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Aykut I. Ölçer · Momoko Kitada
Dimitrios Dalaklis · Fabio Ballini *Editors*

Trends and Challenges in Maritime Energy Management

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The Need for Education and Training in Maritime Energy Management in Myanmar

Thet Hlaing Swe, Momoko Kitada, and Aykut I. Ölçer

1 Introduction

Current technological developments in the maritime industry have been largely led by so-called developed countries in terms of the quantity and quality of maritime transport. Containerisation, faster and bigger ships and ports are good examples of technological developments in the twentieth century. In the last decade, the idea of development has evolved from the mere implication of economic development to the more comprehensive implication of sustainable development. Over 150 world leaders adopted the 2030 Agenda for Sustainable Development, including the Sustainable Development Goals (SDGs) at the United Nations (UN) Sustainable Development Summit on 25 September 2015. In this new direction of a sustainable future, the role of developing countries is more emphasised in the realisation of ideological sustainable development.

One of the key tasks in the maritime sector is to respond to its contribution to the accomplishment of SDGs. In particular, SDG 7 'Ensure Access to Affordable, Reliable, Sustainable and Modern Energy for All' along with SDG 12 'Ensure sustainable consumption and production patterns', and SDG13 'Take urgent action to combat climate change and its impacts' are the goals that the maritime industry can contribute to through the implementation of energy efficiency. This global challenge has been addressed by various stakeholders, such as policy makers, regulators, shipowners, manufacturers, port operators, ship builders, educators, and NGOs.

T. H. Swe (✉)
Myanmar Maritime University, Yangon, Myanmar
e-mail: s14011@alumni.wmu.se

M. Kitada · A. I. Ölçer
World Maritime University, Malmö, Sweden

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However, when SDG 7 is localised in developing maritime countries, like Myanmar, there are a number of challenges and restrictions in terms of available resources to achieve the Goal by 2030. Considering the fact that Myanmar is producing seafarers to work in the high seas, it is reasonable to assume that Myanmar's role in advancing SDG 7 in the maritime sector will be to educate future seafarers and equip them with relevant knowledge and, thereby, build competence for energy efficient ship operations. Therefore, this paper discusses how Myanmar, as a developing country, can respond to energy efficient shipping through education and training.

To begin with, the paper reviews the situation of Myanmar's maritime industry and examines both strengths and weaknesses of the industry. Then, it looks into the measures developed by the International Maritime Organization (IMO) regarding energy efficiency on ships.

2 Review of the Maritime Industry in Myanmar

In the discourse of energy efficient shipping within the future landscape, it is important to consider the role that developing countries to play in achieving the global goal, such as SDG 7. This section presents a review of Myanmar's maritime industry in terms of both its strengths and weaknesses in its national context.

2.1 Strengths of Myanmar's Maritime Industry

Among many strengths that Myanmar's maritime industry has, it is notable that Myanmar is geographically advantageous in maritime operations and services. Myanmar has great potential in its location to be a strategic hub for South-East Asia in terms of maritime-related facilities, such as ports, ship building and repair.

In Myanmar, there are a number of deep-sea ports situated along the coastline (see Fig. 1). The benefits of deep seaports are that large international seagoing vessels can berth and goods can be transported by connecting the inland route to China and other East-Asian countries. Therefore, the effective use of deep seaports in Myanmar would bring the huge merit of shorter and more economical transportation routes than the current seaborne lane, which passes the Malacca strait. With this potential, Myanmar ports are expected to play a vital role in the intermodal transportation of East Asian and South-East Asian trades in the near future (Embassy of the Kingdom of The Netherlands in Myanmar 2016).

