

## EXPLORING THE FRONTIERS OF MARITIME ENERGY MANAGEMENT RESEARCH

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**Abstract.** The analysis in hand identifies and examines existing gaps in the contemporary research stream of maritime energy management, via a relevant survey. Based on the input provided by academia, maritime practitioners and industry experts, it also discusses the opportunities that arise for the International Association of Maritime Universities (IAMU) member universities to advance the specific domain of research and promote an energy efficient mode of maritime transport. Energy efficiency has been receiving more and more attention by the wider maritime industry after the Paris Agreement at the 21st Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP 21). Research in maritime energy management is still rather new; there are plenty of opportunities for maritime scholars to contribute in the specific domain. The World Maritime University (WMU) has timely foreseen the need of education and research in the field of maritime energy management, long before the adoption of the United Nations Sustainable Development Goals (SDGs); the launch of its new MSc specialisation, under the title “Maritime Energy Management (MEM)” in September 2016 provides a self-explanatory argument. To inaugurate this new specialisation, WMU hosted the International Conference on Maritime Energy Management (MARENER 2017) in Malmo, Sweden, from 24 to 25 January 2017. This forum of intense interaction attracted over 300 participants from more than 80 countries around the world. The conference provided a comprehensive picture of contemporary issues in the maritime energy management research, including parallel sessions according to the pre-determined seven themes: “Regulatory Framework”, “Energy Efficient Ship Design and Operation”, “Energy Management in Ports and Shipyards”, “Alternative Fuels and Marine

Renewable Energy”, “Social and Human Dimensions of Energy Management”, “Economics of Energy Efficiency”, and “Theoretical Aspects of Maritime Energy Management”. Upon the completion of the event, the organising committee of MARENER 2017 conducted an online evaluation survey in order to better understand the latest developments within the domain of maritime energy management research. In total, 55 responses were received from the external conference participants. The survey identified a number of issues that must be addressed in the future. Indicative examples include how to bridge the identified gap between developed and developing countries, and the role of maritime education and training (MET) in maritime energy management. The current analysis categorises emerging areas of research and puts forward the necessary suggestions to promote future research and collaboration among the IAMU member universities.

**Keywords:** Maritime Energy Management · Research and Collaboration · Maritime Education and Training (MET) · MARENER 2017

## **1. Introduction**

The topic of “Energy Efficiency” has long been evolving in the maritime industry, with the aim to improve its environmental footprint and at the same time maintain an economically competitive shipping business. This trend became very clear after the Paris Agreement at the 21st Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP 21), that established strong requirements upon the wider maritime industry to play an active role in relation to energy efficiency. In order to respond to the global needs in low carbon emissions by maritime transport endeavours, multidisciplinary research on maritime energy management is necessary; from technical and engineering subjects, to legal, economic, and even social ones. However, research in maritime energy management is still rather new; this is a strong indicator that there are plenty of opportunities, not only for those that very “maritime” oriented but also for many other scholars to contribute in the specific field of study.

The analysis in hand is heavily based on a relevant study conducted by the World Maritime University (WMU) in order to gather ideas and thoughts about future research in maritime energy management from academics and practitioners around the world. The main aim is to provide potential directions and identify the right scopes within the maritime energy management research stream for the benefit of the International Association of Maritime Universities (IAMU) member universities. There are numerous benefits under the above-

mentioned framework; pursuing similar agendas could further encourage collaboration in teaching and research activities among the member universities.

## **2. Current discussions on energy efficiency in shipping**

Sustainable Development Goals (SDGs)<sup>1</sup> include Goal 7: “Ensure Access to Affordable, Reliable, Sustainable and Modern Energy for All”, which has raised the concern of how the maritime transport industry can contribute to the energy efficiency issue. All transport sectors are criticised by slow adaptation to diversified energy choice. Indeed, all modes of transport have been heavily depended on oil as their (primary) energy source. In Europe, the oil dependency of transport sectors accounts for 93.6% in 2014 (Eurostat, 2016a). This fact in turn has raised a number of concerns, including energy, environmental and security ones. Mobility of people and goods are expected to increase globally in the future; therefore, growth needs to be as efficient as possible (OECD/IEA, 2016). In fact, over 90% of world trade (UNCTAD, 2016) and about half of European Union’s (EU) trade in goods are carried by sea as it is well known to be the most cost-effective transportation (Eurostat, 2016b). In this respect, the maritime sector can make a significant contribution to energy efficiency, making an impact at the global level.

