

World Maritime University

The Maritime Commons: Digital Repository of the World Maritime University

Maritime Safety & Environment Management
Dissertations

Maritime Safety & Environment Management

8-27-2017

Analysis of the impact of marine MRV program and market emission reduction measures on China's shipping industry

Qiwen Wang

Follow this and additional works at: https://commons.wmu.se/msem_dissertations



Part of the [Environmental Indicators and Impact Assessment Commons](#), and the [Environmental Studies Commons](#)

This Dissertation is brought to you courtesy of Maritime Commons. Open Access items may be downloaded for non-commercial, fair use academic purposes. No items may be hosted on another server or web site without express written permission from the World Maritime University. For more information, please contact library@wmu.se.

WORLD MARITIME UNIVERSITY

Dalian, China

**Analysis of the Impact of Marine MRV Program
and Market Emission Reduction Measures on
China's Shipping Industry**

By

Wang Qiwen

The People's Republic of China

A research paper submitted to the World Maritime University in partial
Fulfillment of the requirements for the award of the degree of

MASTER OF SCIENCE


(MARITIME SAFETY AND ENVIRONMENTAL MANAGEMENT)

2017

FORMAT OF THE DECLARATION

I certify that all the material in this research paper that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this research paper reflect my own personal views, and are not necessarily endorsed by the University.

(Signature) 

(Date) 16 / 06 / 2017

ACKNOWLEDGEMENT

I am very grateful to World Marine University for offering me an opportunity for postgraduate study, so that I have the opportunity to listen to the world famous professors in the field of maritime lectures, to enhance my professional knowledge and cognitive level.

I am profoundly thankful to my supervisor Prof. Zheng Yunfeng and Prof. Baumler, for guiding me through this work and providing me with invaluable advice and insight into the subject matter. Their rich knowledge and rigorous research attitude will benefit me in my future professional career and whole life. Thanks to the World Maritime University professors to teach me a profound knowledge, I will be rigorous scholarship concept, continue to study the spirit of specialization, into the future of learning and work.

During the study period, due to my body action is not convenient, I am very grateful to my classmates, the class teacher Ms. Wang, Mr. Zhao, Vice President of WMU Prof. Ma on my life care and learning guidance. I am everlastingly grateful to my beloved parents who are always encouraging me by offering their full support during the studies in WMU. This wonderful learning and life time not only gains knowledge, but also gains friendship with professors and classmates. It also makes my mind and body recover quickly. I will never live up to the expectations and encouragement of all those who care about me, work hard and make contributions to society.

ABSTRACT

In recent years, the international shipping industry's greenhouse gas emissions increased day by day, and the increasingly severe climate problems ensued. The research paper from the international convention, international shipping industry boom and capacity situation, new energy, energy saving and emission reduction technology research and application, analyzes the implementation of shipping MRV and subsequent market emission reduction measures impact on international shipping industry.

At meantime, this article analyzes the impact of marine monitoring, reporting and verification program and market emission reduction measures on china's shipping industry.

With the global shipping emission of greenhouse gases, the EU maritime greenhouse gas emissions MRV rules, monitoring means of greenhouse gas emissions in China, explore the impact of EU maritime greenhouse gas emissions MRV rules on China's shipping industry, for the domestic greenhouse gas emission monitoring system and puts forward some opinions and suggestions.

On the one hand, China's shipping industry should focus on improving the ship energy efficiency, reduce greenhouse gas emissions from the technical level; on the other hand, to accelerate the activity of greenhouse gas monitoring of marine ships, preparing for the formation of emission reduction mechanism of the market. China should actively study the rules of greenhouse gas emissions accounting, establish and perfect the specialized institutions for monitoring and controlling greenhouse gases, and establish a database for MRV of marine greenhouse gases. At the same time, China will continue to seek international cooperation to promote the emission reduction mechanism within the framework of the IMO and to build a fair, fair and rational global carbon emission reduction system for shipping industry.

KEY WORDS: MRV, GHG, emissions reduction, China, shipping industry

TABLE OF CONTENTS

Declaration	ii
Acknowledgement	iii
Abstract	iv
Table of contents	v
List of Tables	vi
List of Figures	vii
List of Abbreviations	viii
Chapter1:Background and dynamics of EU shipping MRV regulations	1
1.1The international context of global carbon emissions	1
1.1.1 Important international conferences and regulations	1
1.1.2 EU emissions trading system	3
1.2 IMO and the EU in shipping emission reduction initiatives and joint relations	
1.2.1 IMO initiatives and progress in shipping reductions	5
1.2.2 EU shipping carbon emissions MRV system rules put forward	9
1.2.3 IMO's relationship with the EU in shipping carbon reductions	
1.3 EU shipping carbon emissions MRV system rules of the main content, ideas and objectives analysis	11
1.3.1 EU shipping MRV system rules main content	11
1.3.2 EU through the rules to promote maritime MRV system principles	18
1.3.3 EU to develop maritime carbon emissions MRV system purposes	21
Chapter2: The Impact of Sea MRV Program and Market Emission Reduction Measures on International Maritime Industry	25
2.1 On the international maritime economy cost	25
2.1.1 Impact on shipping management costs	26
2.1.2 Impact on the operating costs of the shipping industry	27
2.2 Impact on international trade	31
2.2.1 The formation of green trade barriers	31

2.2.2 Slow global trade recovery	32
2.3 On the international maritime market vitality	34
2.3.1 On the international shipping industry boom degree	34
2.3.2 Impact on international shipping volume	35
2.3.3 Impact on international shipping efficiency	37
2.4 Indirect impact on the international maritime industry	38
2.4.1 On the international shipping industry capacity and the role of the shipbuilding industry	38
2.4.2 On the new energy, energy-saving emission reduction technology research and development and application of the promotion	41
Chapter3: Analysis on the Impact of Marine MRV Program and Market Emission Reduction Measures on China 's Shipping Industry	43
3.1 Impact on China-EU Trade	43
3.1.1 China-EU trade status	43
3.1.2 Impact on China-EU Trade	44
3.2 On the impact of China's maritime market	46
3.3 On the impact of China's shipping companies	48
3.3.1 increase the operating costs of shipping companies	48
3.3.2 affect the competitiveness of China's shipping enterprises	51
3.4 Impact on China's Shipbuilding Industry	52
3.4.1 Impact on China Shipyard Order Quantity	52
3.4.2 Technical requirements for new shipbuilding	53
3.5 On the development of green shipping in China	54
Chapter4: China 's strategic choice and response measures	56
4.1 The international level insists on both negotiating strategies and seeking the right to speak	56
4.1.1 Take the strategy of parallelism between negotiation and positive action	

4.1.2 Actively seek international voice and participate in the development of emission reduction measures	57
4.2 The overall layout of the domestic level and accelerate the development of low-carbon economy and green shipping	59
4.2.1 Theoretical level of research	59
4.2.2 Technological innovation	60
4.2.3 Management Progress	67
4.2.4 Structural level optimization	69
4.2.5Market level to promote	70
Chapter5: Summary and conclusions	72
References	74

LIST OF TABLES

Table 1	Monitoring method of EU MRV rules	14
Table 2.1	Estimates of administrative costs for EU shipping MRV and market measures proposals	27
Table 2.2	The additional cost of reducing emissions in the different sectors of the shipping industry in 2030 compared with the baseline scenario	28
Table 2.3	Global container shipping capacity allocation table	40
Table 3.1	Operation of China's major aviation enterprises in EU routes	50
Table 3.2	The increase in operating costs of China's major airlines in the European air routes under different carbon tax rates	50

LIST OF FIGURES

Figure 2.1	2001-2012 annual growth of the world's major economies by GDP	33
Figure 2.2	world trade volume change rate in 2001-2012	33
Figure 2.3	2000 BDI index trend chart	35
Figure 2.4	international container, dry bulk cargo, tanker shipping volume change trend chart	37
Figure 2.5	the total capacity of container ships, dry bulk carriers and oil tankers since 2000	39
Figure 3.1	China monthly trade balance data on EU 2000-2012	44
Figure 3.2	2010 China Shipping boom chart	47
Figure 3.3	2006 - China - European export freight forwarding index chart	47

LIST OF ABBREVIATIONS

BDI	Baltic Dry Index
EU	European Union
ETS	Emissions Trading System
GHG	Green House Gas
GSP	Green Shipping Practice
IEA	International Energy Agency
IMO	International Maritime Organization
IOPC	International Oil Pollution Compensation Funds
IPCC	Intergovernmental Panel on Climate Change
MEPC	Marine Environment Protection Committee
MRV	Monitoring, Reporting and Verification
SEEMP	Ship Energy Efficiency Management Plan
UN	United Nations
UNCLOS	United Nations Convention on the Law of the Sea
UNCTAD	United Nations Conference on Trade And Development
UNFCCC	United Nations Framework Convention on Climate Change

CHAPTER 1

Background and dynamics of EU shipping MRV regulations

1. 1 Global context for carbon emissions

Since the 1970s, as scientists have come to a deeper understanding of the earth's atmosphere, the effects of carbon dioxide and other greenhouse gases on the global climate have attracted wide public attention. Over the years, the International Conference on climate change has been held on a regular basis, fostering the development of relevant international laws and regulations. The EU as a regional organization includes most of the western developed countries and the use of existing infrastructure and technology advantages in global climate protection always plays an important role, and actively develops and launches a more influential climate policy.

1.1.1 Relevant international conferences and regulations

On June 4th, 1992, the "United Nations Framework Convention on climate change" (United Nations Framework Convention on Climate Change, referred to as "UNFCCC"), was held by the UN Conference on environment in Brazil Rio De Janeiro. The United Nations Framework Convention on climate change has established five basic principles:

1. The principle of "common but differentiated".
2. To consider the specific needs and conditions of developing countries.
3. Each Contracting Party shall take the necessary measures to predict, prevent and reduce the factors that cause climate change.
4. Respect for the rights of the parties to sustainable development.

5. Measures to strengthen international cooperation to deal with climate change can not be a barrier to international trade.

In December of 1997, the Kyoto protocol was adopted at the third session of the United Nations Framework Convention on climate change. It is the "supplementary provisions of the United Nations Framework Convention on climate change." The goal is "to stabilize greenhouse gas content in the atmosphere at an appropriate level, and for the carbon dioxide emissions of countries to set standards, namely: from 2008 to 2012, industrial carbon dioxide emissions in the world's major industrial countries. Emissions in 1990 averaged a low of 5.2%. On February 16, 2005, the Kyoto Protocol came into effect. This is the first time in human history, in the form of regulations to limit greenhouse gas emissions, in order to promote countries to achieve greenhouse gas emission reduction targets.

In December 2007, the "United Nations Framework Convention on climate change" at the thirteenth conference of the parties adopted the "Bali road map", establishing a clear agenda for the key issues to deal with climate change negotiations, and the provisions of all developed countries emission reduction targets must be measured (Measurable), (Reportable), the verification report (Verifiable), referred to as the "MRV." Developing countries only get the support of international capital, technology and capacity building mitigation actions, and to accept the "MRV" review, adopted mitigation actions do not have to accept the "MRV" standard. This is the first time that the International Conference set the emission reduction targets of the "MRV" concept. Since then, the emission reduction targets of measurement, reporting, and verification has become one of the important issues in international negotiations on climate change.

In December of 2009, the United Nations Framework Convention on climate change met for the fifteenth conference of the parties (the Copenhagen world climate

conference).The Copenhagen conference was to discuss the "Kyoto Protocol", a commitment to expire (2012) after the follow-up plan, that is, from 2012 to 2020, the global emission reduction agreement. The final meeting did not achieve the desired results, but only symbolically reached a non binding Copenhagen agreement.

In November of 2012, the United Nations Framework Convention on climate change met for the eighteenth conference of the parties, held in Doha. At the meeting, the Kyoto Protocol, which expires in 2012, was agreed to extend until 2020.

In December 12, 2015, nearly 200 Parties to the United Nations Framework Convention on Climate Change agreed to adopt the Paris Agreement to make arrangements for global response to climate change after 2020. The new climate change strategy adopted by the Paris Climate Change Conference created a set of targets for controlling global air temperature and greenhouse gas emissions.

1.1.2 EU emissions trading system

The EU Emissions Trading System (EU ETS)is the central component of the EU's climate policy. EU ETS is a typical "cap and trade" system, that is, to achieve emission reduction targets through the "emission ceiling" and "quota trading". By the European Commission to establishing a baseline and calculating the total amount of quotas, the EU member states can be in accordance with their national distribution plan (NAP) to cover all the enterprises in the EU ETS free quota allocation. In order to achieve the goal of quantitative control of greenhouse gas emissions, the EU Member States should ensure that their net emissions of greenhouse gases during the commitment period should not exceed a certain ceiling. All EU members will be the single source of emissions caps on emissions and assigned to specific decomposition industry according to their own characteristics of the industry. The total emissions of each emission source specified in the commitment period must not exceed the

allocation of emission caps. This mechanism relies on "monitoring report (Monitoring), (Reporting), verification (Verification) system (MRV system) to implement all the carbon dioxide emissions the entity must annually report their emissions and monitoring. Carbon dioxide emissions should be controlled within the limits of emissions quotas, and if exceeded, they will face 100 per ton of carbon dioxide Euro fine.

In January 1, 2005, the EU ETS officially launched. The system is divided into three stages:

The first stage of the trading period is from January 1, 2005, to December 31, 2007. During this period, the EU ETS only relates to carbon dioxide emissions, covering nearly 12000 members of the EU industrial emissions entity (not including mobile emission sources), these industries limited energy intensive industries, such as internal combustion engines, the high energy consumption of iron and steel, cement, glass, ceramics, paper industry.

The second phase of the transaction is from January 1, 2008 to December 31, 2012, with the Kyoto Protocol, the first commitment period synchronization. During this period, which only relates to carbon dioxide emissions, each member expand the scope of EU ETS to other departments or to cover more kinds of greenhouse gases, but to go through the approval of the European commission.

The third stage of the trading period is from January 1, 2013 to December 31, 2020. This stage cancels NAP, replaced by a unified European Commission calculation and allocation of emission reductions.

The EU ETS in the flexible body can take the internal cost effective way of reducing emissions abatement, also can buy or sell the quota by the European Climate Exchange, market participants can not only through the implementation of quota spot trading, also can be in the same stage of cross year quota of futures trading, but also

lending quotas. These emission reductions can come from within the EU emissions quotas, but also in part from other United Nations recognized emission reduction targets, such as joint implementation and clean development mechanism under the emission reduction credits.

1.2 IMO and the EU in shipping emission reduction initiatives and joint relations

1.2.1 The progress and development of IMO in marine emission reduction

1. The development of IMO data collection mechanism

The International Maritime Organization (IMO) was established in 1948. Its main task is to regulate all types of navigation activities. In recent years, global warming has become increasingly prominent, and the IMO began to also regulate international shipping emissions.

Up to now, IMO on the development of ship energy efficiency data collection mechanism has gone through the following three stages:

(1) The gestation period (Marine Environment Protection Committee⁶⁴-MEPC 65): starting from MEPC⁶⁴, the United States by the market mechanism to build ships mandatory energy efficiency standards, promote the way proposed to take the stage of progressive three stages of the establishment of operational ship mandatory energy efficiency standards. This program in MEPC 65 by most countries of the European Union, an umbrella group of support. The committee discussed the 65 session of the MEPC agreed to issue 4 (air pollution and energy efficiency) under a new sub topics to discuss and further enhance the ship energy efficiency technology and operational measures, and agreed to establish a working group in the MEPC⁶⁶ session to discuss the issue.

(2) Start time (MEPC66 - MEPC67): the committee established a working group to review the development of the ship fuel consumption data collection system, the working group of great differences did not reach substantive opinions, therefore the 66 session of the MEPC decided to set up by Cyprus is responsible for coordinating the communication between groups, will further enhance the ship energy efficiency technology and operation measures, establish review the ship energy consumption data collection mechanism and mechanism of core elements, and submit a report to the MEPC67 session. Due to large differences between the parties, in the communications group and MEPC67 session to discuss the parties only data reporting cycle, database maintenance and a few problems reached a consensus. There is considerable controversy in the establishment of a data collection mechanism for the purpose, scope, content and other data.

