IMO-EU Joint Project: Capacity Building for Climate Change Mitigation in the Maritime Shipping Industry

National Technology Needs and Barriers Report

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Contents

Acknowledgement 46

1. Introduction

Climate change mitigation in the maritime shipping sector has been a keen concern of the world shipping community. Various efforts and actions, including the regulatory development regarding to the reduction of GHG from ships and green shipping activities, have been taken to help countries improve ship energy efficiency (EE). For the national level, the first necessity to cut shipping Greenhouse Gas (GHG) is to identify its urgent needs and weaknesses about the enforcing issues. This report is one of these efforts initiated by MTCC-Asia, which is established for International Maritime Organization (IMO), with focus on the analysis of 6 nations' technology needs, barriers and future actions for GHG control from ships.

The target countries covered by this report consist of Bangladesh, Cambodia, China, Malaysia, Myanmar and Malaysia. In order to get a comprehensive picture for a specific maritime country, a holistic assessment approach was adopted and all shipping sectors related to ship EE and GHG reduction were identified and examined. The identified sectors cover those of national fleet profiles, national legislation (ratification of MARPOL Annex VI), and the performances of ship operators and ports. Based on these assessments and data collected, recommended actions and solutions were suggested.

Based on national reports, a baseline assessment was made to identify the urgent needs of the 6 target country in terms of GHG control and ship EE promotion, which lead to the opportunity to find the potential solutions or assistance to improve the current situation of a specific nation.

A shipborne air emission monitoring system developed by MTCC-Asia was used during the assessment. This system provides Asian nations with ship emission inventories based on ship AIS data from terrestrial and satellite AIS system. The emission region considered for each country includes its inland water, territory Sea, Continental Zone and EEZ. The total emission of 6 countries was calculated for the year of 2017 in this report.

2. Shipping status of the six targeted countries

This part aims to give a general description on the main points of each country report. Focuses are on the identification of barriers, technical need and measures to achieve relevant assistance. The six nations are different in many aspects. Therefore, the main points were organized in a general manner but with difference focuses.

2.1 Bangladesh

Being a developing country in South Asian region and with a very high population density, Bangladesh is considered as a highly vulnerable country with climate changes. Specially its geographical location in the Bay of Bengal is already continuing to be slammed by climate effects throughout the year.

The national fleet of Bangladesh has a total carrying capacity of 1925.7 dwt with a number around 300 ships. These ships consist of about 100 oil tankers, 50 Bulk carriers, 80 general cargo ships, 20 container ships and the rest are other ships. There are rare national ships engaged into international shipping. However, there are more than 10, 000 different types of ship operating all the year round in Bangladesh, Regulations related to the energy efficiency for inland waterway ships still does not exist.

Bangladesh emitted 190 million metric tons CO2 in 2012, with the agriculture industry contributing nearly 40% to overall emissions. Bangladesh's emissions increased 59% from 1990 to 2012, with an annual average rate of change of 2%. The Bangladesh Climate Change Strategy and Action Plan identifies improving transportation sector energy consumption as a priority since its share of emissions is growing faster than any other sector.

Bangladesh national merchant ship fleet shares 0.096 % of the total world merchant fleet in 2016 as per UNCTAD stat official figures. Further, by considering following Table 2 – Bangladesh National Fleet - Carrying Capacity by type of ship (DWT) and Table 3 – National Fleet by type of ship, it shall be understood with a certain level of growing trend and especially slight biasing towards tanker ships.

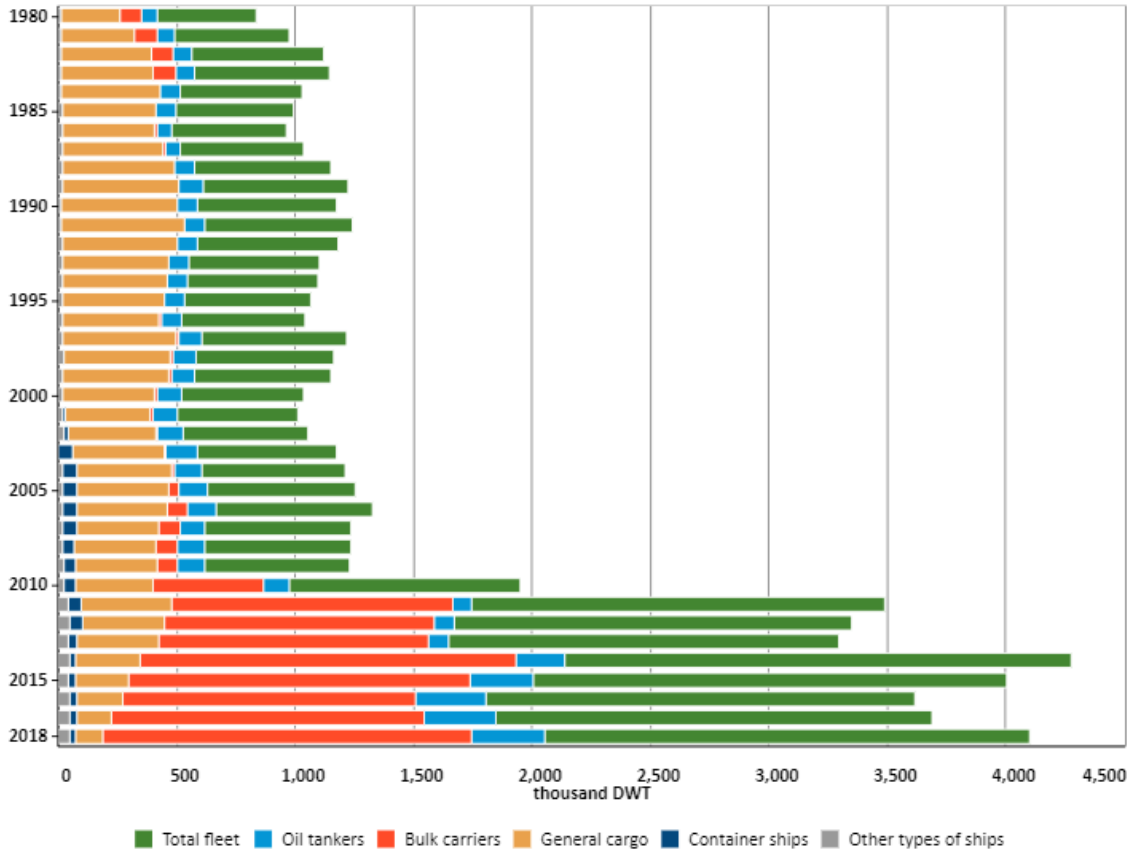

Figure2-1 Bangladesh National Fleet - Carrying Capacity by type of ship (DWT)

(United Nations' Conference on Trade and Development (UNCTAD), 2018)

5

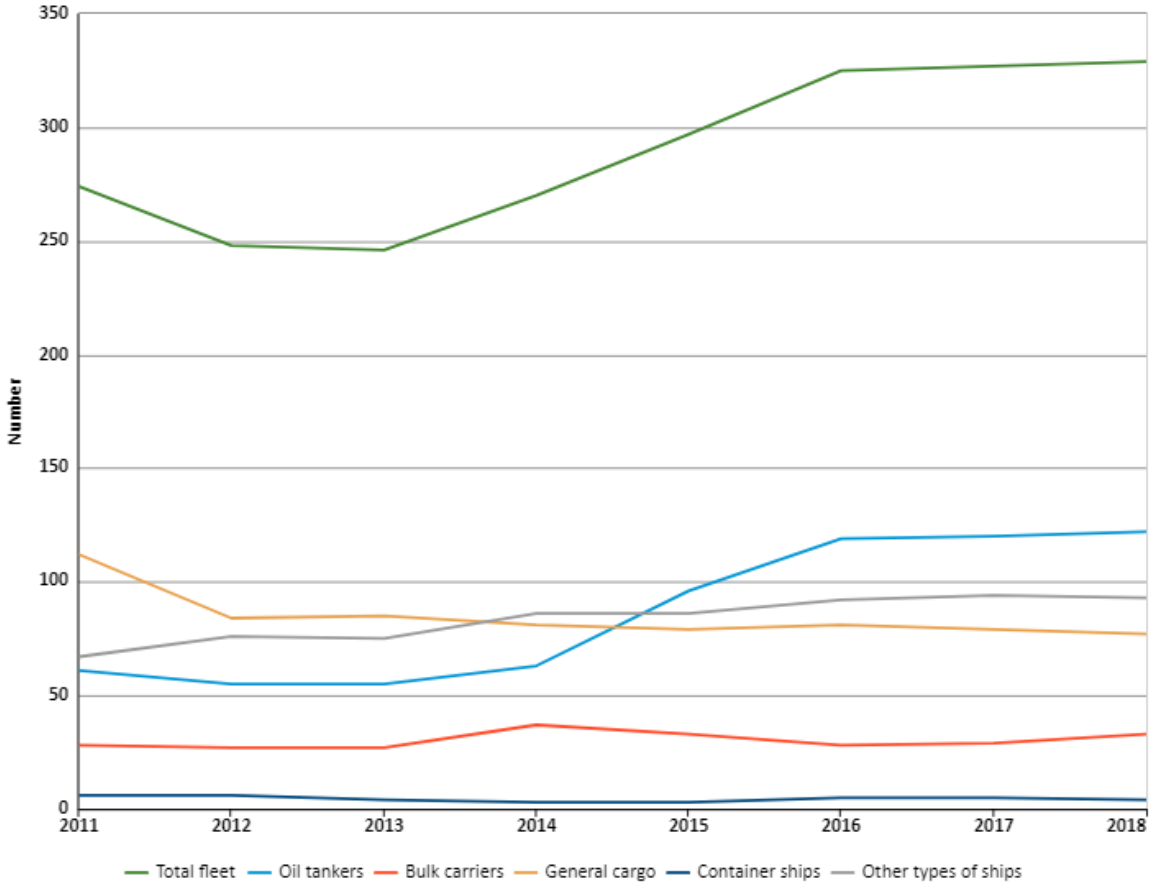

Figure2-2 National Fleet by type of ship

(United Nations' Conference on Trade and Development (UNCTAD), 2018)

As of today Asian shipbuilding industry prevails with three giant shipbuilding nations, i.e. China, South Korea and Japan. However, these giants are more attentive towards larger vessels. As a result, construction of small and medium vessels (25,000 DWT or below) holds a considerable opportunity and this task is being shared progressively by developing nations like India, Pakistan, Vietnam, Philippine, Bangladesh etc. In this perspective, Bangladesh has taken certain initiatives to nurture and develop this shipbuilding industry with the dream of becoming a middle income nation soon. (Rahmana, M Muzibur, 2017)

However, as per UNCTAD official figures, it was revealed only 6 099 GT of ships were built in Bangladesh in the year of 2016. (United Nations' Conference on Trade and Development (UNCTAD), 2018)

In Cambodia, both the public and private sectors involved in maritime training and education can be found as follows as the leading roles:

6

Public Sector

- Bangabandhu Sheikh Mujibur Rahman Maritime University, Chittagong
- Marine Technology, BIMT, Narayangang, Ministry of Labour & Employment
- Mercantile Marine Academy, Chittagong
- National Maritime Institute, Chittagong

Private institutes approved by The Department of Shipping

- Academy of Marine Education and Technology (AMET)
- Atlantic Maritime Academy
- Bangladesh Maritime Training Institute (BMTI)
- Cambridge Maritime College (CMC)
- International Maritime Academy (IMA)

Technology related with GHG control and ship energy efficiency are not used by the national ship, because most of these shipped navigation around national water, and there are not regulation to force them. Lots of these ships use second hand engines, whose energy efficiency performances are very poor.

