A Lloyd's Register Report
November 2013

Gas technology

Inside:

A gas-fuelled future in Canada
LNG bunkering in Singapore
Future engines

Lloyd's Register

LIFE MATTERS

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Interest in gas as a marine fuel continues to grow and it is North America where the greatest progress is being made. We profile a ferry company going with gas and we are now expecting to see more operators in North America to go for liquefied natural gas (LNG). A consortium of North American west coast players has produced a very significant investigation into the potential for LNG as a marine fuel. The report by the West Coast Marine LNG Supply Chain Project is well worth reading (page 16).

And what about the deep sea trades? Singapore is continuing to make investments in developing the capability to be an LNG hub, including provision of LNG bunkers. Lloyd's Register (LR) recently completed a significant piece of work to assist Singapore in getting to the point where gas bunkering could be a reality (page 18).

Generally, developments so far reflect our views of a likely trajectory for gas-fuelled investment: take-up focused on niche trades, trades located in emission control areas (ECAs) and point-to-point traders predominantly in ECAs, such as ferries and small containership operators.

The global expansion of LNG into the deep sea trades remains a relatively distant prospect – although large containerships, on fixed routes, needing only one or two strategic bunkering opportunities remain the likely first deep sea movers. The technology is ready – as LR's 'Clean Sky' bulk carrier project with Golden Union and COSCO Shipyard has demonstrated.

For now, the fast moving action is in North America where they have pricing and can take advantage of existing or developing infrastructure at key locations. But, as we demonstrated in our Global Marine Trends 2030 Report issued in April, future macro-economic, political and social drivers could change anything – different future global development scenarios will shape future global take-up of LNG. Watch this space – we'll have more on this soon. We'll help you work out what it really takes to be 'LNG ready.'

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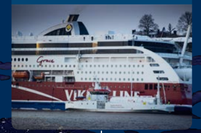
Vancouver Island
"BC Ferries intends to acquire LNG-fuelled vessels": July 2013 announcement that capital expenditure plans for three new ferries have been approved.

North America
LR taking the lead in developing gas as a marine fuel.

Finland
Dec 2012: LR's Tom Boardley visits STX Turku where the LR classed, LNG-fuelled *Viking Grace* had just returned from first sea trials. *Viking Grace* enters service Jan 2013.

Stockholm
Viking Grace bunkers LNG 5–6 times every week in Stockholm.



Quebec
Davie to build LR classed STQ 92m ferries.

Nantong, China
November 2013: Nantong COSCO KHI Ship Engineering Co., Ltd. (NACKS) and LR China announce joint development of an LNG-fuelled 28K dwt type General Cargo Ship – a 'new' ship design to incorporate dual-fuelled propulsion to be built to LR's class requirements.

Gothenberg
LR working with Stena on methanol as fuel.

British Columbia
Canadian Marine Liquefied Natural Gas Supply Chain Joint Industry Project – report publication end 2013.

Quebec
LR classes new STQ ferries.

Trieste
Warstila engine plant, where dual fuel engines for LR classed *Viking Grace* were constructed.

Castellamare di Stabia
STQ 130m Matane ferry being built at Fincantieri.

Great Lakes
March 2013: Shell announces plots to fuel Great Lakes shipping with LNG from Sarnia facility – plans also exist for supply in Geismar, Louisiana.

Florida
Tote announces LNG-fuelled containership developments.

Netherlands
Shell's *Greenstream*, the world's first inland waterway ship using only LNG to drive an electric propulsion system.

Netherlands
Argonon, Deen Shipping's LNG-fuelled inland waterway tanker.

Singapore
October 2013: LR completes LNG bunkering report for MPA Singapore.

Shanghai
2012: 'Clean Sky' design approved by LR in JIP with COSCO Shipyard Group and Golden Union.

Hawaii
November 2013: Matson announces LNG -fuelled 'Aloha' class containership plans.

Lloyd's Register: putting gas on the global map – translating gas carrier leadership into innovation in gas as marine fuel

Seaborne LNG transportation has an enviable track record – and that's an understatement. Next year is the 50th anniversary of the first gas shipment – when the *Methane Pioneer* arrived in the UK. In 49 years of LNG carriage only 40 cu.m of cargo has been lost. Lloyd's Register's goal is to help ensure that the use of gas as a marine fuel is just as safe. This is vital. It is vital for the exciting future of clean fuelled shipping. Any loss of confidence by regulators, operators, ports and the public in gas-fuelled safety will undermine the prospects for LNG as marine bunkers.

Today, Lloyd's Register has the broad capability to address LNG and other alternative fuel options. Right now the regulatory world is trying to catch up with demand. LR has the proven ability to address the risk concerns of both operators and regulators – this becomes particularly complex when international trading is required.

LR is the leading classification society for LNG carriers.

Lloyd's Register's LNG as a marine fuel track record

2007 Lloyd's Register introduces its rules for natural gas-fuelled ships

2011 LR issues LNG Bunkering Study examining likely take-up of gas as a marine fuel – study shows that pricing is key

LR classed *Argonon*, the first LNG-fuelled newbuilding oil tanker, is delivered

2012 LR issues *Rules and Regulations for the classification of natural gas-fuelled ships*

LR develops the 'Clean Sky' LNG-fuelled bulk carrier design with COSCO Shipyard Group and Greek operators Golden Union. This is the first such design that takes bulk carrier design beyond the concept stage to realise the potential for global trading bunk carriers powered by gas

2013 Delivery of the first deep-sea-capable, internationally trading LNG-fuelled vessel – the 2,800 passenger *Viking Grace*: classed by Lloyd's Register and HAZIDS/HAZOPS carried out to address risk issues that go beyond existing regulations

Shell's LR classed 'Greenstream' inland waterway tanker delivered

LR introduces LNG as Fuel training course

LR becomes a member of the West Coast Study

Construction of LR classed STQ ferries commences in Italy and Canada ■

What's driving gas as a bunker fuel?

Interest in gas as a marine fuel continues to grow and it is North America where, perhaps, the greatest progress is being made in the development of ships powered by natural gas.