In addition, Myanmar has another advantage in inland water transport. Four major rivers, which are Ayeyarwaddy, Chindwin, Thanlwin, and Sittaung, flow down through the country from north to south. These rivers are a lifeline for Myanmar people who rely on agriculture as well as inland water transportation. In particular, the Ayeyarwaddy River is commercially navigable and its navigational

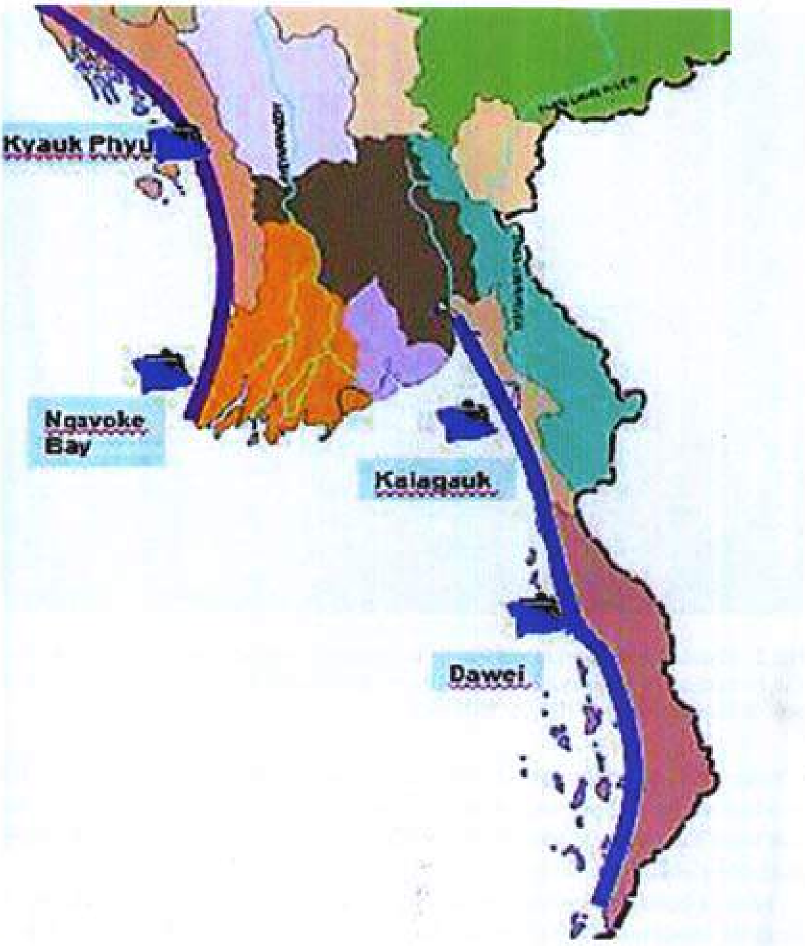

Fig. 1 Ports in Coastal region of Myanmar (originally published by Embassy of the Kingdom of The Netherlands© Ministry of Foreign Affairs (2016); published with kind permission of © Ministry of Foreign Affairs. All rights reserved)

length is 2170 km out of the total of 6951 km. Myanmar has a long history of maritime transportation that dates back to the ancient era when it is recorded that maritime transportation was widely used.

It is also important to note that Myanmar is rich in natural resources, such as gems, oil, natural gas, and minerals. According to the Myanmar Oil and Gas Enterprise (MOGE), there are 51 oil and gas fields in total; of which 26 are in shallow water and 25 are in deep water (see Fig. 2). Some of these sites have already been located but the majority is still unexploited (Embassy of the Kingdom of The Netherlands in Myanmar 2016). In terms of the implementation of energy efficiency measures, Myanmar is suitable for investment in renewable energy because of its