(3)Acceleration period (MEPC 67-MEPC 68): as a result of the dispute between the parties, the second session of the Commission agreed to re set up a communications group to discuss the establishment of (mandatory or voluntary) a data collection mechanism of the ship's energy consumption issues MEPC. The communication group coordinator in the form of questions and answers for the parties to the scope and operation of ship energy efficiency data collection methods and other issues, and the second round of consultation when trying to put forward legal texts by modifying the MARPOL Annex VI way to enforce the ship data collection mechanism, the European Union and the United States as the support group, and submit MEPC68. The MEPC68 session, as our major developing countries and the opposition, the meeting agreed to not discuss implementation issues of data collection mechanism, only collection content and other technical problems to discuss, the frame of IMO data collection system.

2.IMO data collection framework

MEPC68 Conference on the basis of the report of the communication group and the views of the parties on the data collection mechanism has been a heated discussion, and formed the basic framework of IMO data collection:

✍ scope of application: 5000 tons and above;

✍ data collection and submission:

2.1 data reporting cycle: 12 months;

2.2 data report: the end of data reporting cycle within 3 months after the ship owner will submit data flag Administration (which means that part of the ship owner to obtain data from the actual operator).

The 3 flag administration duties:

3.1 ensure that the annual data of the registered ship is submitted to the IMO database within 4 months after the end of the data reporting cycle;

3.2 certificate of compliance with the annual data of the ship in accordance with the regulations;

4 database and data disclosure

4.1 database management by MEPC;

4.2 member countries can obtain anonymous data through the database data, can not obtain specific ship information through anonymous data.

5 identified data collection:

5.1 Ship identification information: IMO;

Technical parameters:

5.2 ship type, total tonnage, net tonnage, tonnage, engine power, engine power, EEDI (if applicable), ice class (if applicable);

5.3 Fuel consumption data (activity data collection for further discussion).

Comparison of IMO data collection mechanism and EU MRV rules

By comparing with the EU MRV rules, we can find that the current IMO data

collection mechanism is applicable to the ship tonnage and the EU MRV rules are consistent, are more than 5000GT, submitted to the same period of a year. To verify the part of the EU MRV rules provisions of the company to develop and submit the monitoring plan, emissions report must be approved by the independent third party verification audits, confirm compliance, issued by the verification certificate of compliance mechanism, while the IMO data collection mechanism for data verification by the competent authorities in the flag and the issuance of certificate of compliance. At present, IMO data collection is only on the basic framework to reach agreement, but the activities of data collection and other content to be further discussed. Compared with the mechanism of monitoring and reporting, verify and improve the rules of EU maritime MRV, stage IMO data collection mechanism in terms of content complexity, form integrity requirements gap, there are many uncertainties in the future, need not to prejudge the premise of emission reduction mechanism under steady and prudent conduct of shipping emission reduction negotiations.

If the IMO developed a global market for a greenhouse gas emission reduction mechanism of the shipping industry, it would be adversely affected by a number of special factors on China's shipping industry. First of all, "the United Nations Framework Convention on climate change" in the developing countries in the global greenhouse gas emission reduction in the "common but differentiated responsibilities" principle will be difficult to apply, because one of the basic principles of IMO is no more favorable treatment, namely" Regulations on port state control applies to all ships, including non convention ships flying the flag of the existing IMO and a number of laws and regulations, yet according to the different ship on the ship with different precedent. And ship owners and ships are usually in different countries, the ship can also be registered in a number of countries between

the transfer. This has caused great difficulties for distinguishing ships from developed and developing countries as well as defining differential treatment of carbon emission reductions.

It is very difficult to establish a mandatory emission reduction regulation of the global shipping industry, which is a complex issue related to the interests of many parties. It is difficult to make the relevant countries, in the near future, to achieve mutually beneficial and win-win emission reduction standards. Although IMO has not yet proposed mandatory emission reduction standards for the global maritime industry, it has been working hard in this direction.

1.2.2 MRV rules for carbon emissions from shipping in EU

According to the economic development in the next ten years plan, namely the EU 2020 strategy, by 2020, the EU greenhouse gas emissions should be lower than in 1990, to reduce by 20%-30%, and the European Parliament and the European Commission requires that all industries are required to participate in emission reduction. In order to achieve this goal, the European Union in 2011, the white paper on transport proposed that by 2050, the EU maritime carbon dioxide emissions should be lower than in 2005 by 40%-50%. In the EU's transportation sector, shipping is currently the only one not included in the greenhouse gas emission reduction commitment to the industry. Statistics show that in 2010 the EU maritime vessels (including ships operating in the European Union waters and in and out of the EU waters) CO₂ emissions are about 1.8 tons. According to the EU's forecast, with the increase in trade volume, the ship's CO₂ emissions will continue to increase.

According to IMO's research data, energy consumption and emissions can be reduced by 75% if the international shipping industry is able to take adequate measures to reduce emissions. However, due to the lack of the mechanism of MRV,

the number of accurate emissions can not be shipping CO₂ and other greenhouse gases, but also because of the lack of reliable statistical data and ship energy efficiency related technical performance, a lot of very cost-effective measures can not be extended. The EU believes that, whether it is at the EU level or global level, MRV can be a positive role for the elimination of emission reduction measures of market barriers, and no matter what the next market measures or technical standards, accurate shipping greenhouse gas emissions data is an important prerequisite.

Although the rules of ship energy efficiency by IMO has been in force, the EU still thinks IMO in the greenhouse gas emission reduction action is too slow. I hope by introducing the MRV mechanism within the European Union, to create ample time to discuss and decide the future emission reduction targets, market mechanisms and energy efficiency standards, lay the foundation for emission reduction actions at the next step. At the same time, the EU MRV rules for example help to promote the establishment of global maritime MRV mechanism.

Therefore, in June 28, 2013, the European Commission to the European Parliament and the European Council submitted a report on carbon dioxide emissions measurement, shipping and verification (monitoring, reporting and verification, hereinafter referred to as MRV) to draft legislation rules. At the beginning of 2014, the European Parliament, the industrial research and energy committee, the Transportation Committee and the environment committee voted for the draft in the European Parliament for three crucial votes in favor of the implementation of the draft. In November 2014, the European Council and the European Parliament reached an agreement on the text of the draft. In April 29, 2015, the EU MRV bill was formally adopted, and went in effect on July 1, 2015.

1.2.3 The relationship between IMO and EU carbon emission reduction

Through the IMO to promote the global shipping industry greenhouse gas emissions in line with the interests of the EU, and in 40 of the IMO's governing body, nearly 30% of the EU Member States, so the EU's influence on IMO is very large. Although the IMO is also studying the shipping emission reduction measures, however, the EU is still the first to take unilateral action. The EU insists that its push to monitor the bill will also be part of a global shipping reduction under IMO.

In the course of promoting the review of the EU's aviation carbon trading system, the process has gone through the proposed bill, resisted and rejected, to suspend the implementation of the amendment, and again raised, then concluded that if the EU carbon emission reduction in shipping and IMO cooperation ultimately failed, then the EU will likely start a unilateral plan, in order to achieve the included in the EU ETS or the introduction of "marine carbon tax" in the shipping industry; if the cooperation between EU and IMO is successful, the EU will use IMO platform to promote and implement shipping emissions management mechanism.

1.3 Analysis of the main contents, ideas and objectives of the MRV rules of carbon emissions in the European Union

1.3.1 Main contents of EU maritime MRV rules

The draft EU rules on MRV is the second draft legislation proposed by the European Union in 2006, after the civil aviation industry was incorporated into the EU emissions trading system. The EU MRV rules are intended to establish a monitoring, reporting and verification system for CO₂ emissions from operating ships within the European union. This Regulation should enter into force on 1, July, 2015 to ensure that the Member States and relevant stakeholders have sufficient time to take the

necessary measures for the effective application of this Regulation before the first reporting period starting on 1, January, 2018.

From 2019, by 30 April of each year, companies shall submit to the Commission and to the authorities of the flag States concerned, an emissions report concerning the CO₂ emissions and other relevant information for the entire reporting period for each ship under their responsibility, which has been verified.

As a first step towards cutting greenhouse gas emissions from maritime transport, the EU requires operators of ships exceeding 5,000 GT to monitor and report their carbon emissions and transport work on all voyages to, from and between EU ports.

All ships exceeding 5,000 GT regardless of their flag, port of registry or home port are concerned, except warships, naval auxiliaries, fish-catching or fish-processing ships, wooden ships of a primitive build, ships not propelled by mechanical means, and government ships used for non-commercial purposes. This also does not apply to ships only to install fuel, crew supplies or up and down for the purpose of its affiliated port.

According to the rules, companies need to develop a monitoring plan for ships, and according to the method and program plan, to monitor the ship single voyage, and annual fuel consumption and emission data submitted to the European Commission, and the state authorities in ship emissions report after the end of the reporting period. For Companies that develop and submit the monitoring plan, the emission report must be verified by an independent third party audit institutions to confirm compliance with the provisions of the certification body issued by the proof of compliance.

EU authorities will take punitive measures for those who do not conform to the rules of the ship, the ship more than one reporting period does not comply with the rules, will be expelled from the EU ports or rejected affiliation. At the EU level, the EU

Maritime Safety Authority (EMSA) to help them carry out related work. Every year, the Commission will be the implementation of the rules of the company and the ship fuel consumption, emissions, annual average energy efficiency index data released at the same time also to IMO or other international institutions reporting information.

3. EU MRV specific provisions

(1)Monitoring

The main rule is monitoring the EU MRV company, namely the owner or the actual ship operators, ship monitoring objects including single voyage and total annual emissions and other climate related data. Prior to August 31, 2017, the company plans to develop a monitoring plan for each ship, and it will be implemented beginning January 1, 2018. The contents of the monitoring plan mainly include the basic information of the company and the ship, the monitoring procedures and methods of the fuel consumption, the ship activity data and so on.

Generally, the ship CO₂ emissions from fuel consumption (including fuel consumption, auxiliary boiler and host, inert gas generator) to determine the product and emission factor, and when the vessel is in port berthing period separately calculated fuel consumption.

$$\text{CO}_2 \text{ emissions} = \text{fuel consumption} \times \text{emission factor}$$

There are four acceptable fuel consumption monitoring methodologies:

- (a)Bunker Fuel Delivery Note (BDN) and periodic stock-takes of fuel tanks
- (b.)Bunker fuel tank monitoring on board
- (c)Flow meters for applicable combustion processes
- (d)Direct emissions measurements

Ships can use a combination of these methodologies if it results in an improvement in the accuracy of monitoring.

The basic principles and applicability of the four methods are shown in table 1.

Table 1 Monitoring method of EU MRV rules

Methods	basic principle	applicability
a.Bunker Fuel Delivery Note (BDN) and periodic stock-takes of fuel tanks	This method is based on the quantity and type of fuel as defined on the BDN combined with periodic stock-takes of fuel tanks based on tank readings. The fuel at the beginning of the period, plus deliveries, minus fuel available at the end of the period and de-bunkered fuel between the beginning of the period and the end of the period together constitute the fuel consumed over the period.	This method shall not be used when BDN are not available on board ships, especially when cargo is used as a fuel, for example, liquefied natural gas (LNG) boil-off.
b.Bunker fuel tank monitoring on board	In the statistical period, every day and every time after the fuel operation, the fuel tank fuel tank Reed measurement, the difference between the measured data will be accumulated every two times, that is, the total amount of fuel consumption during the statistical period.	Ships that use goods as fuel, such as LNG ships, shall not apply.
c.Flow meters for applicable combustion processes	During the statistical period, all the readings of the direct fuel flow meter with the emission source are accumulated to obtain the total fuel consumption during the statistical period.	Only applicable to ships that have been fitted with flowmeters

D.Direct emissions measurement systems	CO ₂ emitted shall include CO ₂ emitted by main engines, auxiliary engines, gas turbines, boilers and inert gas generators. For ships for which reporting is based on this method, the fuel consumption shall be calculated using the measured CO ₂ emissions and the applicable emission factor of the relevant fuels.	Only for ships equipped with exhaust gas measuring equipment
--	--	--

For each ship exceeding 5,000 GT, fuel consumption and carbon emissions on all voyages to, from and between EU ports while the ship is at sea as well as at berth must be reported.

Other relevant information to be reported includes distance travelled, time spent at sea, details of the cargo carried, transport work and average energy efficiency expressed in fuel consumption or carbon emissions per distance or per transport work.

According to the requirements of the rules, the company needs to monitor the relevant data of the single flight times and the whole year. The data of the two monitoring periods and the processing of the data are different.

Which data shall be reported?

port of departure and port of arrival including the date and hour of departure and arrival;

amount and emission factor for each type of fuel consumed in total;

CO₂ emitted;

distance travelled;

time spent at sea;

cargo carried;

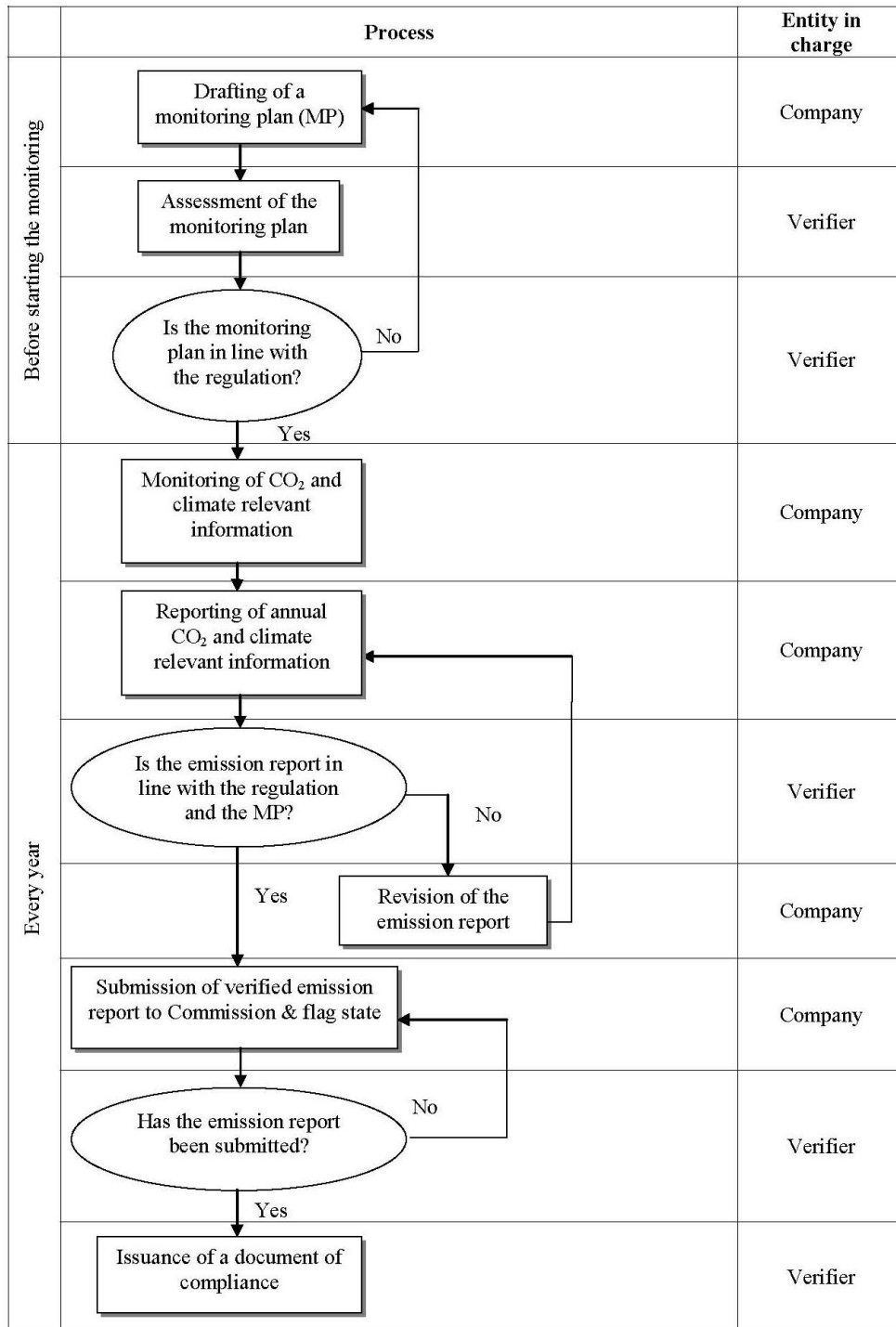
transport work.

