A Next Generation Passenger Ferry*

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1. Introduction

The world's most environmentally sound passenger ferry will sail in the Baltic Sea in a couple of years. The new ship will be equipped with engine technology employing liquefied natural gas (LNG) that reduces the vessel's sulphur and particulate emissions to almost zero.

Propulsion machinery with LNG technology is provided by Wärtsilä, the marine industry's leading solutions provider, for a passenger ferry to be built for Viking Line, a Finnish ship owner. Viking Line placed the order for the vessel at the beginning of the year, and the ship will be built at the STX shipyard in Turku, Finland, part of the international STX Europe Group. Scheduled to enter

service in 2013, it will sail between Turku, Finland and Stockholm, Sweden. It will be the largest passenger ferry to operate on LNG. Among the large passenger vessels built to date, this ship will be the most environmentally sound and most energy-efficient. The agreement includes an option for the supply of equipment for a similar sister ship.

The use of LNG technology in a large passenger vessel is groundbreaking, although Wärtsilä has great experience and strong competence in the technology: the company is a leading global provider of LNG technology. For vessel applications, Wärtsilä supplies dual-fuel engines that are capable of running on gas, crude oil, both heavy and light fuel oil, as well as biofuel.

Fig 1 Copyright: Viking Line

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However, in Baltic Sea ferry traffic, LNG technology is a novelty.

The vessel will be 210 metres in length and carry a maximum of 2800 passengers. Wärtsilä will supply the ship's engines, LNG fuel system including tanks and the total propulsion solution-

2. Strictly compliant with new sulphur regulations

New, stringent sulphur regulations will come into effect in the Baltic Sea in 2015. Thanks to the LNG technology, Viking Line's ferry will meet the most stringent IMO and EU regulations set for maritime applications. In practice, Wärtsilä is introducing a sulphur-free fuel in the Baltic Sea.

Sulphur and particulate emissions will decrease by nearly 100 per cent. Carbon dioxide emissions will decrease by 20–30 per cent and nitrogen oxides by 80–85 per cent. Even the price of LNG is competitive compared to heavy fuel oil.

3. Fuel for the future

Liquefied natural gas and related technical solutions represent, without a doubt, future technology with ever-increasing applications. For instance, old vessels can be technologically retrofitted to employ LNG.

The volumetric ratio of liquefied natural gas, or energy in relation to volume, is good compared to gas. One cubic metre of LNG equals six hundred cubic metres of gas. Although the fuel sets special requirements for materials, its benefits are greater than the material costs. For instance, LNG's thermal value is high. One tonne of LNG contains more energy than one tonne of diesel oil. The carbon content of gas is 20 per cent lower than that of heavy fuel oil, and these factors together make it possible to reduce carbon dioxide emissions by 30 per cent.

The ship owner has various alternatives when it comes to the source of the natural gas. Gas may originate from Norway, for example, or come in a shuttle tanker from Rotterdam, where it can be delivered from any part of the world. One advantage of liquefied natural gas is that the user is not dependent on the pipeline, as LNG can be transported anywhere by ship.

Wärtsilä has estimated that the number of ships using LNG may increase tenfold within the next five years.

Gas engine technology is reliable and is currently being widely used. Wärtsilä has been delivering gas engines since the late 1980s. In LNG tankers, Wärtsilä's dual-fuel engines have rapidly taken over the market. The dual-fuel option increases safety and flexibility as the engine can switch fuels during operation. The ship is also not dependent on the availability of gas, for example, on voyages that are longer than usual.

Other applications of LNG include various offshore support vessels and vessels used in the production of oil and gas. Wärtsilä is the world's leading total solution provider for gas applications with offering ranging from ship design to needed equipment and automation as well as system integration.

Wärtsilä has sold approximately 470 gas engines for vessel applications. Wärtsilä Ship Design has designed more than ten LNG powered vessels in service or contracted. The combined power of power plants employing gas is approximately 8000 MW.

Wärtsilä has supplied numerous gas engines for power plants and maritime applications in different parts of the world. At sea, the technology is used in tankers and, for example, for service vessels at oil drilling platforms. Wärtsilä Ship Design has also designed about a dozen ships that can use gas as fuel.

