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Expanding the Use of Liquefied Natural Gas in the Baltic Sea Region via Tailor-made Training Activities

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Chapitre 5

Expanding the use of liquefied natural gas in the baltic sea region via tailor-made training activities

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Biography

Dr Dimitrios Dalaklis joined the World Maritime University (WMU) in the summer of 2014, upon completion of a twenty-six years distinguished career with the Hellenic Navy (HN). He is serving as an Associate Professor (Safety and Security) in the Maritime Safety and Environmental Administration specialization and is also very familiar with Maritime Education and Training (MET) issues.

Dr. Dalaklis, an Associate Fellow of the Nautical Institute (NI) and a Member of the International Association of Maritime Economists (IAME), holds a Bachelor in Maritime Sciences from the Hellenic Naval Academy (HNA). His postgraduate studies took place in the Naval Postgraduate School of the United States, during which he was awarded with two different Masters' degrees (MSc in Information Technology Management, with distinction & Defence Analysis). He then conducted his PhD research at the University of the Aegean, Department of Shipping, Trade and Transport. From the year 2005 until honourably discharged from service, he has been lecturing in the HNA in many aspects of Navigation; during the years 2013 and 2014, he has served as an adjunct lecturer in the Hellenic National Defence College (HNDC) in the domains of Geopolitics and Maritime Security.

Based upon his expertise, he has performed, coordinated and supervised many series of training involving the use of simulators, as well as on-board practical workout programs. The same applies to various educational and/or professional development activities. He is the author/co-author of many articles & studies in both Greek and English languages. His academic work also includes the books (2008) «Electronic Navigation Equipment» and its new updated version (2016) «Electronic Navigation Equipment and Electronic Chart Display and Information Systems (ECDIS)», as well as (2011) «Contemporary Sea Transport System and Piracy» and (2014) «GLOBAL GEOGRAPHY: The Key role of the Mediterranean in energy, maritime transport and environmental protection», currently in use in various Greek higher education institutions. His latest work (2018) «Trends and Challenges in Maritime Energy Management» is available by Springer International Publishing AG.

Dr Momoko Kitada joined WMU in 2011 and serves as an Associate Professor (Gender, Culture, and Human Element) in the Maritime Education and Training (MET) specialization as well as in the Secretariat of the WMU Women's Association (WMUWA). She leads WMU's collaboration efforts with the International Maritime Organisation (IMO) in terms of women's integration in the maritime sector and assists WMUWA in connection with other IMO regional support networks.

Momoko Kitada is a former seafarer and her research interests lie in gender and diversity issues in shipping, in particular, women seafarers and seafarers' families in terms of identities and welfare issues. She teaches subjects in Maritime Education and Training (MET), including cultural issues, knowledge management, assessment methodology, and contemporary labour issues. Momoko's research expands to the human element and social aspects in maritime energy management as well as capacity building for sustainable development. She also teaches research methodology and study skills for MSc students. Momoko is engaged in international collaborations, for example, Associate Researcher at the Seafarers International Research Centre (SIRC) – Cardiff University; Guest Lecturer at Open University, Japan; and Adjunct Professor at the AMET University, India.

Her previous work experience includes positions within both the private and public sectors, such as several major Japanese companies and organisations of trading, manufacturing, banking, social welfare and international aid (1994-2003); voluntary work for the Department of Conservation of New Zealand (1998); national leader of the 13th 'Ship for World Youth' programme (2000); internship at the Japanese Shipowners' Association, London (2003); research assistant for the IAMU research project (2003-2004); research fellow at SIRC – Cardiff University; writer for the monthly shipping magazine 'Kaiun' (2007-2009).

She has produced the following important publications: "Maritime Women: Global Leadership" (2015, Springer); "Risk management no Shinzui [The Essence of Risk Management]" (2017, Seizando); and "Trends and Challenges in Maritime Energy Management" (2018, Springer).

Dr. Aykut I. Ölçer Nippon Foundation Professorial Chair of Marine Technology and Innovation, Head, Maritime Energy Management specialization. Programme Coordinator, PG Diploma in Maritime Energy. Dr. Ölçer is a naval architect and marine engineer holding the position of Professor of Naval Architecture and Maritime Technology at the World Maritime University (WMU), Malmö, Sweden. Prior to joining WMU, he worked at Newcastle University (England), University of Strathclyde (Scotland) and Istanbul Technical University (Turkey) within the fields of Naval Architecture and Marine Engineering.

For many years, he has conducted research independently/jointly and collaborated with other researchers, academics and students all over the world, in particular from Europe and Asia. Dr Ölçer was involved in numerous EU funded FP5, FP6 and FP7 projects. He is the Head of Maritime Energy Management specialization and currently leads the WMU Maritime Energy Research Group - MarEner (<http://wmu.se/research>) that has secured funding from the EU and IAMU for several

projects including wind assisted ship propulsion (SAIL project, EU-Interreg IVB), improving energy efficiency of ships through optimization of ship operations (IAMU), and development of vocational education for LNG as a marine fuel (OTMW-N project, EU-Marco Polo). He has published results of his research in leading, internationally peer-reviewed journals such as "European Journal of Operational Research", "Quality and Reliability Engineering International", "Computers and OR", and "Applied Soft Computing". Prof. Dr. Ölçer is the first editor of the book, "Trends and Challenges in Maritime Energy Management" (2018) by Springer, ISBN 978-3-319-74575-6.