(2)Reporting

From the beginning of 2019, the company must state to the Commission and the ship on April 30th of each year before the competent authority, submitted by the verification institutions, approve the emissions report. The contents of the report include the basic information of the company and the ship, the Energy Efficiency Design Index (EEDI) or the Estimated Index Value (EIV) , the monitoring methods used and the level of uncertainty, as well as the annual monitoring data. The emission report will be submitted to the electronic data exchange format by automatic system. The Commission will be involved in the formulation and implementation of specific technical problems of bill.

(3)Verification

The main body of the EU MRV regulation is an independent third party verification agency. Verification is of the objective, including the company's monitoring plan and the formation of the emission report, using the specific verification process as shown in figure 1-2.To verify the mechanism by flag administration according to relevant laws and regulations are authorized, the feasibility and accuracy of monitoring plan and emissions reporting companies submitted for verification, and to meet the requirements of ship compliance certification rules. The certificate is valid for 18 months after the end of the reporting period. Certificate of compliance issued after verification, institutions must provide the information to inform the Commission and flag administration as soon as possible. This information will also be submitted to the automatic system by electronic templates and other data exchange formats. The Commission will review the formulation and implementation of specific technical problems of bill. The steps of the MRV process are illustrated by the following figure.



Nuclear in real-time emissions report verification mechanism will report the data submitted by the company and compare the estimated data through the ship tracking and technical parameters, which are obtained to identify possible problems in monitoring and reporting. Sampling inspection can be carried out if necessary to determine the reliability of the reported data. According to the rules, from June 30, 2019, all rules applicable to the ship shall be equipped with a valid certificate of compliance. Members of the ship that do not comply with the rules requires the development of punitive measures, and inform the Commission on July 1, 2017. The port authority of a member state shall issue an order of expulsion to a ship that has not been subject to the rules for more than one reporting period. Any punishment measures taken by the state of the port, including the deportation order issued under the port, in a timely manner should inform the European Commission, the EU Maritime Safety Authority (EMSA), other Member States, and the flag administration. For the expulsion of the ship, that met the requirements before, all Member States will reject the ship anchored in the port. From this perspective, PSC can also be regarded as the ship monitoring and reporting to "verify", but this is only to meet the verification of proof checking, namely whether the ship has only to verify the execution of the rules.

1.3.2 EU rules to promote the principle of marine MRV system

1. Principle of non discrimination

The scope of the EU MRV rules is defined by the size of the ship and the regional nature of the operation, and has nothing to do with the ownership of the ship. No

matter what kind of hanging flag, no matter which ship belonging to the company, as long as it is operating in European waters, or affiliated EU ports is required to execute the rules. Otherwise it will ship to accept the PSC examination in EU ports or it will have a problem that can be punished, and even expelled and refused to call out. Therefore, even if the flag administration of non EU members, if the ship to be anchored in EU ports after rules, you must specify the third party verification institutions to carry out the audit of the ship, for compliance certification.

2. Emphasis on cost effectiveness and reduced administrative burden. In the legislative proposals, the European Commission repeatedly stressed that the formulation of the rule takes full account of the cost efficiency principle, and as far as possible to reduce the administrative burden. It is mainly manifested in the following aspects:

(a) The rules apply only to ships with a total tonnage of 5000 tons or more, which account for only about 55% of the fleet size of the European Union, but the emission rate is about 90%;

(b) To make full use of the existing log ship, noon report, the Bunker Fuel Delivery Notes(BDN) and other methods to collect data;

(c) The existing performance system and institutions to implement the rules by using the international shipping industry, such as the use of an independent third party to carry out the audit and certification, the use of existing ship management and port state inspection mechanism and the disclosure of data and other means, so as to ensure the implementation of the rules.

3. The openness of technical problems

The rules involved in the monitoring method, emission reporting procedures, the approval of the verification agency, verification procedures, port state inspection information bulletin and other technical issues, are principled statements. In practice,

it will encounter many specific problems. Therefore, the terms clearly stated: for these technical issues, the European Commission needs to be authorized to be amended in the future, or to develop a specific implementation of the bill. The rules also pointed out that although the rules currently are only for the ship's CO₂ emissions and ship energy efficiency related data, but in theory, the mechanism can also be applied to other emissions, such as SO_x, NO_x, etc. The ship's existing record cannot be used to calculate the data, and the existing measurement techniques can not be guaranteed because of the reliability and high cost, so, in order to promote the implementation of the MRV as soon as possible, the EU rules are temporarily only for CO₂ MRV. But do not rule out the possibility of expansion in the next step.

4.Diversity and complexity of monitoring data

The EU MRV monitoring data is more complex than the IMO data collection mechanism currently under discussion. The MRV scheme will consider five possible efficiency metrics, based on ship information, emissions (per voyage), activity (distance and number of voyages), capacity(deadweight) and operation (cargo quantity and weather conditions),covering almost all of the data elements currently available for operational energy efficiency methodology.

5.Compatible with IMO data collection mechanism

The European Commission also said in the legislative proposals, they are more inclined to adopt unified global measures to achieve ship emissions. Therefore, in the design of MRV, it is based on the existing international conventions and the existing regulatory system of the international shipping industry. At the same time, in terms of the rules of authorization, after allowing it to reach the international framework, especially in the IMO global measure of consensus, they can revise the EU MRV rules.

1.3.3 The EU aims to develop a MRV system for maritime carbon emissions

The EU is committed to the implementation of marine carbon emissions MRV system, and on the surface this shows its positive control and reduction of carbon dioxide emissions in various industries, and that it takes the initiative to play a major role in the global carbon emission reduction will and determination. But behind the environmental protection and humanitarian issues there is a deeper purpose.

(1) For the shipping industry into the European Union Emissions Trading Scheme (EUETS) system to pave the way

The European Union had previously wanted to incorporate the aviation carbon emissions into EUETS, but in the implementation of the policy process it faced international opposition and resistance, and was forced to suspend the plan. After encountering resistance and drawing upon lessons from the European Union, the relevant actions will be reasonably planned and arranged in time and schedule, to achieve the goal in a slow and orderly manner. EUETS is based on the normal operation of the system of carbon emissions in the MRV system, therefore, for the European Union to develop a marine carbon emissions MRV system, this behavior is to be incorporated into the shipping industry EUETS plan to pave the way.

(2) Comprehensive political and economic interests

If it is to develop a successful implementation of the MRV mechanism of the shipping industry, the EU is conducive to gradually promote the success of the EU ETS system to the shipping industry. It is possible for the EU to pave the way for the implementation of a global industry emission reduction plan for the future of steel, electricity, cement and other industries. The European Union is starting with shipping, aviation and other aspects, being orderly and planned to promote a carbon emissions trading system, and to promote the implementation of the global scope. Obviously, it wants to make low-carbon economic for economic growth opportunities. The

developed countries can use funds and technology, in creating a low carbon technology and a management system, and then by applying pressure to reduce emissions of greenhouse gases in climate negotiations, while fostering the development of a national green industry, increase the EU green technology and clean energy products to the EU export capacity, a number of strategic emerging industries, such as carbon emissions, monitoring reporting and verification services, carbon trading and carbon finance business in the future, to seize the opportunities of the global carbon market, thereby stimulating regional economic recovery as soon as possible.

On the other hand, the implementation of MRV system in Europe, to further promote the carbon emissions trading system of the shipping industry, which also has the right to compete for the right to speak and for pricing factors. At present, the global carbon emissions trading system is not fully established. However, the demand for carbon emission control is getting larger and larger, and it can be used to develop a regional carbon emissions trading mechanism, and to promote the implementation of it, it can win a lot of pricing power in the carbon emissions trading mechanism, to compete and increase its discourse power in the world political and economic fields.

(3) A far-reaching global financial strategy

The European Union has developed a MRV system for maritime carbon emissions, further promoting the establishment and promotion of a carbon emissions trading system. In addition to the EU's own economic and political interests, there is also a huge global financial strategy behind the plan. The EU Shipping MRV system is designed to contribute to building an international system. The first steps in this direction have already been taken at the IMO with active support from the EU and partner countries. By yielding further insights into the sector's potential to reduce emissions, the EU Shipping MRV system will also provide new opportunities to

agree on efficiency standards for existing ships

If you want to achieve a single world monetary system, there is a need for brewing, accumulation, planning, and waiting for the right time to launch in order to achieve. Today, the international financial community has two major groups, respectively, with the Roche family as the core of the "gold environmental groups" and the Rockefeller family as the core of the "oil war groups". The two sides are consistent in the future to control the world's single currency strategy, but there are differences in the level of interest and monetary philosophy. "Gold environmental groups" emphasizes the fairness and rationality of the currency, that the future of the world currency is bound to contain two basic elements of gold and environmental protection, in order to meet the integrity and flexibility of the currency; "Oil war groups" is the emphasis on violence, it believes that as long as the control of the Middle East oil supply, coupled with military and War deterrence, the U.S. dollar or a single currency has a force based on "the credit". The two major groups of the contest, at the international level is the United States (US dollar) and Europe (Euro) . A large number of traditional industries have been or are accelerating the transfer to emerging developing countries. Europe and the United States will have a downward trend in carbon dioxide emissions. At this time, the developing countries are on a large scale, and their carbon dioxide emissions will be on the rise in the foreseeable future. If the future of the single currency is a combination of "gold + carbon emissions" in the form of currency, then the western countries will benefit from it, while developing countries will face great losses.

As mentioned earlier, if you want to achieve a single world monetary system, you need to brew, accumulate, plan, and wait for the right time to launch in order to achieve. The MRV system of carbon emissions by the European Union is the precondition of the shipping industry into the EU carbon emissions trading system, in

order to cut the entrance, put more industries into them, and gradually establish a global carbon emissions trading system, so that the carbon emission quota has financial value, and promotes the "carbon emission quota" as one of the elements of the world's single currency. This is fully consistent with the world's single monetary policy route. Therefore, we should pay considerable attention to the global financial strategy of the international financial power group behind the MRV system and the carbon trading system.

CHAPTER 2

The impact of marine MRV program and market

emission reduction measures on the international shipping industry

All large ships on the European route are included in the EU MRV program within the scope of the rules, more than 11391 European Union ship 5000GT ship, which are operated by the ship operators of the world's 2623 countries. The implementation of the EU shipping MRV program and the subsequent market emission reduction measures will inevitably have a great impact on the international shipping industry. This article is from the international trade, international shipping industry boom and capacity situation, new energy, energy saving and emission reduction technology research and application, and it analyzes the implementation of shipping MRV and the subsequent market emission reduction measures impact on the international shipping industry.

2.1 The influence of international shipping costs

Because of the location of the industrial chain and the characteristics of the shipping mode, the shipping industry is subjected to many factors, such as the upstream, midstream and downstream industries. The profit model is more fragile and the operating risk is larger, for example, in the proportion of operating costs of fuel costs. As the end consumer, the shipping industry has no pricing power on fuel sales prices, directly under high fuel costs; because the shipping industry of international trade dependence shipping profit model is relatively simple, and the ship with high value, capital intensive business, long life and other characteristics, which makes it difficult to effectively resolve the crisis for the ship on a substantial increase or in an excess capacity situation , which exacerbates the risk of fluctuations in the shipping industry

periodically, make shipping more and more enterprises operating load.

Because shipping is in the core position in international trade activities, the influence of any measure to shipping cost may cause turbulence in the shipping economy. The extent of the impact depends primarily on the balance between the cost of saving shipping, and the increase in the cost of the implementation of the measures for the implementation of MRV and the possible carbon reduction scheme in the shipping market.

2.1.1 Impact on shipping management costs

The MRV scheme and the imposition of a marine carbon tax or the incorporation of the ETS into the EU market will increase the manpower and resource costs of shipping management. These management costs include:

(1) Establish and prepare: understand the rules, implementation and progress, consulting, communication with the competent authorities of the industry, such as the early work hours;

(2) Monitoring plan: communicating with ship owners and ship operators the basic information and performance of the ship;

(3) Monitoring and reporting: the establishment of the ship emissions reporting system, including the configuration of the data statistics and management personnel, the calculation of carbon emissions and the cost of working hours, and the cost of writing the reports, etc.

(4) Verification costs: payment of verification fees and legal advice;

(5) ETS program also involves registration fees and transaction costs and other costs.

Reference to the impact of the aviation MRV program on airline management costs, according to the York Aviation estimates, in accordance with the implementation of

the MRV program, the airline management costs will increase by 11.6-18.7 million euros per year. According to AEA estimates, the EU route all 5000GT vessels due to the implementation of the MRV program, an increase of the management cost of 26 million 100 thousand euros per year. Coupled with the implementation of emission reduction measures of the market may be the management cost, and management cost is about 77 million a year (see table 2-1).The increase in management costs in the shipping industry MRV and other possible market emission reduction measures resulting in an increase in the proportion of the total cost is estimated to be about 1% (28/06/2013 – SWD (2013) 237, EUROPEAN COMMISSION), however, the small shipping companies will bring no small cost pressures.

Table 2-1 estimates of administrative costs for EU shipping MRV and market measures proposals

Type of cost	All ships >400GT		All ships >5,000GT	
	€m	€ per vessel	€m	€ per vessel
Set-up and preparation	14.7	800	7.6	660
Monitoring plan	3.7	200	1.9	170
Preparation of yearly emissions reports	28.1	1,500	12.9	1,130
Verification of yearly emissions reports	82.8	4,500	51.3	4,500
Submission of information	6.1	330	3.8	330
TOTAL	135.2	7,350	77.4	6,780

(Data: AEA)

2.1.2 Impact on shipping industry operating costs

(1) The impact of MRV on shipping industry operating costs

The operating cost of shipping enterprises is affected by many factors, such as fuel price, port usage, maintenance and depreciation. Among them, the fuel costs account for about 35%~50% of total operating costs. It is expected that by introducing MRV, greenhouse gas emission reductions of up to 2% compared to business-as-usual and

an aggregated net costs reduction of up to €0.94 billion by 2030 could be achieved. According to the program commissioned by the AEA impact assessment report on the relevant data (see table 2-2), it is expected that to implement the MRV program, will improve the energy efficiency of the ship, resulting in reduced fuel consumption. Fuel cost savings of the growing period of 2015-2030, is expected to save fuel costs totaled at €5 .6 billion .

(2) The impact of possible market carbon reduction measures on the operating costs of the shipping industry based on MRV

Since the operating costs of the shipping business is a trade secret, there is no publicly published European Union airline operating costs and operating data of the ship's fuel consumption data. Reference AEA Technology based energy system optimization model--TIMES(the integrated Markal-Efom system),this paper analyzes the impact of the market carbon emission reduction measures on the shipping operation cost, based on the EU shipping MRV scheme (see table 2-2).

Table 2-2 The additional cost of reducing emissions in the different sectors of the shipping industry in 2030 compared with the baseline scenario

(The asset depreciation rate10%)

Extra cost		Capital cost	Operating cost (Non fuel cost)	Fuel cost	The cost of carbon emission	Total cost
Fuel consumption monitoring	Price(€bn)	-	+0.6	-9.4	-	-8.8
	Percentage	-	+0.3%	-2.0%	-	-0.6%
Fuel tax	Price(€bn)	+2.5	+1.6	-4.8	+66.7	+66.0
	Percentage	+0.4%	+0.5%	-0.8%	-	+4.5%
Carbon tax	Price(€bn)	+2.9	+0.03	-55.9	+26.1	-26.9
	Percentage	+0.5%	+0.01%	-9.6%	-	-1.8%
Contribution compensation	Price(€bn)	+2.9	+0.03	-55.9	+26.1	-26.9
	Percentage	+0.5%	+0.01%	-9.6%	-	-1.8%

fund						
Closed carbon emissions trading system	Price(€bn)	+8.4	+0.07	-55.8	-	-47.3
	Percentage	+1.4%	+0.02%	-9.6%	-	-3.3%
Open carbon emissions trading system with Free Quota	Price(€bn)	+2.8	+0.12	-55.6	+0.7	-52.0
	Percentage	+0.4%	+0.04%	-9.5%	-	-3.6%
Full auction open carbon emissions trading system	Price(€bn)	+3.0	+0.01	-56.0	+30.4	-22.6
	Percentage	+0.5%	+0.003%	-9.6%	-	-1.5%
Target based compensation fund	Price(€bn)	+3.0	+0.01	-56.0	+30.4	-22.6
	Percentage	+0.5%	+0.003%	-9.6%	-	-1.5%

Note: data sources: AEA Technology and others, 2012; Negative value means cost savings.