Bangladesh is a signatory member state to MARPOL Annex VI and due to the complicated administrative procedures, a slightly longer time may be expected for making the enabling local laws in the country.

Being a developing country, Bangladesh expects capacity building and human resource development in maritime sector for effective GHG control and ship EE promotion. Bangladesh also express the willingness to bring MARPL Annex VI into their national law. The technical assistance on national legislation in this regards are expected.

2.2 Cambodia

Cambodia owns no oceangoing ships, 1775 coastal ships and 6053 inland water ships. Most of Cambodian coastal ships are fishing vessels. Almost 80% of Cambodian owned vessels have the age of over 20 years. The national fleet profile is shown in the following table (not include fishing vessels).

Table 2-1 Cambodia Fleet Overview

Vessel type	Sub-category	Number of vessels
Container	Panamax and smaller	6
	Post Panamax	-
Dry cargo (non-container)	General	448
	General/pax	1
	Reefer	17
	Ro-ro cargo	9
	Ro-ro/pax	2
	Passenger (pax)	1

7

	Other	6
Total dry cargo incl container	Total	490
Tankers	Up to 100,000 gt	36
	>100,000 gt	-
Total tankers		36
Bulk carriers	Handy size	9
	Handyman	10
	Panamax	-
	Capsize	-
Total bulk carriers		19
Grand total		545

Cambodia has no international ship registered under their flag. Therefore, the current available technical measures for ship EE promotion are not used on any ships. The small inland and coastal ship have no abilities to adopt technologies related with energy efficiency.

The existing national laws and regulations are:

- Sub-decree no. 14 of 3rd March 1989, authorizes the organization and functioning of the Ministry of public works and Transport. Thereafter, the Merchant Marine Department (MMD) was set up and it prescribes the main responsibility of the MMD for the maritime transport issues.
- Declaration No. 189 of 05th April 1999 on organization and functioning of the MMD.
- Ministry Instruction No. 006 of 01st October 1999 on administrative management and technical survey of Cambodian coastal ships.
- Memo No. 007 of 18th April 2001 on tariffs for registration and ship operation related documents of Cambodian coastal ships.
- Declaration No. 222 of 19th July 2002 on creating and using of MMD-logo.
- The Cambodian Shipping Acts.
- Declaration on Maritime Transport Permit.
- Sub-decree on the Establishment of PSC for the Kingdom of Cambodia.

Cambodian Maritime Code is drafted as the basic law for all the maritime affairs, whereas the Maritime Code or the Merchant Shipping Acts of other countries are generally treated as one of the maritime laws collaterally bundled with other maritime laws such as the Ship Safety Law, the Prevention of Marine Pollution Law, and the Maritime Transport Law. The Code stipulates territorial seas, ship registration, marine safety/ship safety, collision prevention, ports, pilot, search and rescue, seafarers, prevention of marine pollution, marine accidents inquiry as the Public Law, and merchant shipping as the Private Law. The Public Law is constituted to make all the other maritime rules and regulations under the umbrella of the Code. The penalty articles are introduced to most of the regulations in the Public Law. As for the

international cargo transport, Cambodia is going to employ the Hamburg Rule ("Maritime Cargo Transport Convention 1978, United Nation") preserving the rights of shippers.

Cambodia is not a member party of MARPOL Annex VI yet. However, Cambodia is planning to join this Annex under the promotion from Merchant Marine Department of Ministry of Public Work and Transportation. The current national legislation on ship energy efficiency is blank due to the lack of human resource and relevant skills. The main barriers to implement the related ship energy efficiency convention and regulations is the national legislation. Due to the lack of this legislation, the government body has no gear to address this issue.

In Cambodia, although the maritime education and training institute existed before the civil conflict, it has been closed because of the policy of disorganization of educational institutes. In the maritime field, the candidates for seafarers have been educated and trained in ex-socialist countries, such as former Soviet Union and Vietnam; then they have been working as officers of passenger boats or pilots at both ports of Phnom Penh and Sihanoukville. The proper statistics of seafarers has never been developed due to the delay of improvement of registration system of seafarers. The number of seafarers in Cambodia is estimated in line with the number of seamen's book.

The following reports have stated that the number of seafarers in Cambodia has been about 500 and from 5,000 to 6,000 including fishermen:

(1) "Needs Assessment Mission on Maritime Legislation and Administration of Cambodia" by IMO in 2001

(2) "Country Report of Cambodia, Report of the Second Regional Forum on Maritime Manpower Planning, Training, Utilization and Networking of Centres of Excellence", organized by the Economic and Social Commission for Asia and the Pacific (APEC) in 2003

In addition, the Cambodian government endorsed foreign seafarers who are working on the Cambodian flag vessels since July, 2002, according to "No.002 MPWT Circular on Procedure of Issuance of Certificates of Endorsement for Seafarers, 22nd July, 2002". Also for this system, the endorsed record of issue has not been provided. The foreign countries to which the Cambodian government issues the endorsement under the mutual recognition system of certificate of competency are the following 11 countries: Philippines, South Korea, North Korea, Russia, Ukraine, Estonia, Egypt, Rumania, Singapore, Latvia and Georgia.

The Cambodian government has been introducing legislation toward the seafarer education system; however it will take time to complete the legislation because the Cambodian Maritime Code (draft) does not stipulate the seafarer education system in detail and some sub-decrees are necessary so as to make it in force.

The actual present seafarer education system may to be the system of the Maritime Training Center which is operated by "Phnom Penh Autonomous Port" and "Sihanoukville Autonomous Port" under the control of MPWT. The Center was

inaugurated in January 2006 assisted by EU.

Initially, the Center started with the Operational Level of Navigation Course, then expanded to offer the Operational Level of Marine Engineering Course, the Management Level of Navigation and Marine Engineering Courses.

In the progress of implementation of EE technologies in shipping, Cambodia encountered many barriers, including but not limited to:

- Cambodia hasn't ratified MARPOL ANNEX VI, and cannot enact them as national legislation at present.
- Legislation process could take long time, and there is a lack of social awareness, support and network.
- Shipping companies and ports: poor management, financial obstacles, lack of support from local government, lack of mandatory regulations and requirement, social awareness, backwards shipping technologies etc.. Lots of new technologies are costly, and most shipping companies, especially for coastal and inland water shipping companies, are reluctant to implement them.
- Personnel onboard and ashore are lack of awareness and knowledge of EE technologies.
- Most of the ships owned by Cambodia are old ships with age of more than 20 years old. The facilities and equipment are backward, it is impossible to implement some of the new technologies on those ships.

To solve the problems faced by Cambodia in implementation of ship EE technologies, advice includes:

- Actively promote environmental awareness by appropriate training and education of seafarers and shipping industry.
- Encourage replacement of old foreign going, coastal and inland vessels with new environment friendly vessel.
- Explore effective measures (Financial support, etc) to encourage the private vessel owners to replace aged vessels with new vessels (leasing, joint ship building, etc.)
- Seek for technical assistance from developed countries by international cooperation.
- The personnel onshore and onboard in shipping companies need to be trained in ship energy efficiency technologies to enhance their energy-saving awareness.
- Cambodia needs more human resources with regard to the EE or GHG emission to help to enhance the capacity building in shipping EE and GHG control

2.3 China

By December 31, 2017, China has 144,900 ships used for transportation on water, and the total DWT is 256.5 million tons. See table 3-2 "Composition of waterborne transport vessels owned by China, 2017".

Table2-2 Composition of waterborne transport vessels owned by China, 2017 (By area of navigation)

orne transport vessels owned by China, 2017， (By area of navigation)			
Index	**Unit**	**Actual performance**	**Increment over the previous year（%）**
Inland water transport vessels			
Number of vessels	-	132,300	-10.1
Net deadweight	ten thousand tons	13149.73	-1.6
Passenger capacities	ten thousand	72.30	-6.6
Container capacity	ten thousand TEUs	32.48	9.3
Coastal vessels			
Number of vessels	-	10,318	-1.9
Net deadweight	ten thousand tons	7044.41	4.5
Passenger capacities	ten thousand	22.36	9.9
Container capacity	ten thousand TEUs	50.17	19.7
Ocean-going vessels			
Number of vessels	-	2306.00	-4.3
Net deadweight	ten thousand tons	5457.50	-16.3
Passenger capacities	ten thousand	2.08	-13.7
Container capacity	ten thousand TEUs	133.66	11.9

China has built many seaports along its abundant shoreline resources, and has been speeding up development of large-scale and specialized port terminals. These terminals can provide storage, handling, tally and other services for containers, dry bulk cargo, oil and chemicals, general cargo, vehicles and other types of goods. China has established Shanghai, Tianjin, Zhoushan, Xiamen, Sanya as home port for cruise ships. At present, China has formed five port groups around the Bohai Sea, the Yangtze River Delta, the southeast coast, the Pearl River Delta and the southwest coast.

As of year 2015, there are totally 5899 production wharves in China coastal areas, of which 1807 are berths of 10,000 tons and above, with more than half specialized berths. Among the top 10 ports in the world in 2015, seven ports are located in China, namely Ningbo-Zhoushan port, Shanghai, Tianjin, Suzhou, Guangzhou, Tangshan and

11

Qingdao. According to the annual report of 18 listed port companies in China, total operating income was 117.635 billion yuan and net profit was 18.06 billion yuan in 2015.

Table 2-3. Status of berth of ten thousand tonnage and above (Classified by function)

The classification of berths over ten thousand tons in the whole country (Classified by function)			
Berth function	**Year 2017**	**Year 2016**	**Increment over the previous year**
Specialized berth	1254	1223	31
Container berth	328	329	-1
Coal berth	246	246	0
Metal ore berth	84	83	1
Crude oil berth	77	74	3
Product oil berth	140	132	8
Liquid chemical berth	205	200	5
Bulk grain berth	41	39	2
Common bulk cargo berth	513	506	7
General cargo berth	388	381	7

In year 2017, there are around 310 education and training institutions in China, including maritime universities, maritime colleges and seafarer training institutions, which can basically meet the development needs of crew education and training. The quality of crew training has been improved steadily. By the end of 2017, there were 1.4 million registered crew members nationwide. According to the report on seafarer resources published by BIMCO/ICS in year 2015, China supplies 244000 seafarers to the international shipping industry, ranking the first in the world.