Canadian ferry services, a US containership operator and a work boat owner have all already invested in newbuildings while one Great Lakes trader is considering converting a lakes bulk carrier to burn gas. We are now expecting to see more ferry operators in North America go for LNG and it is highly likely that the Great Lakes will see significant investment in LNG-fuelled newbuildings as new ships are acquired for St. Lawrence Seaway and lakes seaborne trades.

Reflecting this interest, a consortium of North American west coast players has produced a very significant investigation into the potential for LNG as a marine fuel. The report by the West Coast Marine LNG Supply Chain Project is well worth reading (see coverage on page 16). Prepared for Transport Canada, one of its most significant conclusions is that, in North America, attractive pricing of LNG is going to be a major positive force to drive adoption of gas as fuel. Whether any price benefit is available globally remains the big question for the rest of the world.

So, in this report we review a major Canadian ferry operator's decision to go for gas and we share the answers to questions we put to Transport Canada about their approach as a regulator.

And what about the deep sea trades? Singapore is continuing to make investments in developing the capability to be an LNG hub, including provision of LNG bunkers. Lloyd's Register recently completed a significant piece of work to assist Singapore in getting to the point where gas bunkering could be a reality (page 18).

Major containership operator UASC has said that 18,000 teu newbuildings they have on order will be made 'gas ready' although their comments are still short of committing to gas-fuelled operations.

Generally, developments so far reflect our views of a likely trajectory for gas-fuelled investment: take-up focused on niche trades, trades located in emission control areas (ECAs) and point-to-point traders predominantly in ECAs, such as ferries and small containership operators.

The global expansion of LNG into the deep sea trades remains a relatively distant prospect – although large containerships, such as UASC's, on fixed routes needing one or two strategic bunkering opportunities remain the likely first movers: if a small network of facilities in Singapore, the middle east gulf and either Antwerp or Rotterdam can supply gas bunkers, the pieces could fall rapidly into place. The technology is ready – as LR's Clean Sky bulk carrier project with Golden Union and COSCO Shipyard has demonstrated.

What has yet to be developed is the infrastructure and a global market for gas. For now the fast moving action is in North America where they have pricing and can take advantage of existing or developing infrastructure at key locations. This is where we are seeing real evolution now across multiple ship types and conditions. But, as we demonstrated in our Global Marine Trends 2030 Report issued in April, future macro-economic, political and social drivers could change anything – different future global development scenarios will shape future global take-up of LNG. Watch this space – we'll have more on this soon.

People and their needs:
that's what's driving gas on the demand side

The big picture for gas

People have demanding needs, for cheaper, cleaner energy to fulfil their living standard requirements. The Lloyd's Register Global Marine Trends 2030 report forecast the surge in middle class population expected in super-populated countries like China and also India, and in highly populated countries like Indonesia, and the subsequent need for governments to fulfil people's demands for cheaper energy. In an era of economic turmoil not fully arrested yet, and while questions about the future appetite for nuclear take-up remain, governments are switching to a gas policy in order to fulfil their people's demand for sustainable and ever better living standards.

Is gas here to stay? Supply is ample and so is social appetite and governments' support. However, I would envisage that certain communities will still work towards a hydrocarbon-free energy source that can maybe even replace nuclear with another clean (and low-to-zero-carbon fuel) that can be widely accepted by all. We see this trend already emerging and Lloyd's Register is engaged with technology innovators and early starters in this space. As global gas consumption grows, the hard, fast pace of technology may point to new possibilities for a cleaner future to replace gas… but probably only in years that lie far ahead. Right now it's all about gas. ■

Luis Benito
Global Marine
Marketing Manager,
Lloyd's Register

Global Marine Trends 2030

Société des traversiers (STQ) was formed in 1971 when a number of Québec ferry companies and their assets were brought together under the ownership of the provincial government.

Pictured: The hop across the St. Lawrence between Québec City and Lévis is a local commuter service provided by STQ, providing efficient transport for thousands of passengers and vehicles every day.

A gas-fuelled future in Québec

With a fleet of 17 vessels operating in the St. Lawrence, Société des traversiers du Québec (STQ) is owned by, and operated for, the people of Québec to support their transport needs, their industries and tourism.

The ferries offer a fundamentally efficient service. Many of its services are free. Some services reduce the need for long, costly and environmentally damaging detours by road. STQ is now working hard to make their future ferries even more efficient – carrying more passengers and cargo, faster and more cleanly. With growing transport needs to serve the economic expansion underway in northern Québec, STQ's decisions also have to fit with the provincial government's plans to reduce the environmental impact of its transport infrastructure.

Speaking in their headquarters overlooking the St. Lawrence in Québec City, STQ explained why they are fully committed to a cleaner future for their new ferries. They already have a diesel-battery hybrid vessel in the water serving nearby Verte island but the big next step is gas.

Louis Guimond-Mongrain, Maryse Brodeur and Benoit Cormier, STQ.

After a lot of thinking and research, today STQ has three new ferries under construction. Two are 92m ships and are being constructed at the Davie yard across the St. Lawrence from Québec City in Lévis. The third, the first for STQ to be built outside of Québec, is under construction at Fincantieri's yard in Castellamare di Stabia, just south of Naples, in Italy. All three of these new ferries will be powered by Wartsila gas engines. The ships represent new generation technology to support STQ's public service mandate and vision to continue to support society by offering effective transport infrastructure in Québec. Lloyd's Register has been involved from the start.

The two 92m ferries being built at Davie will serve the vital Tadoussac – Baie Sainte Catherine route across the mouth of the Saguenay River. This link connects Highway 138 and, with a ten minute crossing, eliminates the need for a 250km journey by road.

The 130m ferry will operate out of Matane on a longer 'V' shape route across the St. Lawrence, connecting alternately with Godbout and Baie-Comeau on the northern side of the St. Lawrence.

Impression of the two 92m long Tadoussac – Baie St. Catherine ships in operation.