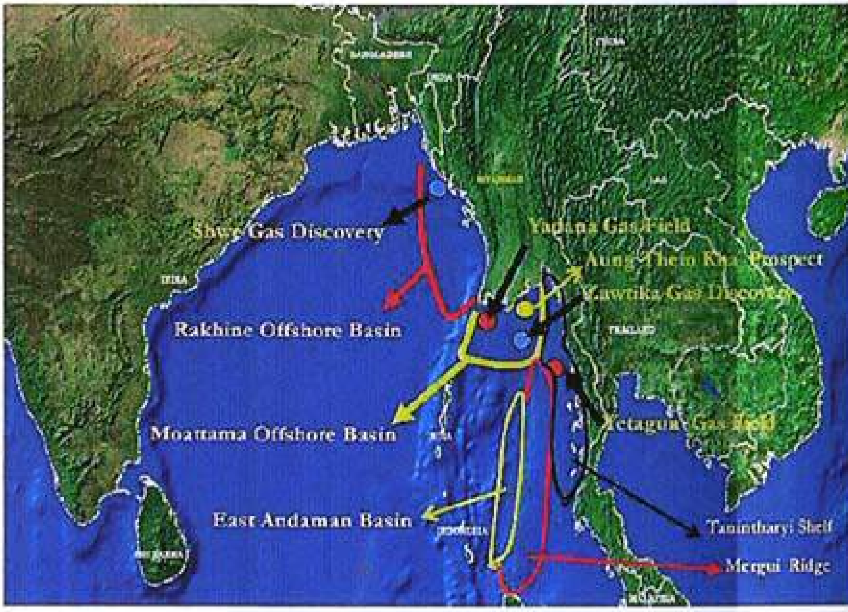

Fig. 2 Myanmar Offshore Oil and Gas fields (originally published by Embassy of the Kingdom of The Netherlands© Ministry of Foreign Affairs (2016); published with kind permission of © Ministry of Foreign Affairs. All rights reserved)

climate and geographical features in favour of sunlight, wind, rain, tides and geothermal heat. This would create a great opportunity for land-based industries that want to employ renewable energy, such as hydraulic energy or bio-diesel gas in producing electricity for domestic use.

From a human resource perspective, the characteristics of people in Myanmar are generally well-received, such as obedience, humbleness and quick uptake of new things, including technology. This is known as one of the valuable assets of the country.

In summary, maritime and energy industries have great potential in Myanmar and South-East Asia; hence, they are recognised as inevitable and important in the future development of Myanmar. The country shares long international borders as well as a long coastline, which makes Myanmar a strategic maritime country. Regional co-operation in various aspects of the maritime industry has become essential not only for Myanmar but also for the region as a whole.

2.2 *Weaknesses of Myanmar's Maritime Industry*

Inland Water Transport (IWT) under the Ministry of Transport has a fleet of about 100,000 tons along with 500,000 tons owned by private owners. These vessels are mainly barges, and mixed cargo/passenger ships. IWT is currently facing financial issues due to the emergence of private fleet operators in inland waters. Consequently, most vessels owned by IWT are becoming old and, thus, they are producing various types of pollution in rivers, such as oil pollution, air pollution, garbage pollution and sewage pollution. Most of the pollutions are due to either the age of vessels or poor operational and maintenance practices resulting from the lack of knowledge and skills of seafarers on board.

Regarding offshore regions where a number of oil and natural gas rigs are located in Myanmar's territorial waters, there are no effective regulations or policies for pollution prevention and contingency plans.

Shipbuilding in Myanmar is a small-scale industry, which emphasises the construction and repair of domestic inland cargo/passenger vessels. In spite of relatively cheap labour costs, Myanmar's shipbuilding sector is neither mature nor competitive at the international level due to the lack of skills, facilities, and technology as well as weak shipbuilding rules and regulations and an unfavourable tax regime. The majority of shipbuilders in Myanmar does not have sufficient knowledge of the Energy Efficiency Design Index (EEDI) technology. Moreover, there are no effective national rules or regulations for Energy Efficiency Implementation Plans for ships. These are the challenges that Myanmar shipowners face when building their ships. Environmental conservation does not receive enough attention although fuel consumption is the main economic driver of operational costs.

2.3 *Education and Training*

To maximise Myanmar's strengths while minimising the effects of the above-mentioned weaknesses, it appears that education and training of people is the key to transforming Myanmar into a more energy efficient country in South-East Asia. The main income of Myanmar relies on exporting raw materials such as natural resources. The over-dependence on natural resources is anticipated to be unsustainable for the future of Myanmar. A more balanced approach is necessary to support sustainable development in Myanmar, which is only possible by investing in people through education and training for human resource development. With acquired knowledge and skills, Myanmar is highly likely to develop in the long term.

For example, Myanmar already has natural gas in its ocean basin. If the country has facilities, infrastructure and experts in LNG bunkering, it will enable to build LNG bunkering stations within their deep-sea ports. At the same time, a new transportation lane can be explored if the country launches LNG bunkering facilities in its deep-sea ports. Such a technology-driven vision will help the advancement of Myanmar's maritime industry. To make it happen, it is vital to cultivate human resources in Myanmar through education and training.