Dr. Alessandro Schönborn is assistant professor at WMU, where he teaches and researches Alternative Fuels and Marine Renewable Energy in the Maritime Energy Management (MEM) specialization. His research interests focus on fuel and propulsion technology, and on marine renewable energy from wave, tidal and ocean currents, but he has further interests in solar and wind power for marine applications.

Before joining WMU, Alessandro worked as research and development engineer at the Injection and Hydraulics department at MAN Energy Solutions in Denmark, as research scientist in the combustion research group at SINTEF Energy Research in Norway, and as researcher on auto-ignition in gas turbines, at Lund University in Sweden.

He graduated from University College London (UCL) with an M.Eng. degree in Mechanical Engineering, with a project on simulations and tests of a Marine Current Turbine, and holds a Ph.D. in combustion (UCL) for a thesis on renewable fuels for diesel engines.

Dr. Fabio Ballini has Economic and Maritime Transportation background. He is currently assistant professor in the Maritime Energy Management specialization and is a member of the Maritime Energy Research Group (MarEner) dealing with research topics related to Port Energy Management Planning, Gaseous Emissions from Ships in Harbours, Externality Cost in Transportation, Externality Modelling, Clean-Tech Solutions and Energy Audit Systems in Port. He furthermore developed an expertise in the Cold Ironing technology and it is cost benefit analysis as part of his PhD topic. He has also published several times on the issue of "cold-ironing technology", focusing on the society and externality impacts.

Dr. Monica Canepa Ph.D. in the field of the Economics of Energy and Maritime Energy Management in Ports.

Monica strong interest are focused on economy and transport policy and research activities related to this area. She has performed scientific coordination of various conferences and possesses many years of experience in the development and management of research projects for the University of Genoa and World Maritime University.

Abstract

Historically, sea-going vessels have been the most important means of transport. With the increasing demands on trade, its importance is becoming ever significant. However, considering their reliance on internal combustion engines and fossil fuels for propulsion purposes, these ships are also responsible for emitting a certain amount of pollutants towards the environment. On the positive side, both the International Maritime Organization (IMO) and the European Union (EU) have clear ambitions to reduce greenhouse gases (GHG) emissions associated with vessels engaged in shipping activities. This new -and rather tight- regulatory framework already created in relation to energy efficiency and monitoring environmental performance of ships is providing a strong driver for the maritime industry to explore different avenues of improving its environmental impact and even consider the use of alternative fuel sources. For the time being, Liquefied Natural Gas (LNG) is looking as one of the most promising solutions for the specific challenge. The “Go LNG” Project is focused on the development of demand and accessibility of LNG in the Baltic Sea Region (BSR). Activities associated with this strategic-in-nature project aim to promote the implementation of European Union’s “Clean Fuel Strategy” and boost LNG usage through the whole transport chain. Among other important tasks, the establishment and operationalization of a BSR LNG Competence Centre is included. The World Maritime University (WMU), along with its capacity building focus, is playing a pivotal role in these tailor-made training activities, which will be the epicentre of the analysis in hand. During the project under discussion, training modules were designed and tested by delivery in the classical classroom mode; distance learning modalities, such as video-streaming of the associated lectures and online tests should be integrated in the future delivery methods.

Keywords: Maritime Education and Training (MET), Liquefied Natural Gas (LNG), Baltic Sea Region (BSR), “Go LNG” Project, LNG Competence Centre.

Introduction

Collective action is needed to deal with the numerous and complex challenges of climate change; the maritime industry must contribute its fair share of Greenhouse gasses (GHG) reduction in those extremely important activities that are already underway and aim to mitigate a risk that can threaten even humanity's own existence. It is not a coincidence that a certain number of international - national policies and/or strategies call for a faster transition towards sustainable energy production and use. Of particular interest is the fact that on September 25, 2015, under the auspices of the United Nations (UN), countries adopted a set of goals *"to end poverty, protect the planet, and ensure prosperity for all"* as part of a new sustainable development agenda. The specific initiative is also more widely known under the title: *"Transforming our world: the 2030 Agenda for Sustainable Development"*. There are 17 Sustainable Development Goals (SDGs)¹; recognizing that all the goals are interrelated and indivisible, of particular interest for energy related issues are Goal 7, which aims to ensure access to affordable, reliable, sustainable and modern energy for all and Goal 12, which focuses on sustainable consumption and production patterns. It is a self-explanatory fact that coordinated actions are urgently needed to achieve the afore mentioned ambitious aims; on the positive side, various regulatory efforts are already underway. For example, the International Maritime Organization (IMO) has rather recently updated the International Convention on Prevention of Pollution by Ships (MARPOL), which governs the issue of pollution in relation to the maritime industry. Especially those provisions in MARPOL Annex VI, have made very crucial for the maritime industry to explore different avenues of improving its environmental impact and even consider the use of alternative fuel sources. This trend is not restricted solely in the maritime domain: other means of transport, such as road and rail industries, are also under continuous scrutiny for their level of gasses emissions; many high level initiatives and regulations are pushing towards a framework of restricting these dangerous emissions and a tighter control on pollution in relation to internal combustion engines. For the time being, Liquefied Natural Gas (LNG) is looking as one of the most promising solutions for this challenge (Dalaklis et al., 2017a; Dalaklis et al., 2017b; Madjidian et al., 2018).