Benoit Cormier, Project Management Office Director for STQ explains why the company chose gas: A decision was only made after reviewing all the options following an in-depth study into the options conducted by Navtech, a Québec based consultancy. "We will operate these vessels for many years – perhaps 35 to 40 – so we wanted to try and find the most modern technology and to meet the requirement for cleaner solutions. For us gas was like hitting the bulls-eye in meeting these needs." But going for gas was definitely not the easiest choice. "Being first to use gas in shipping in Canada is a big, big pressure. We had a lot of people to convince and I am not so sure that we could have done this if we had been a private company".

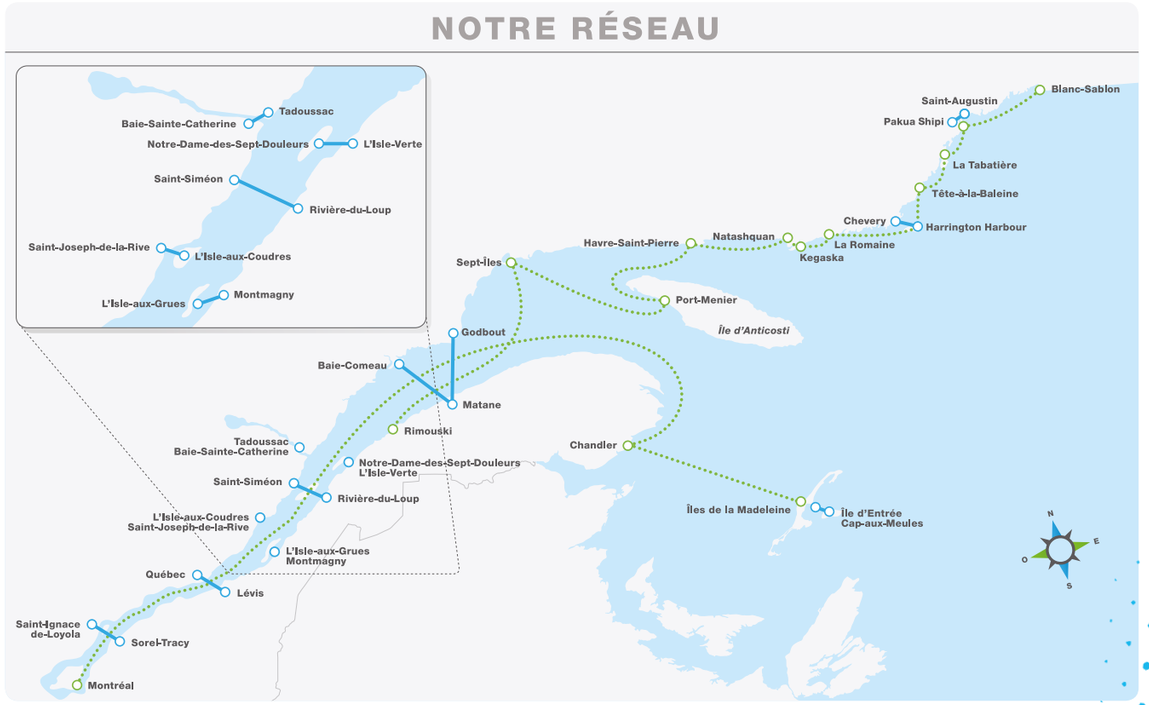
How did they do it?

The company did a full risk assessment. One of the early decisions was whether to choose gas only or dual fuel engines. The choice taken was for dual fuel engines to provide flexibility. "We can always find diesel if we need it if, for whatever reason, we can't bunker LNG. These ships need to support a wider government contingency response, for example, and we may need to operate them in other, more remote areas."

The ships will be supplied with Wartsila 20DF units of varying sizes in arrangements that provide total redundancy under Safe Return to Port requirements. Other factors included ice protection – they paid special attention to podded propulsion units. "We need these ships to be reliable and to last. The winter conditions here are very harsh. The pods will be ice class IAS while the hulls need to be 1A."

"We had to work out the risks involved and then decide how to address them. And we had to decide what's first – the ships or the infrastructure? The answer for us was to choose the ships and then address the infrastructure needs."

Benoit Cormier



STQ's route map

Once the design of the ship had been agreed, the infrastructure issues needed to be decided. Again a full risk assessment was undertaken weighing up the pros and cons of different bunkering and LNG delivery options. The solution chosen was to truck the liquefied natural gas in from the energy utility Gaz Métro's facility in Montreal and bunker direct from the quayside from a hose straight to ferry manifold. Technical Co-ordinator of ship maintenance, Louis Guimond-Mongrain, explained that initially the thought was to build an LNG storage facility on the quayside at both Tadoussac and Matane but after looking at the risks the decision was taken to go for a 'lighter' truck-based solution.

Guimond-Mongrain: "With the extreme weather conditions in winter and concerns over maintenance, the risk assessment clearly showed that the trucks provided a shorter journey than by rail (the only alternative) and that the trucking solution was safer all around." Going for trucks provides continuity as well: STQ ships are all currently supplied with diesel brought by road.

Looking at the project with great interest, and with the responsibility of making vital regulatory framework decisions, is Transport Canada, the federal authority for transportation (see report on page 12). Lloyd's Register plays an active role in helping develop risk management approaches and providing clarity to help with the regulatory process. And one of the vital steps being taken is to train the crews and shore staff to ensure that they are equipped to deal with LNG.

The Québec City Lévis ferry, with the city in the background.

Guimond-Mongrain: "We have three levels of LNG competency that we need. The basic level is that which is required of everybody in the company, from us in the senior management to people selling tickets and facing the public. Then we have an intermediate level so that people from technical managers to emergency responders, including local fire crews, are able to make informed decisions if necessary. Then we have the advanced level for the ships' deck and engineering officers who will be managing the bunkering as well as operations."

STQ is working closely with the Institute Maritime de Québec (IMQ) at Rimouski to develop specific training to produce the level of expertise and awareness required in co-operation with Transport Canada to develop new LNG competency certification standards in Canada.

