Research Study：

The World's Changing Maritime Industry and a Vision for Japan

May 2008

Ocean Policy Research Foundation
(Ship & Ocean Foundation)

INTRODUCTION

The 20th century's rapid advances in transport and information technologies are now resulting in social transformations on a global scale. Along with the planet-wide instantaneous communications of the 21st century, future trends can be seen in the exhaustion of energy resources, the threat of global warming, insufficient food and water supplies, and increases in population. It is with these conditions in mind that the Ocean Policy Research Foundation (OPRF) is carrying out its "Research Study: The World's Changing Maritime Industry and a Vision for Japan, " to set targets for how Japan might best develop its ocean and maritime industries for the future.

The research period is scheduled to last for two years, with the 2050 targets being global warming, population, and energy, all areas requiring decades-long perspectives unprecedented in maritime research. Research will center on global maritime transport but will also include the development of marine energy resources. After positing the likely development of global maritime activities, a Vision model of sustainable maritime activities for Japan will be set forth, supported by concrete measures.

As the areas of research are vast both in terms of their duration and complexity, the approach to be used for drawing up the Vision model is crucial. It was decided, therefore, that the "back-cast" approach, often used in long-term global warming studies, should be employed. In other words, as opposed to year by year projections far into the future, it was thought more realistic to assume ideal conditions for the target year and work backwards to the present to identify the necessary policy measures for the Vision model.

Thus, the present study, incorporating the new "back-cast" approach, will make quantitative and concrete estimates of maritime activities until 2050, based on the continuance of current trends. It will then interview experts from relevant fields to set goals for what Japan's maritime transport activities should be in 2050, as well as the issues that need to be addressed to reach those levels. The Vision model will concentrate on the gap between the prediction based on current trends and the ideal based on interviews with experts.

Although the study is still in progress, the present report indicates trends and underlying factors for change in international maritime activities until 2050. Based on future predictions and expert interviews, we hope in the following year to lay out the basic factors and concrete content of the Vision model as well as its time schedule.

Finally, we at OPRF would like to express our gratitude to Professor Miyashita of Osaka Sangyo University, who assembled and chaired the Research Committee, as well as to the committee members and expert informants.

May, 2008
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1. Overview of the Research Study

1.1 Purpose of Research Study

For the 21st Century Global Maritime Industry, issues of newly arisen or issues of unable to resolve with existing procedure are await (such as changeover of social structure, population and energy issue, global warming, and environmental issues)

In this circumstance, establishment of Technical Strategies and policies as target and conducting it in appropriate manners are needed. In order to seek the options that the Japanese Maritime Industry should take, with current understanding of political, economics, social and technical status, with seek of model how to achieve the target, against the impact of various changeable factors, with the accurate grip of current reorganization and future trend change

The purpose of this research study, are seeking the visions for Japanese maritime concerned parties participating in the global maritime society, and drawing up and suggesting innovative visions that is consisted with direction, international strategies, innovations to realize the future vision, then to support stabilization of people's live-hood as a marine nation.

1.2 Procedure of Research Study

The vision targets in the period till 2050, for the activities of global maritime activities including seaborne activities of goods and marine energy source development.

As an approach, mainly for global warming issues, adapt Back-cast method, which is used to draw up vision for long-term. First, make forecast of world maritime activities with goods seaborne activities as the central focus on till 2050. Second, compare to wished future vision based on interview presenting relevant forecast. Then, draw up henceforth necessary innovative vision (policy target) by the Back-cast method.

1.3 Future Forecast

The future forecast of world seaborne till 2050 is an essential document to build a wished vision of the future, which is settled based on the interview. In order to grip quantitative trend, it is necessary to take an overall view of future seaborne based on wide range of industries such as energy, mining, and agriculture, also the situations of world and local region, and principle states of the world.

1.3.1 Adoption of IPCC scenario A1B

The work of quantitative stochastic above supposed to be based on the combination of the existing future forecasts by authorized organization. This research considers Scenario of Emission (SRES) created by Intergovernmental Panel on Climate Change (IPCC), as the Scenario of world population, economic growth, energy consumption activities till 2005, the target year is concerned.

IPCC scenario was edited in IPCC the 3rd assessment report, and the same scenario was used for the 4th assessment report issued in May 2007.