4. Total solution cherishing sensitive archipelago conditions

According to the agreement with STX Finland, Wärtsilä's scope of supply includes four eight-cylinder 50DF dual-fuel 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. Due to the lowest possible pressure impulses generated by the propellers, the vibration level in the stern hull is very low. Wärtsilä will supply a sound-absorbing system to minimise noise generated by the engine, thus increasing passenger comfort. A low noise level is also important as

the vessel's route passes through the Turku and Stockholm archipelagos in the Baltic sea.

Thanks to Wärtsilä's dual-fuel technology, the vessel can operate without restrictions in the SECA and NECA sulphur and nitrogen monitoring areas.

The new Viking Line passenger ferry will be capable of carrying cars, trucks and road trailers on short international voyages. The construction of the machinery, equipment, outfitting and structure will be monitored by the Lloyd's Register of Shipping classification company.

Viking Line personnel responsible for environmental matters have high expectations regarding the new ferry. Customers of the company's popular conference services are particularly interested in the ecological effects of vessel traffic in the Baltic Sea.

5. Dual-fuel technology meets economic and environmental targets

The essential concept of dual-fuel technology is to provide a means of utilizing natural gas as fuel, while retaining the option and ability to switch to liquid fuels if and when needed. This switch between fuel types can be made automatically, and without loss of operating power. By applying modern electronic combustion control, Wärtsilä has paved the way to improved performance and greater reliability for gas engines. As with many successful innovations, various strands of different technologies have been combined to produce a new and viable solution.

The outcome of all this dual-fuel development work is unprecedented flexibility, both in fuel choice and operational performance. Since natural gas has low levels of harmful emissions, and is relatively low in price, such flexibility is increasingly seen as being the key to compliance with environmental legislation and to controlling escalating operational costs. Flexibility allows the most cost-effective and most readily available fuel to be used where possible, and gas to be used when feasible and where environmental regulations restrict the use of conventional liquid fuels.

6. Exceptional environmental performance

Wärtsilä's dual-fuel engines, when running in gas mode, are capable of meeting the most stringent of environmental

regulations. Emissions of nitrogen oxides (NO_x) are reduced by some 85 percent compared to liquid fuel operation. This is because in gas mode the Wärtsilä DF engines operate on the lean-burn principle, which implies that the mixture of air and gas in the cylinder contains more air than is needed for complete combustion. Since lean combustion reduces peak temperatures, the formation of NO_x is greatly reduced. Furthermore, sulphur oxide (SO_x) emissions are completely eliminated as gas contains no sulphur, and since natural gas contains less carbon per unit of energy than liquid fuels, emissions of CO₂ are also lowered. Natural gas has no residuals, and thus the production of particulates is practically non-existent. Another factor in the environmental sustainability of Wärtsilä's DF engine technology is their high level of performance efficiency. This directly impacts fuel consumption, which in turn leads to lower levels of exhaust emissions.

7. LNG - the marine fuel of the future

Dual-fuel capability is at the spearhead of Wärtsilä's engine technology. It is seen as opening the path towards a more sustainable future for the marine industry, and a natural complement to the work of the International Maritime Organisation (IMO) in reducing the sector's environmental footprint.

The trend towards the use of liquefied natural gas (LNG) as a marine fuel is already very apparent, and the development of reliable and highly efficient dual-fuel engines is clearly the enabler. Since carbon-based greenhouse gas emissions can be reduced by at least 20 percent, and because sulphur and nitrogen oxide emissions are practically entirely eliminated when running on gas, ship owners and operators around the world are more and more looking towards LNG as being the marine fuel of the future.

Not that there aren't obstacles to be overcome. For example, a typically mentioned constraint to further development is the limited LNG bunkering infrastructure. Another is the need for onboard LNG storage and supply systems. However, the former obstacle is in the process of development, and a recent co-operative agreement between Wärtsilä and Shell Oil Company in North America will speed the process. In any case, the problem can already be solved through the use of trucks and small-scale storage facilities. The latter obstacle has already been overcome with the introduction of Wärtsilä's

LNGPac innovation. The LNGPac system includes the insulated LNG storage tanks for the vessel, the shore-to-ship bunkering connections, the pressure control valves and the overall control system. An integrated solution that includes the LNG storage system can already today be offered.