It is important to highlight that these new/updated regulations that were previously pointed out exercise a significant influence on the type of energy and fuel used during shipping operations, as well as the issue of "permitted emissions". More

¹The 2030 Agenda for Sustainable Development, was adopted by all United Nations Member States; it provides a shared blueprint for peace and prosperity for people and the planet, now and into the future. At its epicentre there are seventeen (17) Sustainable Development Goals (SDGs), which are an urgent call for action by all countries -developed and developing- in a global partnership. Each goal has specific targets to be achieved over a certain period of time, with more details being available at: <http://www.un.org/sustainabledevelopment/sustainable-development-goals/>, accessed November 2018.

specifically, MARPOL Annex VI represents the regulatory framework tackling exhaust gas emissions from ships. It prohibits deliberate emissions of ozone depleting substances and sets progressive reductions (tiers) in emissions of Sulphur oxides (SO_x), Nitrogen oxides (NO_x) and particulate matters (PMs). This Annex has also introduced designated emission control areas (ECAs) with more stringent standards for emissions; these areas are called SECAs for SO_x and NECAs for NO_x emissions respectively. Today, these areas are the Baltic Sea (SO_x only), the North Sea (SO_x only), the North American area (SO_x, NO_x and PMs), and the United States Caribbean Sea area (SO_x, NO_x and PMs)². In November 2016, IMO further designated the North Sea and the Baltic Sea as NECAs, coming into effect on 1st January 2021. When it comes to GHG emissions from ships, amendments of Annex VI in 2011 added Chapter 4 which introduced two mandatory mechanisms (entered into force in January 2013), intended to ensure an energy efficiency standard for ships: (1) the Energy Efficiency Design Index (EEDI), for new ships, and (2) the Ship Energy Efficiency Management Plan (SEEMP) for all ships (Ölçer et al., 2018). These regulations have already influenced and will continue to shape the shipping industry's demand for different fuels, which in turn affect the fuel prices and the cost effective available technology and infrastructure. For ship-owners, in order to ensure compliance with these new regulatory demands, changes in their current business models are needed. In summary, three main options are standing out: a) integrating an emission abatement technology, such as a scrubber; b) opting for a more "environmental friendly" energy source (fuel) such as liquefied natural gas (LNG); c) using low sulphur fuel such as MGO (marine gas oil) or MDO (marine diesel oil). For the time being, LNG is considered as a very appropriate choice. It is becoming increasingly available, since bunkering facilities-infrastructure are created with a very satisfactory pace; LNG's physical properties also allow to easily meet the vast majority of stringent requirements within ECAs, without any additional significant costs involved (Dalaklis, 2016; Madjidian et al., 2018).

When the discussion revolves around the topic of "clean" technological solutions for the shipping industry, the Baltic Sea Region (BSR) (comprising Denmark, Finland, Estonia, Germany, Latvia, Lithuania, Norway, Sweden and Russia) is clearly a leading region of the world (Dalaklis et al., 2017b). It is indicative the fact that the countries surrounding the Baltic Sea are not only examining and applying different pollution reduction technologies, but also considering/introducing alternative fuels such as liquefied biogas, or methanol; numerous research and pilot-projects are also already underway in the areas of new-builds' design and retrofits. Of particular interest is the European Union (EU) funded "Go LNG" Project, which is focused on the development of demand and accessibility of LNG within the BSR. Activities associated with this strategic-in-nature project

²[http://www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Pages/Emission-Control-Areas-\(ECAs\)-designated-under-regulation-13-of-MARPOL-Annex-VI-\(NOx-emission-control\).aspx](http://www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Pages/Emission-Control-Areas-(ECAs)-designated-under-regulation-13-of-MARPOL-Annex-VI-(NOx-emission-control).aspx), accessed November 2018.

aim to promote the implementation of EU's "Clean Fuel Strategy" and boost LNG usage through the whole transport chain (Madjidian & Dalaklis, 2017). Among other important tasks, the establishment and operationalization of a BSR LNG Competence Centre is included. The World Maritime University (WMU), along with its capacity building focus, is playing a pivotal role in these tailor-made training activities, which will be the epicenter of the analysis in hand. Some initial thoughts and ideas in relation to the creation of this training initiative were presented in the 11th annual International Technology, Education and Development Conference (Dalaklis et al., 2017a). Considering that a significant period of time has elapsed since that point of time, it is now appropriate to provide the necessary update.