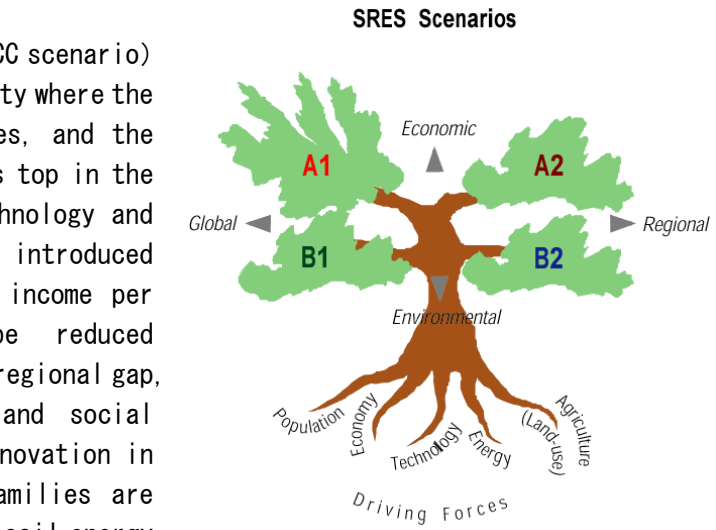
The activities are classified in 4 categories below, based on 2 parameters of global ⇔ regional and economic growth ⇔ environment-oriented. Total 6 scenarios are prepared: 3 scenarios for A1, which has the highest probability and categorized in globalization/economic growth, and 1 each scenario for A2, B1, and B2. The highest probable scenario among A1 is considered as A1B, and this balance-focused scenario is adopted for future forecast of this research study.

Therefore, impact of global-warming-countermeasure is not considered in IPCC scenario, however, in fact, several measures are concerned to be conducted, so it should be reflected at the settlement of future forecast of this research study.

（reference：each categories of IPCC scenario）

A1. It is drawn as Near-future society where the rapid economic growth continues, and the world population reached to its top in the mid 21st century, then new technology and high efficiency technology are introduced rapidly. The regional gap of income per person is estimated to be reduced drastically due to reduction of regional gap, capacity building, cultural and social exchange. Due to technology renovation in energy system, A1 scenario families are divided in 3 groups: focusing fossil energy source（A1FI）, non-fossil energy source（A1T）, or balance of all type of energy（A1B）

A2. In A2, regional economic development is major factor. Personal economic growth and technology changeover are varied and moderate comparing to other scenarios.



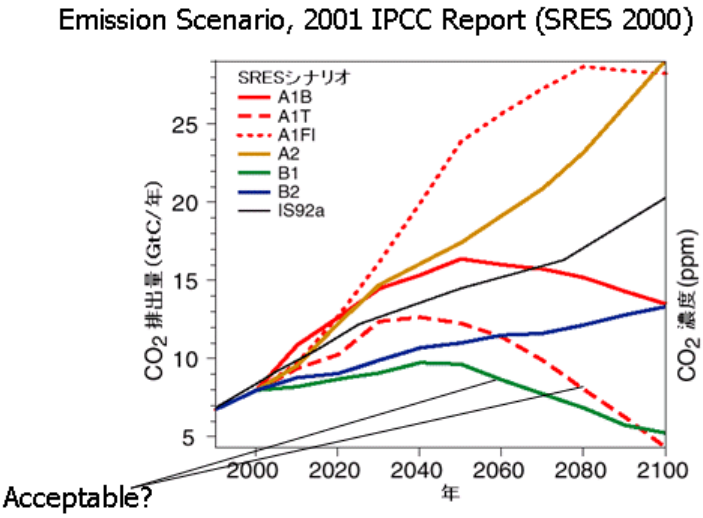


Fig.1.1CO2emission estimate in each scenario

B1. In B1, the society of gap-reduction among region is drawn. Economic structure changed rapidly toward service and information economics, and material-oriented trend is declined and clean and eco technology is introduced. It focuses on the global level correspondence to sustain economic, society, and environment.

B2. In B2, the society which focuses on regional correspondence in order to keep sustainability of economic, society, and environment. World population keeps growing in more moderate speed than A2, and economical development stays in intermediate level.