Table 2-4 International seafarers registered as of 2017

Type	2013	2014	2015	2016	2017
Ocean-going	417924	447054	470512	497197	524498

12

Table2-5 International seafarer structure in China, as of 2017

Type	Position	Number	Type	Position	Number
3000GT or above	Master	16272	3000KW or above	Chief Engineer	15386
	Chief Officer	10546		Second Engineer	8890
	Second Officer	14719		Third Engineer	13661
	Third Officer	21347		Fourth Engineer	16826
500-3000 GT or above	Master	258	750-3000 KW	Chief Engineer	502
	Chief Officer	256		Second Engineer	354
	Second Officer	169		Third Engineer	296
	Third Officer	15		Fourth Engineer	24
500GT or below	e Seafarer Deck	63635	750 KW or above	e Seafarers Engine	45439
	Senior Able Seafarer Deck	28320		Senior Able Seafarers Engine	18874
Total		275789			

Source: Seafarer Development Report, 2017, MSA China

China is a party of STCW convention, and complied and implemented requirements of the provisions of this convention in accordance with Reg.1/8 of Quality standards. The standards of implementing STCW convention and code has been recognized by the major shipping countries in the world and has signed an agreement with 24 countries

13

(regions) on mutual recognition or unilateral recognition of seafarers' certificates of competency.

At present, China has a number of maritime universities and maritime research institutions, mainly engaged in maritime education, training and research, including Dalian Maritime University, Shanghai Maritime University, Wuhan Science and Technology University, Jimei University, Zhanjiang Ocean University, Maritime Technology Cooperation Center for Asia (MTCC-Asia), Shanghai Maritime University Maritime Research Center, Dalian Maritime University Maritime Research Center, etc. These institutions have been tracking the latest developments in the legislation, standards and technologies of the IMO and the international community on the energy saving and GHG emission reduction form ships, and are actively conducting research to make outstanding contributions to improving the energy efficiency of ships and reducing GHG emissions in the global shipping industry.

China has ratified MARPOL Annex VI, which came into force in China on 23 Aug, 2006. As a Party to Annex VI of the MARPOL Convention, China has actively promoted the domestication of the relevant provisions of the rules on energy efficiency of ships by issuing effective notices and revising the Technical Rules for Statutory Survey of Oceangoing Vessels to incorporate relevant domestic requirements. Good conditions and background have been created for the implementation of the ship's energy efficiency rules. Meanwhile, the Maritime Safety Administration (MSA) of the Ministry of Transport has led the development of the "Guidelines for Port State Inspection of the Energy Efficiency Rules for Ships in Chapter IV of Annex VI to the MARPOL Convention" under the framework of the Tokyo memorandum. The China Classification Society (CCS) has also developed relevant technical specifications to provide services for authorized statutory surveys and class surveys for ships, and provide guidance for the development and application of China's green shipping technology, optimization and upgrading of ship industry and shipping industry structure, and construction of energy efficiency management system for shipping enterprises.

Under the MARPOL convention and relative domestic legislation, industries in shipping field in China actively implement EE technologies in order to reduce GHG emission. However, in the progress of implementation, China encountered various barriers. These includes: Lots of new technologies are costly, and most shipping companies are reluctant to implement. Not all the crew member are well trained for the technologies. The implementation of some techniques will bring extra work to crew members, and they are reluctant to spend more time on it.

At present, the implementation of ship energy efficiency technologies on ocean-going ships and in ocean-going ship management companies is relatively adequate, while for some coastal ships and the vast majority of inland water ships, almost no attention was paid to the use of ship energy efficiency technology.

To solve the problems faced by China in implementation of ship EE technologies, questionnaire feedback provided some improving advice.

- Train onshore and onboard personnel of shipping companies in ship energy efficiency technologies to enhance their energy-saving awareness.
- Reward the ships and individuals who perform better in ship energy efficiency

technologies to boost their motivation.

- Proper training to the onshore and onboard personnel is the most valuable way to promote the implementation of ship EE technologies.

2.4 Malaysia

Malaysia operates a Dual Registry system, namely: (i) a closed domestic registry with its domestic ports principally Port Klang and Penang for the Traditional Ship Registry ("TSR"); and (ii) an open/international registry at the port of Labuan for the Malaysian International Ship Registry ("MISR"). The Malaysian authorities do not want its MISR to be viewed as a flag of convenience and, accordingly, have taken measures to curtail such a view. However, there are 5180 flagged ships in the Malaysia and it occupies total tonnage of 12 million.

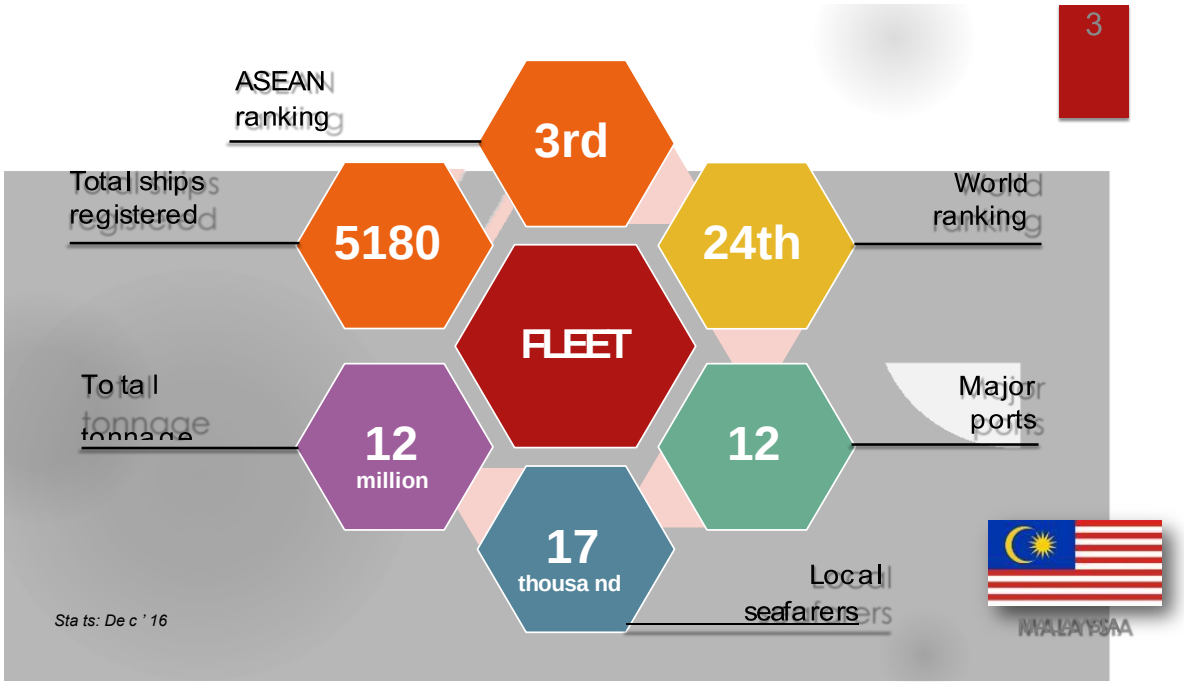

Figure2-3 Status of Malaysian fleet

In Malaysia, there are 12 major ports which were connected with international shipping network and coastal shipping trade. Among them, the following ports are more popular as follows:

- Port Klang
- Port of Tanjung Pelepas
- Penang port
- Johor port
- Kuantan port
- Kemaman port
- Bintulu port
- Kuching port
- Miri port

Among these ports, the Port Klang is the main port of Malaysia for container cargoes import/export and the Kuantan port is the sea port for oil tankers. Moreover, the ports

15

are intended to join new Silk Road Economic Belt in future and there were USD 3.2 trillion total trades in 2006.

Malaysia is a party of STCW convention and complied and implemented requirements of the provisions of this convention. Malaysia Maritime Universities and Colleges are as follows:

- · Governmental - Ungku Omar Polytechnic (PUO), Ipoh, Perak
- · Governmental - Universiti Malaysia Terengganu (UMT), Kuala Terengganu, Terengganu
- · Governmental - Universiti Teknologi Malaysia (UTM), Skudai, Johor
- · Private - Malaysian Institute Of Marine Engineering Technology, UniKL (MIMET), Lumut, Perak
- · Private - Malaysian Maritime Academy (ALAM), Melaka
- · Private - Netherland Maritime Institute Technology (NMIT), Johor Bharu, Johor
- · Private - RANACO EDUCATION & TRAINING INSTITUTE (RETI), Kemaman, Terengganu

Each year, these schools can produce a large number of international and domestic seafarers who meet the requirements of the STCW Convention. Malaysia is more advanced in maritime education and training than Cambodia and Myanmar.
Presently, Malaysia has ratified MARPOL ANNEX VI. The government has been aware of the problems of greenhouse gas emissions from the shipping industry and Malaysia has also shown a positive attitude towards environmental protection measures taken by United Nations and IMO throughout, and specifically in shipping sector. Malaysia's voluntary initiative is to achieve up to 40% reduction in greenhouse gas (GHG) emissions intensity of Gross Domestic Product (GDP) by 2020 based on 2005 level. This target is to be achieved under the condition that technology transfer and financial support are provided from developed countries. More recently in 2015, Malaysia released its Intended Nationally Determined Contribution (INDC) of achieving 45% emissions intensity by GDP by year 2030 as compared to year 2005 level, under the same condition of receiving technology transfer and support. Nevertheless, modern technology, human resources and infrastructure facilities has been needed to implement GHG emission control.

In international shipping network, the Malaysia is situated as a major geographical country as the Malacca strait was beside and it connects with the Pacific Ocean and the Indian Ocean. Therefore, most of shipping routes converge into the Malacca strait. It is difficult for Malaysia authorities to control the level of energy efficiency and emissions of international ships in transit. It is difficult for Malaysia Maritime Authorities to control the level of ship energy efficiency and GHG emissions for the ships in transit.
Most of the national fleet are old-aged vessels engaging domestic shipping. These ships are using very old engine and burning heavy fuel oil. Although, MARPOL has entered into force in 2010 in Malaysia, Most of national ships are not bind by it. So, Malaysia need an assistance on the improving energy efficiency performance of national fleet.
In the progress of implementation of EE technologies in shipping, Malaysia encountered many barriers, including:

- The public in Malaysia is showing a low level of awareness of Climate change,

16

carbon capture and storage

- Legislation in maritime sector is backward.
- Lack of social awareness, support and network.
- The level of knowledge, attitude, skill and participation of Malaysian shipping companies towards GHG emission control are low and there is a compelling need for more environmental education in Malaysia.
- Shipping companies and ports： poor management, financial obstacles, lack of support from local government, lack of mandatory regulations and requirement, social awareness, backwards shipping technologies and etc.
- To solve the problems faced by Malaysia in implementation of ship EE technologies, questionnaire feedback provided some improving advice:
- More realistic and practical workshops and training programs are expected for effective knowledge transfer and practical skills gaining.
- Malaysia is now in an urgent need to improve shipping company performance on GHG control and ship energy efficiency.
- Explore effective measures (Financial support) to encourage shipping companies to replace aged vessels with new vessels or upgrade the ships' equipment.
- Seek for technical assistance from developed countries by international cooperation.

