers in the mining, steelmaking and shipping industries in northern Sweden and Finland.

SMALL-SCALE OFFERS SPEED

Whereas a large-scale LNG plant may take up to 10 years to develop, a small- or medium-scale plant can be constructed in one to four years. Requiring significantly smaller capital investments, smaller-scale plants sometimes offer a more economically viable solution than their large-scale counterparts. Smaller satellite terminals also have an important part to play in the overall LNG infrastructure, providing energy to communities or fuel to local industries.

“So far, the investment costs associated with LNG projects have typically kept receiving terminals relatively large and thus unsuitable for a ‘single gas consumer’ philosophy,” says Eykerman. “However, we’re now seeing more small- and medium-scale LNG activity, with a growing number of regional storage hubs, from which gas is supplied by tanker or truck directly to the end user. The capacity of these storage facilities typically ranges from a couple of hundred m³ to 20,000 m³.”

As the number of these satellite terminals continues to grow, the need for small-scale LNG carriers will increase. Whereas large-scale terminals can receive large-scale carriers, one of the main limitations of a small-scale terminal is the kind of vessel it can accommodate.

SIZE LIMIT

“Limitations may be related to the length of the ship or the depth of its draft,” notes Eykerman, adding that most small- to medium-sized terminals cannot accommodate vessels longer than about 150 metres. However, there is no minimum size restriction to prevent smaller ships from calling at larger terminals.

“Moreover, it would make no sense for a giant tanker to call at a terminal that only needs 10,000 m³ of LNG, when it could unload 200,000 m³ elsewhere,” he says. “With the abundance of LNG cargo that’s globally available today, the trading of smaller volumes will increase – as will the number of small-scale ships – as opposed to what we’ve seen up to now, with only very large quantities being transported.”



The small-scale LNG carrier market is growing. Eykerman estimates that there are currently some 35 to 40 vessels in the 0–50,000 m³ range that are dedicated to the small-scale LNG business – plus a small number of bunkering barges – and that these have all been custom-built for a specific project.

EIGHT MULTIGAS CARRIERS

For example, one of the most recent examples of a newbuilding of small-scale carriers is Evergas' "Dragon Class" range of eight 27,500 m³ multigas carrier vessels. These ships have been specifically designed to fulfil a 15-year contract with Ineos to transport ethane from the Charlotte terminal in North Carolina to Europe.

"Nobody is building small-scale carriers speculatively," says Eykerman, explaining that tank size, draft and length are all being custom-made for the trade route, because the market has not yet agreed on an optimum small-scale carrier size.

"However, looking at the terminals that exist – both on the supply and receiving ends – I think it's clear that there's a market for vessels with a tank of around 20,000 m³ and a length of no more than 150 metres. These ships would be able to call at Charlotte, Tornio and most other terminals of this kind and would have the flexibility to be deployed wherever there's a need," he continues.

"Moreover, Wärtsilä specialises in turnkey LNG solutions, which means that we can deliver whatever solution is needed – from cargo handling to reliquefaction, regasification and pump systems – on a case-by-case basis, regardless of size or capacity." ●

"NOBODY IS
BUILDING SMALL-
SCALE CARRIERS
SPECULATIVELY."





in-depth

SMALL CARRIERS DIVERSIFY THE LNG FLEET

A new breed of LNG consumers has spurred on smaller-scale deliveries. Forward-thinking companies are taking note, not least Wärtsilä whose, cargo handling systems can easily be adapted to all size requirements.



in-depth

“THE GROWTH OF THE
SMALL-SCALE LNG MARKET
HAS REMAINED GRADUAL
AND POSITIVE.”





The small-scale LNG market may still be in its infancy, yet it is starting to draw more and more attention, with industry players from around the world showing growing interest in both trading and bunkering LNG in smaller quantities.

“Unlike the large-scale market, which saw a massive boom for several years and then slowed down quite dramatically at the end of last year due to the low price of oil, the growth of the small-scale LNG market has remained gradual and positive,” comments **Stein Thoresen**, Director, Business Unit Marine, at Wärtsilä Gas Systems.

Many analysts agree that the long-term outlook for LNG remains positive as countries commit to phasing out coal and adopt a stricter environmental stance following the Paris climate change summit. As part of this transition, power plants and fuel suppliers will be looking to secure reliable access to LNG, resulting in a growing need for small-scale supply.

“Small-scale LNG vessels are typically used for short-distance coastal trading, distributing LNG to end users such as power generation plants, land-based industries and suppliers of LNG as fuel for vehicles or ships,” Thoresen says. “As more users transition from oil and coal to gas-based fuels in the coming years, we expect this market to grow significantly.”

THE NEED AND THE DESIRE FOR GREENER OPTIONS

Kjell Ove Ulstein, Business Development Manager at Wärtsilä Oil & Gas Systems, says multiple factors will drive the speed of transition.

“In Europe, where LNG is expensive, the main driver is environmental legislation, which is requiring us to go greener. In other places such as the US and Asia, it’s driven by a combination of economic and environmental concerns,” he comments.

“In China, the level of pollution is forcing policy makers to realise that they simply can’t keep using coal the way they do now. They need a greener energy source, and LNG is the option that makes the most sense.”

“Meanwhile, in Indonesia, where some places still aren’t covered by the power grid, it doesn’t make sense to start building oil-powered power stations now, so they’re building them for gas power or dual fuel from the outset,” continues Ulstein, who underscores that accessibility has historically been a stumbling block to adopting LNG. However, as the number of small-scale LNG shuttle tankers, bunkering vessels and barges continues to grow, it will enable smaller users and ports to secure a reliable supply of LNG.

“As we have already seen on the large-scale market, once the supply lines are available, it gives users the confidence to invest in LNG facilities.”

WHAT IS “SMALL SCALE”?

While there is no industry-wide accepted definition of what constitutes a small-scale LNG carrier, the maximum size of the tanks on board these ships is typically around 30,000 to 40,000 m³, as compared with a large-scale LNG carrier with a

capacity of approximately 160,000 to 170,000 m³. The smaller vessel can therefore be transporting as little as a sixth or a fifth of one of the huge carriers' cargo volume. According to shipping services company Clarkson's, there are currently 26 of these smaller vessels in existence, with a further 13 on order – a number that does not include multigas carriers, many of which also fall within this size range.

One such example is Evergas' "Dragon Class" range of eight 27,500 m³ multigas carriers, three of which have been delivered to date. Originally contracted to ship ethane as part of a 15-year contract with Ineos, these ships are also fully equipped to carry LNG. This built-in flexibility makes the new Evergas vessels "future proof" – meaning that they have been adapted from the outset for possible redeployment at the end of their contract.

WORLD'S LARGEST MULTIGAS CARRIER

At 180 metres long and 26.6 metres wide, with a draft of approximately nine metres, Evergas' Dragon Class vessels are the world's largest multigas LNG-ethane carriers. For each of these ships, Wärtsilä is supplying two Wärtsilä 50DF dual-fuel engines, propulsion equipment including the gearbox, two Wärtsilä 20DF auxiliary generating sets, a LNG fuel system, Wärtsilä cargo pumps and a Cargo Handling System custom-made for C-ethane from US shale gas.

And while the ships were originally designed to run on LNG, the Wärtsilä dual-fuel engines were re-engineered also to be able to run on ethane, following a request from the customer. "The delivery of these Dragon Class vessels – which allowed Evergas to be the first mover into the shale gas trade out of the US – marks the beginning of a new era in the transportation of liquefied gases," comments Evergas CEO **Steffen Jacobsen**.

"No other vessel in the world fleet today is able to burn ethane as a fuel in the engine," continues Jacobsen. "The advanced technology solution, whereby the cargo handling system, the gas supply system and the propulsion machinery are fully integrated, make the vessels probably the most modern and environmentally sustainable LNG carriers ever built."

"[At the outset] Evergas had a lot of questions, because the 4-stroke was uncharted terrain, and, you know, when you stick your neck out, there will always be competitors going 'Boys, what are you doing?', the kind of Cassandra pessimists that think it will never work," says **Jens Karlsson**, General Manager, Sales, Wärtsilä Denmark Marine Solutions. "But you know what, it's gone tremendously well, and will keep doing so."

"We had an enormous number of good references," he adds. "We showed them all our LNG carriers, and we said, 'There's nothing remarkable here. If you want a gas-driven engine design with a proven track record, here you go!'" ●



Wärtsilä LPG cooling plant onboard 135,000m³ LPG FPSO Sahnā.

“THERE WILL ALWAYS BE COMPETITORS GOING ‘BOYS, WHAT ARE YOU DOING?’, THE KIND OF CASSANDRA PESSIMISTS THAT THINK IT WILL NEVER WORK.”

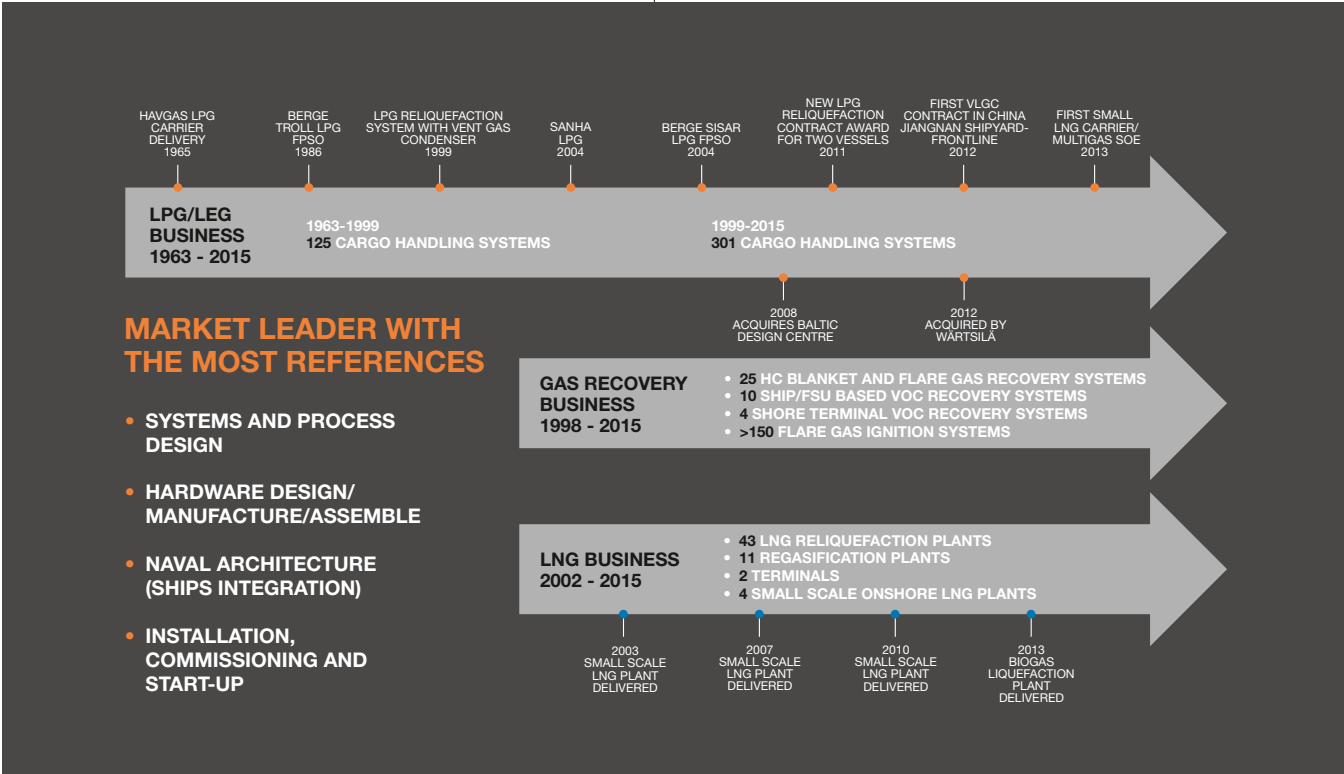
**WHAT WÄRTSILÄ OFFERS:
CARGO HANDLING FOR EVERY SIZE**

Wärtsilä offers the most advanced cargo handling systems in the world for gas carriers of all shapes and sizes. When Wärtsilä acquired Hamworthy, it secured its ability to deliver the broadest portfolio of gas handling systems for gas carriers in the world (see factbox).

In November, complete Wärtsilä Gas Cargo Handling Systems were ordered for a series of six new type Very Large Gas Carriers (VLGCs), as well as for two conventional VLGCs, and for three Medium Gas Carriers (MGCs). The total of 11 systems represents one of the largest single deals for gas cargo handling solutions ever received by the company.

The complete systems also included the latest Wärtsilä Gas Reliquefaction Plants, with three identical units being installed in each vessel, as well as Wärtsilä Purge Gas Recovery Units that collect the hydrocarbons in the purge gas, resulting in a significant reduction in hydrocarbon emissions.