3 Current Status of Energy Efficiency Education in Myanmar

It is evident that Myanmar's maritime industry is growing but is still immature in many areas where modern technologies might be required. With a number of potentials highlighted earlier, Myanmar's maritime industry would be able to develop in a sustainable manner if more experts in maritime technology are produced. A paradigm shift is needed from natural resource-oriented to human-resource oriented thinking to strengthen Myanmar's maritime industry.

Currently, two government-owned training institutions, Myanmar Maritime University (MMU) and Myanmar Mercantile Marine College (MMMC), are the main players contributing to the advancement of education and training in maritime technology for maritime professionals. There are also private training centers under the framework of the Department of Marine Administration providing short training courses to meet the requirements of seafarers' competences. The following sections present how each training institution in Myanmar provides maritime energy efficiency related education and training in order to analyse the gap between the current and future programmes.

3.1 *Current Activities of Training Institutes*

3.1.1 Myanmar Maritime University (MMU)

The Human Development Function of MMU is to train naval architects, marine engineers, marine mechanical engineers, port and harbour engineers, river and coastal engineers, electrical and electronic engineers, and deck officers. In addition, MMU offers a course in Shipping Management and Port Management to maritime experts.

Myanmar also needs to respond to the requirement in Annex VI of the International Convention for the Prevention of Pollution from Ships (MARPOL), which requires all new ships to implement EEDI. In Myanmar, where only inland and coastal vessels are built, shipbuilders do not need to comply with the EEDI measures. However, such updated knowledge, which has been kept among the faculty of Naval Architecture and Ocean Engineering (NAOE) of MMU, can be transferred to shipbuilders and other maritime professionals to design and produce more energy efficient inland water ships. The latest information on maritime rules and regulations as well as maritime technologies are important to be disseminated among the relevant stakeholders in order to prepare them for new trends and changes in the global maritime industry.

The NAOE faculty members have been working on upgrading the naval architecture courses to support EEDI through research since 2014 (see Table 1).

Table 1 An overview of energy efficiency research in MMU

Title	Type of activities	Brief description	Outcome
1. Study of Trim Dependence for Ship performance in the Actual Sea Conditions by Computational Fluid Dynamics (CFD) Simulations	Joint project (cooperation with Weather News Inc., Japan)	The research purposal is to build up a foundation for employing CFD techniques for ship trim optimisation in actual sea conditions.	The University established the CFD application for hull form optimization practice in the students' final year projects and shipbuilding industry of Myanmar.
2. Study on Hull Form Optimisation for Minimum Wave Resistance Based on Rankine Source Method	Master Thesis	The main purpose is to get optimum hull form inland vessels in Myanmar with minimum wave making resistance. Optimisation is by using a nonlinear programming method based on Rankine source method.	In Progress
3. Analysis of the Passenger Ship with Energy Efficiency Specification: Using Light Material for Superstructure	Bachelor Thesis	The key target of the paper is to obtain an Energy Efficient Ship by Renovation Technology. Therefore, the paper analyses reforming the superstructure of an existing ship from steel to aluminium to check the effectiveness of lightweight material by verifying whether the newly renovated ship attained EEDI with required EEDI.	– We could see whether using the lightweight material in inland and coastal Myanmar vessels is a possible resolution in saving fuel consumption and cutting CO_2 emission. – We could know how to recover the advantages of aluminium instead of steel in shipbuilding. – Naval Architecture students could understand how to apply and verify EEDI measures in design state.
4. Trim Optimisation of container ship by test tank and numerical simulation	Master Thesis	The main purpose is to develop and maintain a strategy under the mandatory Ship Energy Efficiency Management Plan (SEEMP) as well as achieving real savings to remain competitive and optimise the draft for enhanced fuel savings. To obtain the optimal result, the model ship is tested in towing tank.	In process

These research activities are monitored by experienced faculty members who are well-trained by overseas maritime universities such as the World Maritime University (Sweden), Osaka University (Japan), Korea Maritime University (South Korea), and Shanghai Maritime University (China).

3.1.2 Myanmar Mercantile Marine College (MMMC)

The MMMC was established in 1972. It offers four-year bachelor's degree programmes in merchant marine science and merchant marine technology as well as a post-graduate diploma course in maritime transportation and maritime technology. The training courses are based on the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW), 1978 as Amended.