2.5 Myanmar

Myanmar's shipping industry is underdeveloped. As of end of year 2017, Myanmar has 30,081 ships used for transportation on water. The inland ships in Myanmar accounts for the vast majority of the whole fleet, about 98%. Most of the ships owned by Myanmar are old ships with age of more than 10 years. The facilities and equipment are backward, so many new energy efficiency technologies are difficult to implement on these ships.

Table2-4 Status of ships registered in Myanmar

In Myanmar, there are many inland water transportation ports and nine sea ports which

17

were connected with international shipping network and coastal shipping trade. These nine sea ports are Yangon, Kyaukpyu,Dawei, Mawlamyine, Myeik, Pathein, Sittwe, Kawthoung and Thandwe. Among these ports, the Port of Yangon is the main port of Myanmar for various kinds of cargoes import/export and the Kyaukpyu port is the deep sea port for oil tankers.

The Myanmar is a party of STCW convention, and complied and implemented requirements of the provisions of this convention in accordance with Reg.1/8 of Quality standards. Under the Ministry, Myanmar Maritime University, Myanmar Mercantile Marine College and private institutes recognized by the Department of Marine Administration are currently implementing maritime education and training system. No institutions can do research and teaching in the field of shipping energy efficiency and emission reduction, because Myanmar hasn't ratified Annex VI of the MARPOL 73/78 and also lack of legislation and policies to control GHG emissions. It is more difficult to find instructors and experts in this field to train maritime related personnel.

Presently Myanmar has not ratified MARPOL ANNEX VI. Although there are some maritime laws in the Myanmar, most of the laws are out of date and need to be amended to fully incorporate for relevant provisions of the international conventions and regional agreements.

Moreover, due to lengthy processes and traditions in the prevailing legislative system in the country, Myanmar might consume slightly a longer time period to perform as an impeccable Coastal State and/or Flag State in Green House Gas emission controlling and Ship Energy Efficiency related activities. On the other hand, it is praiseworthy to consider the facts that Myanmar owns a minute portion in the world merchant shipping fleet and local emissions also presents a miniature percentage in global context.

However, the government has been aware of the problems of greenhouse gas emissions from the shipping industry. Considering the prevailing socio-economic circumstances as well as the political issues in the country, entire pessimistic steps cannot be expected towards maritime GHG emission controlling or Energy Efficiency measures.

Nevertheless, Myanmar has shown a positive attitude towards environmental protection measures taken by United Nations and IMO throughout, and specifically in shipping sector, now in the process of ratifying MARPOL Annex VI which can be identified as a worthy indication towards green shipping. National Environment Policy (NEP) was developed and finalized during 2016, and is now pending final endorsement by the Government. The NEP will be the reference for strategic frameworks and action plans in the environment sector, including climate change and waste management strategies, and will provide guidance for mainstreaming of environmental issues in all plans and policies.

In the progress of implementation of EE technologies in shipping, Myanmar encountered many barriers, including:

- Myanmar hasn't ratified MARPOL ANNEX VI, and cannot enact them as national legislation at present.
- Legislation process could take long time, and there is a lack of social awareness, support and network.
- Shipping companies and ports： poor management, financial obstacles, lack of

support from local government, lack of mandatory regulations and requirement, social awareness, backwards shipping technologies etc.. Lots of new technologies are costly, and most shipping companies, especially for coastal and inland water shipping companies, are reluctant to implement them.

- Personnel onboard and ashore are lack of awareness and knowledge of EE technologies.
- The implementation of some techniques will bring extra work to crew members, and they are reluctant to spend more time on it.
- Most of the ships owned by Myanmar are old ships with age of more than 15 years. The facilities and equipment are backward, it is impossible to implement some of the new technologies on those ships.

To solve the problems faced by Myanmar in implementation of ship EE technologies, advice includes:

- Actively promote environmental awareness by appropriate training and education of seafarers and shipping industry.
- Encourage replacement of old foreign going, coastal and inland vessels with new environment friendly vessel.
- Explore effective measures (Financial support, etc) to encourage the private vessel owners to replace aged vessels with new vessels (leasing, joint ship building, etc.)
- Seek for technical assistance from developed countries by international cooperation.
- The personnel onshore and onboard in shipping companies need to be trained in ship energy efficiency technologies to enhance their energy-saving awareness.
- Reward the ships and individuals who perform better in ship energy efficiency technologies to boost their motivation.
- Myanmar needs more human resources with regard to the EE or GHG emission to help to enhance the capacity building in shipping EE and GHG control
- Proper training to the onshore and onboard personnel is the most valuable way to promote the implementation of ship EE technologies.

2.6 Sri Lanka

By 2017, Sri Lanka operated a national fleet of 382 ships. Therefore, Sri Lanka does not possess a bulky of registered merchant ships flying Sri Lanka flag and does not hold a major quota in the world merchant fleet as a flag state. Sri Lankan fleet does not play a vital role in the merchant shipping business in the world. Nevertheless, because of the geo-strategic location of the country, number of ships calling ports in this island shows a significant increasing annually.

Sri Lanka mainly holds 6 sea ports around its coast namely KKS, Colombo, Galle, Trincomalee, Oluvil and Hambanthota. Out of these ports, Colombo is the major international sea port which holds the major portion and Hambanthota, Galle and Tricomalle also hold a certain share in the International shipping activities. All these ports are managed by Sri Lankan Ports Authority (SLPA) while some ports are being developed as Private Public Partnership agreements mainly with reputed Chinese owned companies such as China Merchant Group.

Port of Colombo is being used for operations of all kind of vessels from container

19

carriers to tankers to passenger ships to pure car carriers, while Hambanthota is a newly developed port for Ro-Ro cargoes specially focused on transshipments.

Figure 2-4 Sea Ports in Sri Lanka

Sri Lanka is an IMO white list country in producing both officers and ratings to the industry and on a competitively high salary scale compared to South Asian region labor market, which reflects that, maritime training and education in the country holds a better profile in the region. Several seafarer training schools can be identified and both the public and private sector actively compete in this sector. Ministry of Ports and Shipping conduct annual as well as surprise audits to uplift the standards of those training institutes.

Sri Lankan is not a member state of MARPOL Annex VI, but Sri Lankan maritime administration is in the process of ratifying MARPOL Annex VI, which might consume a slightly longer time period to complete the process. The current status of the ratification of MARPOL Annex VI is that the approval to become party to MARPOL Annex VI has been obtained from Cabinet of Ministers. Preparing of national legislation is in progress, after introduction of national legislation, instrument will be deposited at IMO. The responsible government agencies of this process are Division of Merchant Shipping, Marine Environment Protection Authority and Sri Lanka Ports Authority.

Maritime education and training (MET) of Sri Lanka shows positive image, which provides the maritime labor market with large share of quality seafarers. Although MET of Sri Lanka is at a higher level compared with other maritime shipping fields, the public awareness on GHG control and ship energy efficiency technology is still very low. This facts helps to identify that, on one hand, the current course design of MET in Sri Lanka do not comprehensively cover GHG control and technologies related with energy efficiency promotion; on the other hand, the lack of qualified teachers may also lead to the difficulty on this training.

20

No data found at the moment, drive towards green shipping in the county by locally owned or managed shipping companies. By increasing the consciousness among top management of such shipping companies and the total positive effect on their bottom line would presume the conditions healthier. On the other hand, imposing administrative requirements as a Flag state would benefit for a certain level of advancement.

Lack of information was identified as the major obstacle. Neither public sector nor private sector studies found quantifying emissions from vessels calling Sri Lankan waters. So, deprivation of such data may have caused not to evaluate any kind of environmental or health issues in the country. Therefore, the government capacity is quite low at this moment.

Meanwhile, the identification of a package of ship energy efficiency technology suitable for the fleet would also accelerate the technology adoption in these shipping companies of Sri Lanka. Therefore, technology transfer focusing on practical operations shall have priority among those other actions for effectiveness purposes.

No proper monitoring methodology or defined KPIs introduced by relevant government authorities so far for monitoring or evaluating shipping companies' performance in this regard. So in such a background, it is in a bit hesitant condition to announce on shipping companies' performance on GHG emission control and measures they adopted on energy efficiency. On the other hand, no specific related data found on their own publications such as annual reports or any other press conference releasing about such initiative or some kind of comparison of the figures with last year and current year.

The total ship exhausted gas emission within the waters of Sri Lanka is high compared with similar countries, because the country's location is on the international seaways The south and east going ships emits tremendous GHG and toxic gas off its coastline. Currently, there are considerations in this nation to declare ECA around its sea in order to control total emission; and this action will also promote the improvement of energy efficiency of ships. Relevant assistance on ECA design is therefore anticipated.

3. Ship energy efficiency in the region

This section presents the ship energy efficiency technologies available in selected countries of Asia, based on personal interviews with ship operators in the countries and visits to local shipyards and ship repair facilities.

3.1 Ship energy efficiency technology in Bangladesh, Cambodia, Myanmar and Sri Lanka

In these four countries, inland ships account for the vast majority of the whole fleet. Most inland vessels are old with backward equipment and facilities, resulting in extremely low levels of energy efficiency on these ships. And what's more, the crew on inland ships basically has no concept of energy efficiency and GHG emission control. Therefore, application of Ship Energy Efficiency & GHG emission reduction technologies in the mentioned four countries are not comprehensive and universal. A table down below shows the application status of ship-borne energy efficiency technologies by shipping companies in these four countries.