According to the Third IMO GHG Study (IMO, 2014), the maritime industry annually emits around a thousand million tonnes of CO<sub>2</sub> and is responsible for 2.5% of global greenhouse gas emissions. For the period 2007-2012, on average, the maritime transport sector accounted for 3.1% of annual global CO<sub>2</sub>, which were equivalent to 2.8% of annual greenhouse gases (GHGs). For a future prediction, ships’ CO<sub>2</sub> emissions are expected to increase between 50% and 250% by 2050; however, if operational measures and implementing existing technologies are appropriately applied, there is a potential of reducing CO<sub>2</sub> emissions by up to 75% (IMO, 2009). This responsibility of the maritime industry was timely realised, as shown by the adoption of the Annex VI of the International Convention for the Prevention of Pollution from Ships (MARPOL). Through the specific legal toolbox, it is now an obligation to implement the Energy Efficiency Design Index (EEDI) for certain types of new ships, as well

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<sup>1</sup> On the 25th of September 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 following title: “Transforming our world: the 2030 Agenda for Sustainable Development”. There are 17 Sustainable Development Goals (SDGs); of particular interest 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. Each goal has specific targets to be achieved over the next 15 years, with the complete details being available at: <http://www.un.org/sustainabledevelopment/sustainable-development-goals/>, accessed January 2017.

as the Ship Energy Efficiency Management Plan (SEEMP) for all ships.

While the IMO's efforts are seen as a rather complex operating framework for international shipping due to various other national and regional legislations, EU adopted a legal framework (Regulation EU 2015/757) for the monitoring, reporting and verification (MRV) of CO<sub>2</sub> emissions from maritime transport. Through this MRV Regulation, EU wants to obtain a better understanding of fuel consumption and CO<sub>2</sub> emissions from shipping activities within Europe. Under the MRV framework, three steps are suggested: [1] Monitoring, reporting and verification of carbon emissions from ships; [2] GHG reduction targets for the maritime transport sector; and [3] Further measures, such as Market-Based Measures (MBM).

These initiatives to support SDG 7 have been in fact driven by so-called developed countries and there are scarce research and literature efforts in relation to the developing countries' perspectives on energy efficient shipping. This view is articulated by the UN's SDG 7.a, stating that 'by 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy and energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology (UCLG, 2016).' The global challenge in this context would be how the global maritime industry can contribute to successful actions for SDG 7 without leaving developing countries behind (Ölçer et al., 2017).

### **3. The role of maritime universities in the maritime energy management domain**

The rise of energy efficient shipping increases the opportunities for maritime universities to support the industry needs and participate in policy-making at both national and international levels. For example, the Finnish government advocates policy coherence for sustainable development: The concept of "Towards carbon-free, clean and renewable energy cost efficiently" is taken into consideration of their national plans and strategies (Finnish Government, 2016). The EU project, Sea Traffic Management (STM) presented a case from their study that 4% of fuel saving can be achieved by ship's route optimisation between Sweden and Denmark and this accounts for 2,000 million Euros per year (Siwe, 2017). These examples testify that both policy-makers and industry members are looking for the "right" opportunities to advance an energy efficient maritime transport and are ready for investing into such efforts. However, the involvement of maritime universities in the maritime energy management domain could be more encouraged. As maritime experts, there should follow a more

crucial/leading role; maritime universities can be instrumental in the collaboration with all the relevant stakeholders.

Maritime Energy Management is a rather new area for education and research. One of the very promising initiatives from maritime universities within that domain can be associated with WMU. As part of WMU's contribution to the UN SDGs, a new MSc specialisation called "Maritime Energy Management (MEM)" was launched in September 2016. To inaugurate this new specialisation, WMU hosted the International Conference on Maritime Energy Management (MARENER 2017) in Malmo, Sweden, from 24 to 25 January 2017, attracting over 300 participants from more than 80 countries around the world. The conference provided a comprehensive picture of contemporary maritime energy management issues, including parallel sessions according to the pre-determined seven themes: "Regulatory Framework", "Energy Efficient Ship Design and Operation", "Energy Management in Ports and Shipyards", "Alternative Fuels and Marine Renewable Energy", "Social and Human Dimensions of Energy Management", "Economics of Energy Efficiency", and "Theoretical Aspects of Maritime Energy Management". Creating such opportunities for education and research in maritime energy management is extremely important.