Wärtsilä offers a wide range of technologies including cargo handling for LPG, LEG and LNG vessels, reliquefaction systems for LPG and LNG, regasification systems for LNG, LNG fuel systems, LPG and LNG pump systems, vapour recovery systems for crude carriers, as well as on-shore LNG liquefaction systems. In addition to the complete cargo handling system design, Wärtsilä also offers a newly developed reliquefaction plant specially adapted for the small-scale segment. ●



MARKET MANOEUVRE

A new fuel needs a new fuel infrastructure; thus far LNG suffers from its absence. Wärtsilä now aims to transform the economics of refuelling ferries and power barges with its new transport barge.



research and development

Trucks travel five hours from Rotterdam or Zeebrugge to supply LNG to Hummel, the first cold ironing power barge in the port of Hamburg. It's hardly an ideal solution. With the number of LNG-fuelled cruise ships and power barges at the German port set to take off in 2016, Wärtsilä has designed a new transport barge that takes LNG fuelling to the next level.

"The fuelling of the cold ironing barges by truck from Rotterdam is commercially feasible today because there are only one or two cruise ships that need clean energy in the harbours," explains **Arthur Boogaard**, General Manager, Specials, Wärtsilä Marine Solutions. "But with every new technology there's an economy of scale. If you can think of a more efficient way to serve the need, it's better for the customer and better for the environment."

The new barge is coupled to its tug by a semi-rigid – articulated – connection, allowing it to venture safely into the North Sea in rough weather. When connected, the tug is fuelled by LNG drawn through a flexible CNG hose from the tank, housed in a coffin-like structure on the barge's topside.

The barge in turn receives electrical power generated by the tug's Wärtsilä 20DF engines. This is used to power separate steerable Wärtsilä water jets, allowing the barge to manoeuvre precisely alongside ships and barges.

"It is a relatively complicated manoeuvre, to go alongside a shiny cruise ship," Boogaard explains. "You normally need at least one tug, if not two or three, so the idea is that you have a vessel that is capable of carrying out manoeuvres in confined spaces very precisely."

Once the barge is in place for bunkering to take place, the tug can decouple, switching from LNG to diesel fuel, and move on to its next task, such as picking up an empty barge to return it to Rotterdam.

"You would have a ratio of, let's say, one tug to three barges, so that the tug can be used most efficiently tugging empty barges back to Rotterdam and full barges back to Hamburg," Boogaard explains.

Hamburg saw 168 port calls from cruise vessels in 2015, and all the cruise ship lines have plans to install LNG or dual-fuel engines on their vessels to help meet Germany's new emissions regulations for inland waterways, which came into force in January.

The alternative is investing in a scrubber system to take out the sulphur from the exhaust, or a selective catalytic converter system.

Boogaard stresses that meeting new regulations was not the only driver. It's also an image thing. "You have 4,000 passengers on board and you don't want them to look at your funnel and see greyish, blackish smoke clouds."

The designs for the barge and its fuel system, which Wärtsilä began working on at the start of 2015, were approved by DNV GL, the world's largest classification society, in November.

The first barges are expected to supply Hamburg from Rotterdam, but Boogaard expects orders for other ports to follow too – initially as an intermediary stage in the development of LNG fuelling infrastructure, and later for convenience. Crucially, fuelling can be done discreetly, and removes the need to stop for gas on the way to the next picturesque cruise destination. ●

"IT IS A RELATIVELY
COMPLICATED
MANOEUVRE."



TEXT: ERCILIA PHOTO: GETTYIMAGES / CARL COURT, AL BARARI & CAMERON GLEGG

A modern oasis

A daughter named after a flower has turned her family's dreams of an eco-conscious luxury oasis into reality. In 2015, she became the first Emirati to take part in the prestigious Chelsea Flower Show in London. *Twentyfour7.* spoke with Kamelia Bin Zaal.

"bin Zaal poses for a portrait in her garden at the Chelsea Flower Show in London."

passion



THE UNDERGROUND WASTE SYSTEM SEPARATES ORGANIC FROM INORGANIC WASTE.

Always fresh faced and friendly, **Kamelia bin Zaal**, 40, loves to get her hands dirty – and all for the love of plants.

“Landscaping to me is the language of outdoor space, whether it’s a corner outside your front door, a balcony, or just a window box. Our world cannot be sustained without flora and fauna,” the Emirati garden designer says.

Landscaping seemed like a destined path, considering that she was named after a flower. This passion for green spaces is a trait of the entire Zaal family, who through their real estate company have built an unusually green housing project in Dubai called Al Barari, meaning “The Wilderness”.

It was when the family returned to Dubai from the UK, where Kamelia had spent part of her youth, that the Zaals acutely felt the loss of the abundant greenery. There wasn’t anything like it in Dubai. That was the moment they decided to build it for themselves.

“And that is how Al Barari was born,” says Kamelia, who played a big role in the landscaping of this state-of-the-art USD 3.2 billion green address. It had long been her father Zaal Mohammed Zaal’s vision to build homes integrated with the nature that surrounded them.

The Zaals have made Al Barari their home, but they don’t live there alone. The 14.2 million square foot garden estate with its hundreds of villas houses families from across the world – Pakistan, the United Kingdom, India, Kazakhstan and Sweden to mention a few.

Such is the intelligent design of the development –the layout, the choice of plants and the erection of walls to capture and redirect the wind – that the estate is on average 4 degrees cooler than the rest of Dubai.

PLANTING A SEED

Before getting involved with the family firm, Kamelia worked for the Dubai Development Investment Authority as the assistant manager of project development.

In 2003, her father spoke to her about his plans for Al Barari, which stoked her interest in garden design instantly.

“Within a month I was at the Inchbald School of Design,” she says of her admission to the famed garden design school in London.

A year later, Kamelia returned to Dubai equipped with skills to plan and style outdoor living spaces and began her career as a freelance garden designer for residential villas. She went on to establish her landscape architectural practice, Second Nature, in 2006, and two years later, she formally joined the family firm, where she forged an alliance with the new on-site plant nursery – Green Works – and got to work on Al Barari.

GROUNDWORK

Reflective of a commitment to sustainability and eco-conscious development, Al Barari’s architecture, landscaping and infrastructure all represent good environmental practices.

“The villas employ an acute awareness of natural light and shade, and have been grouped in leaf-shaped clusters to minimise the impact of infrastructure on the land,” Kamelia explains.

Seen from the air, the tightly laid-out pods of nine villas each form an organic pattern that wouldn’t look out of place on a silk shawl. Ponds and waterways intersperse the clusters, adding an occasional turquoise dash.

The houses themselves are designed to help their residents lead a greener life.

“Each residence supports its own energy-efficient home system, and residents are encouraged to recycle through the underground waste system that separates organic from inorganic waste,” Kamelia says.

When it came to the grounds, she selected high-density plants to keep the ground cooler, therefore requiring less water. The ratio of green cover to buildings has been maintained at four to one, helping to sustain Al Barari’s cooler microclimate.

Al Barari may mean the wilderness in Arabic, but it’s a tamed and immaculately thought through landscape that greets visitors and residents alike.



passion



passion



“WE ACTUALLY BROUGHT WATER TO THE DESERT AND THEREFORE FOCUSED OUR EFFORTS ON SUSTAINABLE LANDSCAPING”

The trick to keep Al Barari green is barriers against exposure, achieved through planting tall trees and shrubs and through physical walls. Shade is essential to maintain the cooler temperatures.

NURTURING

To keep Al Barari lush in the arid desert, the family imports and cultivates many water-saving plants such as *Tecomella Undulata*, *Aloe Vera*, *Vitex Rotundifolia*, *Salvadora Persica*, *Juncus Rigidus*, *Carpobrotus Edulis* and *Hymenocallis Littoralis*. These plants can survive in the desert, both in winter and in summer, tolerate high levels of humidity and extreme temperatures (up to 48 degrees Celsius) and are resilient to the saline soil of the United Arab Emirates.

Al Barari's waste materials are put in a compost, to later be added to the soil in order to improve its natural structure and water-retaining capabilities.

“Mulching is used to reduce the amount of water lost through evaporation, which also helps reduce the soil temperature. Sub-surface irrigation systems and larger water droplet sizes on our irrigation sprinklers are also used to reduce the amount of water lost through evaporation,” Kamelia explains.

Treated wastewater that would otherwise be pumped into the ocean is recycled and used to irrigate the gardens.

“We actually brought water to the desert and therefore focused our efforts on sustainable landscaping in which 80 to 90% of the water used is recycled water,” Kamelia stresses.

LIVING SPACE

The first phase of the project saw the creation of 217 villas that were then handed over to their new owners. Six gardens have also been completed, all with themes – the Mediterranean, Balinese, Water, Renaissance, Contemporary and Woodland Garden. The latter could well be a nod to Kamelia's memory of the verdant Britain of her youth; the babbling brook almost has a Cotswolds feel to it.

The Green Works nursery, which covers 38 hectares and currently produces more than 700 plant varieties, has grown to become the region's largest privately owned plant nursery.

Yet living at Al Barari is not just about the gardens, it's about quality of life. To the delight of foodies, Al Barari also boasts an in-house restaurant called The Farm. Much of the fare is organic, and all of it is traceable, meaning that the chefs know exactly where the food comes from.

The family now plans to extend Al Barari, making it into a green experience for a wider audience by building a six-star boutique hotel, a retail village, dining venues and a creative hub and by constructing floating markets, gardens and lakes. This second phase will also see the addition of another 464

homes, including apartments, duplexes, penthouses, sky villas and garden homes, and a cluster of 99 villas called The Nest.

BOUNTY

Exceptional for someone with Bedouin roots, Kamelia has received wide appreciation in the world of landscapers. Several magazines have featured her work, such as the UK Garden Design Journal, Inside Out and Landscape Designers Association Compass Magazine.

When not in the garden, she is a keen photographer and is likely to make plants and flowers her subject. She likes trekking and has gone mountain climbing for charity.

In 2014, Kamelia became the first Emirati to take part in the prestigious Chelsea Flower Show, an annual event on the landscaping scene held in London. It took Kamelia over 10 months to plan and work on the garden, with many trips to nurseries in Spain and Holland, and meetings in the UK.

When the show opened, her “Beauty of Islam” garden was honoured with the Silver Gilt Award and was much talked about in the press for mixing horticulture, poetry, scents and calligraphy to offer visitors a glimpse into Islamic and Arabic culture.

Back at home, the United Arab Emirates are increasingly focusing on the importance of greenery. The Dubai Municipality Outdoor Design Build & Supply show was established in 2013 to allow landscaping-related companies to show their work. The capital Abu Dhabi is introducing the International Flower and Garden Exhibition in December 2015, a fair meant to showcase the latest science and artistry of today's gardening.

“My personal inspiration is His Highness Sheikh **Zayed Bin Sultan Al Nahyan**,” Kamelia says of the founder and former president of the UAE. “He understood the importance of protecting our environment and that it was key to sustaining our community and to the growth of the country.”

More and more public spaces and recreational parks have been opened all over the UAE. The Dubai Miracle Garden has drawn scores of fans thanks to its quirky floral presentations, while Abu Dhabi has long been home to several parks and is often called the greenest Emirate, owing to Sheikh Zayed's initiatives.

Away from the shared public spaces, however, the scene is slightly different, because recycling is still very new to families in the Emirates, but Kamelia believes there can be progress with public awareness work.

Her personal wish is to leave behind a green legacy and to make people happy through her design. She is successfully trudging that path, but her best nurturing is saved for her two-year-old son. No matter the magazine covers, honours at the Chelsea Flower Show and the media attention, in the end it's about family.

“The Silver Gilt Award is my greatest personal achievement to date, other than my beautiful son.” ●

AHEAD OF THE CURVE

2011 The Bit Viking oil tanker is converted to LNG from heavy fuel oil in the first installation of Wärtsilä's LNGPac system.

2012 Wärtsilä buys the UK-based engineering company Hamworthy for GBP 383 million, enabling Wärtsilä to supply shipowners with a complete LNG system for the first time.

2006 Wärtsilä's first on-board LNG liquefaction systems are installed on tankers used to serve the Qatargas 2 project bringing gas from Qatar to the UK.

2004 The first dual-fuel electric LNG carrier, the Gaz de France Energy, leaves France's Chantiers de l'Atlantique shipyard. Four six-cylinder Wärtsilä 50DF dual-fuel engines, with a combined capacity of 22.8 MW, power the ship. In total, Wärtsilä sells 28 Wärtsilä 50DF dual-fuel engines in 2004.

2003 Then Hamworthy KSE, now owned by Wärtsilä, delivers Europe's first freestanding LNG liquefaction plant, Snurrevarden LNG, for the Norwegian LNG pioneer Gasnor, which aimed to deliver LNG to industrial customers by road.