According to the results of the model, all of the schemes will increase the cost of investment because the shipping industry needs to invest in new shipbuilding and emission reduction technologies to improve energy efficiency. By 2030, however, the program will have saved fuel costs to varying degrees. The shipping industry can be obtained at the 2 billion 260 million ~ 5 billion 190 million gains (as emission reduction measures of the market take varies). In the existing shipping market emission reduction measures, there is only the carbon emissions tax caused by the higher operating costs. By 2030, annual operating costs will be €6.6 billion higher than that of the baseline scenario. It should be noted that the above analysis is based on the European Union, which has mastered the application of energy-saving emission reduction technology and energy saving potential of the simulation conditions. And they do not grasp that the existence of these advanced technology or technology investment financing difficulties, can not be a large-scale promotion of

the use of advanced technology, and that the country can not get a substantial increase in energy efficiency of the ship. To the contrary, in the early stage of the EU shipping MRV program and the possible measures to reduce carbon emissions in the market, the cost of fuel saving is far less than the increase in operating costs. A lot of scholars have studied the influence of shipping market emission reduction measures on the operation cost of the shipping industry through the typical case study and scenario simulation.

Case one

Choose Cape of Good Hope bulk carrier, VLCC ship, 4000-6000 TEU container ship as the analysis object. When the CO₂ emission quota price is \$15 /t, fuel price changes in the range of \$ 300-900/t, the results show that the implementation of ETS, ship operating costs rise. 4000-6000 TEU container ship annual transportation costs increased the most, up 4.1%-8.8%; Followed by Cape of Good Hope bulk carriers, transportation costs rose 3.4%-6.1%; VLCC shipping costs affected by the smallest, up 3.2%-5.6%. (Wei Hong Gu, 2012)

Case two

Studies have shown that when the fuel price is \$427 / tonCO₂, the carbon tax is \$20 / tonCO₂, the total cost of 4000-6000 TEU container ship transportation increased by 9%, Capesize bulk cargo shipping costs increased by 7%; When the carbon tax is \$40 / tonCO₂, the total cost of 6000 TEU container ship transportation increased by 19%, the total cost of Capesize bulk carrier transport increased by 14%. (Wang Can, 2011)

Case three

Taking COSCO Ningbo as an example, the paper analyzes the changes of shipping enterprises operating costs after the implementation of the "Marine carbon tax". The specific conditions are as follows:

(1) The standard position of the ship is 9469 TEU, the actual situation of the ship is

full of the case of the volume of 8000 TEU, Captain 350.56m, width 42.8m, speed of 25.4 kn;

(2) The European trade routes to COSCO Shanghai - Illichivsk representative routes, Shanghai - Malacca - Suez - Gibraltar Strait canal - Illichivsk , a range of 8304 n mile;

(3) In Asia port and Europe port fees, respectively, according to Shanghai port and illichivsk port charges calculated to illichivsk port;

(4) Marine carbon tax is calculated at \$25 per ton CO₂.

After accounting, COSCO Ningbo, Shanghai illichivsk route carbon emissions 7507.42t. According to the above rates, the voyage should pay a carbon tax of \$187685. According to statistics, this year the ship voyage for 6 times. As the European Union put forward the "marine carbon tax" for the departure and arrival of the ship to be levied on the marine carbon tax, so for COSCO Ningbo, it should pay a carbon tax of \$2252220 / year. The total amount of the marine carbon tax to be paid for the whole year of the ship, as well as the carbon tax to be paid by the shipping companies of COSCO Group and the whole shipping industry of China in the central European route, is quite large. (Sun Jiaqing , 2012)

2.2 Impact on international trade

2.2.1 Green trade barriers

The advance of shipping MRV scheme and future as a possible implementation of emission reduction measures of shipping market based, in essence, is the European Union with its leading position in the field of low carbon technology, forcing its own laws, rules and standards imposed on the shipping industry, which is set in the "green trade barriers". The text of GATT Article 20 "Subject to the requirement that such

measures are not applied in a manner which would constitute a means of arbitrary or unjustifiable discrimination between countries where the same conditions prevail, or a disguised restriction on international trade, nothing in this Agreement [the GATT] shall be construed to prevent the adoption or enforcement by any contracting party of measures: ...”(b) and (g) the direct provisions of the environmental protection exceptional right, allowing the parties to adopt related trade measures to protect the environment: (b) for the protection of human, animal or plant life or health ; (g) in conjunction with restrictions on domestic production and consumption measures, relating to the conservation of exhaustible natural resources .

On the one hand, the route to work round the company market monopoly efforts, in the Asia Europe route as an example, the three companies Maersk, mediterranean shipping, and CMA-CGM, occupy 50% of the market share. Large scale shipping companies to increase the cost of running a strong resistance, while some smaller shipping companies may be due to rising costs of the EU route, resulting in a loss of the final exit from the market. On the other hand, once the implementation of emission reduction measures of the shipping market, due to the master rules of the EU, by ship energy efficiency requirements set green trade barriers, which indirectly increase other national ship manufacturers, shipping companies to enter the European market threshold, weakening the competitiveness of foreign enterprises in Europe.

2.2.2 Slowing global trade recovery

After the financial crisis in 2008, the global economic recovery on the road by the debt crisis in Europe and the United States, the national economy showed weak growth (see Figure 2-1), the international trade growth slowed sharply(see Figure2-2)

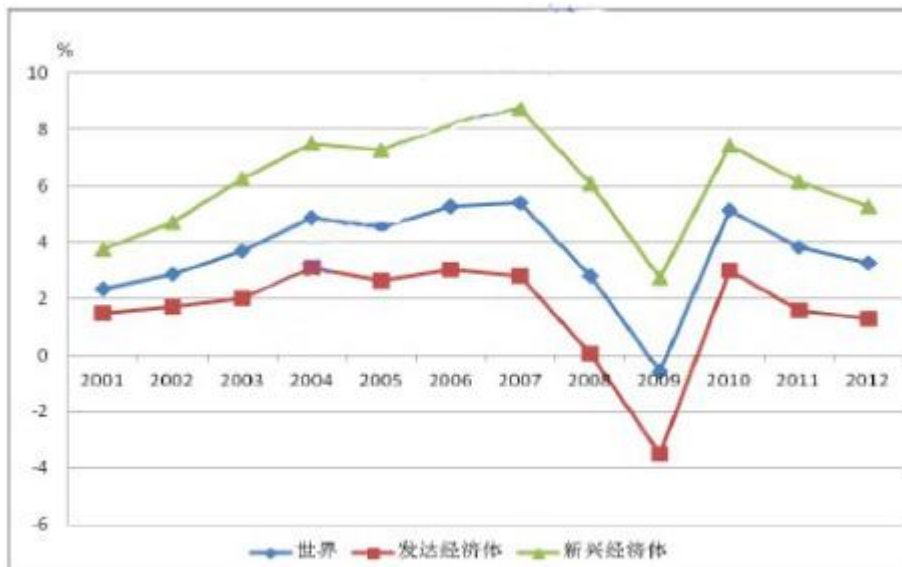


Figure 2-1 2001-2012 annual growth of the world's major economies by GDP

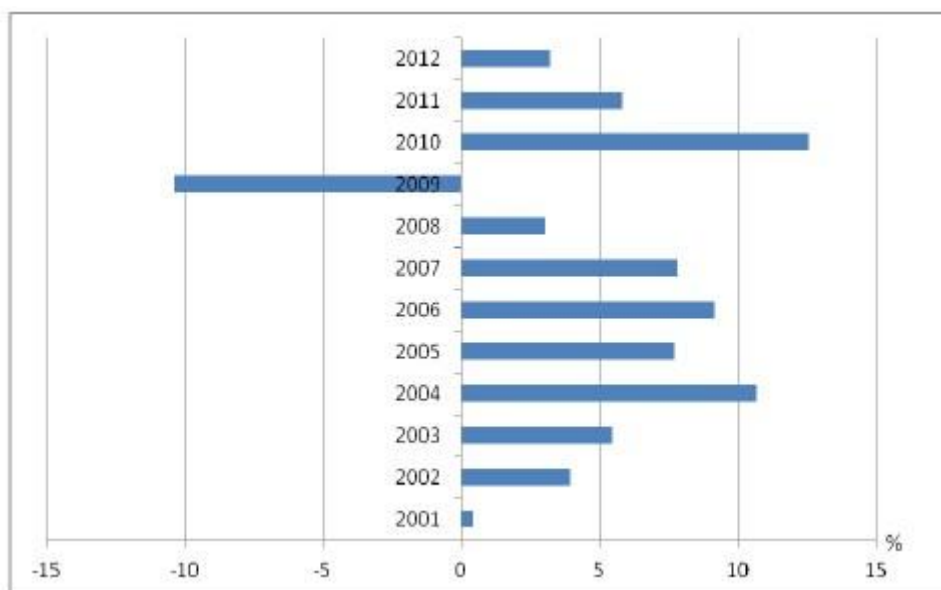


Figure 2-2 world trade volume change rate in 2001-2012

International shipping, as the derived demand of international commodity trade, is the most important mode of transportation in international trade. At present, about 90% of the total volume of international trade depends on maritime transport. And benefit from the trend of global free trade in the shipping industry, and the ups and downs of the international economic situation has a closer relationship. With the

strong growth of international trade, international shipping will drive demand growth, with the development of international trade in the doldrums, the shipping industry will be stagnant. In 1990-2007, the world's GDP grew by 65%, and the international maritime trade volume grew by more than 100% (UNCTAD, 2011). Because the shipping industry and the international import and export trade of major changes in the international shipping industry bound together in a common cause, will also have an impact on the world economy and trade. The shipping industry as a service industry, due to the increase of MRV emission reduction measures plan and market operating costs will increase by transportation costs passed on to the owner, and the freight will rise on foreign trade impact, foreign trade enterprises profit space and living space will be narrowed and extrusion. It is foreseeable that the increase in trade costs is likely to slow the recovery of global trade.

2.3 Impact on the vitality of international shipping market

2.3.1 Influence of international shipping industry boom

Baltic Dry Index is recognized as the measure of international shipping market boom index authority, is the epitome of global trade. From the international shipping industry boom at the end of 2008, affected by the global financial crisis, has dropped to the freezing point, with a short-term rebound after the end of 2011, affected by the debt crisis, the shipping market decline again (see Figure 2-3). Due to the proliferation of new capacity, freight has been much lower than operating costs. Affected by the debt crisis in the euro area, the demand for bulk commodities such as ore, coal and other negative growth. Although the fluctuation of shipping cost will affect the activity of the shipping market to a certain extent, the volume of seaborne trade is mainly affected by the international trade environment. However, in the

international shipping market downturn, unable to pick up in the background, the implementation of MRV scheme and the shipping market of emission reduction measures is the cost of one shipping disaster after another, growth will become an important factor restricting the international shipping industry's slow recovery process.

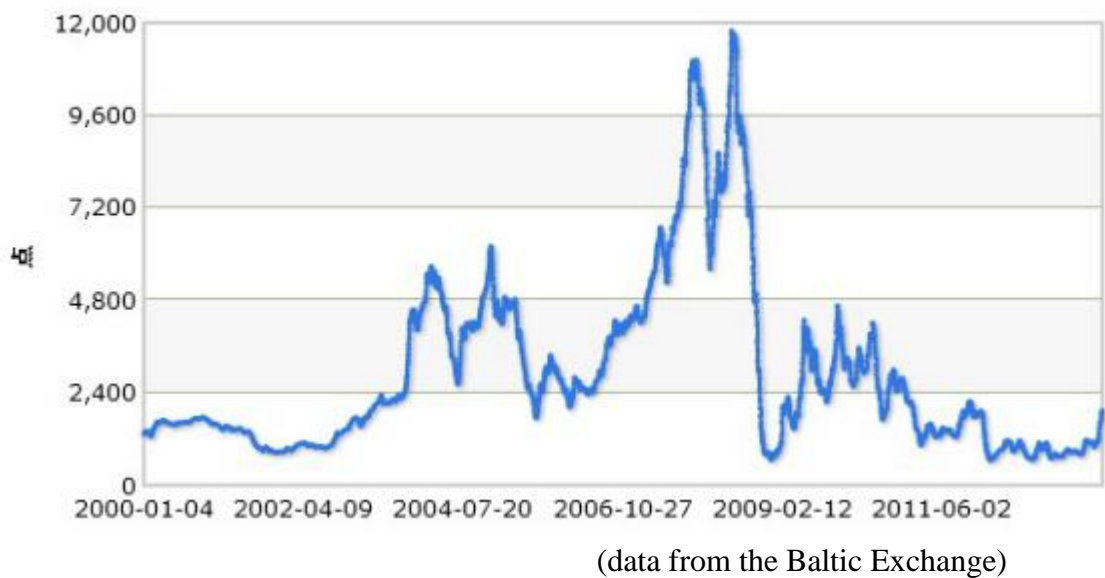


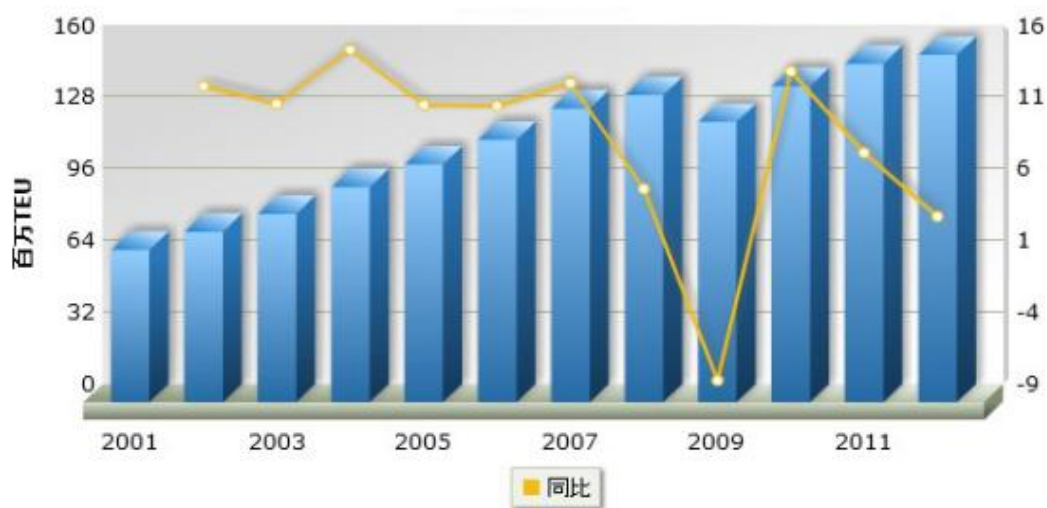
Figure 2-3 2000 BDI index trend chart

2.3.2 The influence of international shipping industry

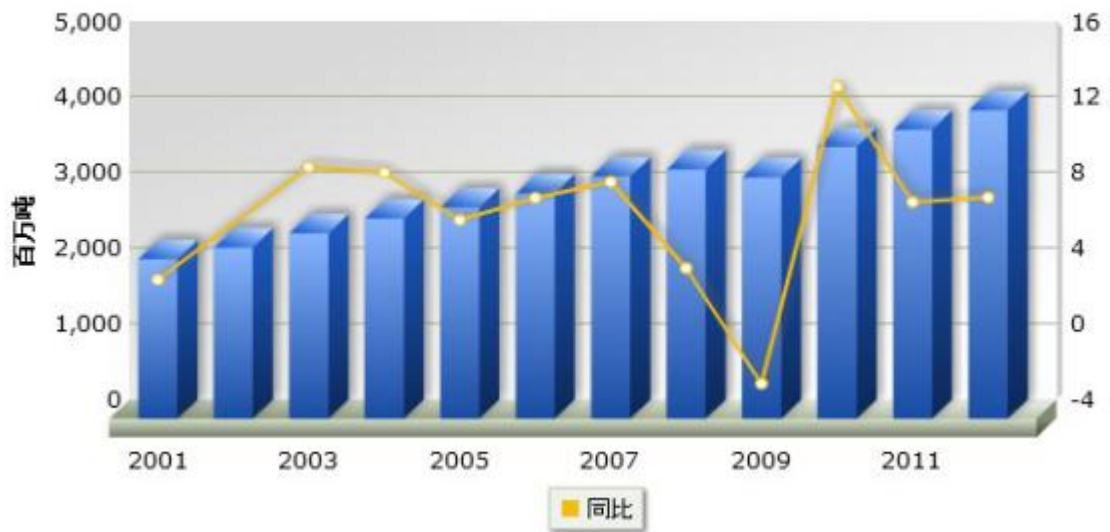
Since 2009 the international cargo market affected by the financial crisis after three years fell to the freezing point, the overall slow recovery, but obviously freight slowdown more than before the financial crisis. As of 2012, global container shipping volume was 157.8 MTEU, compared with 2011 growth of 4.8%, at a historically low level. The Asia-Europe route which showed negative growth, an increase of -0.56%. 2012, the international dry bulk cargo seaborne trade volume of 39.17 tons, an increase of the continuation of the downward trend in 2011. Affected by the slowdown in the growth of trade, container shipping volume growth also fell.