On the other hand, the dissemination of knowledge and information to guide future research directions of this new scholarship is equally valuable; the topic of Liquefied Natural Gas (LNG) provides a strong indicative example (Dalaklis et al., 2017). Therefore, this paper intends to share the analysis of future research needs in the maritime energy management field among the IAMU member universities in order to build research capacity for the global maritime community.

#### **4. Methods**

The need of research in the maritime energy management field was investigated by (honest) opinions shared by the MARENER 2017 participants, who have in-depth knowledge about the real existing challenges and what exact type of opportunities must be exploited in order to ensure the sustainable future of the maritime sector. Such an ontological approach was further strengthened by triangulation which provides a "family of answers" (Pawson and Tilley, 1997), containing several contingent contexts of realities.

Online survey research was applied by immediately following up the conference participants, regarding to their insights, inspirations, and expectations. Other available methods, such as telephone interviews and hard-copy surveys, were not identified as suitable in terms of time and cost issues within the university's conference activities. The link to the

online evaluation survey was sent by follow-up emails with the participants, including a thank-you message and other useful links, such as the presentations files.

In summary, the online evaluation survey about MARENER 2017 was conducted from 30 January until the 14 February 2017. In total, fifty-five non-WMU participants responded, and the overall response rate was 46%. The conference participants were both academics and maritime professionals who had a particular interest in the given subject. Eysenbach and Wyatt (2002) suggest that a qualitative internet survey requires to deliberately looking into specific groups or individuals in order to obtain a profound understanding of their views. Though both quantitative and qualitative data were obtained, the current analysis mainly discusses qualitative data from open-ended survey responses, which are relevant to its scope. The data were coded to summarise and capture the essence of what informants expressed in terms of future research needs in the maritime energy management field. To understand patterns and regularity about the data by coding (Saldaña, 2016) helps the researchers to identify the key issues from the individual experiences of MARENER 2017.

## **5. Data analysis**

The survey respondents were all externals, and many of them (35 out of 55 respondents) identified themselves as coming from education sectors: Almost the half (49.1%, n=27) of the total respondents were university academic staff, whereas 14.5% (n=8) university students. The industry representation was 12.7% (n=7) from maritime-related companies; 7.3% (n=4) from governments; and 3.6% (n=2) from ports. The respondents who were employed in energy sectors were 18.2% (n=10) and environmental sectors 12.7% (n=7). A few respondents were naval architects (n=3), seafarers (n=2), or engineers other than seafarers (n=2). Finally, in terms of gender, male participants were 67.3% (n=37) and female 32.7% (n=18).

### **5.1. Benchmarking maritime energy management research**

The survey respondents discussed their insights about MARENER 2017 and it appeared that the conference had offered several important ways to examine potential maritime energy management research topics. For example, the major contribution of MARENER 2017 was to present multidisciplinary approaches to maritime energy management. Approximately a quarter of the respondents (23.6%, n=13) addressed a wide range of different views and areas of interest in the field of research. It was confirmed by many respondents that the methodologies to achieve/promote energy efficiency in shipping are broad and so as the multidisciplinary aspects of maritime energy management. Another important highlighted

issue was that the existing knowledge about maritime energy management had significantly expanded during the conference (20.0%, n=11). MARENER 2017 benchmarked to what exactly level both industry and academia know about maritime energy management (knowledge-level identification). It is indicative that up-to-date research results, examples and information on energy efficiency, different perspectives by country and EU, and various measures to improve energy efficiency were raised by the respondents. The survey also revealed the current challenges within maritime energy management, which are not all common to every country but rather different countries face different problems. This concern was raised by 9.1% (n=5) of the respondents and was deemed as important by both policy makers and practitioners.