2003 Viking Energy, the world's first LNG-powered offshore supply vessel, is launched from Norway's Kleven Verft shipyard.

2001 Petrojarl 1, an FPSO, takes delivery of the first marine 32DF engines. Norwegian oil services company PGS Production wanted to use gas for power production on the vessel to help meet Norwegian directives on CO₂ and sulphur emissions.

1996 Wärtsilä releases the 32DF. As unreliable gas supply was deterring potential customers from ordering its gas engines, Wärtsilä developed the 32DF dual-fuel engine. It installed the first at Southampton Geothermal in the UK in 1997.

WÄRTSILÄ CONVERTED TO LNG LONG BEFORE IT BECAME TRENDY,
WITH DECADES OF CUTTING-EDGE TECHNOLOGICAL DEVELOPMENTS
SPURRED ON BY THE CERTAINTY THAT GAS REPRESENTED THE FUTURE.

2016 Wärtsilä unveils a new LNG refuelling barge and tug concept, designed initially to take LNG from Rotterdam to refuel cruise ships and cold ironing power barges in Hamburg. Going forward, it will allow access to LNG for smaller and more isolated consumers, unlocking LNG's potential further.

2015 The Belgian dredging company DEMA commissions the world's first LNG dual-fuel dredger, Scheldt River.

2014 Wärtsilä wins the contract to build its first LNG receiving terminal in Tornio, northern Finland. The terminal, ordered by Manga LNG Oy, is expected to be completed by 2018.

2013 Viking Grace, the world's first large passenger ferry fuelled by LNG, is launched from Finland's Turku shipyard. The ferry, powered by four Wärtsilä 8L50DF engines, emits 15% less greenhouse gases than conventionally fuelled ferries.

2014 The Finnish Transport Agency commissions the world's first LNG-powered icebreaker. The vessel type's highly variable load represents one of the most demanding possible applications for an engine.

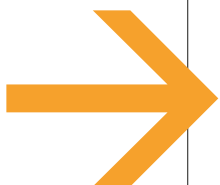
1972 The LNG carrier MV Venator is fitted with a Wärtsilä (Sulzer) 7RNMD90 low-speed dual-fuel marine engine running on low-pressure boil-off gas. The successful installation was ahead of its time; the market for LNG had not yet matured.

TEXT: ISABELLE KLIGER PHOTO: WÄRTSILÄ

[SOLUTION]

LNG NETWORK EXPANDS AROUND THE WORLD

The continued expansion of the global LNG terminal network will ensure access to this key energy source in the years to come.



“WHEN OUR TERMINAL OPENS
IN EARLY 2018 IT WILL MARK
THE FIRST TIME THAT LNG IS
REALLY AVAILABLE IN THIS
PART OF THE WORLD.”

The long-term outlook for the global LNG market is bright. While the current low price of oil may have slowed the boom of previous years somewhat, one of the key conclusions from the recent COP21 climate change conference is that there is an urgent need to shift away from oil and coal towards the cleaner option of gas.

The current LNG market is being limited by supply constraints. A key prerequisite for the market to continue to grow in the way that policymakers demand and expect is ensuring access and availability – which translates as the need to transport the LNG from the source and store it near the users, as well as providing liquefaction, regasification, and distribution. While many users, operators and energy providers may be willing to transition to this cleaner alternative, an absence of supply has proven a major stumbling block up to now.

CHANGE IS COMING

However, change is already under way. In late 2013, the global LNG fleet stood at 357 vessels, with another 108 carriers already in the order books. Going forward, analysts predict that less money will be invested in LNG carriers, while more expenditure will be attributed to terminal projects to provide storage and distribution of LNG. As one of the leading companies in the LNG terminal market, Wärtsilä has an important part to play in this process.

“Wärtsilä is one of the companies in the world with the capacity and expertise to take on full-scale, LNG terminal projects, providing turnkey solutions that include all the Engineering, Procurement and Construction (EPC) work,” comments **Timo Mahlanen**, Senior Business Development Manager, Wärtsilä Energy Solutions.

Mahlanen goes on to explain that, while most of the required large-scale LNG terminals are already in place in countries such as China, Japan, India and South Korea, there is a huge need for small and medium-sized terminals all around the world, and especially in Europe.

THE LARGEST LNG TERMINAL IN THE NORDIC REGION

Wärtsilä is currently building one of these terminals in Tornio, Finland. The terminal, which is on schedule to be up and running in early 2018, will be the largest of its kind

in the Nordic region. Providing a complete range of LNG services, including storage in a 50,000 m³ tank, regasification, pipeline distribution, ship bunkering, transshipment and loading for redistribution, the Tornio terminal will supply LNG to customers in the Finnish and Swedish mining, steelmaking and shipping industries.

The contract to develop the terminal was awarded to Wärtsilä by ManGa LNG Oy, a Finnish consortium consisting of steel producers Outokumpu and SSAB, energy company EPV and Skangass, a gas delivery company.

Since the contract was awarded to Wärtsilä in early 2014, work on the Tornio terminal has continued apace.

ON SCHEDULE AND ACCORDING TO PLAN

“We’re on schedule and everything is progressing according to plan,” confirms Mahlanen. “The civil construction of the LNG tank was finalised before the onset of winter, and we will continue the installation activities when spring arrives.”

Mika Kolehmainen, CEO of ManGa LNG Oy, confirms that he is very satisfied with the progress of the Tornio installation.

“This project will make LNG and natural gas available as a new, sustainable energy solution, in our market area in the North of Finland and Northern Sweden,” he comments. “LNG will replace other energy sources, such as propane, thereby reducing costs and emissions. Our industrial shareholders, Outokumpu, SSAB and EPV will utilise LNG as a fuel source in their manufacturing process and for energy production, while Skangass will supply LNG to other consumers in the region.”

“We foresee considerable opportunities for LNG in this region,” he continues. “When our terminal opens in early 2018 it will mark the first time that LNG is really available in this part of the world. We look forward to delivering a new, alternative fuel source to a variety of end users who will be able to use it for energy and heat production, as well as transport.”

GROWTH OF SMALL AND MEDIUM-SIZED TERMINALS

According to Timo Mahlanen, small and medium-sized terminals are expected to expand rapidly over the coming years.



The terminal in Tornio, Finland, which is on schedule to be up and running in early 2018, will be the largest of its kind in the Nordic region.



“MOBILE LNG HAS
BEEN DEVELOPED FOR
SPECIFIC, CHALLENGING
LOCATIONS WHERE
PIPELINES AND
TERMINALS ARE NOT
FEASIBLE.”

“Medium-sized terminals, like the one in Tornio, supply LNG to a geographic region, while small terminals typically supply one user – such as a power plant or factory. These small terminals will typically consist of a tank with the capacity to store several hundred cubic metres of LNG and a regasification unit,” he explains.

One of such example is the ssAB Raahe terminal, to which LNG will be transported by truck from the Manga LNG Tornio terminal, and used in a steel factory and a power plant, as well as for ship bunkering.

WÄRTSILÄ MOBILE LNG

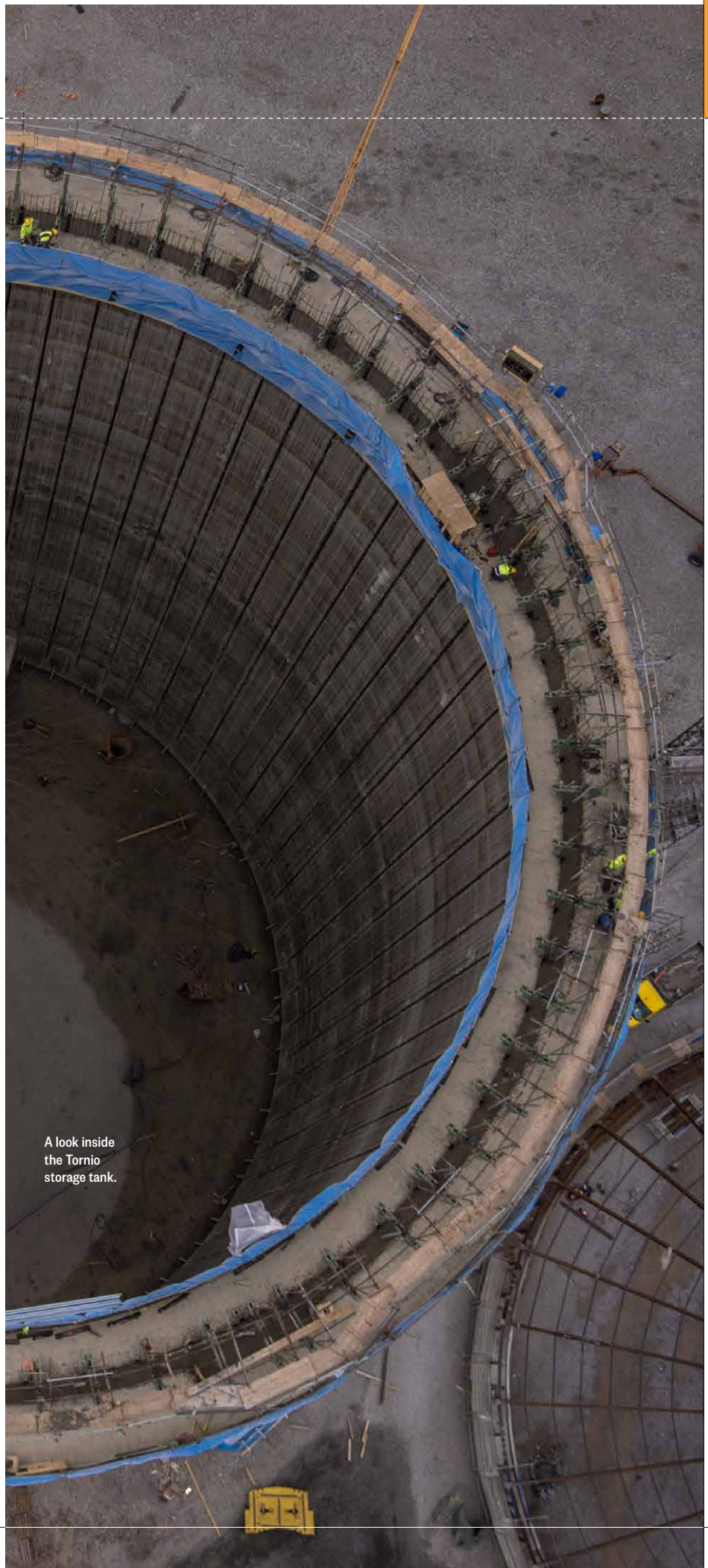
But what options are available in geographies in which building an LNG terminal is not possible? One alternative is an LNG barge, or mobile LNG unit – a new technology that was introduced by Wärtsilä last autumn.

“The Wärtsilä Mobile LNG has been developed for specific, challenging locations where pipelines and terminals are not feasible,” says Mahlanen.


The Wärtsilä Mobile LNG solution, which will be available in sizes of up to 30,000 m³, will make LNG available to new consumer segments, benefitting both utilities and end users. Further, the flexibility of location will enable it to bring clean energy to areas that have only limited or no access to the national electricity grid.

THE FUTURE REMAINS BRIGHT

Although 2016 is expected to be a comparatively slow year, analysts continue to predict a bright future for LNG investments. According to leading energy research group Douglas-Westwood, total spending on LNG facilities is expected to reach USD 241 billion between 2016 and 2020, representing a 34% increase compared with the preceding five-year period. ●



A look inside
the Tornio
storage tank.



NUTS AND BOLTS
WE CAN HELP YOU STORE
GAS NEXT TO THE RIG
page 62

page 66
LNG FERRIES ARE HERE TO STAY
WÄRTSILÄ BELIEVES THAT LNG IS
THE FUTURE OF SHIPPING.

■ **Twentyfour7.**

in detail

59

1 + 1 = WIN-WIN

► TEXT: ANNA AISTRICH ILLUSTRATION: WÄRTSILÄ

IF YOUR AREA DOESN'T USE a large enough volume of LNG to warrant a large terminal, how can you still get in on the LNG action and enable others to take advantage of the flexibility and lower emissions it offers? In many cases, it can be as easy as 1+1.

LNG ALLOWS FOR MORE DIVERSITY AND SECURITY IN THE LOCAL ENERGY MIX, AND ITS PRICE RELATIVE TO ENERGY CONTENT IS FAVOURABLE WHEN COMPARED WITH OTHER FOSSIL FUELS.

LNG will play an important role helping to fuel the expected global gas demand growth. The relatively large investment costs required for LNG projects means that, to date, the majority of receiving terminals have been large in size and capacity. But few locations are well suited to such big terminals. So how is this expansion of the LNG network going to be possible or economically feasible?