1.3.2 Development of basic data following IPCC scenario

Based on IPCC scenario A1B, consumption and cargo movement volume on sea for petroleum, natural gas, coal, iron ore, grain crops, and industrial product are estimated, adding past trend, world and regional future analysis, in order to demonstrate a certain level of whole world's cargo movement. Data should be backed up by information from authorized organization (ex. Energy related = IEA, Grain crops = FAO). Concrete flow is shown below.

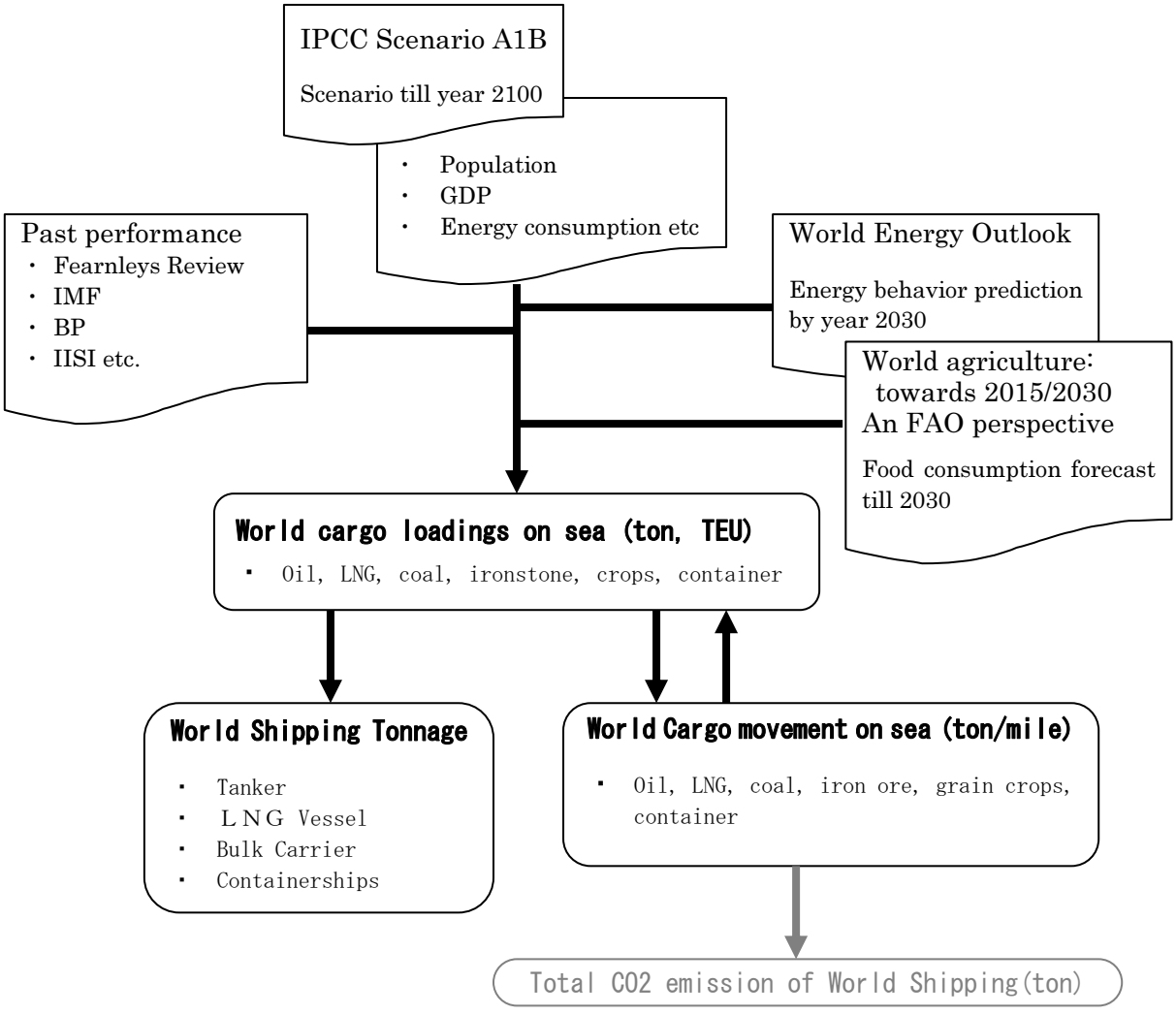
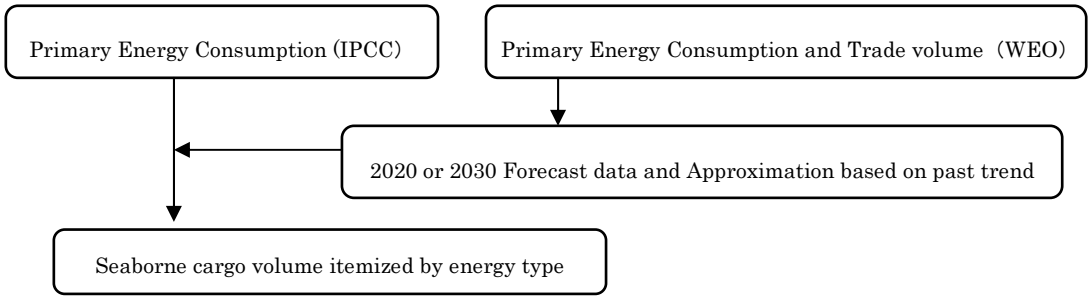
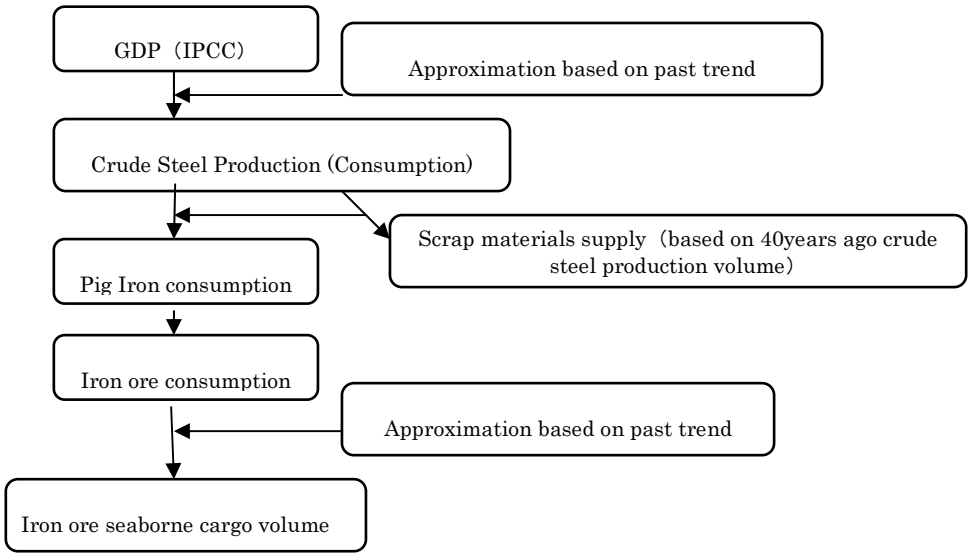