Tadoussac to Baie Sainte Catherine.

Meeting the needs of the locals – in and out of the water

An important issue was addressing the needs of local communities and ensuring that the residents of the ports involved were kept fully informed of developments and that they were assured of the benefits of gas and that the risks involved were being managed properly.

Maryse Brodeur, Communications and Marketing Director, explained the importance of an effective community communications strategy. "We were able to demonstrate the approach we had taken and we had done our homework. We could show that we had identified the risks and what we would do to manage them."

The emissions from the ferries serving the busy crossing will be free of particulates and sulphur, and will have vastly reduced NO_x, all of which is good for business.

There was a very positive response from the communities who are fully behind the cleaner gas solution. Tadoussac, with a population of around 700 in winter, swells to many thousands in summer as tourists arrive to enjoy what the Guide Michelin to Quebec describes as "un superbe site". The Saguenay river which meets the St. Lawrence river at Tadoussac is a deep fjord in parts, in some places over a kilometre deep. The confluence of the rivers is highly attractive to whales, including the mighty blue whale, attracted to waters rich in plankton and krill. Noise was also a factor that the operators wanted to address, Benoit Cormier: "We wanted to make sure that the whales were disturbed as little as possible – we have been careful to get what we think is the best approach to noise and vibration for humans and whales." ■

Steel cutting on two new gas-fuelled ferries to be built at the Davie shipyard commences in December 2013.

Photo courtesy of Chantier Davie.

Chantier Davie

Chantier Davie is Canada's largest shipbuilding facility. The yard lies at the eastern end of Lévis, a town on the South bank of the St. Lawrence River, facing Québec City. Ships have been built there for 185 years and the company has a proud tradition.

Alex Vicefield
CEO, Inocea Group
Photo courtesy
of Chantier Davie

But two years ago it looked like the end of the road. The yard that once employed 3–4,000 workers in busy times was down to a maintenance crew of 35. But, it seems, a corner has been turned. Davie has new owners, who are breathing life into the yard.

In October 2013 the first ship to have been built at Davie was floated out of the Champlain dry dock. The first of a series of three super high specification DPIII subsea construction ships, the CECON PRIDE is proof that Davie is back.

Alex Vicefield, CEO of the Inocea Group is proud of what's been achieved: "We now have 750 workers and the finance in place to deliver the CECON ships and we are pretty excited about the orders for the STQ ferries. Our offshore background is perfect for understanding what's needed to build the CECON ships and those skills are transferable to the other markets we can support".

Photo courtesy of Chantier Davie.

In December steel cutting commences on the first of two gas-fuelled 92m ferries ordered by STQ.

"This order positions us at the start of Canada's LNG-powered future and immediately demonstrates our versatility," says Vicefield. "We are already very busy meeting requests for proposals – in September alone we responded to $1.2bn of proposals and now the interest in gas creates a very interesting market. Additionally, a tie-up with the Babcock Group is positioning us to support Canada's federal shipbuilding programme."

One of the challenges facing the new management team, which includes veterans with both Canadian and global shipbuilding track records, is being in the public eye. "When you are operating offshore vessels off West Africa you are anonymous – here it's very different. To be honest it's quite special in Quebec. Everybody's really interested in what we are doing and the renaissance of the yard is a big story here – we have a lot of expectations to meet!" ■

Photo courtesy of Chantier Davie.

Regulating LNG – Lloyd's Register puts some questions to Transport Canada

Transport Canada is the federal body responsible for transportation safety and regulation. Their Marine departments have been working to support the industry in managing the development of LNG as a marine fuel – in safety.

01A

At a national level, how have you been working with industry to support progress in efforts to use LNG as a marine bunker fuel?

- Transport Canada is participating with key stakeholders (including Lloyd's Register) in the Canadian Marine Liquefied Natural Gas Supply Chain Joint Industry Project (see page 16) focused on developing an in-depth understanding of the barriers – technical, operational and regulatory – to the use of liquefied natural gas as a marine fuel in Canada.

- The project consists of three phases considering different regions of Canada. Phase 1 – West Coast of Canada – was initiated in November 2012. In July 2013 the process was initiated to assess the feasibility of formally expanding the project to two other Canadian regions in two phases: Phase 2 – Great Lakes and St. Lawrence – and Phase 3 – East Coast of Canada.

- The project will provide technical and operational recommendations for Transport Canada's regulatory oversight and will determine the barriers that must be overcome to establish liquefied natural gas as a safe and environmentally responsible marine fuel in Canada.

- Transport Canada continues to engage with industry to facilitate the examination of liquefied natural gas as a marine fuel in Canada from the West Coast to the East Coast.

01B

Are you comfortable that the risks involved in using LNG as a marine bunker fuel are being addressed?

- An outcome of the project will be the development of a suggested regulatory framework. This framework has been developed by considering the risks associated with the use of LNG as a marine fuel in four main areas: vessel design and construction; operations in coastal waters and waterways; bunkering and terminal facilities; and security (in the sense of protection against malevolent or mischievous actions).

- Risk assessments have been undertaken with input from project participants with experience and expertise in each of these aspects of LNG-fuelled shipping. The assessments took into account the availability of present and draft regulations, rules, standards and guidelines and their potential contribution to lowering the probability of incidents or to reducing the severity of their consequences. Results from other published assessments of international case studies and from ongoing work by a number of participating organisations was taken into account.

02

At an international level how would you like to/how do you see the regulatory road going forward?

- The harmonisation of Canadian regulations with international standards has been identified in the Government of Canada's Cabinet Directive on Regulatory Management as a key approach to establishing an effective and appropriate regulatory framework.

- Transport Canada Marine Safety (TCMSS) is participating at the International Maritime Organisation (IMO) to ensure Canadian interests are represented as part of the development of international safety requirements. The proposed Code of Safety for Gas-Fuelled Ships (IGF Code) will address the safety requirements for these types of vessels. TCMSS is also participating at IMO in the development of a regime for the training and certification of vessel crews and will be taking into consideration the recently released draft ISO Bunkering Standard as part of the development of the Canadian domestic regulatory regime.