According to **Kari Punnonen**, Wärtsilä's Area Business Development Manager, Oil and Gas Business, Middle East, Asia and Australia, there is a lot of growth potential "in places where the gas infrastructure is underdeveloped but where there is large demand for gas-fired power generation and natural gas for other industrial uses." These kinds of locations could host a regional storage hub that provides gas directly to consumers, small-scale marine distribution vessels or LNG tanker trucks that can deliver LNG directly to the end user.

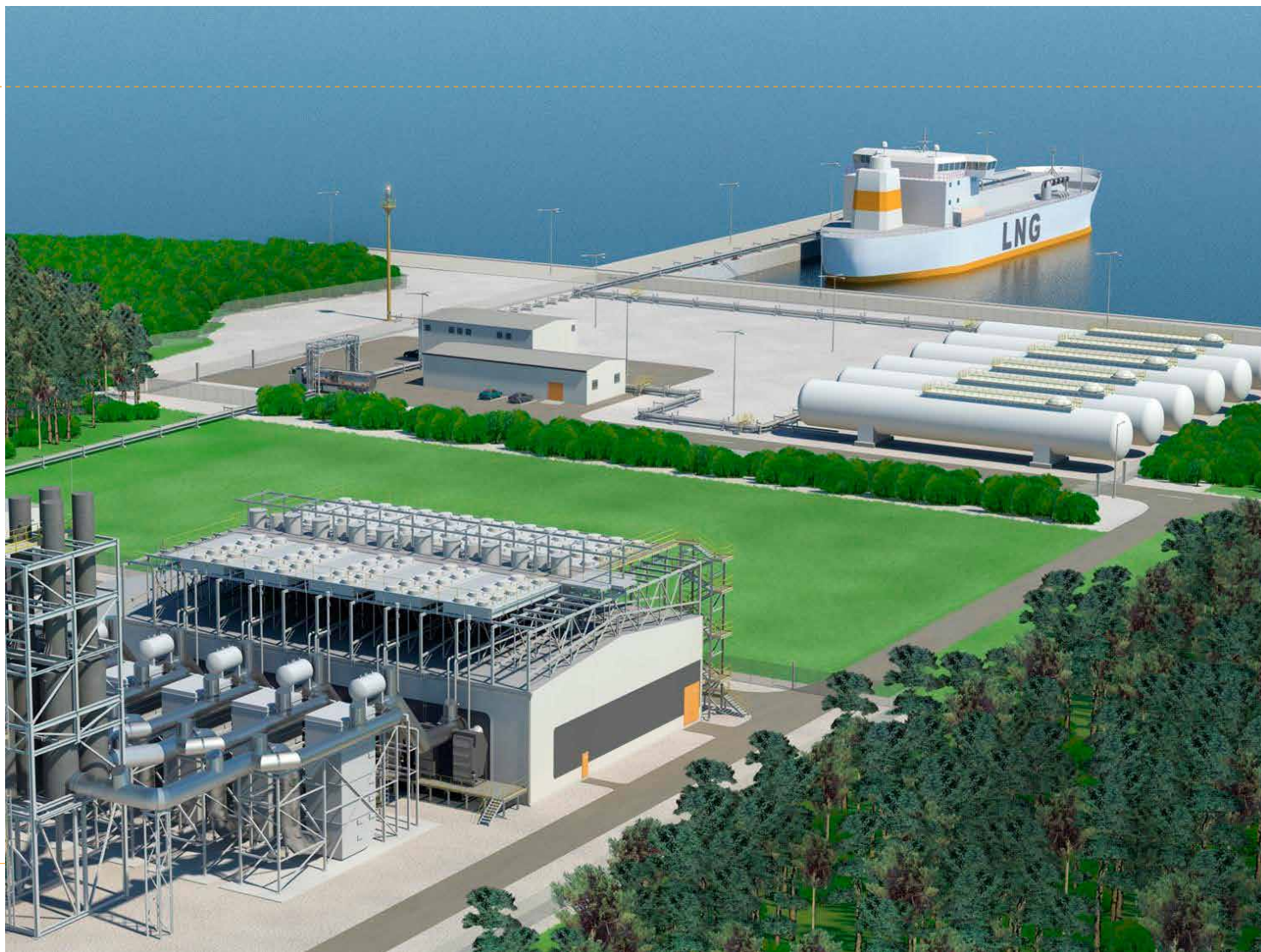
The increasing demand for small and medium-sized LNG receiving and regasification terminals has led to consideration of whether a "single purpose" LNG receiving terminal would be a feasible and realistic addition to the local energy mix. One possible configuration of such a Single Purpose Terminal

(SPT) is to pair it with a gas power plant, a so-called 1+1 LNG solution.

To test the logistical and financial considerations of this concept, Punnonen has studied the feasibility of pairing three different sizes of LNG-fired power plants, running on simple-cycle, high-efficiency internal combustion gas engines, with various LNG terminal capacities. Each of the power plant options, 50 MWe, 100 MWe and 300 MWe, was evaluated both as a stand-alone gas consumer and linked to additional off-takers with a gas demand similar to that of the power plant itself.

GIVEN HIS TERRITORY OF RESPONSIBILITY, Punnonen considered a scenario with Indonesia in mind. To determine the daily LNG volume required by the power plant, he factored in the engine output and fuel consumption under tropical ambient conditions and included a lifetime average degradation of the efficiency between maintenance intervals.

The proposed SPT's storage tank size was then optimised according to the expected fuel consumption, the location of the LNG distribution hub and the tanker vessel size, factoring in tank minimum reserve and a seven-day emergency reserve in case of



any unplanned interruption in LNG supply. The tank's structure and technical specifications depended on the required capacity and the gas distribution pressure. For example, gas may be supplied at low pressure (8 bar) as fuel to the power plant or at high pressure (for example 50 bar) to pipeline off-takers.

Once these parameters were established, Punnonen simulated possible electricity sales prices, taking into account the fuel costs for the three sizes of power plants, both as standalone gas consumers and with additional gas off-takers, and certain investment and operating costs. The feasibility calculation includes the terminal investment over 20 to 25 years to see how much the cost of the terminal increases both the gas price and produced electricity price.

The fuel gas price also varies depending on the total gas volumes consumed. Additional off-takers in the system bring down the cost per MMBtu and are therefore important to the economics of the project. Punnonen notes that even a "satellite concept" of several small power plants in the area that draw from the same LNG terminal is a feasible way to increase gas consumption. In that case, smaller LNG carriers can do a "milk run" to fill tanks at each smaller power plant.

SO DO THE ECONOMICS add up for LNG-based small and mid-sized power generation? Punnonen believes that, even at its highest, the "terminal effect" (of factoring in the cost of the investment, operations and maintenance for the terminal) only increases the power tariff by about 15 to 20%. In places where need and demand are high, the 1+1 solution is a viable one. And although the terminal economics are case-specific, there are several benefits that such projects can expect regardless of their size.

LNG allows for more diversity and security in the local energy mix, and its price relative to energy content is favourable when compared with other fossil fuels. Perhaps most importantly to the local population, LNG significantly reduces SO_x , NO_x and CO_2 emissions when replacing coal or oil for power generation.

"This combined 1+1 LNG solution, including the power plant and LNG terminal, is unique and differentiates us from competitors," Punnonen says. "When doing this development type of work, it's an advantage when we can do the full package – both in the ease of logistics, which includes the ability to bring in a variety of Wärtsilä equipment, and from a financial investment perspective." ●

THE NUTS AND BOLTS

► **TEXT:** KENNETH ENGBLOM AND CAMPBELL BLACK **PHOTO:** DRAGON LNG LIMITED

WE CAN HELP you store gas next to the rig, outfit carriers to bring it ashore, supply regasification units or build terminals of any size on land. And our preferred boil-off gas solution is to... well, use it for on-site electricity generation, because as you know, we build power plants, too.

There comes a point in any relationship when partners decide to go to Ikea. The allure of the flat-pack, however, quickly dies once too many have too many opinions on how to assemble the purchase. The easiest way is to let one person – preferably the more experienced one – be in charge of the nuts and bolts.

Wärtsilä is that one person when it comes to LNG (liquefied natural gas), which, because the liquefaction process reduces gas to 1/600 of its normal volume, is the energy equivalent of flat-pack furniture. That reduction makes it easy to ship large amounts of energy to consumers – affordably and quickly. There's another simile, however, because Wärtsilä offers all the nuts and bolts, with products and experiences that span the length of the LNG value chain.

With our expertise from both Marine Solutions and Energy Solutions, we not only help bring gas to land, but also can help put it to use. The majority of new plants being built today will run on gas, and when we occasionally do get an HFO (heavy fuel oil) plant order we make sure it can easily be converted to gas. The energy industry is trying to shift to gas, but the challenge is one of availability. We want to help change that.

To facilitate the transition, Wärtsilä has developed an extensive LNG product portfolio and know-how, including energy-efficient solutions for liquefaction and regasification.

HOW TO MAKE IT?

Finding the right liquefaction process is the first step. For smaller plants, we deliver mixed refrigerant (MR) liquefaction as a prefabricated module – standardisation lowers the investment cost and speeds up manufacture. This option suits biogas, pipeline gas, CBM and associated gas. In 2014, Oslo's biogas liquefaction plant became the first to put this technology to use.

For the larger sizes (>50 tonnes/day), a liquefaction system with double expanders based on the Reverse Brayton Cycle process is both robust and reliable. Today, more than 40 LNG carriers use the process, which has been finetuned to lower electricity consumption.

HOW TO STORE IT?

The insulated storage tanks will be a terminal's most expensive investment and thus one that needs to be fail-proof. A flat-bottom tank can store 5,000 to 200,000 m³, but is produced on-site and thus takes longer to install than the smaller, prefabricated bullet tanks that can hold 250 to 1,500 m³ each. While smaller, adding capacity is as easy as lining up your bullet tanks in a row.

HOW TO RELIEVE THE PRESSURE?

At minus -162°C, LNG reacts with the much warmer ambient environment. The resulting boil-off gas (BOG) adds pressure inside the tank, which needs to

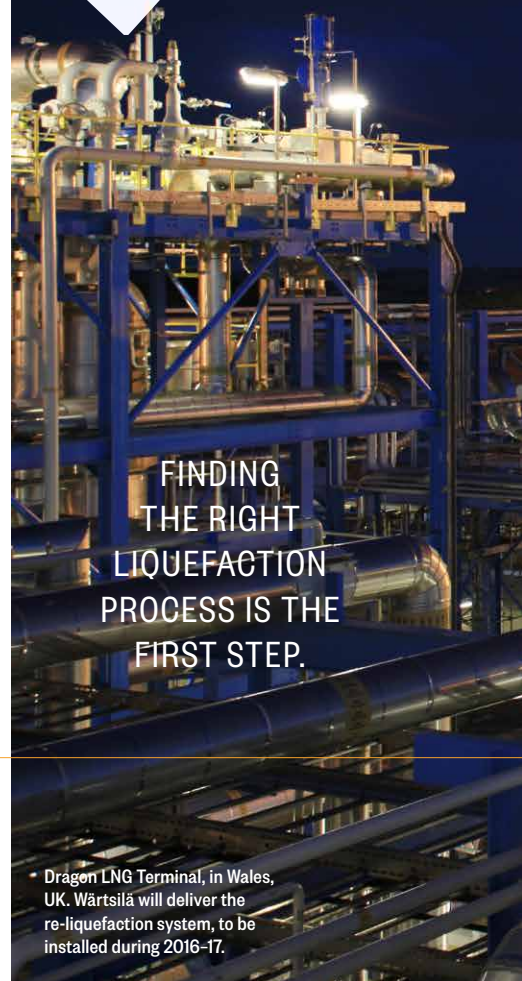
be handled carefully. You can't simply let it out, as it's a greenhouse gas, so the simplest way is to burn or flare it. Yet that just wastes expensive gas.

One option, with a BOG recompressor, is to recool it and add it back to the tank through a vapour return line. Another option comes in the shape of a BOG compressor that pumps the gas either directly to an adjacent power plant or into a pipeline.

Wärtsilä, which has modularised its BOG handling systems, recommends that a terminal be built near gas consumers, who can use the BOG straight away, or that a gas-fuelled power plant be built to produce electricity for the terminal itself, thus closing the loop without any waste. Or sell the electricity to a third party

HOW TO MAKE IT INTO GAS AGAIN?

The clue's in the name: regasification. All the energy that was extracted from the gas to make it liquid in the first place has to be returned to it through a



FINDING
THE RIGHT
LIQUEFACTION
PROCESS IS THE
FIRST STEP.

• Drogen LNG Terminal, in Wales, UK. Wärtsilä will deliver the re-liquefaction system, to be installed during 2016-17.



vaporiser, which is essentially a large heat exchanger. The options are open rack vaporisers (ORV) based on seawater heating, submerged combustion vaporisers (SCV) based on fuel heating, ambient air vaporisers (AAV) based on ambient air heating, or intermediate fluid vaporisers (IFV).