Fig1.2 Future Forecasting Flow

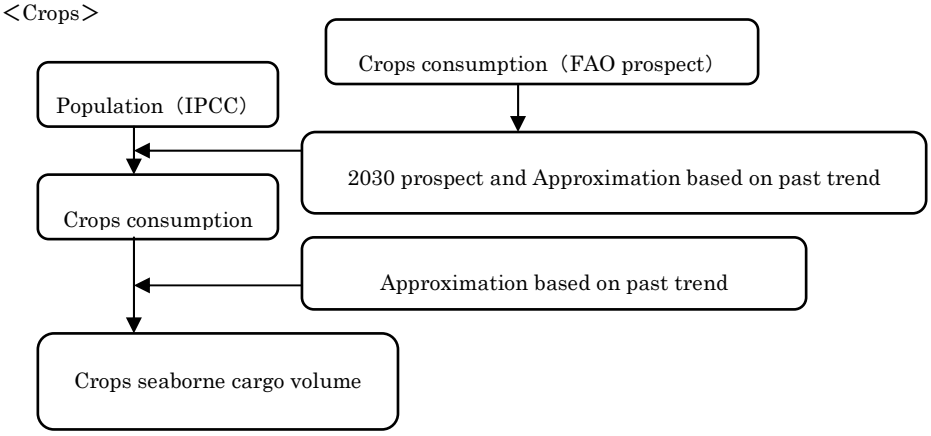
＜Oil, LNG, Coal＞



＜Iron Ore＞



＜Crops＞



＜Container＞

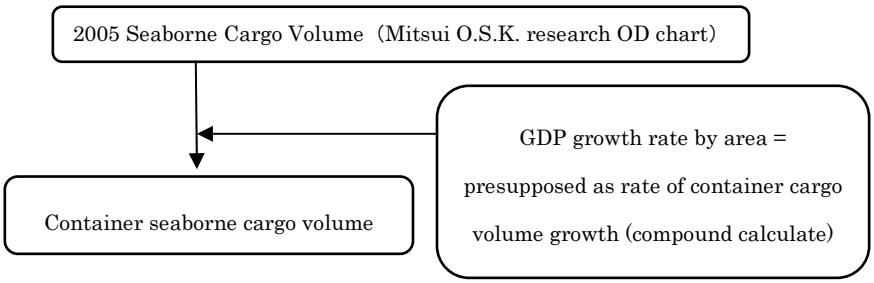