Among them, the amount of iron ore shipments to a certain extent, the impact of the slowdown in the growth of the world's iron and steel production overcapacity, steady growth in the volume of seaborne coal, grain shipping declined slightly. 2012, the global oil seaborne volume of 3 billion 237 million tons, compared with a slight increase in 2011.

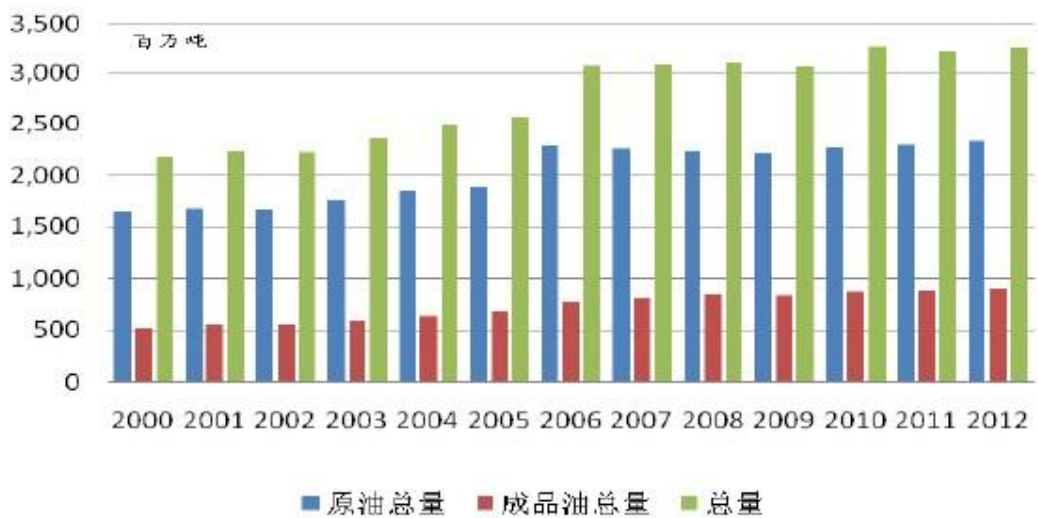
Judging from the current trend, although the international maritime transport volume tries to maintain growth, but growth slowed. Shipping MRV program and the implementation of the market after the implementation of a reduction in the market for some time to slow down, it is likely to restrict the growth rate of the volume of shipping industry to a certain extent.



(Data from Clarkson SIN)



(Data from Clarkson SIN)



Blue-Total crude oil Red-Total amount of refined oil Green-total
(data from Drewry)

Figure 2-4 international container, dry bulk cargo, tanker shipping volume change trend chart Unit: million dwt

2.3.3 Impact on international shipping efficiency

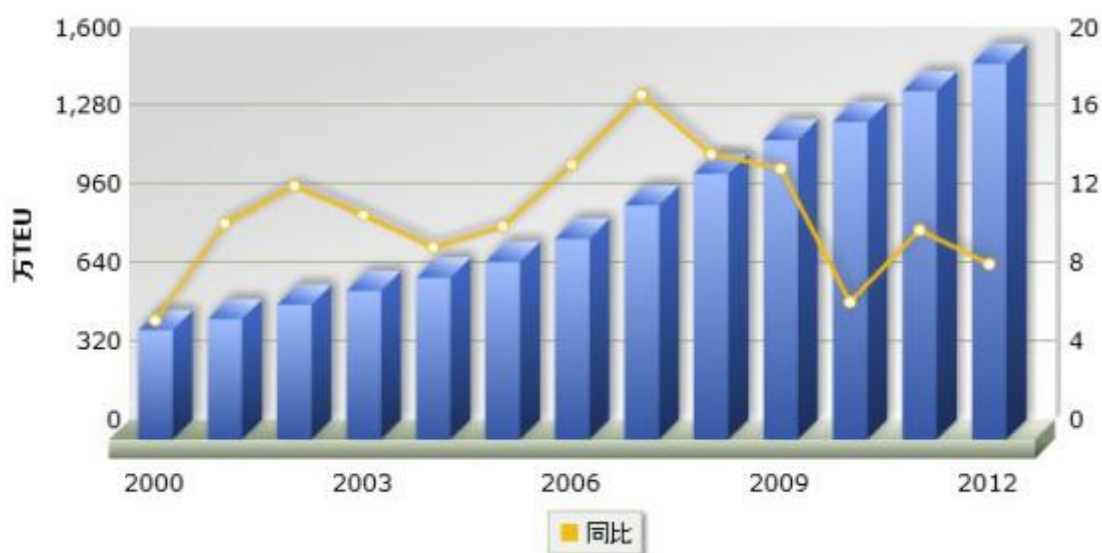
In order to avoid the carbon emission reduction measures of market monitoring , if given up water and direct shipping enterprises within the EU will take cargo overland

transit way, which will lead to reduce the efficiency of the transfer of international shipping routes, and thus may lead to the global shipping industry and international trade "focus".

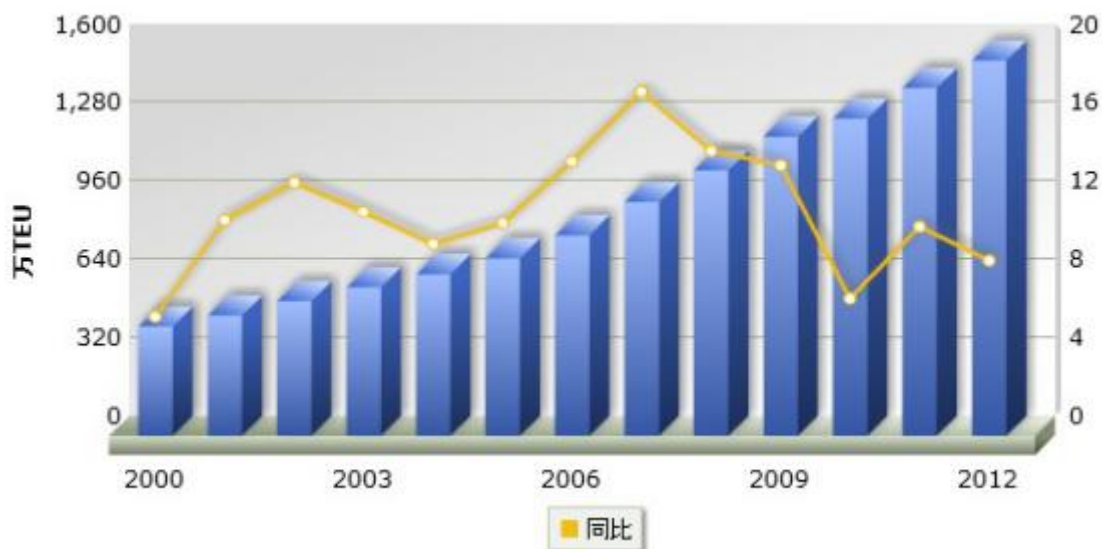
2.4 Indirect impact on international shipping industry

2.4.1 Impact on international shipping industry and shipbuilding industry

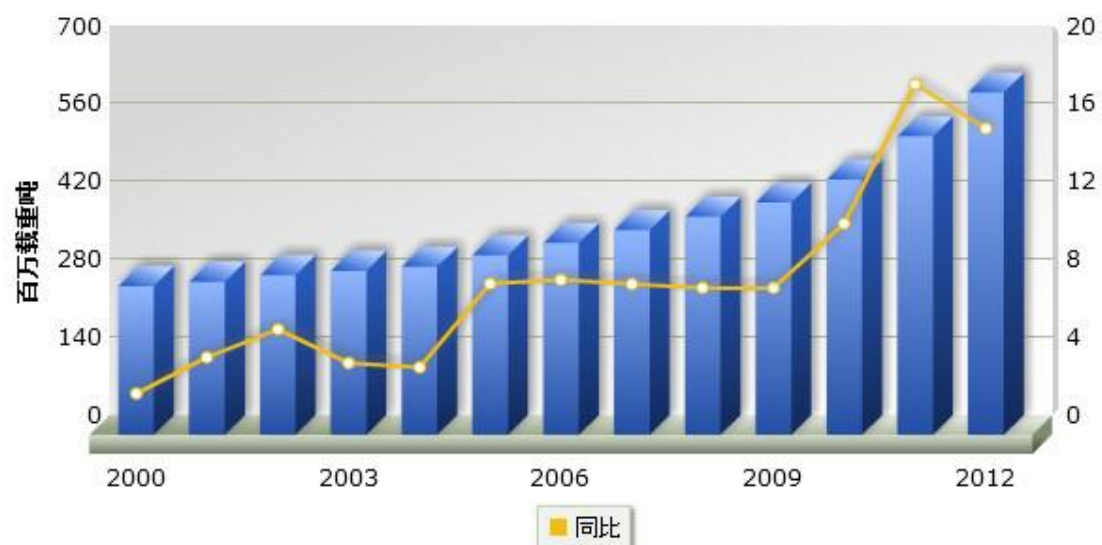
At the beginning of the 2008 financial crisis, the shipping industry was in the doldrums, but companies are still on the market full of confidence, have hunters, with relatively low cost of new ships, to prepare for the next round of shipping recovery, this is also the recent international shipping capacity, which not only did not decrease, but there are also a lot of new ship reasons. However, in the past two years by the debt crisis in Europe and the United States, the world economic situation is weak, the phenomenon of excess capacity in the maritime market highlights that the international maritime transport capacity has slowed growth .



(Data from Clarkson SIN)



(Data from Clarkson SIN)



(Data from Clarkson SIN)

Figure 2-5 the total capacity of container ships, dry bulk carriers and oil tankers since 2000

Since 2011 the number of new shipbuilding orders have begun to decline. In 2012 the world's new shipbuilding orders and new shipbuilding prices fell. International authoritative shipbuilding and shipping research institutions Clarkson released the

latest statistics showing that in 2012 the world's new shipbuilding orders were a total of 45 million 500 thousand DWT, a sharp decline of 45%, as new shipbuilding prices fell nearly 10%.

The European Union is a large proportion of the international shipping industry. In the container, as shown in table 2-3 statistics, container ship by the EU MRV program impact about major global container ship 35% ships, transport accounted for about 40% of the total amount of the main routes of container transportation. Therefore, appearing gradually in the international shipping industry, was the contradiction between supply capacity of the new ship orders which continued to decline, new ship prices continued to decline, the shipbuilding cost rising situation, the implementation of emission reduction measures will be MRV and as the shipping market intensifies the shipbuilding industry becomes a downturn situation. On the other hand, the implementation of emission reduction measures on the improvement of the market will be the new ship energy efficiency requirements, due to the application of the shipbuilding industry low carbon energy technology requirements increase, the shipbuilding cost will rise as a result, while the shipbuilding industry profits continue to shrink, until there is the capacity to achieve a basic balance between supply and demand.

Table 2-3 global container shipping capacity allocation table

Route name	Ship quantity	TEU
East Asia- Northeast Asia	382	688162
Europe- Far East	349	2774807
Far east - west coast of North America	291	1622901
East Asia -Southeast Asia	280	543565

Far East- Middle East	224	1309400
The Far East - India subcontinent	220	911115
Northeast Asia- Southeast Asia	190	354314
Far east- Mediterranean	187	1163146
Far east -east coast of North America	183	885238
The subcontinent of India - Middle East	180	668845
Mediterranean regional route	180	168304
Southeast Asia	160	122807
South Africa - Far East Route	154	471912
Europe -Mediterranean	147	528328
Sino-US Caribbean-East coast of North America	145	256154
Sino-US Caribbean-Far East	144	608456
Europe -The Baltic Sea	143	121217
Europe - India subcontinent	134	650494
European Region	132	72681
The subcontinent of India - the Mediterranean	126	515093

(Data from CI-online)Table data as of October 2012 01

2.4.2 Promote the development and application of new energy, energy saving and emission reduction technology

In recent years, IMO and other international maritime regulations were proposed by the EEDI to promote the development of energy-saving and emission reduction technology and application of clean energy applications. From market to deal with the EU emission reduction measures shipping MRV scheme and then possible implementation of the international shipping industry's operating costs increased, so carbon dioxide emission reduction technology has become a new means of shipping

enterprise competition, and technical advantages will translate into economic advantage. The shipping industry is bound to set off the climax of the research and development of energy saving and emission reduction technology, which will promote clean energy to replace fossil fuels and improve the utilization rate of energy.

Case one

In 2012, the world's largest ocean engineering auxiliary ship (OSV) manufacturer Pacific shipbuilding group independently designed to reduce fuel consumption by more than 20% CROWN energy saving green bulk cargo ship.

Case two

MITSUBISHI Heavy Industries (MHI) development group "MALS-14000C" container ship by optimization of ship design, using MHI and Nippon Yusen jointly developed air lubrication system, the diesel engine and the installation of exhaust gas recycling system and a number of environmental technology, two carbon dioxide emissions can be reduced by 35%.

Case three

By the end of 2012, COSCO Shipyard Group Co. Ltd. and the British Lloyd, Greek Shipowners GOLDEN UNION jointly developed Carle Sam type bulk carrier the world's first LNG can be used as fuel "CLEAN SKY". Using LNG as fuel can reduce carbon dioxide emissions by 10% to 100%, nitrogen oxide emissions by 90%, sulfur dioxide and particulate emissions by about 20%.

CHAPTER 3

Analysis of the impact of MRV scheme and market emission reduction measures on China's economy and shipping industry

The United Nations Conference on Trade and development (UNCTAD) statistics show that China has about 8.6% of the world's maritime transport ships, and about 3.8% of the world's flag registry is located in china. The EU is promoting a regional or global shipping carbon emissions management mechanism, which will bring unprecedented pressure on China to reduce emissions, and will also have an impact on China's economy and shipping industry.

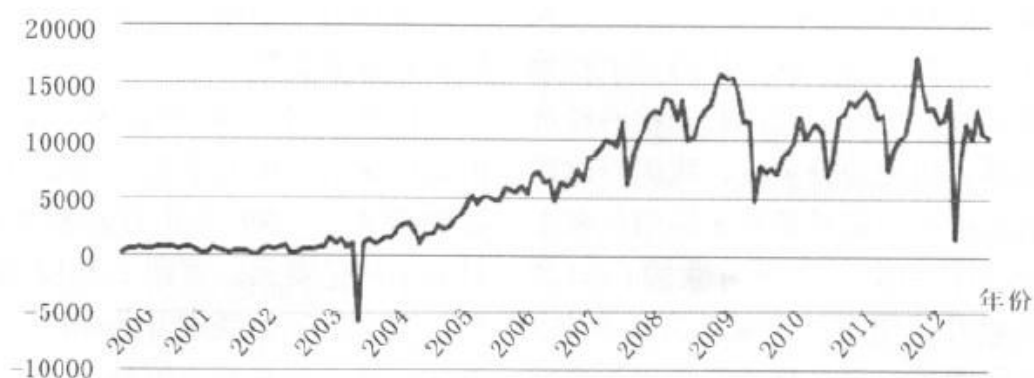
3.1 Impact on China EU trade

3.1.1 EU trade situation

The EU is one of China's three main export region markets. The EU market recovery and economic operation of the euro zone, has a significant impact on the future development of China exports to Europe and the Chinese economy. At this stage, the main features of China's trade with the EU is that the export trade is mainly manufactured goods, and a large number is concentrated in low value-added labor-intensive products. In recent years, China's export commodity structure has improved, especially the export of capital and technology intensive products. However, there are a limited number of products with obvious competitiveness, while the EU mainly exports technology intensive products to China.

As can be seen from figure 2-6, since the twenty-first Century, China has always maintained a trade surplus with the EU. However, the development of China EU trade is also facing some problems, such as the EU's anti-dumping against China, the

establishment of technical barriers and so on. Especially in recent years, affected by the European debt crisis, the euro against the renminbi weakness brought great negative impact on China's export trade. Due to the price effect of currency devaluation, the relative price of Chinese goods in the European market is increasing, which has seriously affected the competitiveness of China's commodities in the European market, reducing China's exports to Europe. At the same time, due to the devaluation of the J curve effect, the impact of the depreciation of the euro on exports to China-EU also has a time lag effect, the negative impact of China's exports to Europe is likely to continue to expand in the coming period of time. As the central European trade in China's economy has a pivotal position, so any impact on China-EU trade factors are likely to bring different degrees of impact on China's economy.