So too will technical advancement. For example, Wärtsilä's dual-fuel engines enabled the LNG carrier market to conduct an industrial technology shift during the mid-2000s. Old and inefficient technologies, such as boiler and steam turbine propulsion, were replaced by highly efficient dual-fuel technology, and today DF engines are the norm for LNG carriers.

Fig2 Copyright : Wärtsilä

The Wärtsilä LNG system range covers natural gas storage, processing and distribution onboard, LNG use in DF engines (both main and auxiliary), power distribution, propulsion equipment, and control and automation systems. Copyright: Wärtsilä.

8. Increased acceptance by shipping companies

The vessels currently being powered by dual-fuel engines are mostly offshore vessels, LNG carriers and passenger ferries. Wärtsilä is convinced that within the coming ten years the number of dual-fuel powered vessels will have grown to more than a thousand. The expansion of Environmental Control Areas (ECAs) and operating cost economics will certainly drive this growth.

Today, the platform supply vessels (PSVs) serving the offshore sector are increasingly being fitted with dual-fuel engines. The 'Viking Energy', owned by Eidesvik Shipping and operated by Statoil, was in 2003 the first PSV to be built for gas engine propulsion. Today six such ships are in operation and another six are currently under construction. Wärtsilä is not only supplying the engines, equipment and electric propulsion for these vessels, but is also the world's leading designer of such ships, having designed ten of these twelve vessels.

9. Converting vessels to LNG propulsion also an option

With the development in the LNG sector and in the infrastructural changes, there is a huge potential also for converting vessels to LNG propulsion. Wärtsilä has already undertaken several gas conversion projects, particularly dual-fuel conversions. In 2010, Tarbit Shipping, the Swedish shipping concern, contracted Wärtsilä to convert the 'Bit Viking', a product tanker, to LNG propulsion, and to supply a Wärtsilä LNGPac system. The vessel is operated by Statoil along the Norwegian coast, and the conversion will enable it to qualify for lower NOx taxes under the Norwegian government's NOx fund scheme.

Despite all the technological advances that have taken place in our lifetime, change can nevertheless still take time to be accepted. This is true of all industry sectors. It is only when the evidence becomes overwhelming that the new way is indeed a better, easier, and/or less costly way, do we become convinced.

If the joint and inter-related economic and environmental challenges that face both the marine and the power plant industries are to be met, then gas has to emerge as a mainstream fuel. Wärtsilä's dual-fuel engine technology makes this both possible and realistic.

10. Proven success of dual-fuel technology -3 million running hours

Wärtsilä has been a pioneer in the development of dual-fuel engine technology and is the acknowledged market leader in this field. In 2011, the company's dual-fuel engines exceeded 3 million running hours in commercial applications, a milestone that is significant in establishing their viability for the future. Of the three million running hours recorded by Wärtsilä DF engines, half have been in marine applications.

Although engines capable of burning both a liquid and a gaseous fuel were invented before the Second World War, their practical use is far more recent. Wärtsilä began development work with dual-fuel gas engines in 1987, the first concept being the gas-diesel (GD) engine with high-pressure gas injection. This was followed by the second generation of gas engines in the early 1990s, when the company introduced spark-ignited (SG) pure gas engines, utilizing low pressure gas.

The real breakthrough, however, came with the third

generation of gas engines, when the dual-fuel (DF) engine was introduced by Wärtsilä in 1995. The result has been the ability to combine fuel flexibility with environmental performance and fuel efficiency. Today, the total number of Wärtsilä DF engines delivered to marine applications exceeds 470.

The subsequent years have seen this technology blossom to the point that today, it represents a realistic means of meeting both the environmental and economic challenges that confront the global marine and power plant markets. The fact that Wärtsilä DF engines have been successfully and reliably operating for more than three million hours is testimony to the viability of this concept.

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The article is based on an interview of Juhani Hupli, Vice President, Ship Power Technology, Wärtsilä Corporation.