Fig1.3 Seaborne cargo volume Calculation flow

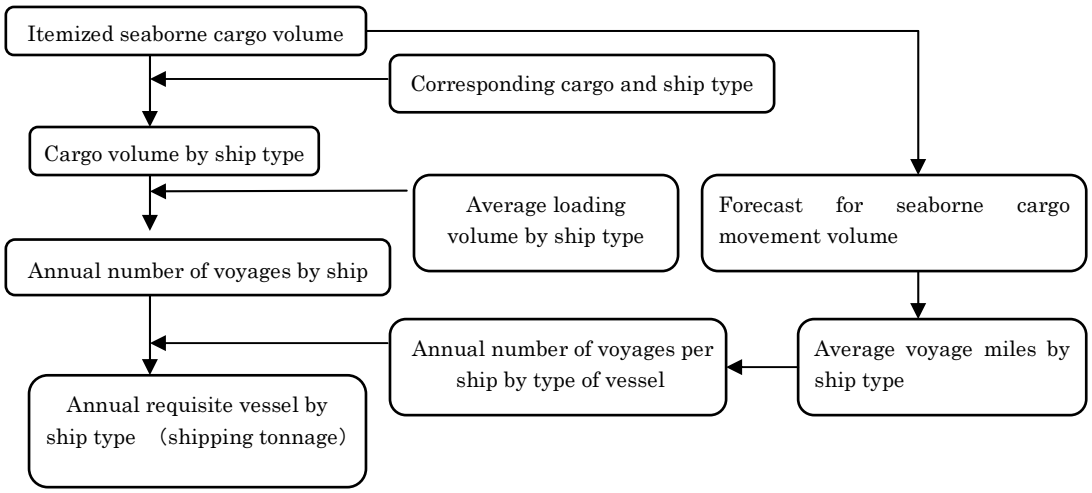
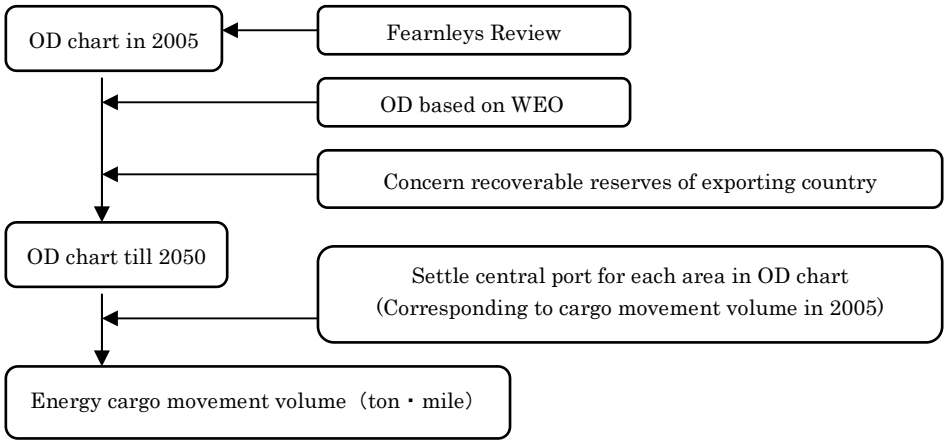
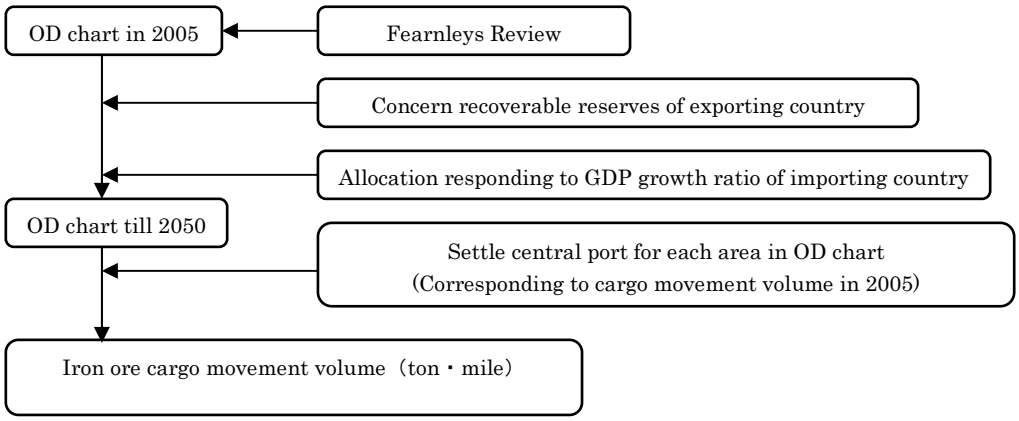