03

Are there any specific bilateral challenges to be addressed in working with the US authorities on gas as a marine fuel?

- The Canadian Marine Liquefied Natural Gas Supply Chain Joint Industry Project will be exploring these potential challenges if the project moves to the Great Lakes. LNG as a marine fuel has been identified as an item of collaboration between Canada and the US As part of the development of the Canadian domestic regime, TCMSS will be taking into consideration any specific policy developments within the US that may be supplemental to the international regime.

04

Do you see LNG emerging as more than the enthusiasm of a few operators and, if so, how fast do you see use for marine bunkers developing?

- Interest in liquefied natural gas used by ships as an alternative to conventional marine fuel is growing quickly within the maritime community due to its low cost and air emission benefits. Liquefied natural gas is a promising option to comply with the upcoming International Maritime Organization limits on sulphur and nitrogen-based pollutant emissions.

- The analysis within the project used port call data for vessels visiting the ports of western Canada in 2011, combined with predicted adoption rates for LNG. The predicted adoption rates considered the type of vessel and the duration of operation within an ECA. Results of this analysis were intended to provide an indication of possible LNG demand on the West Coast.

- The number of LNG vessels in operation at 2015, 2020, and 2025 and the associated LNG demand was forecasted using three different adoption rates: low, medium, and high. (The low rate is half of the medium adoption rate and the high adoption rate is twice the medium adoption rate.) The medium base case adoption rate was generated by the task team after reviewing numerous forecasts and adoption rates presented in studies such as Lloyd's Register's LNG-fuelled Deep Sea Shipping, Germanischer Lloyd's Expected Demand for LNG as Ship Fuel in Northern Europe, and the IMO Feasibility Study on LNG-Fuelled Short Sea and Coastal Shipping in the Wider Caribbean Region. The adoption rates reflect key drivers for certain vessels being more likely to adopt LNG, such as the time spent in an ECA, the trading profile (liner or tramp), and the type of vessel, as LNG propulsion and storage solutions are more easily integrated into certain vessel types. It should be noted that the adoption of LNG by deep sea vessels hinges on the availability of global LNG infrastructure.

- The table to the right (taken from the project's task 2 report) details the composition of the West Coast fleet and includes vessels operating domestically and deep sea vessels making port calls to the West Coast. It shows the number of LNG vessels that would be added to the West Coast fleet under the medium adoption rate scenario.

- The early adopters are most likely to be vessels operating exclusively in an ECA zone such as ferries, cruise ships or tankers. This assumption is consistent with what has occurred in the early 2000s in Norway and more recently elsewhere in Europe where ferry and short sea operators have been the first to use LNG as a marine fuel. Container ships and various types of bulk carrier operating on fixed routes within an ECA are also possible adopters, as evidenced by recent announcements made by Tote for their newbuild and conversion LNG-powered container ships on Alaskan and Caribbean services, and also by Interlake Shipping in the Great Lakes.

Ottawa, seat of Canada's federal government and home to Transport Canada – responsible for Canadian transportation safety.

LNG adoption by vessel type – medium adoption rate

		2015		2020		2025	
Vessel type	Fleet quantity	LNG vessels	Annual LNG consumption (MT)	LNG vessels	Annual LNG consumption (MT)	LNG vessels	Annual LNG consumption (MT)
Tankers	99	1	5,000	9	50,000	20	110,000
Bulk	829	0	0	6	69,000	73	213,000
Container	178	0	0	8	78,000	17	168,000
Cruise	27	0	0	3	135,000	9	330,000
General cargo	20	0	0	0	0	1	1,000
Vehicle/ RoRo	6	0	0	1	4,000	1	4,000
Ferry	45	1	2,000	13	73,000	26	146,000
Tug	35	0	0.0	2	3,000	3	5,000
Total		**2**	**7,000**	**42**	**412,000**	**150**	**977,000**

05

Are the Federal or Provincial governments actively promoting LNG?

- Canada's involvement in the Canadian Marine Liquefied Natural Gas Supply Chain Joint Industry Project demonstrates a clear message to the marine industry that the Federal Government is working co-operatively with its stakeholders in efforts to remove barriers hindering the use of LNG as an alternative marine fuel.

- While the government of British Columbia (BC) is already represented on the committee for Phase 1 (West Coast) of the project, the project is working with other provinces to become involved with the Phase 2 – Great Lakes and St. Lawrence – and Phase 3 – East Coast of Canada – expansion.

06

How enthusiastic are, and what is the level of awareness of, the general public and other stakeholders, such as NGOs, with respect to any widespread adoption of LNG?

- As stated above, interest in liquefied natural gas used by ships as an alternative to conventional marine fuel is growing quickly within the maritime community due to its low cost and air emission benefits.

- The general public may not be aware of the widespread adoption of LNG, but the project is working to address the sensitivities around the public's perception of LNG in relation to safety. The project is recommending a comprehensive policy covering how the benefits of LNG are communicated to the public to ensure that the public's perception of the industry is accurate and positive, and that information being distributed is clear, open, and understandable. ■

West Coast LNG Supply Chain Project addresses key stakeholder questions

Commissioned by Transport Canada and the product of a multi-participant joint industry study, the West Coast LNG Supply Chain Project and its report, due out soon, provide a comprehensive understanding of all issues related to the introduction of natural gas as a marine fuel on the West Coast of Canada.

Canada has a significant supply of natural gas; its East and West Coasts are within the North American emission control area (ECA) and Canadian operators are very interested in gas as a competitive option – both to comply with regulatory requirements and to fast track an industry step change.

But how can Canada really make widespread LNG bunkering happen? British Columbia alone is a vast province – to transform ideas into reality requires a look at the details and an examination of the whole supply chain.

A key strength of the project's approach was the inclusion of a diverse set of stakeholders providing input from all sectors likely to be involved in marine LNG bunker supply, distribution, operations and regulation. The report's findings also have relevance for the prospects for compressed natural gas (CNG) and 'hybrid' gas containment systems.