21

Table-11 Application status of ship-borne energy efficiency technologies in Bangladesh, Cambodia, Myanmar and Sri Lanka

Comprehensive Technology and Operation for the Mitigation of GHG Emission from Ships			Application status
Solution	Category	Technology and Operation	
1 Use less fossil fuel	1.1 Ship design and construction	1.1.1 Air lubrication system	No
		1.1.2 Improved hull coating	Partially(Foreign going ships only)
		1.1.3 Optimized hull form	Partially(Foreign going ships only)
		1.1.4 De-rating main engine	Partially(Foreign going ships only)
		1.1.5 Dual-fuelled main engine	No
		1.1.6 Duct-and-fin assisted propulsion system	No
		1.1.7 Twin screw propulsion system	No
		1.1.8 Waste heat recovery	Partially
	1.2 Fuel efficient operation	1.2.1 Speed optimization	Partially
		1.2.2 Improved voyage planning	Yes
		1.2.3 Weather routing	Partially(Foreign going ships only)
		1.2.4 Trim optimization	Partially(Foreign going ships only)
		1.2.5 Ballast optimization	Partially(Foreign going ships only)
		1.2.6 Just-in-time	Partially(Foreign going ships only)
		1.2.7 Optimized shaft power	Partially(Foreign going ships only)
		1.2.8 Optimal course control	Partially(Foreign going ships only)
		1.2.9 Hull maintenance	Yes
		1.2.10 Propeller maintenance	Yes
		1.2.11 Rudder maintenance	Yes
		1.2.12 Main engine maintenance	Yes
		1.2.13 Auxiliary engine maintenance	Yes

22

		1.2.14	Environmental ship index (ESI)	No
2 Use cleaner fossil fuel	2.1 Liquid fuel	2.1.1	Marine gas oil (MGO)	Partially
		2.1.2	Low sulphur fossil fuel	Partially
	2.2 Natural gas	2.2.1	Liquefied natural gas (LNG)	No
		2.2.2	Compressed natural gas (CNG)	No
3 Use non-fossil energy	3.1 Non-fossil fuel	3.1.1	Biofuel	No
	3.2 Power	3.2.1	Shore power	No
		3.2.2	Wind power	No
		3.2.3	Solar power	No
		3.2.4	Fuel cell	No
		3.2.5	Battery power in diesel-electric hybrids	No
4 Use abatement technology	4.1 Technology for combustion	4.1.1	Humid air method	No
		4.1.2	Water injection	No
		4.1.3	Water emulsion	No
		4.1.4	High scavenge pressure and compression ratio	Partially
		4.1.5	Two stage turbocharger	Partially
		4.1.6	Slide fuel valve	Partially
		4.1.7	Exhaust gas recirculation (EGR)	Partially
		4.1.8	Combustion catalyst in the fuel	No
		4.1.9	Fuel additive	No
		4.1.10	Active diesel particulate filter	No
	4.2 Technology for exhaust gas	4.2.1	Selective catalytic reduction (SCR)	No
		4.2.2	Electrostatic precipitator	No

From analysis in table3-1, it can be seen that the implementation of energy efficiency

measures and technologies on ships in Bangladesh, Cambodia, Myanmar and Sri-Lanka is not satisfactory. Only some of the traditional measures, such as Hull maintenance, improved voyage planning and Main engine maintenance are implemented in some ships, almost no advanced modern technologies are applied.

3.2 Ship energy efficiency technology in China

As shown in chapter 2, the average age of the ships owned or operated by Chinese shipping companies is around 10 years. Compared with the shipping companies in developed countries, the application level of energy efficiency technology of Chinese shipping companies is relatively low, but compared with that of other developing countries, the level of energy efficiency utilization is relatively high. In recent years, in order to promote energy saving and GHG emission reduction, the Chinese government has formulated a series of regulations and policies, and increased the introduction, development and application of ship energy efficiency technology. Chinese shipping companies have also stepped up energy efficiency management of ships, actively using ship energy efficiency technologies and advanced energy efficiency management models. The levels of energy efficiency of Chinese shipping companies are increasing rapidly. Table 3-2 below shows the application status of ship-borne energy efficiency technologies shipping companies in China.

Table 3-2. Application status of ship-borne energy efficiency technologies in China.

Comprehensive Technology and Operation for the Mitigation of GHG Emission from Ships			Application status
Solution	Category	Technology and Operation	
1 Use less fossil fuel	1.1 Ship design and construction	1.1.1 Air lubrication system	Partially(Foreign going ships only)
		1.1.2 Improved hull coating	Yes
		1.1.3 Optimized hull form	Yes
		1.1.4 De-rating main engine	Yes
		1.1.5 Dual-fuelled main engine	Partially
		1.1.6 Duct-and-fin assisted propulsion system	Partially
		1.1.7 Twin screw propulsion system	Partially
		1.1.8 Waste heat recovery	Partially
	1.2 Fuel efficient operation	1.2.1 Speed optimization	Partially
		1.2.2 Improved voyage planning	Yes
		1.2.3 Weather routeing	Partially(Foreign going ships only)

24

			1.2.4	Trim optimization	Yes
			1.2.5	Ballast optimization	Yes
			1.2.6	Just-in-time	Yes
			1.2.7	Optimized shaft power	Yes
			1.2.8	Optimal course control	Yes
			1.2.9	Hull maintenance	Yes
			1.2.10	Propeller maintenance	Yes
			1.2.11	Rudder maintenance	Yes
			1.2.12	Main engine maintenance	Yes
			1.2.13	Auxiliary engine maintenance	Yes
			1.2.14	Environmental ship index (ESI)	Partially
2	Use cleaner fossil fuel	2.1 Liquid fuel	2.1.1	Marine gas oil (MGO)	Partially and increasing
			2.1.2	Low sulphur fossil fuel	Partially and increasing
		2.2 Natural gas	2.2.1	Liquefied natural gas (LNG)	Partially and increasing
			2.2.2	Compressed natural gas (CNG)	Partially and increasing
3	Use non-fossil energy	3.1 Non-fossil fuel	3.1.1	Biofuel	No
		3.2 Power	3.2.1	Shore power	Partially and increasing
			3.2.2	Wind power	Partially and increasing
			3.2.3	Solar power	Partially and increasing
			3.2.4	Fuel cell	Partially
			3.2.5	Battery power in diesel-electric hybrids	Partially
4	Use abatement technology	4.1 Technology for combustion	4.1.1	Humid air method	No
			4.1.2	Water injection	No
			4.1.3	Water emulsion	No
			4.1.4	High scavenge pressure and compression ratio	Partially
			4.1.5	Two stage turbocharger	Partially
			4.1.6	Slide fuel valve	Partially
			4.1.7	Exhaust gas recirculation (EGR)	Partially

25

		4.1.8	Combustion catalyst in the fuel	Partially
		4.1.9	Fuel additive	Partially
		4.1.10	Active diesel particulate filter	No
	4.2 Technology for exhaust gas	4.2.1	Selective catalytic reduction (SCR)	No
		4.2.2	Electrostatic precipitator	Partially

By the analysis in table 3-2, it can be seen that the implementation of energy efficiency measures and technologies on ships in China is encouraging. Not only the traditional measures, such as Hull maintenance, improved voyage planning, main engine maintenance are implemented, but also lots of new technologies such as Shore power, Wind power, Solar power, tidal power are applied and keep improving.

3.3 Ship energy efficiency technology in Malaysia

According to analysis of shipping status in Chapter 2, Malaysia is a modern marine country. Nevertheless, Malaysia needs to encourage shipping companies to mitigate or control GHG emission from their fleets as 80000 Malaysia flagged vessels and 187 certified active ship managers are operating within its jurisdiction.

The Malaysian government attaches great importance to climate change and has taken many measures to control GHG emissions. Malaysian shipping companies have also stepped up energy efficiency management of ships actively using ship energy efficiency technologies and advanced energy efficiency management models. Table3-3 below shows the application status of ship-borne energy efficiency technologies shipping companies in China.

Table 3-3. Application status of ship-borne energy efficiency technologies in Malaysia.

Comprehensive Technology and Operation for the Mitigation of GHG Emission from Ships				Application status
Solution		Category	Technology and Operation	
1 Use less fossil fuel	1.1 Ship design and construction	1.1.1	Air lubrication system	Partially(Foreign going ships only)
		1.1.2	Improved hull coating	Yes
		1.1.3	Optimized hull form	Yes
		1.1.4	De-rating main engine	Partially
		1.1.5	Dual-fuelled main engine	Partially
		1.1.6	Duct-and-fin assisted propulsion system	Partially
		1.1.7	Twin screw propulsion system	Partially

26

			1.1.8	Waste heat recovery	Partially
		1.2 Fuel efficient operation	1.2.1	Speed optimization	Partially
			1.2.2	Improved voyage planning	Partially
			1.2.3	Weather routeing	Partially(Foreign going ships only)
			1.2.4	Trim optimization	Partially
			1.2.5	Ballast optimization	Partially
			1.2.6	Just-in-time	Yes
			1.2.7	Optimized shaft power	Partially
			1.2.8	Optimal course control	Partially
			1.2.9	Hull maintenance	Yes
			1.2.10	Propeller maintenance	Yes
			1.2.11	Rudder maintenance	Yes
			1.2.12	Main engine maintenance	Yes
			1.2.13	Auxiliary engine maintenance	Yes
			1.2.14	Environmental ship index (ESI)	Partially
2	Use cleaner fossil fuel	2.1 Liquid fuel	2.1.1	Marine gas oil (MGO)	Partially
			2.1.2	Low sulphur fossil fuel	Partially and increasing
		2.2 Natural gas	2.2.1	Liquefied natural gas (LNG)	Partially and increasing
			2.2.2	Compressed natural gas (CNG)	Partially and
3	Use non-fossil energy	3.1 Non-fossil fuel	3.1.1	Biofuel	No
		3.2 Power	3.2.1	Shore power	No
			3.2.2	Wind power	No
			3.2.3	Solar power	No
			3.2.4	Fuel cell	No
			3.2.5	Battery power in diesel-electric hybrids	Partially
4	Use abatement technology	4.1 Technology for combustion	4.1.1	Humid air method	No
			4.1.2	Water injection	No
			4.1.3	Water emulsion	No

27

		4.1.4	High scavenge pressure and compression ratio	Partially
		4.1.5	Two stage turbocharger	Partially
		4.1.6	Slide fuel valve	Partially
		4.1.7	Exhaust gas recirculation (EGR)	Partially
		4.1.8	Combustion catalyst in the fuel	Partially
		4.1.9	Fuel additive	Partially
		4.1.10	Active diesel particulate filter	No
	4.2 Technology for exhaust gas	4.2.1	Selective catalytic reduction (SCR)	No
		4.2.2	Electrostatic precipitator	Partially

EE technology utilization in Malaysia International Shipping Company (MISC) is encouraging, lots of new technologies are applied on those ocean-going ships. However, ocean-going ships take a low percentage of its total fleet. On its inland and coastal ships, the implementation of energy efficiency measures and technologies is not satisfactory. Only some of the traditional measures, such as Hull maintenance, improved voyage planning and Main engine maintenance are implemented, and almost no advanced modern technologies are witnessed.

4. Analysis of barriers in the improvement of ship EE & GHG Emission reduction and evaluations

Based on questionnaire feedback, workshop discussions and various reports on shipping GHG emission, MTCC-Asia found Bangladesh, Cambodia and Myanmar have been facing almost the same barriers in the improvement of ship EE & GHG Emission reduction, while China, Malaysia and Sri Lanka have their own unique barriers.

4.1 Bangladesh, Cambodia and Myanmar

4.1.1 Barriers in the implementation process of MARPOL 73/78 Annex VI

Although Bangladesh is a signatory member state to MARPOL Annex VI, a slightly longer time may be expected for enacting the enabling local laws in the country due to the complicated administrative procedures. Cambodia and Myanmar haven't ratified MARPOL Annex VI, therefore, it is rather more difficult for them to implement EE measures in shipping industry.

Some maritime laws and requirements in the mentioned countries are out of date and they need to be amended and need to develop so as to fully incorporate for relevant provisions of the international conventions and regional agreements. Furthermore, there are barriers to promulgate provisions of the international conventions as national laws instantly because legislation alignment process should take a long time.