For FSRUS and on-shore regasification terminals, many companies use only seawater to provide heat, but ice can clog the heat exchangers. Instead, Wärtsilä uses propane and seawater in a cascade loop to warm the LNG. Wärtsilä built the first pilot plant based on this technology in 2005.

WHO GETS TO ASSEMBLE THE FLAT-PACK?

Just as an Ikea chair is only as strong as the bolt your partner forgot to use when you weren't looking, a total system is only as good as its weakest link. Wärtsilä's core competence is the design of a total system, for which the company can take full engineering, procurement and construction (EPC) responsibility.

WHAT SIZE?

Whichever size you want, really. With 1,000 to 30,000 TPA (metric tonnes per annum) plants, the LNG is primarily intended for local consumption. Meanwhile, 20,000 to 300,000 TPA plants are often near the shore, at the end of a pipeline, in order to supply large LNG tankers.

A mid/large scale LNG liquefaction and export terminal, with more than 300,000 TPA capacity, serves the same purpose of supplying tankers. For these mega projects, Wärtsilä usually steps in as a supplier, offering the power plant, reliquefaction units and the liquefaction process.

WHAT ABOUT RECEIVING LNG?

Wärtsilä's product portfolio for LNG receiving terminals includes, in brief, satellite stations for gas power plants, satellite and bunkering stations, storage and regasification barges, small- to medium-scale terminals (read about the Manga Tornio LNG terminal in

Finland on page 54), and large-scale terminals. Turn to page 30 to learn more about FSRUS.

WHY WÄRTSILÄ?

Through a high level of modularisation and reusing proven solutions and modules, Wärtsilä can shorten the construction time and guarantee high quality. The client can typically save 2 to 5% of the total cost and 8 to 12 months on the total project schedule by avoiding an expensive and time-consuming FEED process, which also quite often ends up with an expensive "over-design" that is more theoretical than fit-for-purpose.

AND HOW ARE SUPPORTED?

Wärtsilä currently operates 19 GW of generating capacity across marine and land-based installations. The company can now also operate and maintain LNG terminals and liquefaction plants, with O&M agreements providing long-term performance guarantees. ●



WÄRTSILÄ'S BEST-KEPT SECRET

► TEXT: ANNA AISTRICH PHOTO: WÄRTSILÄ

WHILE WÄRTSILÄ TANK CONTROL SYSTEMS (TCS) is a small part of Wärtsilä Gas Solutions, it is much mightier than many may realise. Find out where they have been hiding and why now is their time to shine.



Formerly Whesoe, what is now Wärtsilä Tank Control Systems (TCS) became an entity of Wärtsilä in 2010, after being purchased as part of the Total Automation group division in 2006. Now the three facilities that comprise TCS are part of Wärtsilä in France, the UK and Singapore. Even though they are relative newcomers to the Wärtsilä family, they are no rookies on the gas scene.

Whesoe moved into the gauging business during the 1960s from its UK base, further expanding with an office in the gateway to Europe, Calais, France. In the 1970s and 80s, its business expanded into the LNG industry. Now, with more than 40 years experience in the global LNG market, TCS currently has the greatest number of LNG installations within Wärtsilä. That's more than 450 vessels at sea and on order and a 50% market share of LNG terminals equipped with its gauges. So, although they are a relatively small, little-known business within Wärtsilä, TCS is a leader in its sector of the global market – making it perhaps Wärtsilä's best-kept secret.

SO WHAT DOES THIS LITTLE powerhouse do? According to **Chris Mais**, General Manager of Wärtsilä Tank Control Systems, Gas Solutions, "Since the early days of liquefied gas storage, TCS has been at the cutting

edge of developing technologies that increase the safety of LNG and LPG storage.

"The marine side of TCS supplies gauges to LNG and gas carriers, and the land-based business side provides storage tank gauging systems and emergency shut-off valve systems for the LNG and LPG markets," adds Mais. In other words, TCS has product offerings for many links in the LNG value chain, from the producer to the supplier, and is a dominant supplier in this growing market. To illustrate its synergy with Wärtsilä's projects, even the LNG terminal in Tornio, Finland, uses tank-gauging systems from TCS, as do additional oil and gas projects within Wärtsilä.

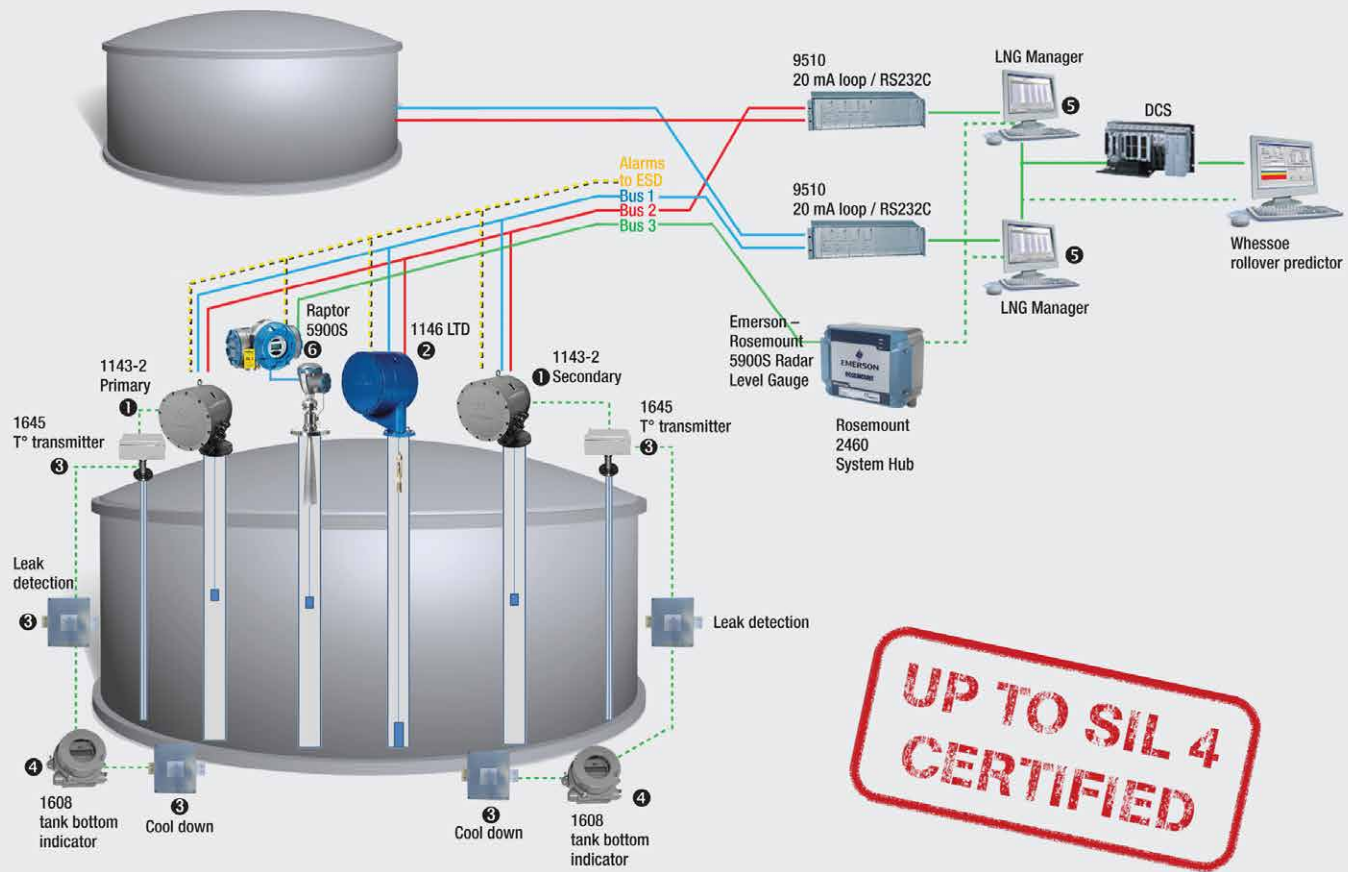
ONE OF THE SHINING stars from TCS is the Whesoe LNG Rollover Predictor software, which enables the LNG terminal operators to monitor all parameters that influence the formation and evolution of LNG stratification. Stratification can occur when storing different grades of LNG in receiving tanks or when the composition changes due to the boil-off of the lighter components of the stored LNG. If proactive measures are not taken, the stratified layers can mix very rapidly and generate a sudden release of pressure, which could damage the storage tank, or a release of gas into the atmosphere. However, by continuously

monitoring all data and forecasting a possible development of stratification, the Predictor automatically generates an alarm if any stratification seems likely to evolve into a rollover situation. This allows operators sufficient time to take corrective action, such as pumping out one layered LNG to another tank.

David Clercq, Sales and Product Manager for TCS, points out, "Of course, operators can take the same measurements, but it's impossible to predict the behaviour of the LNG without access to a prediction model like Predictor. In addition to the fact that it facilitates LNG storage tank operations by accurately displaying tank levels, layer heights, and the average density and temperature of each layer, Predictor warns the operator of a potential risk of rollover *in real time*." With this information immediately available, operators can avoid running mixing pumps continuously and/or reliquifying boil-off gas unnecessarily, thereby reducing the terminal's operational costs.

Now TCS is adapting the predictor for the FLNG (floating liquefied natural gas) market, which is still a relatively new industry surfacing because of the potential environmental, political, financial and lead-time issues related to traditional LNG terminal construction. FLNG extends the possibility to extract stranded gas reserves and to monetise it. In general, FLNG has

LNG STORAGE TANK TOTAL INSTRUMENTATION SOLUTION



WITH MORE THAN 30 YEARS
EXPERIENCE IN THE GLOBAL LNG
MARKET, TCS CURRENTLY HAS
THE GREATEST NUMBER OF LNG
INSTALLATIONS WITHIN WÄRTSILÄ.

fewer environmental or political issues, and the project gestation period and financial threshold are lower. So, by adapting the Rollover Predictor to a new market condition and combining pioneering technology for installation, TCS currently has the only product to measure gas density in real time on an FLNG vessel.

ANOTHER KEY PRODUCT OFFERING and an example of TCS's ability to design specific products for specific applications is the emergency shut-off valve for LPG underground storage caverns. It was developed in partnership with French company Geostock, an engineering company that designs and builds large underground storage caverns for liquefied gas, hydrocarbons and crude oil. The valve was adapted from an existing application to be able to close in an emergency situation, such as in case of an earthquake, and ensure that a potential release of gas into

the atmosphere is avoided.

"With the caverns excavated approximately 200 metres below ground to create the right storing conditions, monitoring the product level inside the tanks is also difficult, but TCS developed a probe for that application that makes it possible to monitor water and product levels and temperature, which are crucial for cavern safety management," says Clercq.

In short, instrumentation and safety systems from TCS ensure that all hazardous aspects related to the storage are known and controllable. For nearly any application, TCS adapts current technologies or creates new ones and then extensively tests them for endurance, accuracy and reliability in the harsh environments associated with liquid gas storage. So TCS's solutions go a long way towards helping protect personnel, the environment, the equipment and the gas itself. And that's no small job. ●

LNG FERRIES ARE HERE TO STAY

► TEXT: ISABELLE KLIGER PHOTO: WÄRTSILÄ

WÄRTSILÄ BELIEVES THAT LNG is the future of shipping. And, as concern for the environment continues to grow, while the regulatory landscape becomes ever stricter, more and more vessel operators around the world are starting to agree.

Passenger vessels represent one of the most promising opportunities for LNG shipping. Not only do these vessels typically remain near the coast – and therefore close to the all-important fuel source – they also tend to operate in Emission Control Areas (ECAs), where clean fuel is not an option but a must. *Twentyfour7* has taken a closer look at two of the world's first LNG-powered passenger vessels – Viking Line's Viking Grace and Reederei Cassen Eils GmbH's Helgoland ferry.

WORLD'S LARGEST LNG-POWERED PASSENGER FERRY

Delivered in 2013, the Viking Grace was the largest LNG-powered passenger vessel at the time. With its ground breaking dual fuel technology supplied by Wärtsilä, the vessel can operate without restrictions in SECA (Sulphur Emission Control Area) and NECA (Nitrogen Oxide (NO_x) Emission Control Area) sulphur and nitrogen monitoring areas.

Wärtsilä's scope in the project included the supply of four 8-cylinder, in-line Wärtsilä 50DF main engines, the transverse bow and stern tunnel thrusters, as well as two stainless steel fixed pitch propellers with propeller shaft lines, including environmentally sound shaft line seal systems, the LNG tanks and

fuel supply and handling equipment with safety and automation systems. Wärtsilä also supplied a sound-absorbing system to minimise noise generated by the engine, thus increasing passenger comfort. A low noise level is also of importance due to the route of the vessel, which passes through the Turku and Stockholm archipelagos.