(Data from: macro database)

Figure 3-1 China monthly trade balance data on EU 2000-2012

3.1.2 Impact on China EU trade

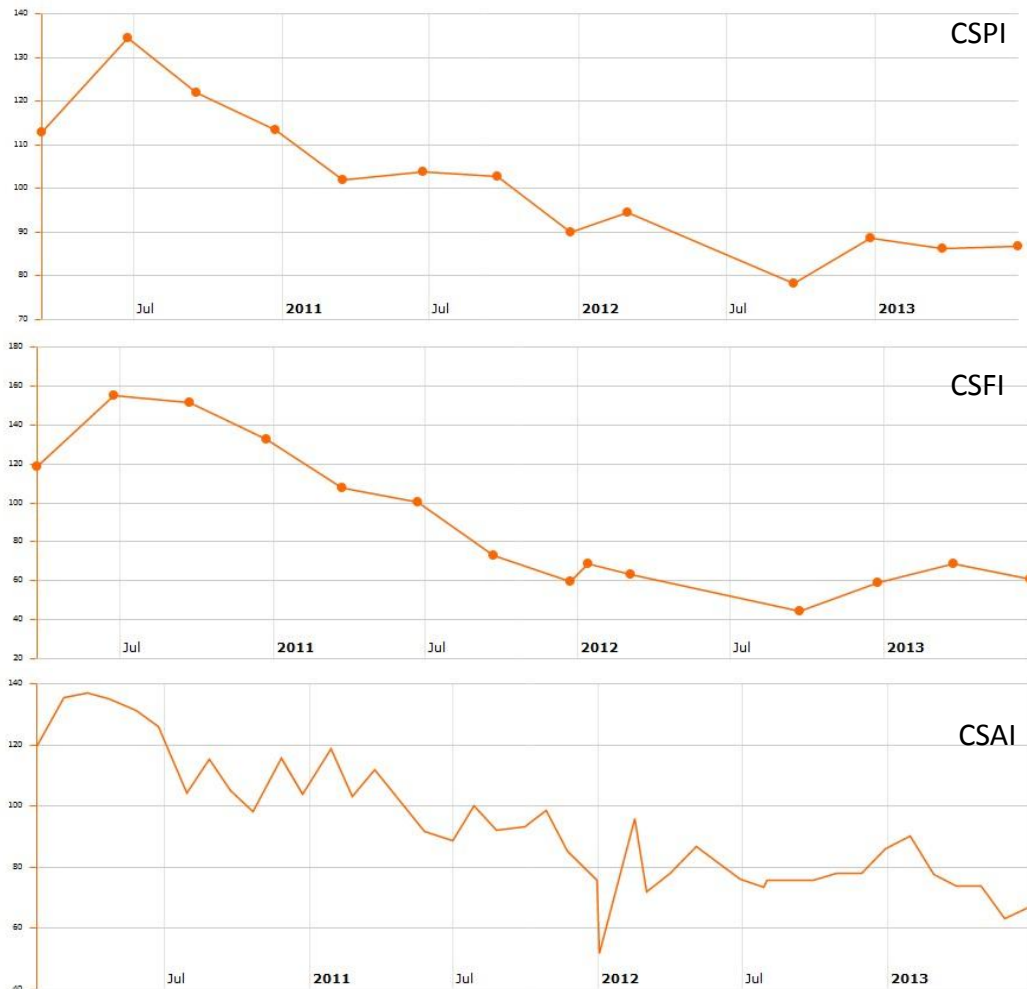
From the point of view of dependence on foreign trade, the EU's import and export trade volume of 3/4 borne by the sea. According to Lloyd's intelligence data show that Europe main artery 21 ship companies operate 49 routes, and 503 ships. Once the implementation of the MRV scheme and the market emission reduction measures,

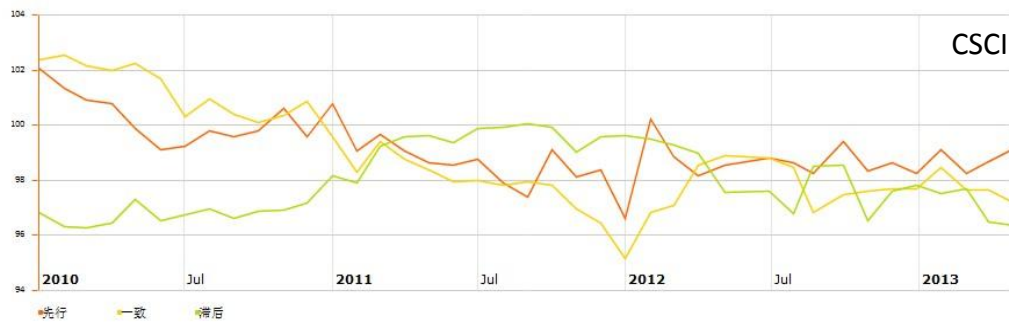
these vessels will be affected. China's exports of goods to Europe by sea, China's dependence on maritime trade with the growth of China EU trade growth. The implementation of emission reduction measures of the shipping market will directly affect the overall operating costs of shipping industry, China EU trade this policy may be wrong, in addition to industrial product safety, health, technical standards and other EU technical barriers to trade, and the new green trade barriers. The shipping industry as a service industry, the increase in operating costs, transportation costs increased will eventually be passed on to the owner of the freight and will rise on foreign trade adversely affect the expected growth of Sino-EU trade may be affected, especially the low value-added products are affected by trade. In the export of high value-added products, the situation is more optimistic, China's exports to the EU's high value-added products accounted for 4% of the EU's total imports of high value-added products, while the proportion of the value of up to 21%. Compared with Russia, Norway, Brazil exports to the EU lower value-added products, China's implementation of the EU market for shipping emissions reduction measures caused by the strong resistance.

In addition, if the EU MRV and the smooth implementation of the shipping market emission reduction measures, following the aviation industry, will be incorporated into the EU ETS, opened another implementation of market measures in the field of international high carbon emissions. The European Union will be in the leading position in international control of greenhouse gas emissions. Next, if the EU is to develop, and develop a series of new rules and regulations for the implementation of market measures, it will impact on China's carbon emissions related industries and enterprises, and thus expand the impact of trade between China and Europe.

3.2 Impact on China's shipping market

There are four indexes: China Shipping Prosperity Index (CSPI), China Shipping Confidence Index (CSFI), China Shipping Prosperity Alertness Index (CSAI) and China Shipping Composite Index (CSCI). Since 2010, CSPI and CSFI index continued to decline; CSAI index has always been in the recession range, showing a downward trend in the overall trend; CSCI's leading index showed a downward trend in volatility. It can be predicted that China's shipping market will continue to be in a downturn for a period of time (see Figure 2-7).





(Shanghai International Shipping Research Center)

Figure 3-2 2010 China Shipping boom chart

The prosperity of the shipping market in China and the EU is also not optimistic. The freight rate index of China Europe exports is in a declining phase (see Figure 2-8). The data source of the index for the China international shipping network business members of the major ports issued by the corresponding route 20 feet container ALLIN shipping freight rate data.China - European routes have a basic port: Antwerp, Bremen, Felixstowe, Hamberg, Le Harve, Rotterdam, Zeebrugge。



(Data from: China International Shipping Network)

Figure 3-3 2006 - China - European export freight forwarding index chart

EU MRV and the implementation of the reduction of the shipping market, through the impact of China EU trade volume and freight rates, will affect the prosperity of China's shipping industry and operating costs. Under such circumstances, the possibility of short-term reversal of the trend of China's shipping market will be

smaller.

3.3 Impact on China's shipping enterprises

3.3.1 Increase the operating costs of shipping companies

Since 2009, the Baltic Composite Freight Index (BDI), the most important indicator of the global economy, continues to decline. In the context of the slow global economic recovery, the high level of ship fuel prices, the rising operating costs of shipping companies and the serious imbalance between supply and demand, the road to recovery in the shipping market still twists and turns. The EU implementing the MRV program and the shipping market emission reduction measures, but also to a certain extent, increasing shipping costs, is undoubtedly worse. China's shipping companies will face a severe test.

MRV and the possible implementation of the shipping market on the impact of emission reduction measures on the management costs of shipping companies are described in Section 2.1.1.1. As the operating costs of shipping companies are corporate business secrets, and access to research data less, the industry statistics in this area are not perfect. At present, only the annual operating costs of container ships in China are collected. Therefore, for dry bulk carriers, general cargo ships, multi-purpose vessels and oil tankers, the key shipping enterprises operating in China are selected to investigate and analyze the possible implementation of the shipping market Measures on the Operating Cost of Shipping Enterprises. Taking into account the carbon emissions trading system and the GHG emission reduction fund, there is a big difference between the relevant proposals, and it is not easy to explore the impact of the implementation of the program. This study takes the carbon tax plan as an example.

This study through the carbon tax and the EU carbon dioxide emissions route for shipping enterprises (or ship voyage CO₂ emissions) the product of carbon tax calculation, the carbon tax into the fuel cost, due to the impact of carbon tax on the cost of the operation of the ship. Because the EU has not yet announced the carbon emissions of the shipping industry tax price, shipping industry carbon emissions trading price and the possible implementation remains uncertain, so in the discussion on Levying carbon tax on the analysis of the influence of the ship sailing operation cost, assuming that marine carbon tax from the amount of taxable and fixed tax rate form. Tax rates refer to the International Maritime Organization's propensity to \$20 / ton ~30 U.S. dollars / ton and EU ETS aviation industry carbon emissions trading current price of 7 euros / ton. According to the current exchange rate conversion, the tax rate scenarios used in this study were 60 yuan / ton, \$100 / ton and \$190 / ton.

(1) The impact of carbon tax on ship operating cost

The following models incorporate the carbon tax levy into the fuel price to explore the impact on the operating costs of the ship:

$$F_{CT} = \frac{FC \cdot CT \cdot A}{TC} \cdot 100\% = \frac{FC \cdot CT \cdot A}{FC \cdot PF + OC} \cdot 100\% \quad (1)$$

FCT: The impact of carbon tax on operating costs%;

FC: The ship voyage fuel consumption, tons;

CT: Carbon tax rate, yuan / tonCO₂;

TC: The ship voyage total operating cost, yuan;

A: CO₂ emission factor, diesel oil is 3.1604 tons CO₂/ tons, fuel oil is CO₂/ tons of 3.2366 tons;

FP: Fuel price, yuan / ton

OC: The other ship voyage cost except fuel cost, yuan / ton.

(2) Analysis of the impact of carbon tax on shipping enterprises operating

costs

According to the survey data of the operation of the key airlines in China (COSCO and China Shipping), the operating costs of COSCO and China Shipping's EU routes are affected by the carbon tax rate by using the formula (1).

Table 3-1 Operation of China's major aviation enterprises in EU routes

	Annual fuel consumption (ton)	Total fuel cost (Ten thousand yuan)	Total operating cost (Ten thousand yuan)	Fuel costs account for the total cost (%)
COSCO	1152108.1	435545.87	933927.86	46.64%
China Shipping	692044	254386	637134	39.93%

As can be seen from table 2-5, with the increase of the carbon tax rate, the total operating costs of COSCO, China Shipping's EU shipping routes increased significantly, the higher the rate of increase. When the carbon tax rate increased to 190 yuan / ton , COSCO and China shipping routes of the EU total cost ratio reached 7.59% and 6.68%, in this case, the European airline fuel costs accounted for the proportion of operating costs also increased to 50.40% and 43.69% respectively.

Table 3-2 the increase in operating costs of China's major airlines in the European air routes under different carbon tax rates

Carbon tax rate, yuan / ton		60	100	190
Increase in operating costs (%)	COSCO	2.40%	3.99%	7.59%
	China shipping	2.11%	3.52%	6.68%
Proportion of fuel cost to total cost (%)	COSCO	47.88%	48.68%	50.40%
	China shipping	41.17%	41.97%	43.69%

3.3.2 Weaken the competitiveness of China's shipping enterprises

First, after the preliminary test, China's international shipping line of energy efficiency of large ships and Germany, Belgium and other developed countries close to, but the small and medium-sized ship energy efficiency and the main developed countries have a certain gap. The implementation of emission reduction measures in MRV and shipping market will result in unfair market measures in our country for a long time. At the same time, the market emission reduction measures will inevitably lead to competition for energy efficiency of the ship, the European Union of small and medium ships in the poor competitiveness of the ship, freight volume will inevitably shrink.

Second, 2003-2008 shipping market boom, the majority of our shipping companies to order the new batch of ships, and for the capacity of large container ships, which under the background of international financial crisis of China's shipping industry overcapacity, create fierce competition. The increase in operating costs will inevitably exacerbate the situation in the shipping market emission reduction measures, and give a hidden danger to the competitiveness of China's air transport industry.

Third, in addition to China COSCO and China shipping and several large shipping companies, most other shipping enterprises are small scale, these enterprises lack sufficient resilience in the face of complex policy and market changes. These small shipping companies will be unable to resist the negative impact of the increase in operating costs in the short term in the shipping market. This kind of small and medium-sized shipping enterprises will lead to the air transport industry competitiveness of China, is difficult to coordinate, and will eventually lead to the weakening of the competitiveness of the entire shipping industry.

Fourth, the EU emission reduction plan and measures to promote the MRV shipping

market, from the aspects of management and technology, the European shipping enterprises by the pressure will certainly be higher than our shipping enterprises should be small, because such as Maersk shipping company, its advanced technology, higher management level. Therefore, although the implementation of emission reduction measures of MRV and the EU shipping market, shipping costs generally increase, but in contrast, our shipping enterprises due to undertaking more work and improving the energy efficiency greatly increased burden. Therefore, the EU shipping companies will be in a more advantageous position in the shipping market.

3.4 Impact on China's shipbuilding industry

3.4.1 The influence on the order quantity of shipyard in China

Before 2010, China's shipbuilding industry's rapid development momentum, new orders, and shipbuilding capacity continues to rise, once for the first time in 2009 over South Korea ranked first in the world's shipbuilding capacity, new orders, hand-held orders accounted for 34.8% of world market share, 61.6% and 38.5%. However, the global downturn caused by the background of the ship under the financial crisis, highlighting the phenomenon of excess capacity, coupled with the European debt crisis, China shipyard since the end of 2011 general orders dropped, prices diving, in 2012 the situation became more difficult to survive. According to the Ministry of Industry data show that in 2012 China's shipbuilding completed 60.21 million dwt, down 21.4%; new ship orders to 20.41 million dwt, down 43.6%; as of the end of December, hand-held ship orders 106.95 million dwt, 28.7%.

In the case of reduced shipbuilding market demand, the global shipbuilding industry competition will be more intense. According to the Korean Ministry of Knowledge Economy and the Korean Shipbuilding Association, 2012 shipments of new

shipbuilding shipments reached 7.5 million CGT, accounting for 35% of the global shipbuilding project orders, orders which amounted to 29.984 billion US dollars. Although the global economy is in recession, the market needs to continue to reduce the new ship, but the Korean shipbuilding ship orders, and the amount of orders for two consecutive years ranked first in the world. While the second row of Chinese new ship orders for the 7.1 million CGT (15.45 billion US dollars).

On the other hand, in recent years, marine engineering equipment, LNG ships and other high value-added special ship orders showed an upward trend. However, the proportion of high value-added ships in China's shipbuilding industry is relatively small, far less than Japan and South Korea. In 2012, South Korean shipbuilding LNG ship orders accounted for 73% of the global market.

In this situation, the MRV and the shipping market emission reduction measures, once implemented, with shipping companies facing higher operating costs, the original capacity of the shipping industry will be more serious as shipbuilding orders will shrink, coupled with China's high value-added shipbuilding market share. The smaller the pace of recovery in China's shipbuilding industry will eventually slow down.