LNG and the shipping industry

Apart from the already well-established transport method of pipelines, specially designed barges and large sea-going vessels with cryogenic capabilities (LNG carriers), as well as road tankers with cryogenic equipment are already extensively used for LNG transport around the world. The progress already made in engine design, vessel design, performance and efficiency, as well as bunkering, containment and monitoring of LNG has given the maritime industry a pragmatic solution to traditional oil alternatives. It is true that LNG is a fossil derived fuel and therefore its use will result into the release -one way or another- of GHG in the Earth's atmosphere. However, despite being of fossil origin, LNG is considered to be a viable alternative and a contributor towards "cleaner" shipping. The main reason for this notion is that it is associated with better exhaust properties, when compared with other available (conventional) marine fuels. For example, in comparison to diesel, typical emissions savings associated with natural gas are: GHG reduction of between 11% and 20%, NO_x emissions reduced by 80% and particulate matters and SO_x emissions are removed by 99% (LNG Master Plan Project, 2016). As was already briefly mentioned, the IMO's restrictions on emissions have established the necessary framework that creates a unique opportunity for increased LNG demand within the whole maritime transport sector. However, in order to facilitate a fast and safe deployment of LNG in the shipping industry, not only regulations and respective responses from the involved actors must be on track, but also sufficient education and capacity building of people that in various and different ways will be operating LNG is needed. Within the BSR and under the EU's Interreg framework project "Go LNG", a strategy for a smoother and more efficient use of LNG as a fuel for transport is to be put in place with the aim to enable blue transport corridors in the region³. Additionally,

³Although the complete details are provided in a different chapter within the same book, for reasons of clarity it is also pointed out here that this will be done by investigating current and future transport flows, as well as LNG infrastructure future developments; researching and putting forward ways to improve the wider transport chain by incorporating all available transport modalities, including the enlargement of the number that correspond to entities/industries that can benefit from the use of

well before the end of the project, a “LNG Competence Center” should be established and deliver various training offerings in relation to LNG activities. This Center revolves around the partnership of the “Go LNG” project and the stakeholders connected to it, with the Maritime University of Szczecin, Poland, being the partner responsible for coordination. This partnership consists of twenty (20) main partners and about fifty (50) associated partners spread across the BSR. The aim of that Center is to offer LNG expertise through specialized and competitive training courses to the maritime industry on a global level. To enable a joint service, the Centre gathers BSR-based LNG competence, knowledge, as well as heavy specialized training facilities and research competencies in a well-functioning network that provides collaboration and management models.

Applications of LNG within the shipping industry have clearly gained momentum in recent years. On the other hand, gas and other low-flashpoint fuels pose their own set of safety challenges. IMO responded in a timely manner, via the adoption of the Code of Safety for Ships Using Gases or Other Low-Flashpoint Fuels (IGF Code), with amendments to make that Code mandatory under the International Convention for the Safety of Life at Sea (SOLAS)⁴; obviously, the provisions of the Code provide the overall framework for the associated training activities necessary to support safe and efficient LNG operations. For example, considering that LNG is kept in a cryogenic state, there is a need for rightly skilled operators to balance tank pressures and temperatures during bunkering operations. Explaining in more depth the properties of LNG, the specific fuel is kept in its liquid state through the application of very low (cryogenic) temperature (near -163 Celsius). As a result, it can be stored within a high pressure tank (10 bar or more), or within an “ordinary” atmospheric tank depending upon the fuel system demands. Currently, many coastal vessels are fitted with independent type “C” pressure tanks because of their small capacity needs. Ocean going ships will certainly require much larger capacity than the coastal ones and therefore utilize membrane atmospheric tanks. Nevertheless, all types of LNG storage tanks are designed with extensive safety features, to include containment and monitoring. When LNG is exposed to the atmosphere, it will warm and return to its natural gaseous state. This is done

LNG will also take place. The strategy under discussion will further provide LNG stakeholders with a knowledge-base on policies and regulation as well as on technological standards that relate to LNG, and describe well-functioning solutions and business models already present in the transport sector of the region under discussion.

⁴This new “toolbox” of regulations came into force in 2017. The purpose of the IGF Code is to provide an international standard for ships, other than vessels covered by the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code), operating with gas or low-flashpoint liquids as fuel. The basic philosophy of the Code is to provide mandatory criteria for the arrangement and installation of machinery, equipment and systems for vessels operating with the specific types of fuel to minimize the risk to the ship, its crew and the environment, having regard to the nature of the fuels involved. The Code’s basic philosophy considers the so-called “goal based approach”. Therefore, goals and functional requirements were specified for each section forming the basis for the design, construction and operation. <http://www.imo.org/en/OurWork/Safety/SafetyTopics/Pages/IGF-Code.aspx>, accessed November 2018.

by rapid boiling and evaporating. This evaporation process can be accelerated when LNG contacts surfaces with a higher temperature, such as seawater or even ice (Dalaklis et al., 2016). Initially, LNG is heavier than air and settles on the water's surface while changing state. As the temperatures elevates to -107°C , it will become lighter than air and begin to rise from the surface. Wave action will naturally sustain the accelerated evaporation, expediently dissipating the risk in absence of an ignition source. Vaporization studies have been on-going for several decades; a report from 1970 conducted by the U.S. Coast Guard Hazardous Materials Division (in a controlled environment) found that the vaporization rate was 0.037 lbs/ft sec (United States Coast-Guard, 1970). Flammability range, undeniably present, is only slightly higher than light oils and does not pose an explosion risk, despite public perception. LNG has a relatively low reactivity and low burning speed with a flammability range of 5 - 15% volume in air (Dalaklis, 2016). Unless a spill is trapped where vapors can accumulate over a period of time, such as a tank space or engine room, only then it might be possible to build pressure and cause rapid expansion. However, the level of detection mandated by the IGF Code requires detection redundancies in nearly every phase of the fuel system, proper installation of adequate ventilation (as outlined in the IGF Code); swift response action by the crew would also quickly mitigate any occurrence, with the importance of conducting realistic training in order to develop these competencies necessary to be highlighted here.