The project establishes that "price, and the price differential with other marine fuels is critical to the adoption of LNG by the shipping industry." The report is not trying to forecast future gas pricing but, based on current relative prices, and the increasing supply of gas and the variables involved, the report is extremely positive: the key finding of the report is that LNG is likely to be highly competitive as a marine fuel on the Canadian West Coast. This is despite the cost of additional infrastructure to enable the safe supply of gas to ships.

The overall challenge the study finds is to ensure that there will be enough LNG available "where and when it will be needed." The report does not try to recommend specific approaches to ensuring that demand is met but it details the issues involved and how bunker delivery systems might be developed between today and 2025. How the LNG is supplied to ships will depend on the nature of the ship and its operations – "not all ships have the same priorities and considerations for bunkering operations."

The potential economic benefits of LNG as a marine fuel may also be relevant to the wider economy as well as to ship operators. The environmental benefits are well known and gas adoption may drive associated socio-political benefits for Canada as a whole in supporting the further development of an LNG export capability and LNG expertise across the supply chain.

The report concludes with recommendations: for all stakeholders to promote LNG – its environmental and economic potential; for the development of an appropriate regulatory framework; and for the Canadian federal government to support LNG as a marine fuel by encouraging LNG as fuel capability to be built into the huge investment in Canadian shipbuilding and ship repair currently underway.

Project participants
- American Bureau of Shipping
- BC Ferries
- BC Institute of Technology
- BC Ministry of Transportation
- Canadian Natural Gas Initiative/CNGVA
- Canadian Standards Association
- Encana
- Environment Canada
- FortisBC
- Lloyd's Register
- Natural Resources Canada
- Port Metro Vancouver
- Rolls-Royce
- Seaspan
- Shell
- Teekay
- Transport Canada
- Wartsila
- Westport Innovations

The drivers for the adoption of LNG as a marine fuel are environmental, socio-political and, crucially, economic – "LNG is likely to be highly competitive as a marine fuel on the Canadian West Coast".

Port of Vancouver with the North Shore in the background.

"With the information from the Lloyd's Register report, we are in a strong position to offer LNG bunkering in the Port of Singapore."

Capt. M Segar
MPA's Assistant Chief Executive (Operations)

LNG bunkering in Singapore

Singapore achieves a significant milestone in the development of its LNG bunkering standards.

A world first for the world's top bunkering port – Singapore has taken a significant step forward in the development of the world's first practical operational procedures and standards for LNG bunkering operations – with the support of Lloyd's Register.

The Maritime and Port Authority of Singapore (MPA) and its appointed consultant, Lloyd's Register, have completed its study on the Technical Standards and Procedures for LNG Bunkering in the Port of Singapore and have consolidated information on key areas that need to be addressed before LNG bunkering can take place.

These five key areas are:

01
LNG bunkering standards and procedures within the port's limits

02
Technical requirements and specifications for LNG bunker tankers and receiving vessels with regard to transfer system, fittings and safety equipment

03
Safety standards for LNG bunkering operations

04
Identification of safety exclusion zones and emergency procedures

05
Competency standards for personnel handling LNG bunkering

With this study being completed, MPA is now ready for industry consultation and will be organising sessions for the industry to share their knowledge and best practices for LNG bunkering. The feedback received from the industry consultation sessions will enable Singapore to move forward in offering LNG bunkering services.

"There is an increasing necessity for the shipping industry to look at alternative sources of fuel and LNG is an affordable option that we should consider. With the information from the report, we are in a strong position to offer LNG bunkering in the Port of Singapore and we would like to share this significant progress with the industry", said Capt. M Segar, MPA's Assistant Chief Executive (Operations).

Singapore is recognised for its transparency and places a strong emphasis on the quality of bunkering services and safety standards. In 2012, the Port of Singapore recorded a bunker sales volume of 42.7 million tonnes, retaining its position as the world's top bunkering port. Singapore's strong performance in bunker sales can be attributed to its strategic location at the crossroads of international trade and the industry structure that results in competitive bunker prices and assured quality and safety standards. ■

Singapore is already an important centre for LNG carrier support: LR surveyors working on a life extension docking programme for a gas carrier in Sembawang Shipyard, Singapore.

Viking Grace – progress report

With a busy summer season over, LR spoke to Viking Line's President and CEO, Mikael Backman, about the operations of *Viking Grace*, the company's brand new gas-fuelled ship which has been in operation since January following delivery from the STX yard in Turku. Obviously the bunkering has received a great deal of attention.

"The actual bunkering of LNG has been done over 100 times now without any challenges and the entire bunkering process has proceeded extremely fast, more smooth and safely – far beyond our expectations," commented Mr Backman. And feedback from passengers about the extremely comfortable and now very low-emission ship has been "only positive – LNG is well known as an environmentally friendly product with extremely low emission levels."

"Overall, the experience has been better than expected", Backman says. But the company sounds far from complacent and not inclined to stand still. When asked what Viking might do next he says, "LNG is a very interesting type of fuel, but as a part of the company's continuous improvement process, Viking Line is actively looking around for other new possible technologies, which could also be implemented into the existing fleet vessels."

Asked if he is surprised that some large recent orders have not stipulated gas as fuel he says that with the LNG supply chain still under development in other parts of the world, it is fully understandable that owners would like to secure the availability of fuel before signing orders.

Mikael Backman
President and CEO,
Viking Line
Photo, Kjell Söderlund,
courtesy of Viking Line

The development of bunkering infrastructure in ports where Viking ships call, such as Turku, Tallinn and Helsinki, is something that Viking has been watching carefully. The latest news is that the city of Turku has already given permission to Gasum to start the design of an LNG production plant close to the port, while a similar project has already been started in Tallinn, and Helsinki is actively following the possibility to start the similar kind of process.