Though MMU and MMMC seem to have some overlap, they actually have different approaches. MMU focuses on training both competent seafarers and experienced maritime engineers whilst MMMC is specialised in training competent seafarers in deck and engine departments.

3.1.3 Private Training Centers Authorised by the Department of Marine Administration (DMA)

The courses relating to the Certificate of Competence (CoC) are also taught in private training centers, authorised by the Department of Marine Administration (DMA) under the Ministry of Transport and Communications. Table 2 shows

Table 2 Training courses, relevant to energy efficiency, of private training centers and MMMC (originally published by Lin (2015); modified with kind permission of ©Lin (2015))

Course titles	Related topics for SEEMP	Covered topics in the courses
1. Certificate of competency course based on the IMO model course 7.01 (this course is for Master and Chief Officer)	Plan a voyage and conduct navigation	Voyage planning
	Forecast weather and Oceanographic conditions	Weather routing
	Plan and ensure safe loading, stowage, securing, and care during the voyage and unloading of cargoes Control Trim, Stability and Stress	Trim optimisation
2. Certificate of competency course based on the IMO model course 7.02 (this course is for Chief Engineer officer and Second Engineer officer)	Physical and chemical properties of Fuels and lubrications	Low sulphur fuel content
	Operation and maintenance of Marine Engine and Auxiliary Engine Waste heat utilisation	Waste heat recovery system

training courses relevant to energy efficiency conducted at private training centers and MMMC.

Furthermore, workshops, seminars and conferences are occasionally organised by DMA and Myanmar Engineering Society. For example, 'Workshop on prevention of air pollution from ships and action by IMO to address GHG emissions' was held in Yangon City between 18 and 19 March 2013. With such events, the professionals in the Myanmar maritime industry are kept updated on specific subjects like energy efficiency.

3.2 *Review of Academic Activities in Myanmar Towards Energy Efficiency*

Both Tables 1 and 2 summarise ongoing academic and research activities within Myanmar's maritime industry in relation to energy efficiency. Some areas, such as resistance minimisation, hull form optimisation, and EEDI calculation and verification, have been addressed. However there are still gaps in which some missing elements need to be fed into the academic activities. For example, a towing tank experiment is needed at the EEDI preliminary verification stage. At present, MMU's towing tank is used for making calculations for resistance and powering of domestic vessels. For high-speed craft models and complex hull forms, the power and resistant data can be obtained by the application of a CFD simulation. The infrastructure in MMU and the experience gained for domestic vessels provide great opportunities for the maritime industry to take the first step of the EEDI verification stage for complex hull forms.

On the other hand, MMMC and private training centers are making their way to upgrade seafarers' competences and skills relevant to energy efficient ship operations. They offer training courses to cover onboard Ship Energy Efficiency Management Plan (SEEMP) and its evaluation tool, Energy Efficiency Operational Indicator (EEOI). Though the current situation in Myanmar does not fully reflect the best scenario for effective implementation of maritime energy management, various efforts can be initiated to promote energy efficiency as one of the main streams of future maritime education and training in Myanmar.

4 Future Training Model for Maritime Energy Efficiency in Myanmar

The previous section analysed the current situation of Myanmar's maritime industry in terms of maritime energy management. This section proposes four key areas to improve the quality of Myanmar's education and training on energy efficiency.

These four areas, which need to be focused, are Legislation; Research collaboration and dissemination; IMO model course; and Regional cooperation.

4.1 Legislation

The first area to support Myanmar's education and training is legislation. Myanmar has already signed MARPOL Annex I, III, and V. However, Annex VI has not been ratified by Myanmar as of November 2017. This hinders the development of national regulation and policy in Myanmar to prevent air pollution resulting from the maritime industry.

Moreover, most new ships currently being built are to be used for inland water transportation and coastal liners. According to Regulation 19 of MARPOL Annex VI, EEDI does not apply to ships sailing entirely within flag state waters.

If MARPOL Annex VI is ratified by Myanmar and strict national laws are set up, it will encourage various stakeholders to work towards a low carbon and energy efficient future for the maritime industry; for example, classification societies will come to follow those regulations; shipowners and shipbuilders must comply with compulsory rules in their ship construction process; port and terminal operators need to provide adequate reception facilities for exhaust gas cleaning residues in Myanmar Ports.