World Maritime University's previous involvement in LNG

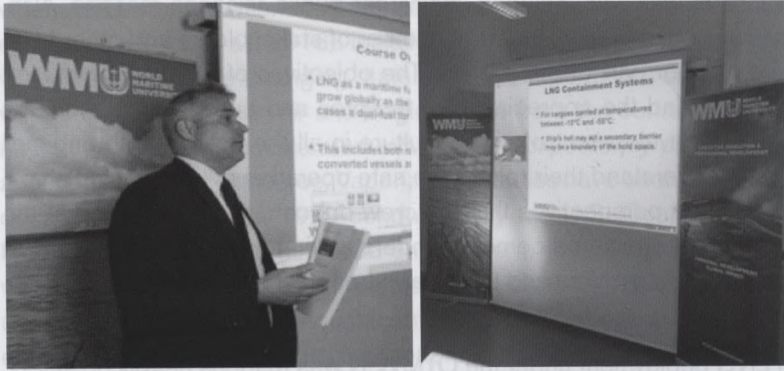
With IMO as its parent organization and engaged in postgraduate maritime education activities, WMU's mission is to be the world center of excellence in postgraduate maritime and oceans education, professional training and research, while building global capacity and promoting sustainable development. WMU has gathered valuable cumulative experiences in relation to LNG, under an EU Project within the Marco Polo framework: "On the Mos Way Network (OTMW-N)". That project revolved around an extended set of professional trainings and vocational education activities in four (4) different EU countries, developed in five (5) distinct modules. The partners involved in this project developed and delivered a certain number of trainings that were categorized as follows: a) LNG fueled vessels design training; b) Safety of LNG Handling on Plant, Bunkering Station and On-Board Vessels; c) LNG cargo and ballast management training on LCHS simulator; d) Maneuvering of LNG driven vessel, special conditions and operations; e) Propulsion and power generation training of LNG driven vessel. Other activities included a number of dedicated visits on facilities related to LNG production/distribution, as well as various bunkering locations in order to identify/evaluate the type of technology applications available and best practices already in use.

Furthermore, a portal for disseminating news in relation to on-going developments in the LNG market was also included, mainly for public relations reasons. Also, clustering activities that engaged a large number of stakeholders and other LNG projects were a major part of the project. The objectives of OTMW-N included the understanding and the appreciation of the pros and cons of LNG's use as a marine fuel, the development of a new culture in all the actors (both onboard and offshore) to understand their role to the safe operation of LNG fueled ships, bridging the different perspectives that the crew onboard the vessels and at the port have, as well as creating a common understanding and bridging the gap in the existing training procedures and the different perspectives on the use of LNG for bunkering⁵.

The take on LNG deployment under the OTMW-N was to focus heavily on safety. This choice was influenced by LNG's cryogenic nature and volatility, its properties, characteristics and behavior (which differ significantly from conventional marine fuels); introduction of new technology in the field must always be combined with the necessary training activities. On the positive side, the experience of the LNG marine transport industry so far shows that, when LNG is handled professionally, all the associated risks can be mitigated and kept under complete control. Under the specific research initiative, WMU developed and delivered a dedicated training module for maritime professionals in relation to the wider domain of LNG safety. This training package covered all aspects of the necessary procedures to assure safe and efficient handling of LNG under a wide variety of circumstances and to initiate an appropriate response in case of emergencies. More importantly, it provided participants a unique opportunity to interact directly with experienced technicians and authorities on firefighting, safety and security, specifically taking advantage of the first LNG practical training course in Europe. During 7-11 September 2015, WMU held the Safety of LNG Handling on Plant, Bunkering Station, and On-board Vessels course. This course was offered free of charge and included nearly sixty-five (65) participants, the majority of whom joined remotely (on the distance learning mode, via transmitting on-line the associated lectures in real time) from around the world; five (5) more individuals participated on-site, at WMU premises (Figure 1). Topics covered included properties of LNG, bunker delivery modalities, firefighting procedures, and emergency procedures. Key objectives (which are detailed in Table 1 below) were aiming at developing a working knowledge of LNG bunkering operations through best practices, industry standards, and regulations, properly identifying roles and responsibilities for safe and efficient operations on-board the delivery vessel and the receiving vessel including shore-side trucks or terminals, and appropriate and effective emergency response in terms of both spill and fire⁶.

⁵<https://www.onthemosway.eu/onthemoswaynetwork/?cn-reloaded=1>, accessed November 2018.