Discussing the explosion of interest in LNG as fuel in North America and whether things could move very fast now, Mr Backman says that Viking is following the development of LNG prices, changes within the production chain and the overall LNG infrastructure very closely. When asked if the pace of development of LNG-fuelled shipping will now accelerate in the Baltic and Northern Europe, he commented: "I would expect that the next order for merchant ships in the Baltic region will be powered by LNG." ■

Viking Grace bunkering in Stockholm
Photo courtesy of Viking Line.

Viking Grace cargo operations
Photo courtesy of Viking Line.

New gas as marine fuel NGO to promote best practice

Use of LNG as a marine fuel is a major and exciting opportunity for the shipping industry to make a leap frog into the future, says Mark Bell. However, the underlying goal is to ensure that the LNG bunker supply chain can match if not exceed the exemplary safety record the bulk LNG transportation sector enjoys.

The Lloyd's Register classed *Mozah*, the first ever Q-max LNG carrier, built for Qatar Gas Transport Company (Nakilat) at Samsung Heavy Industries (SHI) and delivered in 2008.

Mark Bell
General Manager,
Society for Gas as a Marine Fuel (SGMF)

Society for Gas as a Marine Fuel (SGMF) has been established to drive the adoption of best practice in the use of LNG as a marine fuel. Based in London, the new non-governmental organisation (NGO) has been derived out of SIGTTO, the Society of Gas Tanker and Gas Terminal Operators, following a decision taken at their board meeting in May 2013.

SGMF will represent shipowners, fuel suppliers, bunker providers and port authorities, indeed anybody who is involved in using LNG or considering getting involved in LNG bunker-related activities. Andrew Clifton, the General Manager of SIGTTO, explains that the new body is a significant step towards the enhancement of safety and best practices covering the use of LNG as a marine fuel.

SGMF will:

- Encourage the safe and responsible operations of vessels using LNG as fuel and all marine activities related to the supply of LNG used for fuel
- Develop advice and guidance for best industry practice among its members
- Promote criteria for best practice to all who have responsibilities for, or an interest in, the use of LNG as a marine fuel.

At a time when LNG is spreading into bunkers and the earliest date for the introduction of the first global regulatory standard for gas as fuel – an evolution of the IGC (International Gas Carriage) Code and the IGF (International Gas as Fuel) Code – is July 2017, it is vital that the risks of LNG bunkers and bunkering operations are managed effectively.

Both Clifton and Bell reference the enviable safety record of the LNG shipping sector – across 49 years of LNG shipping, only 40 cu.m of cargo have been spilled. "That's probably the same quantity of conventional bunkers lost every day", suggests Clifton.

Role of class

Lloyd's Register, a longtime member of SIGTTO, is a founder member (associate) of the SGMF. Commenting on the role of class in gas technology and in the introduction of gas as fuel, Andrew Clifton says that it is important for us to get input from class and all the leading societies have contributed to SIGTTO. Lloyd's Register is a 'steady rock' when it comes to technical standards and maintaining a strong core classification capability.

Both Andrew Clifton and Mark Bell have expressed considerable interest in LR's work with the Maritime and Port Authority of Singapore (MPA) to support development of LNG bunkering in Singapore
Lloyd's Register's contract with the MPA to develop operational procedures and technical standards required to develop LNG bunkering capabilities is an industry first. The contracted work (see page 18), which has now been completed, saw Lloyd's Register identify technical specifications, LNG bunkering procedures, and development of crew competency for LNG bunkering in the Port of Singapore, to support Singapore in developing its ambitions to develop the capability and infrastructure to supply LNG as a fuel for ships.

Pragmatism about likely use of LNG as fuel in deep sea

The excitement about LNG being ready for widespread use is probably misplaced says Andrew Clifton. "It's going to take time – even if there was enough gas to replace HFO, the combination of infrastructure, expertise and investment required and, not least, training needs, is going to see expansion of LNG to date in niches or point-to-point ferry trades in ECAs. Containerships could be among the first but the combination of loss of cargo space, cost of boil off and cost of training are all factors that can't be forgotten."

"It's going to be more complicated than many might think for the wider industry to be gas ready – it's hard enough to get trained gas engineers for LNG carriers. Imagine the amount of training needed for global bunkering and ship operations. It's not going to happen overnight." But when it does SGMF will be there to help make sure it happens safely.

"We're a neutral organisation – and long may that remain so", comments Bell. "Before SGMF was created SIGTTO was accused by some of being anti-LNG as fuel. This is far from the case but caution should not be taken as a brake on progress. What will really hinder progress for gas transportation is an incident – whether on board or along the bunker supply chain. The best SGMF can be is the facilitator of best practice in the industry. To achieve that we have to welcome all members to have an input so our output can be the refined best practice, that can only serve the best interests all round."

"What a tremendous opportunity for the maritime sector to take a giant leap into the future, beyond mere compliance and to perhaps challenge other transportation sectors, in CO_2 emissions for just one example. There are also fundamental challenges for the bunker supply industry and its suppliers to also safely manage the supply of LNG to shipping. We are here to assist all parts of the industry meet these challenges." ■

Andrew Clifton
General Manager,
SIGTTO

"It's going to be more complicated than many might think for the wider industry to be gas ready – it's hard enough to get trained gas engineers for LNG carriers..."

Andrew Clifton
General Manager
SIGTTO

Excelerate Energy's regasification vessels *Expedient* and *Express* performing an LNG STS gas-up and cool down operation off the coast of Dubai.

Lloyd's Register Approval in Principle (AIP) was provided for the MAN B&W ME-GI engine in 2012; for the ME-LGI engines operating on LPG early in 2013; and, most recently, now for operation on ethane as well.

Pictured: An illustration of the MAN B&W S90ME-GI engine
Image courtesy of Man Diesel & Turbo.

Marine engines and future fuels update

With an increasing range of power generation products entering the market, ships operating frequently in environmentally sensitive areas could soon be bunkering fuels not traditionally associated with marine power generation.

Ed Fort
Global Technology Leader,
Lloyd's Register

Offering reductions in SO_x, CO_2 and (when combined with lean burn engine technologies), NO_x emissions, the use of low flash point fuels like LNG, if safely managed, could have a significant role to play in helping the industry to meet the challenge of sustainable shipping.