Under the background of global GHG emission control, some steps have been witnessed for prevention of air pollution in these three countries. However, they need to enact the IMO requirements as national legislation before those EE measures and

28

requirements in MARPOL Annex VI are fully implemented.

4.1.2 Government Capacity

As explained in section 3, the shipping industry in these countries is underdeveloped and the fleet is relatively small, so their governments are not willing to devote too much efforts to energy efficiency and GHG emission control in the shipping field.

The governments have been aware of the problems of greenhouse gas emissions from the shipping industry. Considering the prevailing socio-economic circumstances as well as the political issues in these countries, entire active steps cannot be expected towards maritime GHG emission controlling or Energy Efficiency measures.

4.1.3 Social awareness, support and network

The level of public awareness regarding the CO_2 emissions, climate change, carbon capture and storage (CCS) is vitally important for mitigation and control of air pollution. The empirical evidence will provide a basis for the formulation of strategic actions, pro-public and governmental decisions and the public awareness of a country. Public awareness in the mentioned three countries, the least developed countries, is still relatively limited, so it should also be widely acknowledged.

To identify the social awareness and the status of support and network, MTCC-Asia analyzed all the feedback and information collected through a series of seminars, workshops, questionnaires, made discussions by a group of researchers involved for the report, and interviewed various personnel involved in maritime industry(mainly from maritime authority, institutions and shipping companies) face to face or by telephone call or other means available. It was revealed that those three countries have been facing considerable challenges with the management of air pollution as a result of increasing income and consumption levels of fuel, urban, population, growth, and lack of effective treatment, and social awareness of GHG control was at a considerable lower level compared with other countries, especially those developed countries.

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4.1.4 Maritime education and training (MET)

Although the MET in these countries is at a higher level compared with other maritime shipping fields, the public awareness on GHG control and ship energy efficiency technology is still very low as analyzed previously. It was found that the current course design of MET in these countries do not comprehensively cover GHG control and technologies related to energy efficiency promotion; and the lack of qualified instructors, researchers and experts may also lead to the difficulties in the training.

4.1.5 Shipping company performance

Over the past years, shipping companies in these countries have been showing sluggish steps towards green shipping. The situations may be caused by poor management, financial obstacles, lack of support from local government, lack of mandatory regulations and requirement, social awareness, backwards shipping technologies and etc.

4.2 China

4.2.1 Top level design needs to be strengthened

Although both the State and the Ministry of Transport have introduced and developed the “13th Five-Year Plan” for the Control of greenhouse Gas emissions, there is a lack

29

of an overall strategy and implementation programme at the maritime transport industry level. The systematic and forward-looking deployment of marine energy efficiency and greenhouse gas emission control needs to be strengthened, and development goals and priorities need to be further clarified.

4.2.2 Basic work still needs to be rammed

Although the relevant energy consumption monitoring and statistical system established by the Ministry of Transport provides a certain data basis for the evaluation of maritime energy consumption and emissions, the coverage of the marine energy consumption monitoring and statistical system, statistical methods and detailed requirements need to be further improved in order to master the basic data of maritime energy efficiency and emissions and provide effective support for related management and decision-making.

4.2.3 The levels of energy efficiency management in shipping industries are varying

The level of energy efficiency management in the industry is uneven, and some shipping companies, especially small and medium-sized shipping companies and their employees, have weak awareness of energy efficiency management and weak management level. There is a lack of communication and cooperation among shipping companies in research and development and application of energy efficiency technologies. Affected by the bad shipping market, shipping companies have insufficient investment in improving ship energy efficiency through technical means.

4.2.4 Existing raising rate of the vessels' GHG emission needs to be reduced

"The Enhanced Action on Climate change-China's National Independent Contribution" China submitted by China to the United Nations proposed that CO_2 emissions peak by around 2030 and strive to reach the peak as soon as possible. However, according to the prediction, if the vessels' GHG emission in China is still maintaining the existing raising rate, the total amount of CO_2 emission will exceed 19.19 million tons by 2020 for the coastal vessels, and reach to 22.99-24.34 million tons by 2030. It is very difficult to reach the peak value. For ocean-going vessels, CO2 emissions will be about 34.9-37.3 million tons by 2020 and 38.5-49.2 million tons by 2030. Facing new targets to address climate change, the maritime industry must accelerate its low-carbon development process and adopt more proactive energy efficiency management and emission reduction measures to participate in the global climate change governance system to provide support for the implementation of the national strategy to combat climate change.

4.3 Malaysia

4.3.1 Implementation process of MARPOL 73/78 Annex VI

The Kingdom of Malaysia had signed the MARPOL Annex VI and it entered into force on December 27, 2010. Recently Malaysia is trying to implement Energy Efficiency Main Initiatives and to control GHG and air pollution within its national waters. Furthermore, Malaysia held international conferences with foreign countries regarding Energy Efficiency activities.

- Malaysia is one of the 10 Lead Pilot Countries executing IMO-UNDP GloMEEP program

30

- 2015–to date, under GHG & EE, Malaysia had hosted 1 Regional workshop, 3 National Workshops, 1 National Seminar, 1 Green Shipping Conference, 1 Green Port Conference.
- National Minister's KPI to reduce 70,000 tones/year of CO_2 e mission.

4.3.2 Government Capacity

In accordance with decisions 1/CP.19 and 1/CP.20 of the UNFCCC, the Government of Malaysia is pleased to communicate its Intended Nationally Determined Contribution (INDC), together with relevant clarifying information. Malaysia intends to reduce its greenhouse gas (GHG) emissions intensity of GDP by 45% by 2030 relative to the emissions intensity of GDP in 2005.This consist of 35% on an unconditional basis and a further 10% is condition upon receipt of climate finance, technology, transfer and capacity building from developed countries.

The country continues to allocate financial resources for the implementation of climate change mitigation programme through both public and private sector initiatives. The climate-related policies are implemented along with national priorities such as poverty eradication, improving quality of life and development. In addition, financial resources are also frequently reallocated to address losses due to increased incidences of natural disasters.

4.3.3 Social awareness, support and network

Global warming, climate change, greenhouse effects, pollution, deforestation are some of the environmental concerns confronting Malaysia. However, the importance of handling the environmental issues is not being accurately communicated to the public. A study conducted by the WWF-Malaysia and Partners in the year 2007 (Environmental citizenship: a report on emerging perspectives in Malaysia) found that 45% of adults and students understood the cause of environmental problems and climate change. Between 52.7% to about 65.3% admitted that they have placed some efforts towards environmental activities. Another study reported that the level of knowledge, attitude, skill and participation of Malaysian students towards environmental citizenship is very low and there is a compelling need for more environmental education in Malaysia (Meerah et al., 2010). Approximately 35% of the students have some knowledge on environmental citizenship, 20.3% have knowledge on fauna and biodiversity, 25% on international environmental treaties, and 20.2% of the students gathered environmental information from newspaper and television programs.

4.3.4 Shipping company performance

Over past decades, the Malaysia shipping industry had developed gradually but there are still weak points in terms of control over shipping companies in respect of GHG emission by authorities. That condition was caused because of financial obstacles and need of modern technology as the Malaysian flagged vessels are existing vessels of which most of the inland vessels have a high age.

4.4 Sri Lanka

4.4.1 Implementation process of MARPOL 73/78 Annex VI

Lack of information can be identified as the major obstacle. Neither public sector nor private sector studies found quantifying emissions from vessels calling Sri Lankan waters. So, lack of such data may have caused not to evaluate any kind of environmental

31

or health issues in the country. Therefore the government capacity is quite low at this moment.
As of now, Sri Lankan maritime administration found to be in the process of ratifying MARPOL Annex VI, which might consume a slightly longer time period to complete the process due to reasons mentioned in the previous chapters of this report. In any case, this initiative shall be considered as a green light towards green shipping in the country. The subsequent complications might occur once the country enacts enabling local legislation, due to insufficient funding, human resources and infrastructure facilities, unavailability of experts in the field and so on where international succor might benefit to improve the conditions.

The current status of the ratification of MARPOL Annex VI is that the approval to become party to MARPOL Annex VI has been obtained from Cabinet of Ministers. Preparation of national legislation is in progress, after introduction of national legislation, instrument will be deposited at IMO. The responsible government agencies of this process are Division of Merchant Shipping, Marine Environment Protection Authority and Sri Lanka Ports Authority.

4.4.2 Government Capacity

Sri Lanka is a small island country strategically located on the international shipping routes. Compared with other services in the maritime shipping domain, port operation service is main component of its maritime shipping industry.

As part of the national strategy, the seaports are now promoting the ship energy saving and emission reduction from ships. Cold ironing is identified as key technology and will be widely used among seaports of this country. With regards to technical assistance, operational and management skills on cold ironing application are at the urgent need both for the port operators and port authority. Meanwhile, knowledge and information on green port building are also expected by this country.

The total ship exhausted gas emission within the waters of Sri Lanka is high compared with similar countries, because of the country's location is on the international seaways. The south and east going ships emit tremendous GHG and toxic gas off its coastline. Currently, there are considerations in this nation to declare ECA around its sea in order to control total emissions; and this action will also promote the improvement of energy efficiency of ships.

4.4.3 Social awareness support and network

The government of Sri Lanka has been taking actions to strengthen public awareness and institutional support in relation to environment protection. Following the United Nations Framework Convention on Climate Change in 2015, the Ministry of Mahaweli Development and Environment commenced a programme called 'Sri Lanka NEXT-A Blue Green Era' in 2016, to create awareness among people on climate change and future development strategies. The Cabinet of Ministers has approved to develop 10,000 'Blue Green Beautiful Lanka Villages' within the 2016 to 2020 period, in collaboration with community organizations such as the SANASA movement of Sri Lanka, the Sarvodaya movement and the organizational network of the Divinaguma Department under this programme. In addition, the sixth National Symposium on Air Quality Management in Sri Lanka was held under the theme of 'Air That We Breathe-2016' in May 2016. The event was a platform to discuss the views of technocrats,

scientists and other professionals from a number of state and private institutions in the country, involved in air quality research, development and implementation activities for a green economy."(Central Bank Annual Report - Sri Lanka, 2016)

4.4.4 Shipping companies

No data found at the moment, drive towards green shipping in the country by locally owned or managed shipping companies. By increasing the consciousness among top management of such shipping companies and the total positive effect on their bottom line would presume the conditions healthier. On the other hand, imposing administrative requirements as a Flag state would benefit for a certain level of advancement.

Meanwhile, the identification of a package of ship energy efficiency technology suitable for the fleet would also accelerate the technology adoption in these shipping companies of Sri Lanka. Therefore, technology transfer focusing on practical operations shall have priority among those other actions for effectiveness purposes.