"We've been working with Wärtsilä for many years, and most of our ferries are already fitted with their engines," says **Kari Granberg**, Manager NB Project and Technical Development, Viking Line. "However, apart from being the natural choice, Wärtsilä also presented the best proposal, from the point of view of both of technology and cost – so it was an easy decision to make."

In 2007, when Viking Line first started looking into building a sustainable new vessel, choosing the right fuel was not as straightforward as it might seem.

SECURING LNG SUPPLY

"We didn't like the idea of using Heavy Fuel Oil (HFO) with a scrubber for environmental reasons, while marine gas oil was too expensive. LNG was an option but, at the time, there was no supply of LNG in the Baltic Sea – so we were in a bit of a tight spot," continues Granberg.

Viking Grace uses only 16,000 tonnes of LNG per annum compared to the 24,500 tonnes of HFO consumed by the smaller diesel vessels.

WÄRTSILÄ ALSO SUPPLIED A SOUND-ABSORBING SYSTEM TO MINIMISE NOISE GENERATED BY THE ENGINE, THUS INCREASING PASSENGER COMFORT.



100 BC

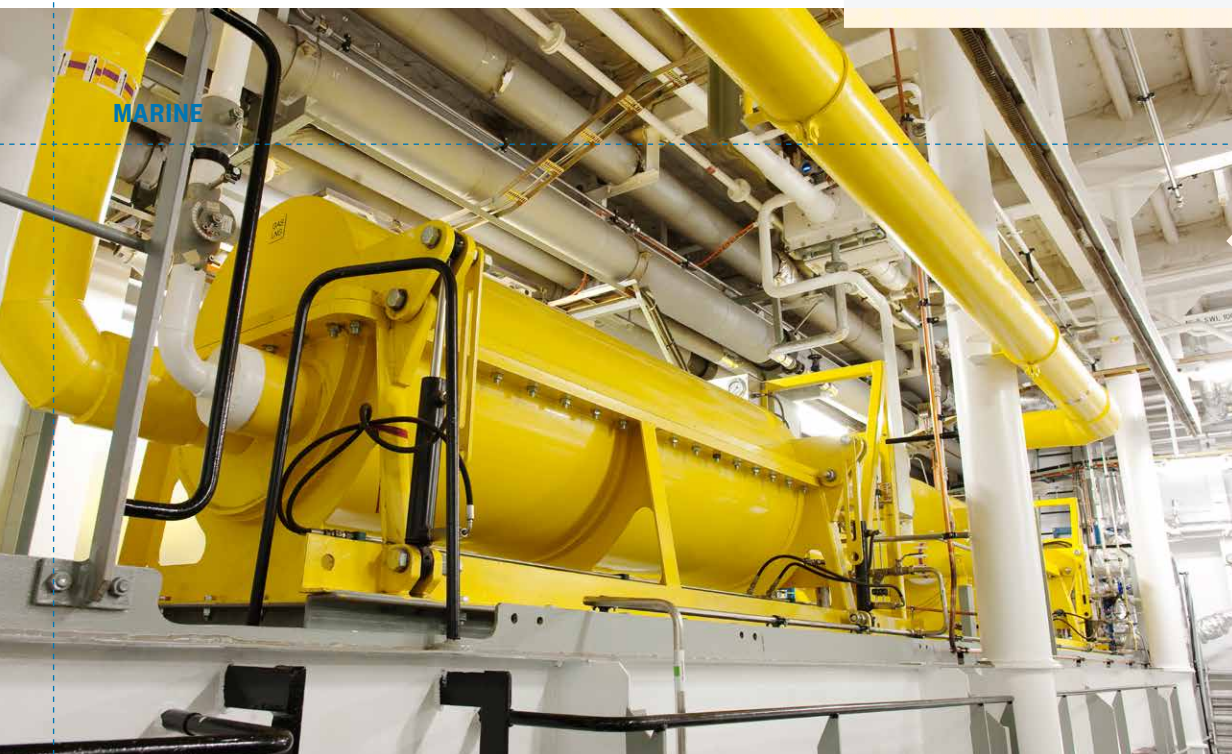
Canadian operator BC Ferries is in the process of building the second in a series of three new Ropax ferries at the Remontowa shipyard in Poland. As more and more ferry operators are opting for gas, this build hardly seems novel. However, one of the three 8-cylinder Wärtsilä 20DF engines destined for installation on this ferry will be the 100th Wärtsilä 20DF dual-fuel engine built, just 4.5 years after the first one was shipped from the factory.

"Once again, the advantages of Wärtsilä's dual-fuel technology, and the fuel flexibility and environmental benefits delivered by this technology, have been emphasised with this milestone 100th delivery. The Wärtsilä 20DF shows that these benefits are as important for auxiliary applications, such as generating sets, as they are for main engine applications,"

says **Stefan Wiik**, Vice President, Engines, Wärtsilä Marine Solutions.

The 100th Wärtsilä 20DF engine is to undergo its Factory Acceptance Test (FAT) within the coming weeks with representatives from BC Ferries in attendance.

"We congratulate Wärtsilä on this milestone delivery. We take our responsibilities for environmental compliance very seriously, which is why these additions to our ferry fleet will operate primarily on liquefied natural gas. The Wärtsilä dual-fuel technology is highly advanced and well proven, and we are confident that the Wärtsilä 20DF engines are the right choice for this application," says **Mark Wilson**, Vice President, Engineering, British Columbia Ferry Services Inc.



Gas Valve Unit of
Viking Grace.

The choice of LNG was facilitated when Viking Line's gas supplier AGA decided to build an LNG terminal in Nynäshamn, south of Stockholm. This terminal has been the exclusive provider of LNG to the Viking Grace since it was delivered in 2013.

Three years into its service life, the Viking Grace is approaching 24,000 running hours, and Granberg confirms that he is extremely satisfied with its performance for a number of key reasons.

LNG IS SUSTAINABLE AND EFFICIENT

"The first and most obvious reason is the environment benefit," he explains. "Running on LNG enables us to reduce greenhouse gas emissions by more than 15%, NO_x emissions by 92% and particle emissions by 84%. Meanwhile, sulphur emissions are close to zero."

There are also efficiency gains to be made from an LNG engine. Despite being 60% larger than the average Viking Line vessel, the Viking Grace uses only 16,000 tonnes of LNG per annum compared with the 24,500 tonnes of HFO consumed by the smaller diesel vessels. What is more, the Viking Grace also requires significantly less maintenance. While maintenance is typically done on an HFO engine after 16,000 to 18,000 operating hours, Wärtsilä's dual-fuel engines require maintenance after 24,000 hours.

The Viking Grace is covered by a five-year maintenance agreement with Wärtsilä. As part of this agreement, Wärtsilä provides a broad range of services for the vessel, including engine maintenance planning, maintenance work, condition monitoring, spare parts supply, technical support and workshop services. The objective is to extend service intervals, while improving the logistics for spare part deliveries, and ensuring optimal operating efficiency and fuel consumption, thereby reducing costs.

Granberg also explains that the engine room on an LNG-powered vessel is cleaner than a conventional engine room. It requires less day-to-day maintenance

and, as a result, fewer crewmembers are needed. In addition, the Viking Grace consumes only 18% of the amount of chemicals and 20% of the lubricant of Viking Line's other vessels.

"If we were building a new vessel today, we would definitely go with LNG again," confirms Granberg.

FIRST LNG-FUELLED GERMAN FERRY

An even more recent addition to the LNG ferry fleet is Cassen Eils' Helgoland ferry, the first-ever newbuild LNG-fuelled German seagoing vessel. Powered by a complete Wärtsilä LNG propulsion solution, the ship completed its maiden voyage on 11 December 2015. Operating between Cuxhaven and the island of Helgoland, the ferry's route takes it close to the UNESCO World Heritage-listed Wadden Sea National Park, an ecologically sensitive area in the southeastern part of the North Sea. In order to minimise exhaust gas emissions, the Helgoland ferry operates primarily on LNG using two 9-cylinder Wärtsilä 20DF medium-speed dual-fuel engines.

"We are very proud to be operating the first new-build German vessel fuelled by LNG," comments Dr. **Bernhard Brons**, Managing Director of Reederei Cassen Eils GmbH and CEO of AG EMS. "Compared with conventional diesel fuel, this ship will produce 20% less CO₂, 90% less NO_x, and almost zero SO_x and particulates. Thanks to Wärtsilä's dual-fuel technology with built-in redundancy, the vessel can operate efficiently and without restrictions in the Wadden Sea National Park. Furthermore, it was very important for us to select a reliable and experienced partner who was able to deliver a complete propulsion package."

Wärtsilä has also retrofitted AG Ems' Ostfriesland with two gas-powered, dual-fuel, 6-cylinder in-line Wärtsilä 20DF engines. The MS Ostfriesland, which re-entered service after conversion in the spring of 2015, also operates close to the Wadden Sea.

**"IF WE WERE BUILDING
A NEW VESSEL TODAY,
WE WOULD DEFINITELY
GO WITH LNG AGAIN."**

"The owners of Cassen Eils went for LNG because they wanted the cleanest and first zero-emission ship in this area. It was also important for them to find an experienced partner with a strong understanding of the short sea passenger shipping business," says **Matthias Becker**, General Manager Marine Solutions, Wärtsilä Germany.

LNG IS THE FUTURE - IN SPITE OF CHEAP OIL

"In my opinion, LNG is the shipping fuel of the future," continues Viking Line's Granberg, adding that he maintains this opinion in spite of the low cost of oil at the present time.

"If you take a short-term view and base your decision on the current oil price, the alternative would be to use HFO with a scrubber. While this option cuts sulphur emissions, it doesn't have any of the other environmental benefits of LNG," he says.

"I think it's highly unlikely that oil will remain at its current price for very long. Taking a more long-term view, I'm convinced that LNG will, once again, be the most sustainable AND cost-effective option on the market," concludes Granberg. ●

The “Little Red Dot” that runs on gas

Most Asian and world maps depict the city-state of Singapore as a little red dot. So that became the endearing nickname that Singaporeans use to refer to their small, yet successful, nation. The red dot also emerged as the key element in the SG50 logo, which was developed for the celebration of Singapore's 50th anniversary in 2015.

Despite its physical limitations, Singapore is a busy metropolis. Like many cities, it has been looking to move away from petroleum products and toward cleaner energy sources to keep up with electricity demand in a more sustainable way. So Singapore opted to switch to using natural gas, which in the past decade expanded from 74.4% in 2005 to 95.5% of Singapore's fuel mix, according to the latest statistics from the Energy Market Authority (EMA). Singapore aims to stabilise and limit its yearly greenhouse gas emissions to about 65 million tonnes by 2030, even if the economy continues to grow.



Sign off

AT YOUR SERVICE | CLASSIC | CULTURE WATCH | WÄRTSILÄ STORY | LITTLE ENGINEER | EVENTS

WE REALISED THAT WE
NEEDED TO ADAPT TO
THE SPECIFIC NEEDS
OF EACH CUSTOMER
INDIVIDUALLY.

[AT YOUR SERVICE]

LNG through and through

EVER SINCE MATHIAS JANSSON wrote his master's thesis for Wärtsilä, he has been thinking about how to use LNG. In his early years at Wärtsilä, he had the opportunity to experience and learn about the whole spectrum of tasks from development, sourcing and engineering to delivery for the first LNG fuel conversion project of the Bit Viking for Tarbit Shipping. Now, as General Manager, Innovation and Product Support, Fuel Gas Handling for Marine Solutions, he focuses more on new developments and on supporting engineering, sales and deliveries. Along the way, he has evolved into one of the best LNG spokespeople Wärtsilä has to offer.

1 WHAT HAVE YOU FOUND MOST INTERESTING/SURPRISING ABOUT THE RISE IN POPULARITY OF LNG?

Originally, LNG was used only for small ferries and offshore supply vessels and was very regional, mostly in Norway. So it is surprising that so many vessel segments have adapted so quickly, within the last couple of years, to using

LNG – first in Europe and North America, then in the Middle East and Asia. Today it's used for a wide variety of ship types: cruise ships, tugs, dredgers and semi-submersible crane vessels.