3.4.2 Increased technical requirements for new shipbuilding

As the EU to promote the MRV program and the possible implementation of the shipping market emission reduction measures are for the control of CO₂ emissions, so the ship energy efficiency level will become an important factor in enterprises, and China's shipbuilding industry will face some new technological challenges. China is a big shipping country, but also a shipbuilding power. From the shipbuilding industry, the new shipbuilding capacity ranks second in the world. China's shipbuilding industry's most powerful opponent, Korean built ships, compared with

China's fuel efficiency is 15 to 20% higher. And 2009, a technical proposal submitted by Japan in 2015 to 2020, the ship energy efficiency standards for the baseline down 25% -35%, indicating that Japan's ship energy efficiency technology level is full of vitality. Therefore, the current situation in China's shipbuilding industry, opportunities and challenges coexist, the ship's energy efficiency level may be China's shipbuilding industry to form a technical barrier. The EU's major developed countries have accumulated more advanced green energy-saving low-carbon technology, the implementation of emission reduction measures in the shipping market will lead to China's shipbuilding industry facing the introduction of green energy-saving carbon technology to absorb the higher cost and longer stage, which pulled the ship passive cost, thus weakening the international competitiveness of China's shipbuilding industry to a certain extent. The implementation of the EU MRV program and the shipping market emission reduction measures will not directly change the market advantage of China in the shipbuilding industry, but the requirements of the shipbuilding market orders in the ship's energy efficiency and low carbon technology will certainly be improved if our country can seize the opportunity to step up technology research and development, it may be in this new round of shuffle to win.

3.5 On the development of green shipping in China

At the same time, we must also realize that the EU implementation of MRV and shipping market emission reduction measures on China's shipping industry, and even the production chain, has a positive effect, which will be my country to achieve the transformation of the shipping industry development opportunities. The implementation of the MRV program will speed up the process of developing the energy efficiency and carbon emission standards for the operation of ships. The

implementation of emission reduction measures in the shipping market on the one hand will enable China's shipping companies to rely on various forces to strengthen the ship energy-saving emission reduction technology research and development, improve fuel efficiency, and fuel costs, to achieve energy-saving emission reduction targets.

In shipping management, compared with the leading international shipping companies, China's shipping companies management level and efficiency is low. The implementation of MRV program and shipping market emission reduction measures will enable our shipping companies to improve corporate governance, strengthen management level, reduce management costs and general operating costs, and further improve the operational efficiency of shipping companies, and enhance the soft power competitiveness of China's shipping enterprises.

CHAPTER 4

China 's strategic choice and response measures

Reducing greenhouse gas emissions and slowing global climate change has become the consensus of the international community. Greenhouse gas emission reduction has an important impact on the national economic development, which involves the definition of the responsibility and obligation of emission reduction between countries and the coordination of interests. Countries in the global greenhouse gas emission reduction in the field of struggle, compromise and cooperation, in fact, is to maintain global public interest based on the international political game, is the country's own development rights and interests of the competition. With the globalization of economic and environmental issues, China faces more and more challenges and opportunities for greenhouse gas emission reduction, only to understand the nature of the game of international cooperation, rational choice of strategy in order to maintain the global public interest at the same time, fully protect their own interests, for more development rights and interests.

4.1At the international level adhere to both the negotiation strategy and fight for the right to speak

4.1.1Take a negotiation strategy

The EU in the "aviation carbon tax" by the United States and Russia and the other 26 countries boycotted, still put forward the implementation of maritime MRV program, its desire in the field of shipping "navigation carbon tax" intention is obvious, will inevitably lead to the corresponding boycott. Therefore, the Chinese government should adopt a strategy of boycotting and negotiating parallel strategies, with similar

positions, coordinating diplomatic action, and resolving the strategies and methods of "aviation carbon tax", and resolutely resisting it from a political level. Such as participation in other countries and international organizations in the EU litigation, contact developing countries to take more joint action to jointly resist the EU levy "maritime carbon tax."

It is noteworthy that the world's major shipping markets, with the exception of the major participating countries in the EU, are countries such as China, Japan, the United States, South Korea, and Singapore, with less stakeholder countries than those affected by the "aviation carbon tax". Therefore, in the boycott of "navigable carbon tax" with other countries to form a coalition of the scale and strength will be different than before, so our country should use diplomatic means to prepare early.

While resisting the EU maritime carbon tax, China should use the international charity, conventions, regulations, agreements and special status of developing countries in China to coordinate the industry management, industry associations and shipping companies etc., with the EU authorities to engage in dialogue and consultation. The United Nations Framework Convention on Climate Change (UNFCCC) is the general framework for international carbon reduction negotiations, and although no consensus has yet been reached, negotiations in any sector should not deviate from this general framework. In the overall framework of national greenhouse gas emissions negotiations, as far as possible "hysteresis" EU in the International Maritime Organization outside the collection of "maritime carbon tax" and other unilateral action.

4.1.2 Actively seek the right to international discourse and participate in the formulation of emission reduction measures

While resisting and negotiating, China should also be actively involved in the

development of international carbon tax rules and standards. At present, there is no uniform standard on the issue of "maritime carbon tax", which provides an opportunity for our government to participate in the formulation and standard negotiation of the "maritime carbon tax" rules, providing the right to speak for our "maritime carbon tax" convenient. Therefore the Chinese government should actively participate in the international planning and development of energy-saving emission reduction measures, and strive to enhance China's shipping carbon emissions in the initiative and the right to speak. Although the EU has a greater influence on the IMO, but as IMO for many years of A class members, China should actively participate in IMO's carbon emission reduction rules development and implementation work to accelerate the expansion of China's influence in the international shipping industry, and actively participate in the improvement of the ship's energy efficiency regulations and implementation, can be improved through the cooperation and consultation between countries in the IMO platform to find a loss of our important interests of the shipping emission reduction measures to replace the EU unilateral regulations.

The EU in the maritime industry, the aviation industry has a heavier voice of the fact is undeniable, so for the EU to promote "maritime carbon tax" matters, China should do enough to prepare. Once the situation has changed, such as the EU eventually wishing to implement the "maritime carbon tax" or the completion of the shipping industry carbon trading system, can not reverse the situation. China should take advantage of the specific operational details and technical issues to communicate with the EU, through various channels for intervention about sailing carbon tax and carbon emission quota allocation the rules on non discrimination, transparency, supervision principle problems are discussed and the allocation of quotas for the EU, as many quotas on carbon emissions can be obtained free of charge through a variety

of ways to participate in the development of carbon emission reduction rules, and actively guide its direction to China in the direction of development.

4.2 A comprehensive layout at the domestic level and accelerate the development of low-carbon economy and green shipping

The enormous pressure and challenges in the face of international shipping greenhouse gas emission reduction in the work of a great opportunity at the same time, we should also recognize that this is China's shipping industry, the development of shipbuilding industry in the new period. This will be conducive to a comprehensive transformation of technology structure to accelerate China's shipbuilding industry, research and promotion to enhance the efficiency of the new type R & D technology, new energy technology, fine shipbuilding technology in ship industry; conducive to promoting China's shipping industry comprehensive operation and management level, comprehensive training standards and international advanced ship management the crew and a full range of logistics management; is conducive to China in the post crisis era to grasp the new trend of economic growth driven by the pulse, the domestic related industry management policies, establish and perfect the market system under " low carbon economy ".We must be fully aware of the importance of the development of green low-carbon shipping and urgency, seize the time to do the overall layout, starting from the theoretical research, technical innovation, management level, market level to promote the progress and so on, to do a good job of carbon emission reduction in China shipping.

4.2.1 Theoretical research

To tackle the problem of climate change is a matter of science, research on the science of climate change law in China started late, do not know the place, there is a

big gap between shipping and carbon emission reduction in developed countries, so the key areas in the relative lack of discourse. Only in the correct theoretical support, to make the right choice and action. Therefore, our country should continue to organize relevant experts, and scholars, who should address the problem of carbon emission reduction and shipping issues of climate change are systematically and thoroughly studied, supported by theories take the direction for the development of industry and government measures to provide accurate and reliable basis.

First of all, our country should closely follow the latest developments in the EU shipping plan MRV. As a matting and test marine carbon tax "issued, pay close attention to the EU shipping dynamic MRV scheme is helpful for the EU" marine carbon tax "and to grasp the dynamic process; through the interpretation and analysis of the EU shipping MRV project file, which we can learn from.

Secondly, we should organize relevant experts and scholars from the perspective of economic impact, industry development, global strategy and other aspects of the current problem of carbon emissions reduction and analysis of the system. Including the EU and other developed countries and organizations of the shipping carbon emission reduction measures interpretation and analysis, on the global carbon emission reduction situation in the development of the shipping forecast, all possible cases of China's shipping industry and the economic impact of global carbon emissions trading system, the establishment of the international financial system, the influence of China in international carbon in the political game strategy, our country should take the carbon emission reduction measures etc.

4.2.2 Technical innovation

The development of low carbon economy is not only the choice under international pressure, but also the inherent requirement of China's sustainable economic

development. To vigorously promote the work of carbon emission reduction, the most fundamental way is to rely on technological progress. At the present stage, our country should pay attention to the research and development of the low carbon core technology, but also increase the research and development of the basic technology. In order for the new ship energy efficiency level to measure and judge, IMO has launched EEDI as new ship energy efficiency standards. The implementation of the relevant technical standards of EEDI will have a profound impact on China's shipbuilding industry. The future shipyard to build the ship to achieve the minimum emission reduction requirements, and the requirements will continue to improve over time. In this case, the lower the ship's EEDI ship, the more competitive the market, if it fails to meet the minimum standards will be eliminated by the market. Samsung Heavy Industries to learn from the United Kingdom and the United States design technology engineering company's technical achievements for the development and design of energy-efficient container ships, the introduction of medium-sized container ship new ship than the same level of the ship can save about 15%.The slender linear design allows container ships to reduce wind and other resistance, the latest physical dynamics theory, aerospace and aerospace dynamics theory and some of the latest scientific and technological achievements have been introduced and grafted into ship R & D designs to improve fluid mechanics performance. Such as stern fins and rudder, propeller to reduce the resistance to optimize the design of the technology, to absorb the theory of aerodynamics. Because some designers of modern heavy industries and Samsung Heavy Industries with air dynamics based on theory, based on the ship power system "ordinary" component to the optimization design and improvement of energy efficiency can be increased by about 5%.The use of low fuel consumption and low emissions of the ship is the development trend of the shipping industry. But compared to shipbuilding technology developed countries,

China's existing ship fuel consumption and carbon emissions are still large.

As a shipbuilding and shipping power, we should closely integrate the technological development of developed countries, should always adhere to scientific and technological progress and scientific and technological innovation this fundamental way to reduce emissions, give full play to the scientific and technological progress of the pilot and basic role, and gradually change our ship Construction of low value-added status, in the ship design optimization, propeller design improvement, engine technology upgrades, green energy technology and other fields to promote the development and application of new technologies. We should speed up the study and the introduction of international advanced ship construction and operation of ideas and methods, while vigorously promoting independent innovation, to enhance the sustainable development capacity to provide a strong technical support.

(1)Hull linear optimization

Through the hull linear optimization to reduce the wave resistance and frictional resistance is to improve the efficiency of the ship to promote the main way, while can effectively reduce fuel consumption, thereby reducing the ship carbon emissions. The method of reducing the resistance of the waves is mainly focused on the design of the nose and the hull shape. A good nose design minimizes the shock between the nose and the bow, and the good hull line can further reduce the resistance of the ship. On the basis of the CFD evaluation of the prototype scheme combined with the expert experience and the related optimization technology, the improved scheme needs to be verified by the model test. Finally, the optimized scheme will be applied to the ship to promote the performance of the ship.

(2)Propeller design improvement

The design of the propeller is a key factor affecting the propulsion efficiency of the ship. Although the ship propeller can turn most of the mechanical power into

propulsion, but there are still a lot of energy loss. The actual efficiency of the propeller is controlled by the hull performance and the actual navigational conditions of the ship. Combined with the hull itself and the ship sailing conditions, the propeller design to improve, while optimizing the ship, machine, paddle with, to a certain extent, will improve the efficiency of advance, and then achieve the purpose of energy conservation and emission reduction.

(3) Ship engine technology upgrade

The main source of carbon emissions from ships is emissions from ship engines, so the energy saving and emission reduction design of marine engines can help reduce fuel consumption per unit volume and greenhouse gas emissions from the source. The ship engine manufacturers around the world have increased their R & D efforts to develop new technologies and new products. Through technical innovation for improving the performance of energy-saving and environmental protection of the engine, combustion process, emissions control and exhaust in improving engine fuel postprocessing technology, marine power utilization technology development and application of comprehensive energy, made a lot of improvement, actively study the new design scheme to promote carbon emissions minimization, and with continuous improvement the classification standard.

In contrast, China's marine engine products overall development level and foreign well-known marine diesel engine, there are still large gaps; mainstream products are foreign patent licensing products, technology development is limited to the level of ship engine, independent intellectual property products is not high; supporting technology cannot meet the level of development of marine diesel engine and the requirements of the key parts imported.

The future should focus on research and development and application of ship technology, high pressure common rail technology, intelligent control technology,

efficient combustion and emission technology, comprehensive utilization of energy technology for engine high pressure; to study and master the key technology of diesel engine intelligent control unit, with high power ship developed independent intellectual property rights with the ability of intelligent engine control system; carry out the gas engine, dual fuel engine and clean alternative fuel engine design and development; research on marine engine emission control technology, control of ship emission control technology and the machine before post processing technique, in order to meet the increasingly stringent emission regulations for ship.

(4) Application of green energy

In the ship fuel oil fuel, although for a period of time will still remain as the main energy source of the status of the shipping industry, but in the cost factors and emission reduction pressure, people will seek long-term solutions more emission reduction effect. These efforts have focused on finding alternative energy sources, such as the use of liquefied natural gas (LNG), fuel cells, natural wind, solar, etc..

Natural gas because of its rich reserves, high environmental efficiency, low prices, and other three major advantages, becomes the industry's hottest green fuel. Hyundai Heavy for its production of "Hercules" ship to carry out technological transformation, making it a natural gas as the main engine, emission reduction effect than the previous increase of 15.7%. Hyundai Heavy Industries and R & D cooperation for Wartsila LNG ship supporting engine with electric propulsion, ship machine adopts heavy oil, diesel oil and natural gas as fuel, and according to the three kinds of fuel price movements in the market to choose the cheapest, to reduce production costs. At the same time, according to the different requirements of the marine environmental protection, the use of different fuels, the emission reduction effect is: 25% reduction of carbon dioxide, nitrogen oxides reduced by 85%, oxygen and sulfur compounds almost reduced to zero emissions. Although there are still many bottlenecks in the

application of LNG fuel on the ship, but to promote the implementation of energy-saving emission reduction projects, it is necessary for us to actively explore and study the technology. In addition to the need to develop a marine LNG fuel engine, China is also facing the problem of lack of infrastructure such as LNG filling stations. Due to the limited carrying capacity of the LNG powered ship, the lack of LNG filling stations on the global route, the problem of difficult to fill gas, resulting in the application of LNG on ocean ships is temporarily restricted. If we want to promote the ship with LNG fuel, it can be in China's coastal waters and the Yangtze River and other inland river layout LNG filling stations, increase the development of marine LNG engine investment, for the promotion of LNG green fuel base. At the policy level should also be related to support. In Norway, if the use of LNG as a marine fuel, then only need to pay a very low NO_x tax or tax exemption, and even get the state given NO_x fund. China should also formulate relevant preferential policies to encourage the promotion of LNG application for ships.

A fuel cell is an electromechanical device that directly transforms the chemical energy of fuels such as hydrogen, natural gas, propane, and methanol into electrical energy. As a new generation of marine fuel, marine fuel cells can make the ship almost no emissions of harmful gases such as NO_x, SO_x, CO₂, etc., in line with the increasingly standardized environmental requirements. The initial research and development of marine fuel cells is carried out by the European shipbuilding power, so most of the advanced technology is mastered by European countries. Norway classification society is the most active. At present, the Norway society is carrying out comprehensive research work about marine fuel cell and development of fuel cell power unit with a new electronic technology, power electronic technology and control system, and tested and certified power unit on the shore, the real ship experiment.

With regard to the use of wind energy, in recent years, the country has put forward the use of wind energy which is an ancient natural energy as the driving force of the ship, and launched related research and development work. This new type of sailing ship is automated and can be adapted to small changes in the wind to maximize thrust. This new type of sailing will use "Skysail" technology, an advanced system similar to the kite. At present, this technology has been applied to many vessels. It can save fuel and decrease emissions.

About the use of solar energy, the Japanese merchant ships Mitsui, Mitsubishi Heavy Industries and Sanyo Electric are jointly developing the "use of natural energy hybrid car ro-ro ship"; selected as the Ministry of Land, Infrastructure and Transport "ship carbon dioxide emission reduction technology development business" support business. The aim is to combine the use of solar cells and lithium-ion rechargeable batteries to establish the technology to reduce carbon dioxide emissions from ships. The system developed in the process of navigation will be generated by the solar cell power stored in lithium-ion rechargeable batteries, and then use the park. Stop using existing diesel generators at berthing and achieve zero emissions.