MTCC-Asia is now carrying out a pilot project on promoting shipping energy efficiency by optimal trim. This technology has the advantage of ease of understanding and handing, and very suitable for ships with old ages, as there are no retrofitting fee imposed on ship operators. Technology transfer could be made in the near future from MTCC-Asia to companies in Sri Lanka.

However, no proper monitoring methodology or defined KPIs introduced by relevant government authorities so far for monitoring or evaluating shipping companies' performance in this regard. So in such a background, it is in a bit hesitant condition to announce on shipping companies' performance on GHG emission control and measures they adopted on energy efficiency.

4.4.5 Maritime education and training

Maritime education and training (MET) of Sri Lanka shows positive image, which provides the maritime labor market with large share of quality seafarers. There are approved state and privately owned seafarers training colleges, and the existing active seafarers are about 18,000. Due to the good quality of MET, Sri Lanka has been one of the IMO white List countries, and both officers and rating hold relative high salary scale compared to South Asian region labor market.

However, the current course design of MET in Sri Lanka do not comprehensively cover GHG control and technologies related with energy efficiency promotion. Low social awareness and lack of qualified instructors may lead to the difficulty on this training.

Sri Lanka supplies seafarers not only for domestic labor market but also for the world shipping labor market as well. The absence of ship energy efficiency in its MET shall be made up as quickly as possible. IMO and other international organization could play a significant role in this regard by carrying out a series of capacity building activities. At the beginning stage, incorporating instructors from maritime institutes of Sri Lanka into international workshops, conferences related with ship energy efficiency could be an effective way taking the current situation forward.

33

5. Baseline assessment and proposed action to be taken

5.1 Baseline assessment

The sources of information in preceding paragraphs in this report includes official statistics, own research results, existing survey results and quality research reports, journal and newspaper articles. A baseline assessment was established for each country, based on the information provided above, questionnaire feedback and the CO_2 emission monitored by “MTCC-Asia On-line real time ship air emission monitoring system”.

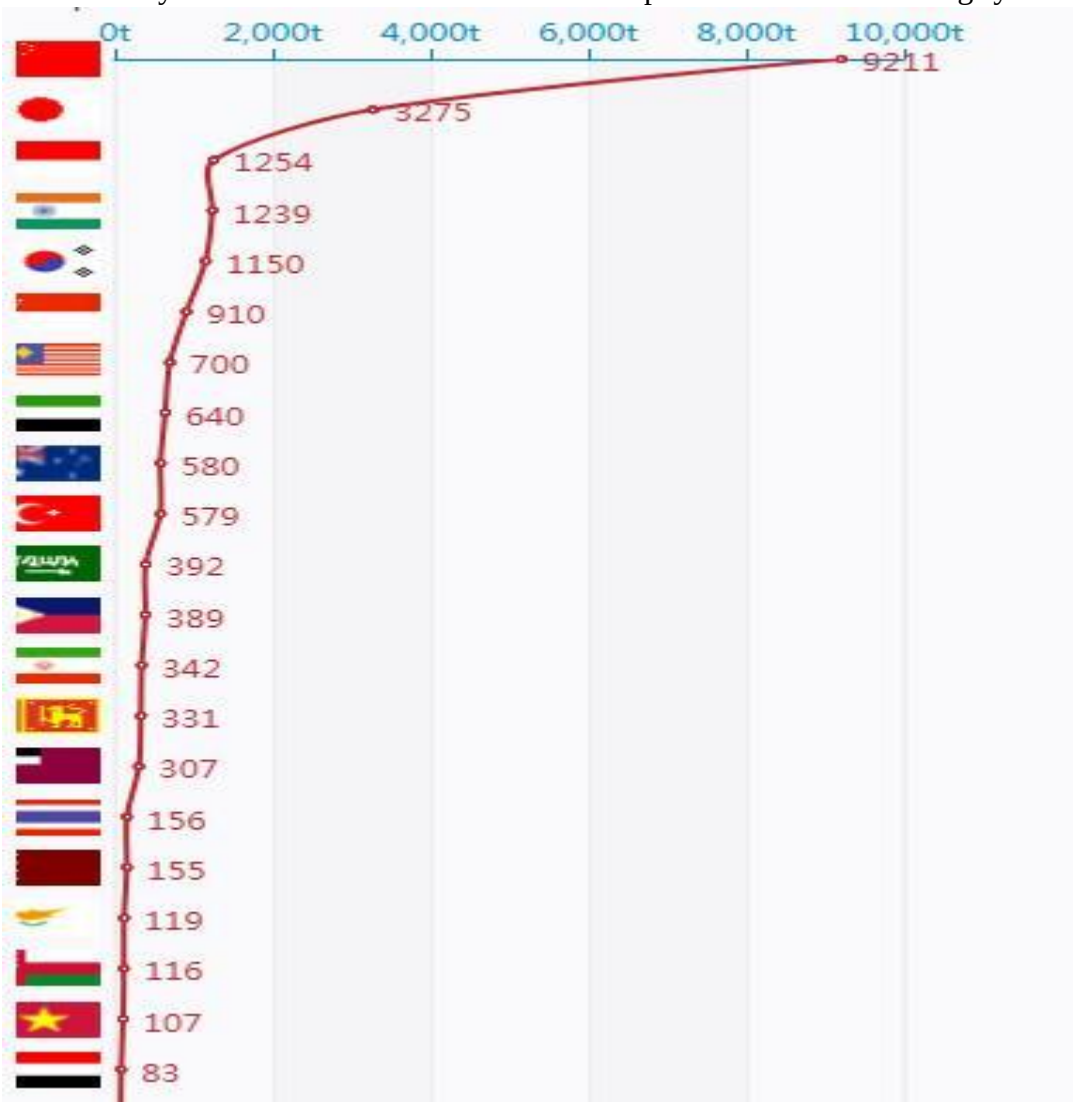

Figure4-1 Hourly CO2 emission within of each states monitored by MTCC-Asia

34

National needs questionnaire in respect of shipping EE

NO.	Name	Country	Organization	Position	Q1: Support from MTCC-Asia	Q2: Priority steps their organization can help reduce ship emission	Main barriers to implementing MARPOL Annex VI	Is your country a signatory to MARPOL Annex VI?	Has your country passed national legislation related to MARPOL Annex VI?	Does your country have a dedicated officer within the relevant national administration focuses upon Energy Efficiency /data collection?	Does your country have a database of green technology existing for ships registered to your flag and/or visiting your ports?	Does your country have a database on vessel fuel reporting?	Does your country havea a national task force focused upon maritime energy efficiency?
1	xxx	Bangladesh	Bangbandhu Sheikh Mujibur Rahman Maritime University (BSMRMU)	xxx	Awareness and capacity building; Institution strengthening; interim mechanism development to collect E data; Development of a coordinating mechanism within the industry	BSMRMU could work as the centre for coordination, capacity building by managing workshops and other tools of awareness; Regarding the administration, we could obviously talk with them in this matter	Awareness; Capacity; Complex administrative procedures	Yes	No	No	No	No	No
2	xxx	Cambodia	Inland waterway transport department	xxx	MTCC-Asia is the main supporter on technical training program/capacity building of Cambodia maritime administration, where is needed to enhance the competence of the maritime administrators	1st priority: capacity building of the administrators and trainers; 2nd priority: ratifies the convention of MARPOL Annex VI; 3rd priority: promotes public awareness about GHG emissions and the maritime environmental issue;	Lack of human resources with regard to the EE or GHG emission; Laws and Regulations ratification; Lack of financial support from the government as well as partner countries; Lack of attention of the	No	No	No	No	No	No

						4th Priority: conduct the EE system with the teams work on GHG emission control	management level on maritime issues						
3	xxx	China	Guangzhou MSA	xxx	more training for PSC	Tell them why they should try their best to reduce emission for a developing country	Professional Manual	Yes	Yes	Yes	Yes	Yes	Yes
4	xxx	China	China Maritime Safety Administration (Guangdong)	xxx	To help the regional administrations to develop harmonized emission data collecting techniques as well as information sharing platform	establish several emission control area to guide the industry with certain pressure to the mandatory requirements set forth by the Annex VI	Lack of funding	Yes	Yes	Yes	N/A	N/A	Yes
5	xxx	China	China MSA, China GloMEEP	xxx	Capacity building; International cooperation	We have already launched lots of international projects during the post few years so we have experiences on the global projects like MTCC ands GloMEEP. Those kinds of projects can help the awareness of ship EE, we have also established the incentive mechanism and have launched the special actions.	Lack of comprehensive strategy for maritime EE; Insufficiency in capacity building; Capacity gaps in EE management	Yes	Yes	Yes	Yes	Yes	Yes

6	xxx	China	Shanghai MSA	xxx	Information, technology, discuss, exchange vision; Explain conventions, improve maritime help shipping side and administration side.	Implementation of international conventions and State's law; Set ECA and upgrade.	Large number of shipping fleet and ports versus few officers of MSA.	Yes	Yes	Yes	Yes	Yes (o the way)	Yes
7	xxx	China	MSA	xxx	MTCC-Asia can provide help for member countries, including carrying out the international platform for research, application promoting and international cooperation of maritime technology. MTCC-Asia can hold meetings and share experience for the implementation of the convention.	China has done a lot since IMO adopted EE Regulations, example: regulations for statutory of sea-going ships and a set of technical guidelines for EEDI and SEEP for regulations and guidelines; 13th five-year plan on energy saving and emission reduction for transportation and Energy Conservation and Emission reduction strategy (210-2020) for strategy and planning	Large number of shipping fleet and ports versus few officers of MSA.	Yes	Yes	Yes	Yes	Yes	Yes
8	xxx	China	MSA	xxx	MTCC-Asia can provide changes including carrying out the international platform for research, application and promoting international cooperation.	The implementation plan on Domestic Emission Control Areas in waters of the Pearl River Delta, the Yangtze River Delta and Bohai Rim (Beijin, Tianjin, Hebei) has come into force on 1st January 2016.	Large number of shipping fleet and ports versus few officers of MSA.	Yes	Yes	Yes	Yes	Yes	Yes

9	xxx	China	China Maritime Administration	xxx	Since MTCC-Asia is located in China, it can work as a bridge connecting China's maritime Authorities, such as CMSA, with the competent authorities of other Asian countries as well as other relevant organizations in the field, facilitating information sharing, exchange of ideas and dissemination of good practices.	To tighten the control over the emission of ships sailing in China's jurisdiction, to enforce the laws and regulations more strictly and to carry out inspections more frequently and to monitor the air-quality in the areas falling in the China's jurisdiction more closely on a regular basis.	Costs; Awareness of the stakeholders; enforcement of laws and regulations.	Yes	Yes	Yes	Doesn't have information about it	Doesn't have information about it	Yes
10	xxx	Malaysia	Marine Department Malaysia	xxx	provide a collaboration platform in GHG & EE data collection across multi-coastal states; offering/lecturing on several types of case studies(as real as possible) and open them in open-discussion method among Asia's dedicated GHG/EE personnel; Building up all proactive/ realistic suggestions from MTCC to IMO/ MEPC	SEEMP verification into ISM audit (no compliance means a huge defect to SMS); perform national task force committee in reliance with GloMeep guidelines proactively; adapting CO2 emission reduction into National Minister's KP1.	limited ship-type for EED/ reduction factor/ reference line under ch.4 Marpol Annex VI, reliability of data collection; knowledge of know-how implementation based on domestic… factors; technology/ measure for EE limited buy-in	Yes	No	Yes	No	No	Yes