2 HOW IS WÄRTSILÄ MAKING LNG MORE ACCESSIBLE OR A MORE REALISTIC OPTION FOR POTENTIAL NEW CUSTOMERS?

We first started out believing we could sell something standardised to everyone, but soon we realised that we needed to adapt to the specific needs of each customer individually. So now we make LNG accessible by creating tailor-made LNG solutions, not just a particular component. For example, we have the flexibility to look at different types of tanks and materials that are ideal for each application. We also can integrate other Wärtsilä equipment, such as the Gas Valve Unit and an LNG pump like the ECA fuel pump, which was designed for cargo but also works for fuel use. So we create a good package, all with the benefit of the Wärtsilä

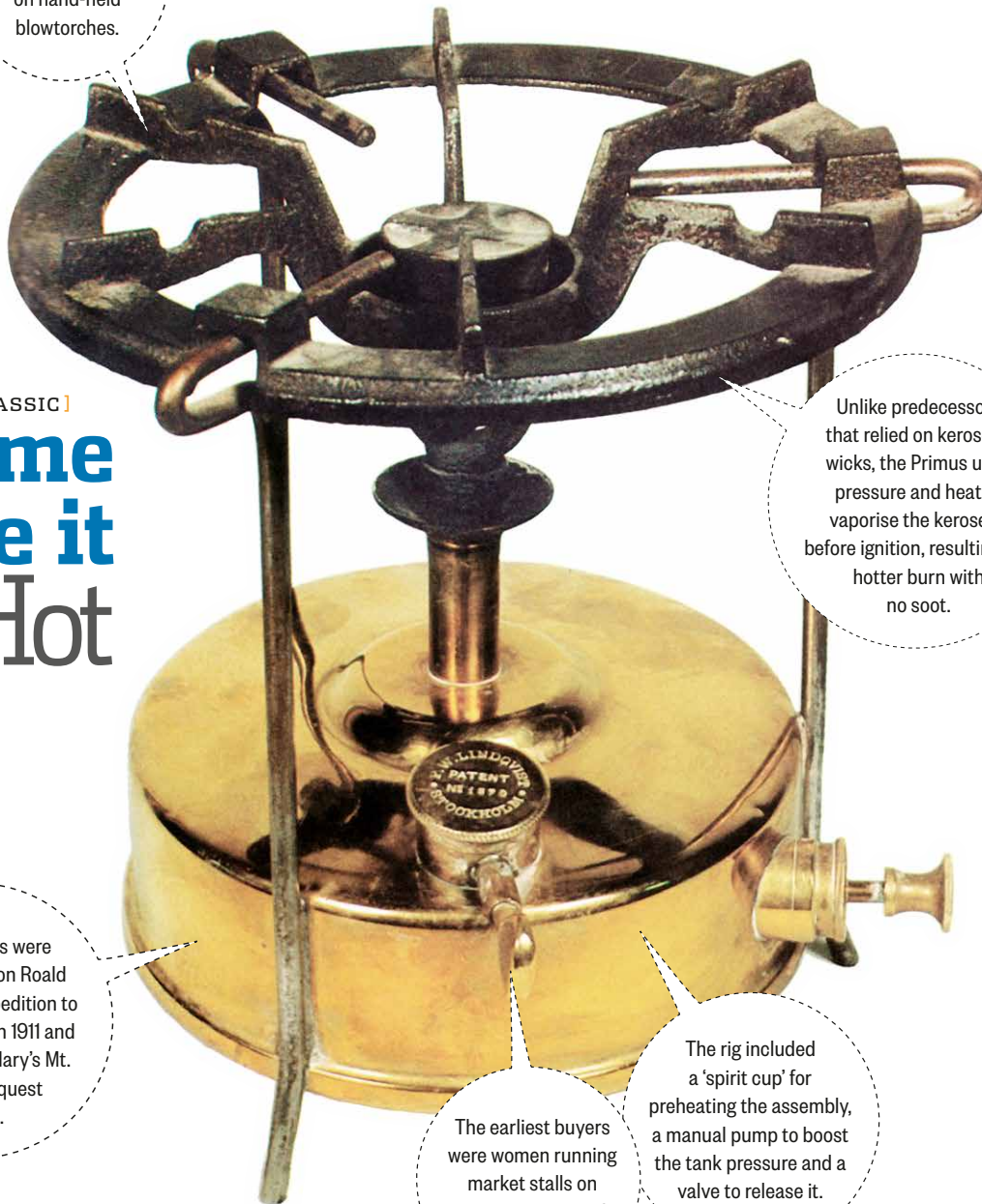
name to back the products, and then add complementary maintenance and services.

3 WHAT KIND OF INNOVATIONS DO YOU FORESEE IN THE WORLD OF LNG?

It's exciting to be part of the shift from diesel oil to alternative solutions, including gas, exhaust gas after treatment and hybrids, because it brings a mix of opportunities. We are making history in this big conversion so it's not a mature market in terms of technology. Because there's no established "right way" to do things, we are working continually on new concepts. For instance, we're considering many possible options for new fuel tank types, designs and insulation materials. In terms of operations, we are interested in making systems inherently safe from any human error and in keeping equipment in good, reliable shape. Developments on the data and digitalisation front will allow us to add further value to our physical products and make them even easier for customers to adopt and use in their specific applications.

The original Primus concept was based on hand-held blowtorches.

[CLASSIC] Some like it Hot



Unlike predecessors that relied on kerosene wicks, the Primus used pressure and heat to vaporise the kerosene before ignition, resulting in a hotter burn with no soot.

Primus stoves were essential gear on Roald Amundsen's expedition to the South Pole in 1911 and Tenzing and Hillary's Mt. Everest conquest of 1953.

The earliest buyers were women running market stalls on the cold streets of Stockholm.

The rig included a 'spirit cup' for preheating the assembly, a manual pump to boost the tank pressure and a valve to release it.

ORIGIN

Next time you're off on a camping trip, raise a steaming cup of Java in salute of Swedish inventor **Frans Wilhelm Lindqvist**. In 1892 he created the Primus No. 1, the world's first portable and soot-free kerosene stove. Generations of outdoorsy types have since lauded Primus stoves for their efficiency and rugged simplicity. Updated versions, sold in 70 countries, now light the fires under everything from rock festival curry to rabbit stew.

TECHS & SPECS

Developers

Frans Wilhelm Lindqvist, Johan Viktor Svenson

Dimensions

Height: ~ 22 cm
Diameter: ~ 17cm
Weight: ~ 1.1 kilos

Material

Brass

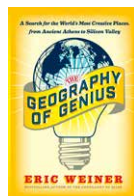
[CULTURE WATCH]

[SCIENCE]



Brightly coloured sea slugs engage in chemical warfare, Queensland University researchers have found. These carnivorous 'butterflies of the ocean' gobble up toxins, storing up the deadliest of them, Latrunculin A, for use against their enemies. Scientists hope the compound's cell-killing properties will make it useful in cancer research.

[LITERATURE]



Weiner journeys from ancient Athens to Silicon Valley in search of common threads. Part travel essay and part intellectual pursuit, the work comes absolutely jam-packed with fascinating anecdotes and factoids.

Why do hotbeds of creativity spring up in some places and not others? In his highly entertaining book, *The Geography of Genius*, best-selling author **Eric**

[TECHNOLOGY]



stretchy fibers that mimic the power-generating properties of electric eels. Made from ultra-thin carbon nanotubes wrapped around rubber filaments, these fibers generate enough juice for electronic lights and watches, and could one day be woven into clothing as a way to power wearable tech.

Researchers at Fudan University in Shanghai have developed

TEXT: PAUL CONNOLLY PHOTO & ILLUSTRATION: WÄRTSILÄ

"CUSTOMERS GET
BETTER RELIABILITY
AND LOWER COSTS. AND
FEWER SURPRISES."

[AMBITION]

Seaworthy storage

Wärtsilä's dual-fuel engines are capturing the imagination of the lucrative Floating Production Storage and Offloading (FPSO) market.

[SIGN OFF]



Located near oil and gas platforms, FPSOs process and store oil and gas until the products can be transferred to a tanker for transporting.

There can hardly be a *less* hospitable environment for a power unit. Heaving seas, precious cargo, miles from land. The oil is raw crude, the gas is freshly piped. Welcome to the world of Floating Production Storage and Offloading, or FPSOs for short. Located near oil and gas platforms, their job is to process and store oil and gas until the products can be transferred to a tanker for transporting.

Unsurprisingly, FPSOs are not a mass-market proposition. “This is the prestige end of the engine market,” says **Patrik Wägar**, Wärtsilä’s General Manager, Drilling & Production Business. “Our customers – usually one of the big oil companies – will be outfitting an LNG FPSO that will be costing them in the billions.”

“Our customers want safety, redundancy and compliance,” says Wägar. “They also look at the lifecycle costs of running the plant. With this market sector we usually take the approach of bundling our offerings – so we include the equipment with a service agreement. This means that customers know what the plant will cost to maintain for the next 10 years or so.”

This arrangement gives Wärtsilä a crucial competitive advantage over its competitors. “Our engines have a big advantage,” Wägar says. “With us they get better reliability and lower costs. And fewer surprises.”

FPSOs can be stationed more than 300 kilometres offshore – so how do you fuel what is essentially a static storage facility in the middle of the ocean?

“That’s not so difficult,” says Wägar. “After all, you’re sitting

above huge fields of raw energy. With an LNG FPSO, with our Wärtsilä 50DF dual-fuel engines, we can run the engine on LNG. People onboard have to assess the gas to ensure it can be used and to provide guidance. The dual-fuel engines allow flexibility – and when they use LNG they are also clean.”

But can Wärtsilä persuade the conservative oil and gas industry that the combustion engine, fuelled by LNG, offers key benefits? Wägar is confident it can. “Producing cleaner engines is vital in a post-Paris agreement world,” Wägar says.

Customers have cited the superior propulsion efficiency as a key attractive feature, not to mention the environmental advantages. The nitrogen oxide (NO_x) emissions are at levels at least 85% below the IMO’s regulation, thus passing the bar with bravura. When it comes to CO₂ emissions, it’s some 25% lower compared with a conventional marine engine running on diesel fuel. Finally, when it comes to SO_x and particle emissions, running the engine on gas offers such low emissions that they’re in practice negligible.

“LNG is what more and more people want, mainly due to environmental factors,” Wägar continues. “That gas is cleaner is a big driver for customers. And even given the recent fall in the oil price, gas is still a cheap energy resource.”

These results have given Wärtsilä engines a major credibility boost. “The market is quite conservative,” Wägar says. “But once a few more operators swap to our LNG engines, we should get close to the tipping point.” ●

[TRAVELLERS' GEAR]



Skip the wall-socket hunting on your next trip with **Ampware's new iPhone case**, the first smartphone protector with a built-in crank charger. Five minutes of cranking provides about 20 minutes of talk time or an hour's worth of Angry Birds.

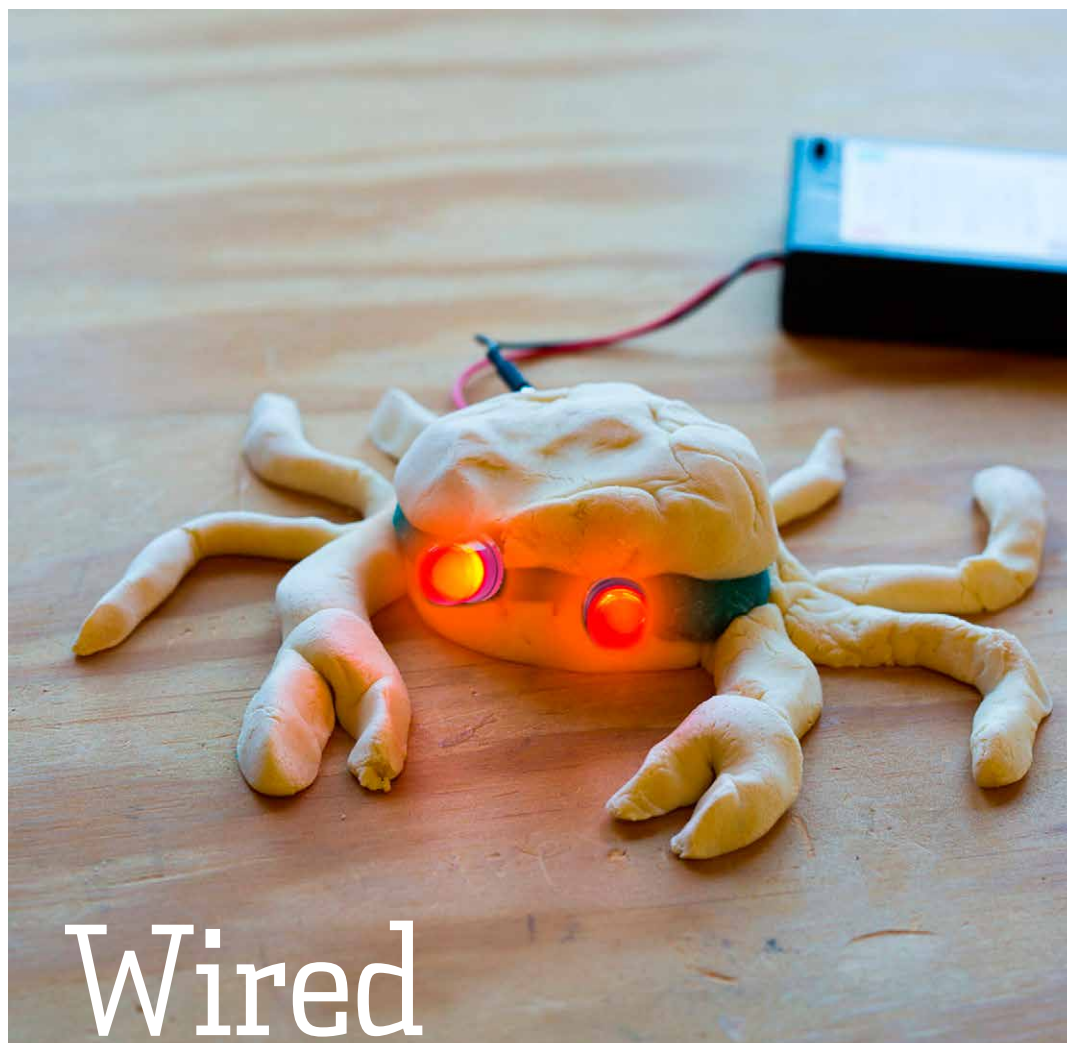


Drift off to dreamland on an airplane or in a strange hotel room with a lot more ease by listening to tunes via the ultra-comfy **SleepPhones**. These 'pajamas for your ears' are soft headbands with wireless speakers set inside. The bands come in five colours and are even washable.