⁶The course opened with remarks by WMU's President, Dr. Cleopatra Doumbia-Henry, who welcomed the participants and also noted the importance of the course in relation to the 2030 UN Sustainable Development Goals; she also highlighted the significance of the course as a collaborative

Figure 1. Delivery of the course under the OTMW-N Project**Table 1.** Learning outcomes accomplished under the “Safety of LNG Handling on Plant, Bunkering Station and On-Board Vessels” Module

LEARNING OUTCOMES
Understand the unique characteristics of LNG as a cryogenic fuel
Develop a clear understanding of the background of LNG fuelling operations and regulations to assure safe and efficient operations on board bunker vessel, LNG vessels and LNG fuelling terminals
Be able to differentiate between different Hydrocarbon gases and their carriage conditions
Be familiar with the hazard of fire of gases and firefighting procedures of pool and pressure fires
Be familiar with operating commonly used instruments and monitoring equipment for LNG
Assure students a smooth transition to manage and operate LNG fuelling protocols starting with delivery of a LNG-fuel vessel, including barges, initial operations, familiarization of operations under routine and emergency situations
Understand common hazards of LNG storage, transfer, and handling
Develop and maintain on-going training of replacement crewmembers, LNG terminal staff and managers
Understand in detail the appropriate safety procedures in the event of an LNG emergency, including fire, spill, and rapid-phase transition
Understand the unique safety challenges associated with ships and terminals utilizing or handling LNG
Potential LNG Incident Scenarios and strategies
Be able to understand the basic procedure of Risk Assessment and Jettison of cargo in case of emergency

partnership with other Universities and its role in supporting the IMO's mandate in the area of energy efficiency. WMU staff, along with external instructors were involved in the course delivery. Expertise integrated in the delivery included Mr John Egan of Excelerate Energy, a leading expert with over 36 years of experience in the LNG industry and Mr. Johan Lilliesköld, LNG Business Development Manager, of Mann Tek, who shared his in-depth LNG experience and first-hand knowledge of the MS Viking Grace LNG operation in Stockholm (the first large scale passenger ferry to be powered by LNG). <https://www.wmu.se/news/free-online-lng-course-delivered-wmu>, accessed November 2018.

Development of a LNG competence centre in the baltic sea region

A “Go LNG” affiliated Conference, under the title “Building LNG Competence and Business Partnership for the Baltic Sea Region” was held on the 26th of April 2017 in Vilnius, Lithuania. The main goal of that Conference was to formally establish two international cooperation platforms: a) the Baltic Sea Region LNG Cluster; and b) the LNG Competence Centre of the Baltic Sea Region (BSR)⁷. To elaborate more on the details, an agreement among thirteen (13) educational institutions from the BSR to establish a Competence Centre aimed at facilitating the growth of innovation, technologies and infrastructure in the area of LNG was signed. By pooling LNG competences and the right type of educational resources, this Centre brings together educational facilities and science oriented institutions in order to create a specific network which will enhance access to LNG technologies and enable the improvement of knowledge in the extended domain of LNG operations. It will also strengthen the critical mass of LNG specialists, an action which is imperative for the development of LNG technologies in the BSR. This network of institutions has been established to mobilize the infrastructure of science and research studies in the Baltic Sea countries, to further promote LNG study programs, to develop training and research in support of LNG activities, and to increase the availability of knowledge about LNG technology among business representatives, developers and the implementers of energy and environmental policies. The BSR LNG Competence Centre is based on a model of interinstitutional cooperation that will enable the development of the joint projects and services required for the LNG sector⁸. For the time being, there are two main categories of training activities provided (which are both summarized in Table 2): a) LNG Value Chain training (VC)⁹; and b) LNG Maritime Basic training (MB).

⁷<https://www.wmu.se/news/wmu-joins-baltic-sea-region-lng-competence-centre-go-lng-conference>, accessed November 2018. It is necessary to highlight here the fact that the BSR LNG Cluster is a business cooperation organisation which includes national parties from Lithuania, Sweden, Norway, Denmark, Germany and Poland which are now united to strengthen and to speed up the further development of LNG innovations, LNG technologies and LNG infrastructure in the BSR.

⁸<https://www.wmu.se/project/lng-value-chain-clean-shipping-green-ports-and-blue-growth-baltic-sea-region-go-lng>, accessed November 2018.

⁹The content of this type of training is quite flexible and corresponds mostly towards dealing with the needs, and future possibilities- opportunities of local stakeholders in relation to LNG field applications.

Table 2. Training Activities under the BRS LNG Competence Centre

No	Date	Place	Type of training	No of participants
1.	15-16/11/2017	Lithuania / Klaipeda	VC + MB	127
2.	6-7/12/2017	Poland / Swinoujscie	VC + MB	25
3.	06/03/2018	Poland / Gdansk	VC	50
4.	25-26/04/2018	Sweden / Malmö	VC + MB	38
5.	16/05/2018	Estonia / Tallinn	VC	17
6.	7-8/06/2018	Germany / Rostock	VC + MB	12
7.	11/09/2018	Norway / Oslo	VC	42
8.	20/09/2018	Latvia / Riga	VC + MB	52
9.	26/09/2018	Denmark / Fredericia	VC + MB	18
10.	3-4/12/2018	Lithuania / Vilnius	VC	----
11.	7-8/02/2019	German / Hamburg	VC	----