## **5.2. Bridging the gap in maritime energy management research**

Though MARENER 2017 covered a wide range of aspects in maritime energy management research, the survey enabled the identification of some gaps in which the conference could not fully address. The answers from the respondents were generally spread over different areas, however 12.7% (n=7) of them expressed that the maritime energy research in relation to the human element should be strengthened, including the issues of education and training, social and economic impact on sustainable energy, gender, and awareness. The importance of human element in maritime energy management is already addressed by Kitada and Ölçer (2015). Other similar examples include Dalaklis (2016); Ölçer et al. (2017). Another identified gap is related to industry views on maritime energy management (10.9%, n=6). The responders were mainly interested in how business and commercial aspects can influence maritime energy management, such as split incentive cases, applications of energy systems, integrated logistic services, and the ways of coping with practical issues. Furthermore, the areas of ship design (9.1%, n=5), ship operation (7.3%, n=4), renewable energy (7.3%, n=4), regulation (7.3%, n=4), port (7.3%, n=4), and fuel (7.3%, n=4) have been pin-pointed as areas of further interest. For example, ship design research can include ship retrofitting for energy efficiency by manufacturers; ship operation research can address wind propulsion, voyage optimisation, and weather routing; renewable energy research can develop more on ocean energy; policy and regulation research can focus on ship's energy auditing, regulatory framework, ratification and implementation of IMO conventions, and biodiversity protection; port research can explore smart port, infrastructure, standards, and management; and fuel research can look into fuel cells, alternative fuels, and LNG. Other opinions also suggested the areas of climate change and offshore industry in relation to maritime energy management.

### **5.3. Future directions of maritime energy management research**

The survey explored the respondents' views about the future directions of maritime energy management research. The most common answer (20.0%, n=11) was to build specialised expertise within the field. For example, a more narrow focus on a specific area of maritime energy management is on demand. This trend was clearly expected, because some of the on-going research efforts on maritime energy are still in the development phase or immature. People are interested in further development of new ideas and their applications into practice. It can be also stated that most of the available data about energy are not necessarily specific to the maritime sector. Generally speaking, it is not easy to find relevant research and reports about maritime energy management, especially at a national level. This suggests that more and more experts in maritime energy management are “demanded” by the industry, and thus, the future directions of maritime energy management research could be to narrow down the existing knowledge and to understand the issues of maritime energy management in depth.

Another topic to be included in the future research agenda should be practical applications of theories (16.4%, n=9): For example, the actual examples of implementing regulations; practical approaches from maritime companies; applicability of maritime energy technologies in developing countries; ship owners' perspective in decision-making about applying new technologies; commercial experiences and their relation to academic research; viewpoints from energy efficiency equipment manufacturers; and more technical, efficient and economically feasible methods.

In addition, research relating to SDGs was also identified as a need (7.3%, n=4). For instance, how to bridge the gap between developed and developing countries to meet the SDGs is an important research objective. Though specialised knowledge on maritime energy management is necessary, it is also important to look the agenda of energy beyond the maritime sector. Energy in SDG Goal 7 has a linkage to other SDGs, such as Goal 13 (Climate Change) and 14 (Ocean). An intersectional approach addressing several SDGs would be one of the future directions in maritime energy management research. Other answers were also interesting and they included the topic of human element (5.5%, n=3), port (5.5%, n=3), technology (5.5%, n=3), and others (e.g., Monitoring, Reporting, and Verification (MRV); ship operation; and governments).

## **6. Conclusion and remarks**

The analysis of the MARENER 2017 evaluation online survey identified the current status of



maritime energy management research (benchmarking), as well as the gaps to fill in for the future. From the conference and the survey study, it is evident that there is a need for more practical examples and real-life applications to facilitate the already available theoretical understanding. In this regard, WMU has already taken an action to address such needs and established a module called [EGY 107] “Applied Energy Research” within the MEM specialisation. This module offers a unique experience of practical applications of theories in practice for the MEM specialisation students in their early research career. Though the majority of literature and reports relating to energy efficiency in the maritime sector has been published in so-called developed countries, it is equally important to understand how the other countries, especially developing countries, deal with similar problems of maritime energy management by proper scientific methods.

As a final note, the study also confirmed that a multidisciplinary approach is a necessary direction of future research in maritime energy management; the later requires a very wide range of experts across the interrelated transport and engineering industries. Human element and industry views were found to be particularly important in terms of effective implementation of regulations and policies. Needless to say, the role of maritime universities is crucial to create research-based knowledge in the field; the IAMU network must lead the way and lead research and innovation within the maritime energy management domain.

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