4.2 Research Collaboration and Dissemination

The Myanmar Maritime University has, itself, been conducting research to build capacity in maritime energy management, for example, topics related to technical measures and EEDI. These research activities are kept rather in-house and the dissemination of research is not strong. Thus, promoting research in maritime energy management at both national and international levels is crucial. To do this, exploring collaborative opportunities with local and overseas universities would be helpful. For example, the Myanmar Maritime University has been a member of the International Association of Maritime Universities (IAMU) since February 2015. IAMU has 62 universities of the world's maritime education and training universities/faculties as of November 2017. Such a global network of maritime education and training will provide a forum to exchange research findings and collaborations and benefit the maritime energy management studies in Myanmar.

Another issue is the lack of connection between academia and industry. The research conducted by academics does not go beyond; therefore, in order to make effective use of the research outcomes, academia and industry need to cooperate on applying energy efficiency measures. This will also trigger future research topics through understanding of the industry's needs and may create funding opportunities for research.

4.3 IMO Model Courses

There are many ways to facilitate education and training on energy efficiency in the maritime industry. One of the most well-known methods is to follow the IMO model courses. This method is effective especially in developing countries like Myanmar where resources are limited and some technical guidance such as IMO Model Courses is a good start to design a suitable curriculum. The other useful guide is a handbook called *"Training course on Energy Efficient Operation of Ships"* developed by the World Maritime University (Baumler et al. 2014) and recently updated by IMO (IMO 2016).

It is also worth noting that training is important not only for trainees but also for trainers. In this philosophy, IMO and WMU developed a train-the-trainer (TTT) package in 2013. The primary goal of the TTT course is to support developing countries as part of the IMO's capacity building activities. In 2015, TTT was updated by adding a new module on the regulatory framework related to energy efficiency of ships, an EEDI Calculator for training purposes, and relevant training resources, such as posters, assignments, exercises and presentations (IMO 2016). The modules in this course and their potential benefits are given in Table 3.

Table 3 IMO train the trainer courses on energy efficiency ship operation

Module materials	Benefits for trainers in developing countries
M1: Climate Change and the Shipping Response	– Logically explaining air pollution and climate change issues – Could know the current reactions of International Organizations and IMO
M2: Ship Energy Efficiency Regulations and Related Guidelines and EEDI Calculator and Relevant Document	– Clear instruction to distribute to the trainees on how to verify EEDI – Could clearly understand the EEDI's expectations – Easily to understand Attained EEDI and EEOI calculation
M3: From Management to Operation	– Comprehensive information of advantages and disadvantages of Best Practices of SEEMP – Clear explanation how to apply the best practices
M4: Ship Board Energy Management	Good guide to the responsibilities of seafarers in their respective ranks
M5: Ship Port Interface for Energy Efficiency	Knowledge on technical compatibility aspects of ship-port interface and communication mechanism between port and ship
M6: Energy Management Plans and Systems	Good Steps to hold energy efficiency implementation by monitoring, reporting from the shipping company sector

4.4 Regional Cooperation

In addition to national and international scopes of interventions, it is also important to highlight the need for regional cooperation in maritime energy management. Myanmar cannot maintain itself without regional cooperation. Regional unity and amity provide a good foundation for Myanmar and other neighbouring countries to move toward a zero emissions and energy efficient future of the region (UNDP 2013).

Myanmar is a member of regional associations, such as the Association of Southeast Asian Nations (ASEAN), the Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC), and the Colombo plan. These regional associations strengthen the opportunities for their Member States to initiate energy efficiency in the maritime sector and in other transport sectors in the region. In fact, regional countries have already been active in establishing environmental conservation, protection and contamination plans in the current decade.

4.4.1 Energy Efficiency Initiatives in ASEAN

Myanmar has been actively participating in the regional initiatives for energy efficiency within the ASEAN countries. Although the preventative measures against air pollution in the maritime industry is still at a very early stage in the regional countries, ASEAN fully supports global goals, such as the Paris Agreement, and is keen to contribute to those measures to mitigate the effect of climate change (Table 4).