If your top-secret files fall into enemy hands, it's curtains for the Free World. But with **Toshiba Encrypted USB flash drive**, you can rest easy. In addition to a PIN lock, it comes with military grade, 256-bit hardware encryption and brute force attack defences.



[LITTLE ENGINEER]



Wired for Play

KIDS AND HOMEMADE ELECTRONICS have always been a tricky pairing. You want to get your five-year-old switched on to the wonderful world of circuit building, but there's no way you're going to hand him or her a soldering gun. Prototyping boards are dull, and clip leads lose their charm after the first croc battle.

But what about play dough? Kids love play dough, and as it turns out, it's a great material for building circuits. That's the basis of Squishy Circuits, a project developed by the Playful Learning Lab at the University of St. Thomas in the US. The idea is to whip up two different kinds of nontoxic dough – one conductive, one insulating – at home using ingredients most non-bachelors will find around their kitchen. Connect electronic components to them and, presto, you're an electrical engineer!

The Squishy Circuits Kit, available separately

through online retailers, comes with a 4AA-battery pack, a motor, two kinds of buzzers, 25 LEDs of various colours, and the dough recipes. Online tutorials from multiple sources will show you how to build basic circuits, squishy animals with LED eyes and spinning tails and other fun projects.

While developing their sculpting talents, kids will get hands-on experience in fundamentals like series vs parallel circuits, resistance and load. Advanced users can add their own additional elements to make a squishy battery or a squishy speaker circuit.

Adult supervision is needed, since it's possible to overload and pop the LEDs or overheat the batteries. You're going to want to be there anyway, watching the discovery process and seeing your child's eyes light up, completely unaided by AC power. Recommended for ages five and up.



PHOTO: WÄRTSILÄ

sign off

A winning attitude

IN LIFE, IN BUSINESS or in basketball, thinking positively is a slam dunk when everything is going your way. In a shooting slump, your confidence can be easily shaken. But slumps are 99% mental.

A truly good player knows that he can influence his team's success in more ways than simply making baskets, and he will just keep devoting as much as he can. Sometimes a winning attitude is the best contribution of all.

As the newest "coach" of Wärtsilä's Energy Solutions team, I have immense pride in my team and unwavering confidence in its abilities. Despite the slump in the energy market, Wärtsilä has tremendous potential to come out on top, thanks to new markets, new ideas and new technologies. The market might not be so strong, but Wärtsilä's market share is. Having a solid position gives the organisation a lot of potential to shape the future market and become leaders.

Take the LNG market, for example. Our ambitious strategy aims to expand our solution portfolio and, at the same time, expand our market presence geographically. Our marine solutions background enables us to design robust, simple and reliable LNG solutions – clearly a competitive advantage Wärtsilä brings to the market.

Our advanced EPC competencies in providing complete LNG terminals, which incorporate even the liquefaction and/or regasification processes, make us confident we can strengthen Wärtsilä's position in this market. Creating total LNG solutions is clearly a team effort, where we develop projects together with our customers, to offer customised packages that can include even an LNG terminal combined with a gas power plant.

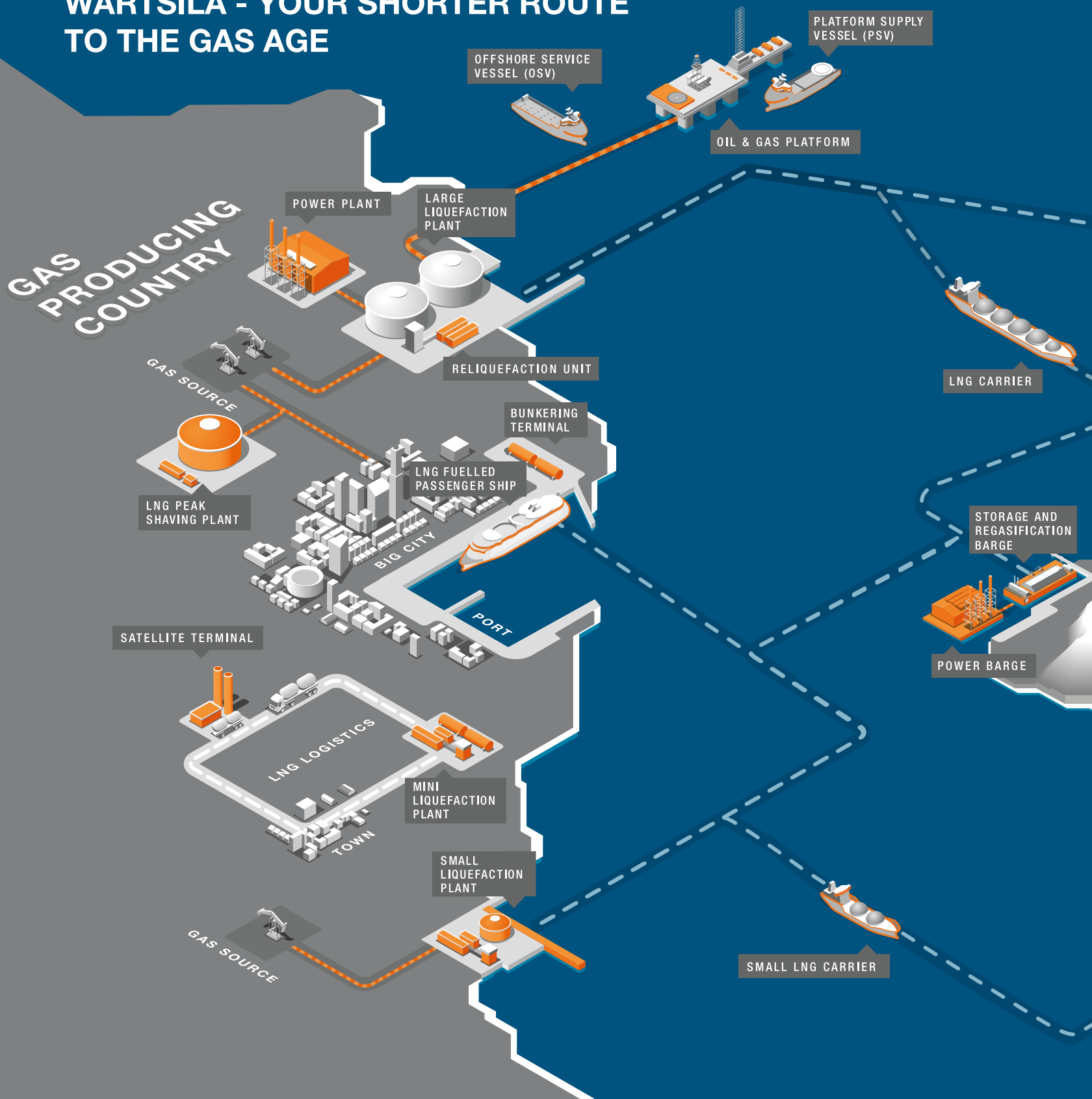
Coming out on top demands not only the right business tactics and a healthy level of confidence in our abilities, but I believe that energy and drive are critically important as well. We need positivism and excitement about what we do, and my mission is to bring this energy, this belief, to everybody within the organisation. In a nutshell, we must ensure that Energy Solutions is full of energised people, ready to bring the highest possible value to our customers.

Javier Cavada

President of Energy Solutions
Wärtsilä Corporation

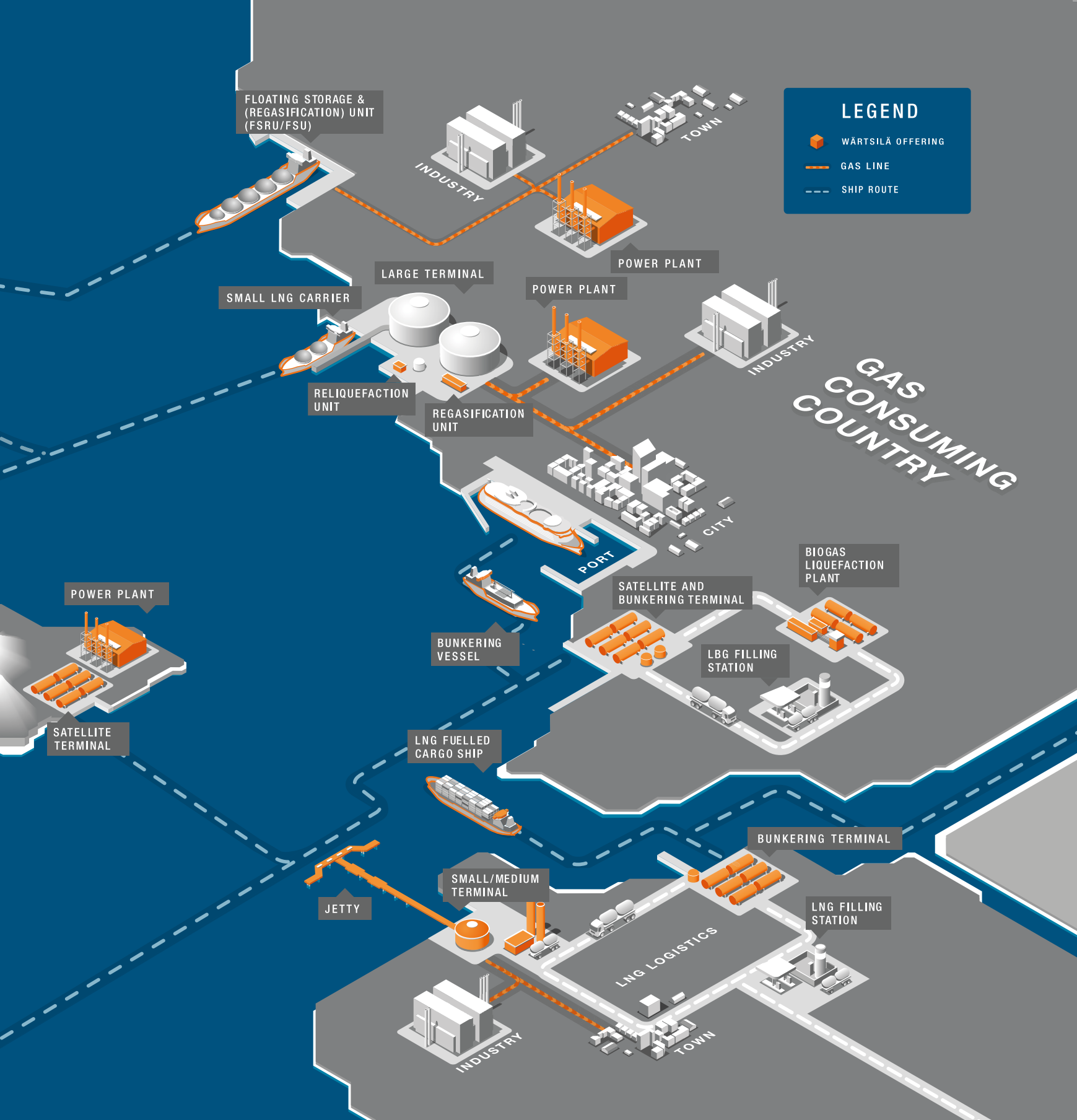


WÄRTSILÄ - YOUR SHORTER ROUTE TO THE GAS AGE



WÄRTSILÄ CONNECTS THE DOTS

Wärtsilä has the expertise, experience and offering you need. Our offering covers integrated solutions, EPC turnkey delivery, services and products for all phases of the LNG lifecycle. Read more about what we have to offer your business at www.wartsila.com





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