LNG MB type training (offered on behalf of the BSR Competence Centre) took place at the WMU premises in Malmö, Sweden, on 25-26 April 2018 with a total number of 65 participants from Sweden, Denmark, Norway, Lithuania, Germany, Poland and Turkey (Figure 2). The scope/composition of this training covered mainly requirements of the International Convention on Standards of Training, Certification and Watch-keeping for Seafarers' (STCW) regarding maritime personnel competencies. More specifically, STCW-related requirements concerning ships subject to the Safety for Ships using Gases or other Low-flashpoint Fuels (IGF) International Code were analysed in a sufficient level of detail. Participants representing providers of LNG technologies, LNG suppliers, science institutions, maritime authorities and ship-owners came together to learn about best practices involving LNG in the extended energy and transport sectors. Briefly, the content of this MB type of training reflected the STCW requirements for seafarers that are not directly responsible for transferring LNG or using LNG storage or fuel systems. It was dealing with: a) Explanation of physical and chemical properties of LNG and other low flash point fuels; description of fuel and storage systems for cryogenic liquids; b) procedures and devices providing the safety during LNG operations; c) Transfer/bunkering operation of LNG; d) Description of health, ship, equipment and environmental hazards associated with LNG operations and explanation on how to control these hazards; e) understanding of fuel characteristic presented on a Safety Data Sheet; f) Description of safety means applied during LNG operation; g) basic knowledge on Medical First Aid with references to a Safety Data Sheets; h) Organization of firefighting actions, firefighting agents and methods, firefighting system operations; i) (Theoretical only) Description of emergence procedures and requirements for: emergency breakaway, Emergency Shut Down procedures etc.; and ia) Description of

measures and procedures to be taken in the event of leakage, spillage, venting of the fuels.

Figure 2. Delivery of the course under the “Go LNG” project



Summary and conclusion

In the 21st century where an increasing demand of trades to supply necessary foods, goods and resources around the globe, sea-going vessels are rightly considered the most important means of transport; vessels engaged in maritime transport activities hold the so-called “comparative advantage” over all other modalities. It is not a coincidence that associated statistics indicate that about 90% of the total volume of global trade is borne (exclusively – or, at least partially) by sea (UNCTAD, 2018); safe and secure shipping is a prerequisite for the normal conduct of global trade, many times termed as the “backbone of globalization” (Dalaklis, 2012). However, considering their reliance on internal combustion engines and fossil fuels for propulsion purposes, these ships are also responsible for emitting a certain amount of pollutants towards the environment. The rather tight regulatory framework already in place in relation to energy efficiency and monitoring environmental performance of ships is providing a very strong driver for the maritime industry to explore different avenues of improving its

environmental impact and even consider the use of alternative fuel sources. On the positive side, modern technology provides a plethora of options of alternative fuels for future consideration: from hydrogen to methane, or even biofuel. For the time being, LNG is looking as one of the most promising solutions for the improvement of the shipping industry's "environmental footprint". However, in order for the LNG market to increase more rapidly, it needs to be spread more widely, and not just within the ECAs. Moreover, for the specific market to become more financially viable, the number of sectors interacting with it needs to increase further. One area of opportunity being already explored is the spread of LNG to remote regions: due to its properties, the volumetric energy density of LNG is 2.4 times greater than that of compressed natural gas (CNG) or 60% that of diesel fuel, allowing larger quantities of LNG to be transport in comparison with the other "competitors"¹⁰. Additionally, LNG is cost efficient to transport over long distances, in the case pipelines do not exist. Once the maritime industry has become prepared with a functioning distribution chain it is therefore quite probable that many other industries and more specifically entities that are located in more remote areas will switch to using LNG as a principal source of energy.

In many cases, the introduction of LNG is considered as a regulation-driven demand that has arisen to comply with the environmental regulations enforced by the Sulphur Emission Control Area (SECA), as introduced by IMO's MARPOL Annex VI. The Baltic Sea is also designated to become a Nitrogen Emission Control Area (NECA) as of 2021; this means that vessels built after 2021 will be required to reduce nitrogen oxides (NOx) emissions by 80% compared to the current emission levels. With the introduction of these regulations, a forced shift has been placed upon vessels/ship-owners operating in the region; changes to the current business models (and technologies involved) are necessary. For the maritime industry in the BSR, the question is no longer if LNG could be a solution to adhering to international regulations, but rather how much of the market will be replaced by LNG, and, importantly, how the LNG can best be introduced as the preferred fuel/source of energy. Although certain fuel alternatives provide a better environmental performance than LNG, unfortunately, they have limited bunker availability and the purchase-installation costs of the related equipment-systems can be quite high. LNG could therefore be considered as an extremely important facilitating tool in the shipping industry's on-going effort to become more environmentally friendly within a very short time-frame. Promoting the use of LNG can result into significant environmental benefits, with substantial economic savings included in the same equation. In any case, the numerous technical innovations already achieved in order to facilitate production and transport towards the end consumer of LNG have already created a significant need of trainings to ensure a high level of safety during LNG related activities. By considering that the specific type of fuel is now viewed as one of the least expensive transportable

¹⁰http://www.envocare.co.uk/lpg_lng_cng.htm, accessed November 2018.

ones, further use and build-up of additional infrastructures should be expected in the near future. By also factoring in that a rather high number of further research activities in the transport and usage of LNG domains are already underway, the roll out of new systems should be expected in the next few years; more opportunities for training will also follow swiftly. Finally, all the activities that were delivered in the last two years under the BSR LNG Competence Center were following the “physical presence” method (classical classroom setting); taking advantage of distance learning modalities and especially online tests should be integrated in the future delivery methods.