Even though maritime-related energy efficiency is not yet very clear from each national goal, the IMO's leadership and its Member States in the region are expected to facilitate the implementation of energy efficiency in the maritime industry. In

Table 4 Setting goal for energy efficiency regionally (adopted from © OECD/IEA 2017 Southeast Asia Energy Outlook, IEA Publishing. Licence: www.iea.org/t&c; as modified by WMU)

Member States	Energy efficiency saving goal(s)
Brunei	Reduce total energy consumption by 63% from BAU levels by 2035
Indonesia	Reduce energy intensity by 1% per year to 2025
Lao PDR	Reduce final energy consumption from BAU level by 10%
Malaysia	Promote energy efficiency in the industry, buildings and domestic sectors with methods of standard setting, labelling, energy audits and building design
Myanmar	Reduce primary energy demand by 8% by 2030 from 2005 level
Philippines	Reduce energy intensity by 40% by 2030 from 2010 level Decrease energy consumption by 1.6% per year against baseline forecasts by 2030
Singapore	Improve energy intensity by 36% by 2030 from 2005 levels
Thailand	Reduce energy intensity by 30% by 2036 from 2010 level
Vietnam	Increase commercial electricity savings to more than 10% of total power consumption by 2020 relative to BAU

BAU business-as-usual scenario

order to achieve this globally concerning issue, it is essential to promote regional cooperation to create a regional dialogue and response to the global concern. Smooth flow of information and technology in a relatively limited time is necessary to accelerate the process of implementation toward the sustainable future. By learning best practices from the European Union (EU), a large regional block, South-East Asian countries can also develop an institutional framework for the implementation of energy efficiency measures across all the industries, including the maritime industry.

5 Discussion

Among many strengths and weaknesses in maritime energy management in Myanmar, the paper has identified key areas to build capacity to support the process toward a sustainable future. So, how can we achieve this goal? To apply energy efficiency technology in Myanmar, this paper proposes a hierarchical model shown in Fig. 3. The government's leadership and the awareness of energy efficiency amongst local people and maritime professionals become a foundation. This leadership of the government also helps to take actions, such as developing an environmental conservation plan, sharing best practices of energy efficiency measures among both developed and developing countries, and cooperation with international organisations, regional organisations, and national and overseas universities.

For effective implementation of such action plans, cross-ministerial cooperation within the Myanmar government is necessary, for example, the Department of Marine Administration, under the Ministry of Transport and Communications as well as the Ministry of Natural Resources and Environmental Conservation.

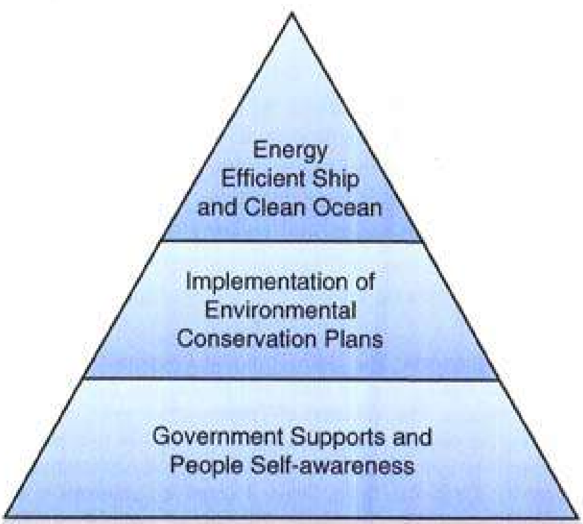

Fig. 3 Hierarchies for implementations of marine energy efficiency measures

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Aykut I. Ölçer · Momoko Kitada · Dimitrios Dalaklis · Fabio Ballini *Editors*

Trends and Challenges in Maritime Energy Management

This book provides an overview of contemporary trends and challenges in maritime energy management (MEM). Coordinated action is necessary to achieve a low carbon and energy-efficient maritime future, and MEM is the prevailing framework aimed at reducing greenhouse gas emissions resulting from maritime industry activities. The book familiarizes readers with the status quo in the field, and paves the way for finding solutions to perceived challenges. The 34 contributions cover six important aspects: regulatory framework; energy-efficient ship design; energy efficient ship and port operation; economic and social dimensions; alternative fuels and wind-assisted ship propulsion; and marine renewable energy. This pioneering work is intended for researchers and academics as well as practitioners and policymakers involved in this important field.

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