Fig1.4 Shipping Tonnage Calculation flow

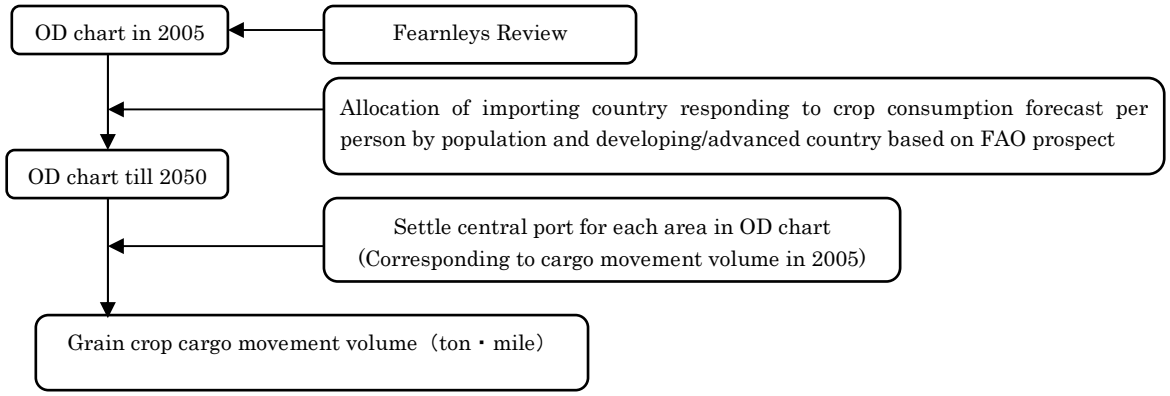
＜Oil, LNG, Coal＞



＜Iron Ore＞



＜Grain crops＞



＜Container＞

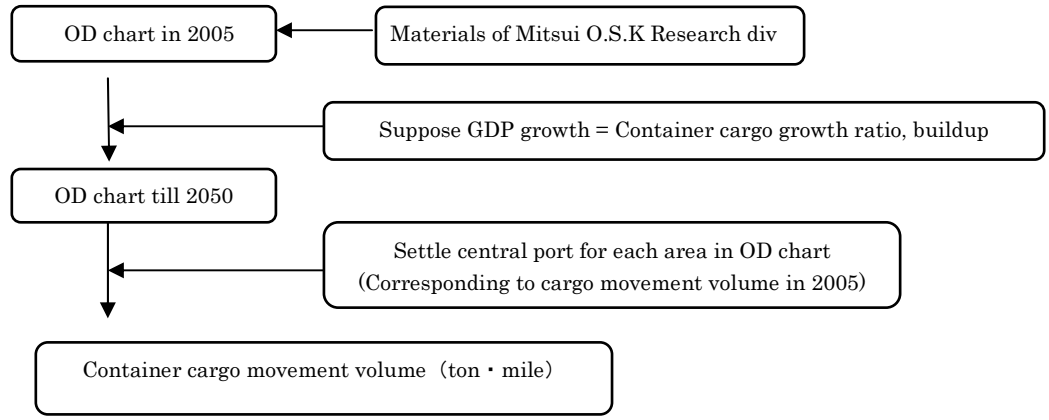


Fig1.5　Seaborne movement volume Calculation flow

2. Overview of world seaborne till 2050

2.1 Basic Data (IPCC scenario A1B etc)

Consumption and cargo movement on sea of petroleum, natural gas, coal, iron ore, grain crops, and industrial products are estimated based on past trend, with concern of future population, GDP, energy trend etc. Trend analyses are done coupled with analyses of world and regional areas, and primary countries. It demonstrates a certain level of whole world's cargo movement.

The analyses are backed up based on the information from International Energy Agency (IEA) and Food and Agriculture Organization of the United Nations (FAO) in use of this scenario. Main output result of basic data is indicated on appendix 1.

(1) Estimate of seaborne cargo volume

・ Oil and Coal

Seaborne cargo volume in 2030 in IPCC scenario A1B is estimated based on the trade estimate in 2030 in IEA World Energy Outlook 2006. Correlation of primary energy consumption (IPCC scenario estimate exists) and seaborne cargo volume is going to be estimated by approximate based on the performance value before 2005 and estimate value of 2030.

・ LNG

Seaborne cargo volume in 2020 in IPCC scenario A1B is estimated (Primary energy consumption is in proximity) based on the trade estimate in 2030 in IEA World Energy Outlook 2006. Correlation of primary energy consumption (IPCC scenario exists) and cargo volume is estimated based on actual performance value before 2005 and estimate value of 2020, using approximate.

・ Iron Ore

Crude steel consumption (production) and iron ore production are in relationship as indicated below:

Amount of Crude Steel = Pig iron ascription + Scrap ascription

Amount of Pig iron = Iron ore consumption × coefficient

Past crude steel consumption and GDP (total amount) are in relationship in certain correlation. Due to its property of steel material, which is strongly related to infrastructure improvement, the growth of steel consumption stops when GDP per person exceeds the certain amount. From this reason, for GDP to estimate iron ore consumption volume is based on Japanese examples.

Countries with GDP per person over US$30,000 in IPCC scenario A1B were estimated its GDP for estimate as its GDP would not increase any further, and estimated the world crude steel consumption till 2050 from the past correlation.

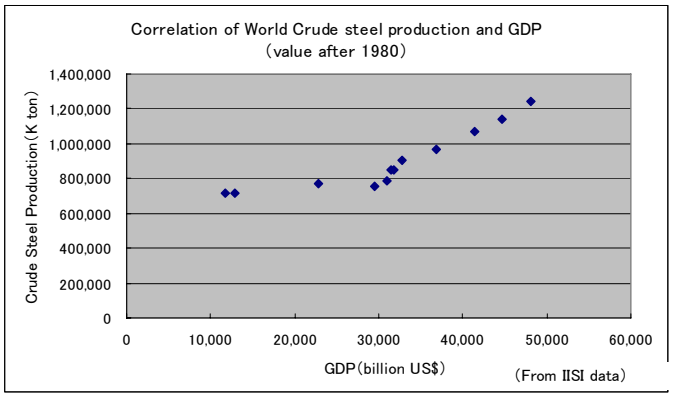


Fig. 2. 1 Correlation of Crude Steel production & GDP

Scrap means the recycled steel materials from the past, and its recycle ratio is generally approx 80%. From the past static, steel product made from scrap material of 1960 and 1965 are equivalent to the 40 years later ratio of 75 – 78 % of each year's crude steel production. From the crude steel consumption estimated above, amount of recycled scrap material, which is estimated based on the crude steel volume of 40 years ago, should be subscribed Iron ore consumption is calculated out of the rest pig iron-originated amount, by coefficient process.