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References

- Dalaklis D., (2012), “Somali Piracy: Some Good News, but a Lot More Needs to Be Done”, *Maritime Security Review*, (9), Waddesdon-UK.
- Dalaklis, D., (2016), Best Fire-fighting Practices for LNG Bunkering Operations, *LNG Competence Development in the Baltic Sea Region Conference*, Nyborg-Denmark, 25 August 2016.
- Dalaklis, D., Ölçer, A.I., Balini, F. & DeWitz, J., (2016), Protecting the Arctic Environment: Challenges and Opportunities for Liquefied Natural Gas, *Human Sea – Marisk Symposium: Economic challenges and new maritime risks management: what blue growth?*, Nantes-France, 4 October 2016
- Dalaklis, D., Ölçer, A., Madjidian, J. A., Ballini, F., & Kitada, M. (2017a). Bridging the LNG Knowledge Gap in the Baltic Sea region: The Go LNG initiative and the establishment of a Competence Centre. In *Proceedings of 11th International Technology, Education and Development Conference (INTED)* (pp. 1417–1425). Valencia, Spain, 6–8 March 2017, ISBN: 978-84-617-8491-2.
- Dalaklis, D., Madjidian, J. A., Ölçer, A., Ballini, F., & Kitada, M. (2017b). Liquefied Natural Gas (LNG) as a Marine Fuel: Optimizing the Associated Infrastructure in the Baltic Sea Region. In J. Madjidian et al. *Kyoto-Japan, International Association of Maritime Economists 2017 Conference*. <https://doi.org/10.13140/RG.2.2.12247.98724>.
- Krilic, T., (2015), News from IMO, *Transactions on Maritime Science*, 4(01), pp. 54-57.
- Madjidian, J. & Dalaklis, D., (2017), Developing the Go LNG Blue Corridor Strategy, *Baltic Ports 2017 Conference*, Trelleborg-Sweden, 6 September 2017.

- Madjidian, J., Dalaklis, D., Paulauskas V., Henesey, L., Ölçer, A.I., Ballini, F. & Kitada, M. (2018), Developing a Strategy for Liquefied Natural Gas Powered Transport Corridors in the Baltic Sea Region. In: Ölçer A., Kitada M., Dalaklis D., Ballini F. (eds) Trends and Challenges in Maritime Energy Management. WMU Studies in Maritime Affairs, vol 6. Springer, Cham DOI: 10.1007/978-3-319-74576-3_27
- Ölçer, A.I., Kitada, M., Dalaklis, D., & Ballini, F., (2018) Editorial Conclusion. In: Ölçer A., Kitada M., Dalaklis D., Ballini F. (eds) Trends and Challenges in Maritime Energy Management. WMU Studies in Maritime Affairs, vol 6. Springer, Cham DOI: 10.1007/978-3-319-74576-3_36
- United States Coast-Guard, (1970), Hazard of LNG Spillage in Marine Transportation, Final Report Supporting Investigation: MIPR No. Z-700099-9-92317. Department of Transportation, U.S. Coast Guard Hazardous Materials Division.
- United Nations Conference on Trade and Development (UNCTAD), "Review of Maritime Transport 2018", available at: https://unctad.org/en/PublicationsLibrary/rmt2018_en.pdf, accessed November 2018.
- www.lngmasterplan.eu, accessed May 2016 (LNG Master Plan project).
- www.golng.eu, accessed October 2018 (Go LNG project)
- www.un.org/sustainabledevelopment/sustainable-development-goals/, accessed November 2018.
- [www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Pages/Emission-Control-Areas-\(ECAs\)-designated-under-regulation-13-of-MARPOL-Annex-VI-\(NOx-emission-control\).aspx](http://www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Pages/Emission-Control-Areas-(ECAs)-designated-under-regulation-13-of-MARPOL-Annex-VI-(NOx-emission-control).aspx), accessed November 2018.
- www.imo.org/en/OurWork/Safety/SafetyTopics/Pages/IGF-Code.aspx, accessed November 2018.
- www.onthemosway.eu/onthemoswaynetwork/?cn-reloaded=1, accessed November 2018.
- www.onthemosway.eu/on-the-mos-way-network-module-2-safety-of-lng-handling-on-plant-bunkering-station-and-on-board-vessels, accessed November 2018.
- www.wmu.se/news/free-online-lng-course-delivered-wmu, accessed November 2018.
- www.envocare.co.uk/lpg_lng_cng.htm, accessed November 2018.
- www.golng.eu/en/bsr-lng-competence-center/, accessed November 2018.
- www.wmu.se/project/lng-value-chain-clean-shipping-green-ports-and-blue-growth-baltic-sea-region-go-lng, accessed November 2018.