In addition to what are fast becoming 'established' marine power generators, such as the Rolls-Royce Bergen B & C series, spark-ignited, 4-stroke Otto cycle engines, operating on low-pressure natural gas and the Wärtsilä DF (dual fuel) series, pilot fuel ignited, 4-stroke Otto and Diesel cycle engines capable of operation on both low-pressure natural gas and conventional fuel oils (HFO and MDO), a number of other engines, and with them fuel options, will soon be available. Wärtsilä DF engines are already approved, installed and in service on board Lloyd's Register classed vessels while, in a developing relationship, Lloyd's Register is currently working with Rolls-Royce in analysing the design of the B & C series gas engines with the intention of achieving and demonstrating an equivalent level of safety and reliability to that provided by conventional oil-fuelled marine diesel engines.

As regards new engines, with the order book growing, MAN Diesel & Turbo's ME-GI series, low-speed, 2-stroke Diesel cycle engines, operating on both high-pressure natural gas and conventional fuel oils, will undoubtedly increase the uptake of LNG as a bunker fuel, both for environmentally sensitive areas and also, with reducing global sulphur limits, worldwide trades too. Lloyd's Register granted Approval in Principle (AIP) for the ME-GI engine in 2012. The uptake of LNG will only continue to grow with the introduction of Wartsila's first RT-flex DF and X DF series, low-speed, 2-stroke Otto and Diesel cycle engine operating on both low-pressure natural gas and conventional fuels.

Beyond natural gas, both MAN and Wärtsilä are opening the door to other alternative low-carbon fuels. Wärtsilä, in co-operation with shipowner and operator STENA and Lloyd's Register, is currently engaged in the conversion of existing diesel engines on board the ferry *Stena Germanica* to allow operation on methanol (MeOH), a potentially highly sustainable low-carbon fuel, when operating in the Diesel cycle and using a pilot fuel for ignition. MAN have also recently announced the introduction of their ME-LGI (liquid gas injection) engine and in doing so, increased the fuel options still further. ME-LGI conversions to their existing 2-stroke ME series engines will, in addition to methanol, permit operation on liquefied petroleum gas (LPG), dimethylether (DME) and ethanol.

Lloyd's Register granted AIP for the ME-LGI operating on LPG early in 2013 and has recently granted AIP for operation on ethane.

In the longer term hydrogen, the ultimate clean fuel, offers the prospect of true zero-emission power generation. While the operation of internal combustion engines on hydrogen is possible, and indeed has been demonstrated, it is unlikely that the evolution of internal combustion engine technology would extend to operation on hydrogen. Instead, should hydrogen become a viable marine fuel in terms of cost and availability, it may be expected that fuel cell technology, not constrained by the efficiency limits of the Otto and Diesel thermodynamic cycles and offering significantly higher efficiencies from what are effectively solid state, silent and vibration free devices, would be the choice for the power generators of the future. Lloyd's Register has significant experience with marine fuel cell technology and is currently engaged in a number of development projects including the evaluation of both onboard hydrogen generation and low-temperature hydrogen fuel cell technology. ■

Do you want to be 'LNG ready'?

One of the things starting to get some attention is that if you want to be LNG ready, you need training.

SIGTTO's Andrew Clifton said in conversation recently: "Today it's hard enough to find qualified crew for LNG ships – it's going to be a challenge, as the use of LNG as fuel increases, to meet the need for gas trained personnel on non-gas carrier tonnage."

Lloyd's Register as the leader in LNG carrier classification understands why the carriage of LNG has been one of the great success stories in shipping: safety has been paramount – and 49 years of LNG operations show that training is vital if you want safe operations. If LNG is going to be used as fuel, everybody will hope that the record of LNG transportation can be continued in the LNG bunkering era.

So, LR has done something to help. Our new two-day course provides industry personnel with the insight and understanding necessary to ensure they are aware of what is involved in using gas as fuel. Knowledge gained on the course will allow participants to make early and confident assessments of the realities of using LNG as fuel across their fleets.

We have just held the first course in Gothenburg. The next courses to be held are: Victoria (British Columbia), 11–12 November, Montreal, 18–19 November and Fort Lauderdale, 21–22 November. Further locations in the forthcoming six months include: Bergen, Copenhagen, London, Southampton, Paris and Piraeus. ■

For course details and booking, go to www.lr.org/lngtraining

Lloyd's Register to host Centres of Technical Excellence at Gastech 2014 in Seoul

The Centres of Technical Excellence (CoTEs) at Gastech are free-to-attend educational theatres located on the exhibition show floor. They are dedicated to delivering knowledge, education and awareness of technological innovations in the gas industry. Attracting thousands of industry professionals, these seminars provide a platform for high-level industry leaders to showcase their latest developments in gas technology.

After successfully hosting the 'LNG as a shipping fuel' CoTE seminar at Gastech London 2012, Lloyd's Register will return to Gastech Korea 2014 to present the same stream on 25 March. We intend to address new issues and challenges of gas as fuel, including the reality of LNG bunkering at port and the forefront marine application of other alternative gas-fuels.

In addition, we are also commissioned to organise the 'LNG & gas carrier shipbuilding' CoTE seminar on 26 March. We will bring forward the latest technology development of the most popular niche shiptypes, such as FLNG, FSRU, VLGC and small LNG carriers, within the gas shipbuilding sector. The seminar will also cover various built-in solutions for gas ships to achieve practical, verifiable energy efficiency and performance. ■

Lloyd's Register's Ed Fort speaking at Gastech.

Making gas-fuelled shipping possible

Lloyd's Register is at the forefront of supporting innovation in gas technology, helping our clients understand risk so that they can operate safely.

As well as leading developments in gas-fuelled shipping, we're making safe LNG bunkering possible. We have been assisting ports and port operators to help them develop a solid understanding of the steps involved in addressing LNG bunkering risks. And we have helped develop the world's first practical operational procedures and standards for helping make gas bunkering safe.

Discover more at www.lr.org/gas