For the use of green energy above, China should organize scientific research, increase the direction of scientific research, in the introduction and absorption of foreign advanced technology at the same time, efforts to develop independent intellectual property rights of energy-saving emission reduction core technology, and increase in Practical application in the promotion of the intensity. Due to the large investment, the slow return of output and the lack of flexibility in the investment channels, the relevant departments of our government should further enrich and improve the special funds for shipping construction and solve the problem of shortage of funds so that the shipbuilding and shipping enterprises can take a positive attitude to carry out energy-saving emission reduction work, and actively seek

low-carbon technology and green low-carbon ship in the research and development work. At the same time, China should strengthen the government, enterprises, scientific research institutions of the tripartite scientific research cooperation, increase technology and complete sets of equipment research and development and promotion efforts, through technical means to achieve ship energy saving.

On August 22, 2016, China's Ministry of environmental protection issued “the limits and measurements for emission limits of marine engines (China's first and second stages)”, which were implemented in July 2018. China's coast, along the river and port cities will be the main beneficiaries of the above-mentioned emission reduction benefits, which is of great significance to improve the air quality in these places and cities.

4.2.3 Management level of progress

In response to international maritime greenhouse gas emission reduction work in addition to the technical level to be a breakthrough, the rational regulation of the ship operation and management is also essential. To this end, we should improve the comprehensive management level of shipping companies, and further promote the concept of system management, through the establishment and operation of standardized work processes, the ship, crew and related operators in energy conservation and emission reduction of specific work to control, feedback, comprehensive control of greenhouse gas emissions. In order to promote energy efficiency management of ships during the operation, IMO has developed the guidelines for the formulation of the Ship Energy Efficiency Management Plan(SEEMP) and the guidelines for voluntary use of Energy Efficiency Operational Indicator (EEOI).SEEMP is intended to be a management tool to help companies manage their ship's energy efficiency during operation. The ship owners operators

and other interested parties should develop targeted plans for each ship to improve the efficiency of the ship through the four steps of planning, implementation, monitoring and self-assessment. To meet the requirements of EEOI as low as possible, it requires the shipping company to take a more effective mode of operation of the ship, rationally design the route and arrange the ship to stay in Hong Kong. And China's current and developed countries in the efficient logistics management is still a gap, and needs to make greater efforts in this regard.

Relevant research and practice show that during the operation of the ship, deceleration navigation is an effective energy saving and emission reduction operation measure. Taking into account the ship to meet the flight time and port time to reach the business needs, costs and income, greenhouse gas emissions and other factors, appropriate to reduce the speed of navigation, contribute to the ship fuel savings and emissions reduction. As this can achieve the purpose of reducing costs, this strategy has been gradually accepted by the shipping company. Studies have shown that the low speed of the container ship fuel savings can even meet the need to maintain the voyage density and another ship of oil needs, so slow down navigation is an easy and significant effect of the ship energy saving and emission reduction methods.

Energy-saving by optimum trim for large ocean-going vehicle by the US Energy Conservation Commission included in one of the top ten energy-saving measures. A large number of experiments show that the use of ballast water to adjust the pitch, so that the ship is in the best pitching state, is simple, safe and reliable without any equipment, as a significant energy-saving measure. When the load is constant, the length of the hull waterline and the underwater geometry change when the inclination is constant, causing the change of resistance and propulsion efficiency, and the required power is minimum in this state. When the ship sails in the best trim,

the hull resistance is reduced and the propulsion efficiency is improved, which greatly saves the host power. And thus to a certain extent, reduce the ship's fuel consumption, reducing ship emissions.

Second, in the operation of the ship to improve energy efficiency methods, such as Weather Routing, to determine the economic speed and so on, will help reduce the ship's carbon emissions. These effective operational and management tools require the crew and the relevant staff to have a comprehensive understanding of the requirements of the new Convention and have the appropriate expertise and experience as a basis for the requirement that our crew and shipping industry-related staff should be a higher quality and get more systematic training.

4.2.4 Structural level optimization

Old and backward ships generally have high fuel consumption, high emissions shortcomings, and are not suitable for today's green low-carbon shipping development trend. Energy-saving emission reduction and green shipping is not only the general trend, but also the future development of the shipping industry strategic direction and profit growth point, China should guide the shipping enterprises ahead of the layout, eliminate backward capacity. China's shipping companies should take this as an opportunity to follow the development trend of green shipping, increase technological innovation, eliminate backward capacity, the development of green-oriented ship, take the initiative to promote the upgrading of the mainstream ship, from the capacity structure to be adjusted and optimized , and gradually adapt to more stringent environmental requirements.

In addition, the shipping industry is facing the cyclical, monetization of profitability and other aspects of the negative characteristics, and in the current economic weakness, excess capacity under the rigid conditions, how to improve the ability of

enterprises to become the key to the survival of the current shipping companies. Therefore, the innovative service model, innovative business model, jointly hold together for warmth, and even mergers and acquisitions become the inevitable choice of the current shipping companies. Such as the establishment of shipping companies strategic plan to reduce fuel procurement costs, and even through the sale of fuel futures to avoid the risk of oil price fluctuations; the establishment of cargo alliance, that is, shipping companies and shippers joint operations, both to ensure the tariff and supply, but also won the service quality and efficiency; merger and reorganization, expand the size of shipping companies, optimize the ship type, age, broaden financing, supply channels, innovative service plans will greatly enhance the shipping business's ability to reduce risks, to a certain extent, the risk and pressure of carbon tax levied.

4.2.5 Market level promotion

At present, the international shipping industry has recognized the need for greenhouse gas emissions, but also accepts the technical and operational aspects of emission reduction measures to take the initiative or passive to achieve emission reduction and energy conservation. But the key question is whether the solution adopted by the maritime industry to meet the international regulatory agencies to reduce emissions requirements, if not, the industry will face economic regulation of emission reduction, that is, through the market mechanism to promote emission reduction.

In recent years, with some developed countries trying to international aviation, navigation in the field of active promotion, the market mechanism has become the international maritime greenhouse gas emission reduction negotiations as the top priority.

As the mechanism involves a series of industries related to shipping (such as export trade, etc.), so the impact on China is particularly large. From the current submission of the IMO market mechanism proposal, according to the control means can be divided into tax and Emission Trading Scheme(ETS) two categories. Among them, the ETS based on the "no difference" principle, requires developed countries and developing countries to jointly assume compulsory emission reduction obligations, ignoring the "common but differentiated" principle, may be China's shipping industry will bring the essence influence. Compared with Europe and the United States and other developed countries, China is currently in the market mechanism, especially in the "Emission Trading Scheme" started late, the experience is still relatively lacking, and in the legal system, market environment and even social and cultural aspects are inadequate. China needs to recognize the status of the global carbon finance circle, pay attention to the development of the rules of the game, in the carbon finance value chain, in the upper reaches. In the carbon trading circle, the monopoly of the mainstream supply channel is the biggest beneficiary of the market. Europe and the United States have formed a more clear layout in the field of carbon finance: the establishment of a global influence of carbon emissions exchanges, competition for international carbon trading rules to develop the dominant position, to seek carbon trading pricing, improve the level of carbon measurement technology, improve the various Carbon standards approved by the rules, to master the carbon approved jurisdiction; the introduction of carbon finance products, the development of complex carbon trading derivative market, affecting the carbon trading entity market; the development of various carbon reduction technology, while profiting from technology transfer.

CHAPTER 6

SUMMARY and CONCLUSIONS

China should pay close attention to the development of a domestic voluntary emission reduction market, intensify the construction of the Chinese version of ETS, to take the principle of independent emission reduction standards to speed up the development and improvement of independent emission reduction standards and strive to be recognized at home and abroad, through the development of laws and regulations to ensure the market's normal operation. Through the introduction of similar measures to reduce the shipping carbon emissions as a EU or internationally acceptable alternatives to avoid the EU or other countries of the maritime carbon tax, to avoid China's shipping industry to face the EU carbon trading rules of the passive, but also can actively and effectively promote the domestic carbon emissions trading market development. When China's domestic carbon trading mechanism matures, it is easier to master the right to speak in the international community, then, foreign countries in China or the arrival of the ship to apply to China's carbon emissions trading mechanism is also possible.

Shipping carbon reduction is part of the international carbon politics and carbon finance game, and the rules of the game makers will certainly be skilled users of the technology leader in financial instruments. Therefore, China should increase research and development of energy saving technology, strengthen the new energy policy guidance, expand new energy for port infrastructure construction, strengthen the focus on the development of green shipping, skilled use of financial instruments, improve the formulation of relevant regulations and inspection of ship carbon trading market regulations, to promote the development of green shipbuilding in China and

the related industry, thus forming green shipping to promote green shipbuilding, so as to develop industry rules, leading the development of the industry, and enhancing the right to speak.

On the one hand, China's shipping industry should focus on improving the ship energy efficiency, reduce greenhouse gas emissions from the technical level; on the other hand, to accelerate the activity of greenhouse gas monitoring of marine ships, preparing for the formation of emission reduction mechanism of the market. China should actively study the rules of greenhouse gas emissions accounting, establish and perfect the specialized institutions for monitoring and controlling greenhouse gases, and establish a database for MRV of marine greenhouse gases. At the same time, China will continue to seek international cooperation to promote the emission reduction mechanism within the framework of the IMO and to build a fair, fair and rational global carbon emission reduction system for shipping industry.

China attaches great importance to the issue of climate change, and resolutely implements the concept of innovation, coordination, green, open and shared development, and adopts effective policies and actions to respond positively to climate change, which has made remarkable achievements. This is not only China's international responsibility as a major developing country, but also an inherent requirement for China's sustainable development.

REFERENCES

AEA Technology and others, 2012

EUROPEAN COMMISSION, 2013. Communication: Integrating maritime transport emissions in the EU's greenhouse gas reduction policies.

EUROPEAN COMMISSION, 2013. Impact assessment: Proposal for a regulation of the European parliament and of the council on the monitoring, reporting and verification of carbon dioxide emissions from maritime transport and amending Regulation

Kyoto_protocol (http://unfccc.int/kyoto_protocol)

Bali Road (http://unfccc.int/key_steps/bali_road_map)

Paris Agreement (http://unfccc.int/paris_agreement)

At MEPC 65 in May 2013

At MEPC 68 in May 2015

At MEPC 69 in April 2016

(<http://www.imo.org/en/MediaCentre/MeetingSummaries/MEPC/Pages>)

Corbett, J, et al. (2009). Study on Reduction of Greenhouse Gas Emissions in Ocean-Going Shipping: Evaluation of Possible Solutions. Japan International Transport Institute. Washington D. C: Author.

Eyring Transport impacts on atmosphere and climate: Shipping, Atmospheric Environment 4.2009

Gu,Humphrey Global Governance and Developing Countries: The Implications of the Rise of China. World Development Vol. 36, No. 2 (2008).

Holmes Modeling the economics of Greenhouse Gas Mitigation: Summary of a workshop. Washington: National Academies press.

The Korean Ministry of Knowledge Economy and the Korean Shipbuilding Association, 2012

Ministry of Transport of the People's Republic of China, (2009). Report on China's

- shipping development. Beijing: China Communications Press.
- UNCTAD, 2011. Review of maritime transport. United Nations Conference on Trade and Development.
- WU Weihong, XU Ruihua. Uncertainty of Market Mechanism of Marine Greenhouse Gas Emission Reduction [J]. Journal of Shanghai Maritime University 2012, 33 (3): 52-57
- Shanghai International Shipping Research Center, International Container Liner Transport Market 2012 Review and 2013 Outlook
- Shanghai International Shipping Research Center, International Dry Bulk Cargo Market 2012 Review and 2013 Outlook
- Shanghai International Shipping Research Center, International Tanker Transport Market 2012 Review and 2013 Outlook
- Shanghai International Shipping Research Center, China Shipping Prosperity Report
- Shen Jiaoyuan, Sun Qianwen, Huang Qingbo. China's shipping industry to deal with the EU "marine carbon tax" strategy [J]. Water Transport Management, 2012
- XU Guang-yue SONG De-yong; An Empirical Research on the Relationship of Export Trade, Economic Growth and Carbon Emissions[J]; Journal of International Trade; 2010-01
- The limits and measurements for emission limits of marine engines (China's first and second stages), 2016, <http://english.mep.gov.cn/>
- China's Energy Demand and Greenhouse Gas Emission Scenarios in 2050[J]; Advances in Climate Change Research; 2008-05
- CH Wenying, G Pengfei Energy, Environment and Economy Research Institute, Institute of Nuclear and New Energy Technology. (Tsinghua University, China);
- Impacts of future carbon emission reductions on the Chinese GDP growth[J]; Journal of Tsinghua University (Science and Technology); 2004-06

- Cui LB, Fan Y, Zhu L, Bi QH (2014) How will the emissions trading scheme save cost for achieving China's 2020 carbon intensity reduction target?
- Demailly D, Quirion P(2008) European Emission Trading Scheme and competitiveness
- Gao PF, Chen WY (2002) Carbon tax and carbon emission. Tsinghua
- He JK (2011) Economic analysis and effectiveness evaluation on China's CO2 emission mitigation target.
- Hoffmann VH (2007) EU ETS and investment decisions. EU Management J
- Li KJ, Qu RX (2012) The effect of technological change on China's carbon dioxide emission. China Soft Sci Magazine
- S Sun, C Li, Evaluating Impact of Congestion Pricing on Greenhouse Gas Emission Reductions.
- P Crist (Oecd/itf Joint Transport Research Centre Discussion Papers) Greenhouse Gas Emissions Reduction Potential from International Shipping
- SH Zhang The trends of the GHG emission reduction by the international shipping and its implication to China (China Maritime Safety)
- Second IMO GHG study 2009 update of the 2000 GHG study: final report covering phrase 1 and phrase 2(J).London, IMO, 2009.
- Impact Assessment Accompanying the document Proposal for a Regulation of the European Parliament and of the Council on the monitoring reporting and verification of carbon dioxide emissions from maritime transport and amending Regulation(EU) June 2013.
- Dagmer Nelissen Jasper Faber. Economic Impacts of MRV of Fuel and Emissions in Maritime Transport(J).2014.
- European Commission Proposal for a Regulation of the European Parliament and of the Council on the Monitoring, Reporting and Verification of Carbon Dioxide Emissions from Maritime Transport and Amending Regulation (EU)[Z]. Brussels, 2013.

Bali Action Plan [Z]. Report of the Conference of the Parties on Its Thirteenth Session, Bali, FCCC/CP/ 2007/6/Add1, 2008

Germany and Japan. Further Details of Possible Metric Options to Develop Further Technical and Operational Measures for Enhancing the Energy Efficiency of International Shipping(Z). IMO MEPC 66/4/6, 2014.

EU Members and European Commission. Framework for a Global Data Collection System for Maritime Transport Covering Fuel Consumption, CO2 Emissions and Energy Efficiency (Z). IMO MEPC 66/4/9, 2014.

Establishing a Mandatory Global System for Monitoring and Reporting Fuel Consumption, Taking Account of the United States Proposal to Enhance Energy Efficiency in International Shipping(Z). IMO MEPC 66/4/ 3, 2013.

Sino German climate change project capacity building sub project "greenhouse gas monitoring, reporting and verification" working group. Greenhouse gas monitoring, reporting and verification training materials (Z).2013.

Li Wen, Wang Nini. Analysis of the impact of the EU shipping MRV program and the market emission reduction measures on the international shipping industry(J). China water transport. 2014

Notice of the State Council of China on printing and distributing the work plan for controlling greenhouse gas emissions in 12th Five-Year (EB/OL)(D). 2012

Gu Weihong, Xu Ruihua. Prediction of greenhouse gas emissions from China's international shipping (J). Journal of Wuhan University of Technology: traffic science and engineering(1).2013

China's Ministry of environmental protection issued “the limits and measurements for emission limits of marine engines (China's first and second stages)”.2016

<http://www.uscg.mil/imo/mepc/>

<http://www.hellenicshippingnews.com>

<http://www.verifavia-shipping.com>

<http://www.cleanshippingproject.se/>

<http://www.bsr.org/en/our-work/working-groups/clean-cargo>

http://ec.europa.eu/clima/policies/transport/aviation_en

<https://www.bdiindex.com/index.php>