11	xxx	Myanmar	Department of Marine Administration; Ministry of Transport and Communications	xxx	We are not MARPOL Annex VI member yet. MTCC could support when we become a party of MARPOL Annex VI.	Awareness to stake holders Encourage to ship-owners regarding the EE engine and propellers. Have to ratify MARPOL Annex VI	Procedures for the promulgation of legislation; Translating IMO instruments into national language; lack of suitable technologies	No	No	No	No	No	No
12	xxx	Myanmar	Department of Marine Administration	xxx	MTCC-Asia can give support as my organization needs the capacity building to aware this theme and so require some more training &workshops	needs awareness of training and workshops	Lack of awareness; Lack of competence persons in the specific area; Requirement of the natural regulations; Lack of communication between department &department as well as ministry and ministry	No	No	No	No	No	No
13	xxx	Sri Lanka	Marine Environment protection authority; Sri Lanka ports authority	xxx	Assist to formulate necessary legislation and procedures; Assist to capacity building and training ; Provide resource persons in selected area data sharing and knowledge sharing	Establish procedure to control emission from coastal ships; Prepare legislation and become a party to MARPOL; Prepare national strategy to control ship emission	We have obtained government approved to become a party to MARPOL Annex VI, but still needs to introduce legislate; formulation legislation is become an issue. Second is capacity building.	No	No	No	No	No	No

Table 4-2 National needs questionnaire in respect of shipping EE

5.2 Proposed actions to be taken

In the past two years, MTCC-Asia has conducted a full study and analysis of the condition of the energy efficiency and GHG control in shipping industry in the six countries mentioned in the report, by means of workshop, seminar, field survey and international cooperation, etc., and put forward the corresponding proposed actions for respective countries. These recommendations or conclusions represent only the views of the MTCC-Asia and do not create any prejudice or discrimination against any country.

5.2.1 Bangladesh, Cambodia and Myanmar

Due to the deficiencies in implementation of IMO energy efficiency rules and standards and in ship energy efficiency technology, it is difficult to achieve full energy saving and emission reduction in shipping industry by the three countries own power alone. They are in urgent need of technical and financial support from other countries, especially developed countries, to help them to achieve the strategy of energy efficiency and GHG control in the shipping field all over the country.

Actions to be taken are proposed as below, but not limited to:

- Develop the maritime environment policies, strategies and legal framework of
- Shipping energy efficiency and GHG emission control. This can be achieved by speeding up ratification of MARPOL Annex VI and promulgation of related national laws in Myanmar.
- Actively promote environmental awareness by appropriate training and education of seafarers and shipping industry. IMO, MTCC-Asia, developed countries and other capable international institutions are invited to provide the necessary human, technical and financial support.
- Provide more human resources with regard to the EE or GHG emission to help them to enhance the capacity building in shipping EE and GHG control.
- Speed up construction of port facilities, improve terminal management, apply environmental protection measures and technologies such as shore power, wind power, solar power, etc. The financial problems can be solved by bank loan, financing or attracting international investment.
- Establish a monitoring system to enhance the monitoring of air emissions from ships in their region.
- Encourage replacement of old foreign going, coastal and inland vessels with new environment friendly vessel. To achieve this, financial support from local government and international are necessary.
- Examine effective measures (Financial support, etc.) to encourage the private vessel owners to replace aged vessels with new vessels (leasing, joint ship building, etc.)
- Import environmentally-friendly and energy- saving vessels and other low-carbon technologies in the initial stage.
- Develop enforcement mechanisms and effective vessel inspection system, help the administrations to develop harmonized emission data collecting techniques as well as information sharing platform.
- Seek technical assistance from developed countries through international cooperation.
- Better plan and coordinate among the responsible government agencies.
- Other effective measures.

40

5.2.2 China

- **Establishing an inventory and incentive mechanism**

The maritime transportation should be harnessed in a more systematic way. All the data and information should be shared among different sub-system for GHG assessment and evaluation purpose so that a general picture of GHG can be gained. In order to substantially improve the energy efficiency of existing operating ships and reduce greenhouse gas emissions, it is recommended that a systematic study be carried out for different types of vessels, and produce a list of technically feasible and cost-effective technologies in order to provide a reference for shipping companies to carry out the technical transformation. Meanwhile, in view of the different concerns of the relevant stakeholders on the energy efficiency level of the ship under different charter modes, it is recommended to actively explore the innovative business operation mode or mechanism, and strive to make the promotion of the energy efficiency of the ship become the common concern of all stakeholders, so as to eliminate or reduce the obstacles in the promotion and application of energy saving and emission reduction technologies.

- **Designing better technologies and standards, seeking for systematic development**

It has been realized that China has to explore, research and utilize more technologies and to find out more good practices in pursuing greener shipping. In an era of big data, the industry shall also engage in the data collection.

Technologies and best practices which are applicable to other countries shall be continuously discovered so that they can be shared with relevant maritime nations around.

- **Increasing the performance of relevant reporting system**

China transport departments have established a relatively complete system of regular statistical reporting, including the comprehensive statistical report system for transportation, the comprehensive statistical report system for ports, the statistical report system for fixed assets investment in traffic, statistical report system for energy consumption monitoring of transportation, statistical report system for survey of water traffic situation, etc. However, because there are many subjects involved, the number of data is huge, and the unified electronic data exchange platform has not yet been established, it brings some difficulties for the comprehensive collection and in-depth analysis of the basic data. In addition, the design of these systems mainly considers the domestic management needs and habits, and the design of some reports needs to be strengthened in connection with the requirements of relevant international conventions. In view of the problems existing in the current data base and considering the development of the current big data acquisition, storage and analysis technologies, it is suggested that the scope of statistical data be further expanded, and adjust and refine statistical data categories as far as possible in accordance with the relevant provisions of international conventions and statistical customs. At the same time, the unified and fast EDI platform should be set up and the corresponding data verification mechanism should be established to ensure the completeness, accuracy and reliability of the data.

5.2.3 Malaysia

MARPOL Annex VI has been ratified by Malaysia, which can be seemed as a key step forward on the improvement of ship energy efficiency emission compared with other

41

Asian nations. For the more effective enforcement of this instrument, the following measures are suggested considering the current national situation.

- Capacity building takes the first priority for the effective enforcement of MARPOL Annex VI. Currently, Malaysia is trying to implement Energy Efficiency Main Initiatives and to control GHG and air pollution within its national waters. More realistic and practical workshops and training programs are expected for effective knowledge transfer and practical skills gaining.
- Malaysia is now in an urgent need to improve shipping company performance on GHG control and ship energy efficiency. Most of the national fleet are non-conventional vessels engaging in domestic shipping. These ships use very old engine and burn dirty fuels. Although, MARPOL has entered into force in 2010 in Malaysia, most of national ships are not bind by it. So, Malaysia needs assistance on improving energy efficiency performance of national fleet.
- Financial support and technology transfer from developed countries are needed. The Prime Minister of Malaysia announced Malaysia's voluntary initiative to achieve up to 40% reduction in emissions intensity of Gross Domestic Product (GDP) by 2020 based on 2005 level. To achieve this target, foreign assistance is one of the key condition according to the Minister.

5.2.4 Sri Lanka

The implementation of MARPOL Annex VI is identified as the core measure of this country for emission and ship energy efficiency promotion, which requires a series of technical assistance including capacity building projects. For the effective implementation of MARPOL Annex VI and other ship energy efficiency policies, the following points are identified as urgently needed for the improvement of green technology of this country.

- The ratification of MARPOL Annex VI will come true very soon. The complex import and export economy base of this nation introduces great challenges for it to develop a national strategy for ship emission control.
- For the effective implementation and enforcement of MARPOL Annex VI, Sri Lanka is in urgent need of the experience on preparation of national legislation.
- Flag state responsibilities shall be clearly identified and defined for the effective implementation of MARPOL Annex VI.
- A range of technologies with regards to acting as competent port state under MARPOL Annex VI shall be introduced.
- Necessary facilities to compliance ship emission monitoring are needed.
- Seafarer's education regarding new changes in regulations shall be assisted and upgraded.
- Green port and emission reduction in port area technologies and monitoring measures are expected from outside and introduced in quick manners

42

List of Acronyms

ADB: Asian Development Bank
ASEAN: Association of Southeast Asian Nations BIMCO: The Baltic and International Maritime Council CCS: China Classification Society
CCS: Climate change, carbon capture and storage
DWT: Deadweight (in tons)
ECD: Environmental Conservation Department EE: Energy Efficiency
EE: Energy Efficiency
EIA: Environmental Impact Assessment
EEDI: Ship Energy Efficiency Design Index EIA: Environmental Impact Assessment
GDP: Gross Domestic Product
GHG: Greenhouse Gas
GloMEEP: Global Maritime Energy Efficiency Partnerships GMSEOC: GMS Environmental Operation Centre
GPC: Global Protocol for Community Scale Greenhouse Gas Emission Inventories
ICS: International Chamber of Shipping
IETC: International Environmental Technology Centre IFC: International Finance Corporation
IMO: International Maritime Organization
IMO GISIS: IMO Global Integrated Shipping Information System
INDC: Intended Nationally Determined Contribution
INGO: International non-governmental organization IMO: International Maritime Organization
IPPs: Individual Power Plants
IRDA: Iskandar Regional Development Authority
IUCN: International Union for the Conservation of Nature
IPCC: the Intergovernmental Panel on Climate change IWRM: Integrated water resources management
IWRM: Integrated water resources management
JICA: Japan International Cooperation Agency
JPA: Johor Port Association
KOICA: Korea International Cooperation Agency and Norwegian Environment Agency
LDC: Least Developed Country
LULUCF: land use, land use change and forestry
MARPOL: International Convention for the Prevention of Pollution from Ships
MET: Maritime Education and Training
MISR: Malaysian International Ship Registry
MSA: Maritime Safety Administration
MTCC-Asia: Maritime Technology Cooperation Center for Asia
NEB: National Energy Balance
NEP: National Environment Policy
NSDS: National Sustainable Development Strategy
STCW: International Convention on Standards of Training; Certification and Watch-keeping for Seafarers
PEI: Poverty Environment Initiative PSCO: Port State Control Officer
SEEMP: Ship Energy efficiency Management Plan TA: Technical Assistance

43

SOLAS: International Convention on Safety Of Life At Sea
TSR: Traditional Ship Registry
TEU: Twenty foot Equivalent Unit
UNDP: United Nations Development Programme
UNEP: United Nations Environmental Programme
USAID: United States Agency for International Development

44

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46

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47