Seaborne cargo volume of Iron ore till 2050 should be estimated based on the correlation of consumption and seaborne cargo volume before 2005.

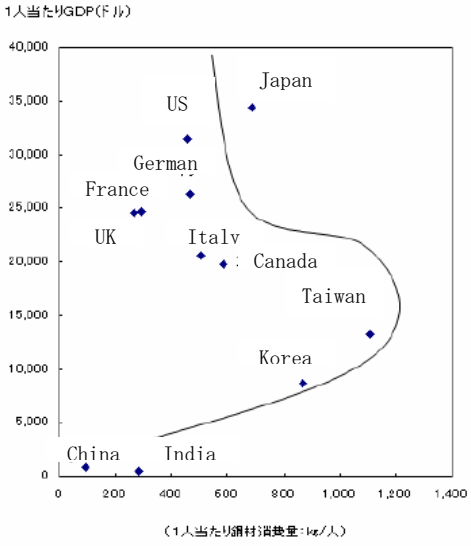


Fig. 2. 2「Steel Industry in Japan」

from lecture materials in Japan December 2004

X = steel material consumption kg/person, Y = GDP /person (US$)

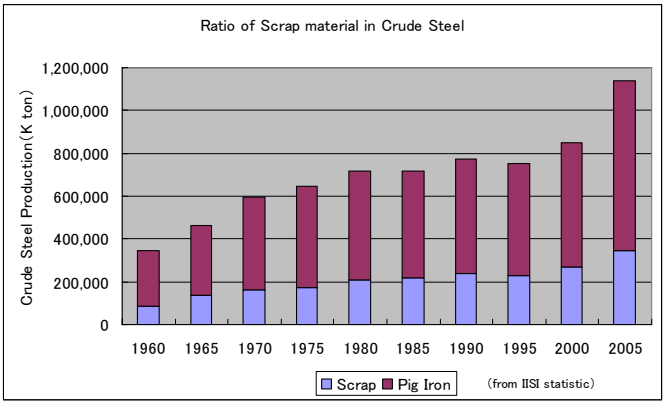


Fig. 2. 3 Ratio of Scrap materials in Crude Steel

・ Grain Crops

From FAO Perspective of 2030 trade estimate, crops consumption of 2030 is estimated. Then estimate of crops consumption is calculated from actual value before 2005 and estimate of 2030, correlation with the population. And then, estimate of cargo volume on sea is calculated based on the correlation with value before 2005.

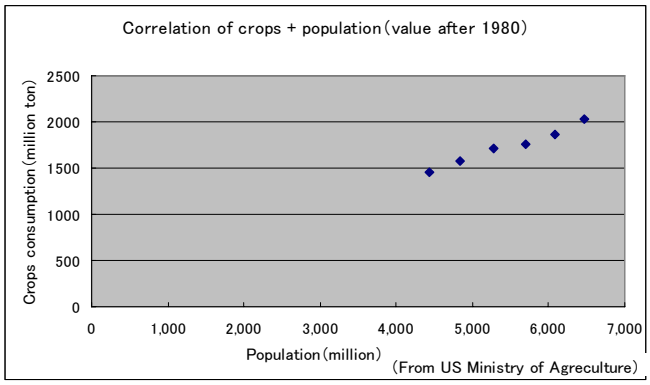


Fig. 2.4 Correlation of Crops and population

・ Container

There is only status from 1990's and it is difficult to estimate out of past performance. Based on the 2005 OD chart from Mitsui O.S.K.' document, it is estimated per exporting areas in the assumption of "GDP growth rate = Growth rate of Container cargo"

(Reference: back ground of "GDP growth rate = Growth rate of Container cargo")

The transition of world actual GDP growth and production / export volume of products are indicated as figure 2.5. The growth rate of exported products is increasing in recent years due to globalization. Also, growth of GDP and production of products are increasing by ratio of approximately 1:1. Looking at the growth rate of GDP and total exporting volume in Japan (fig. 2.6 and 2.7), during the growth (80-95)

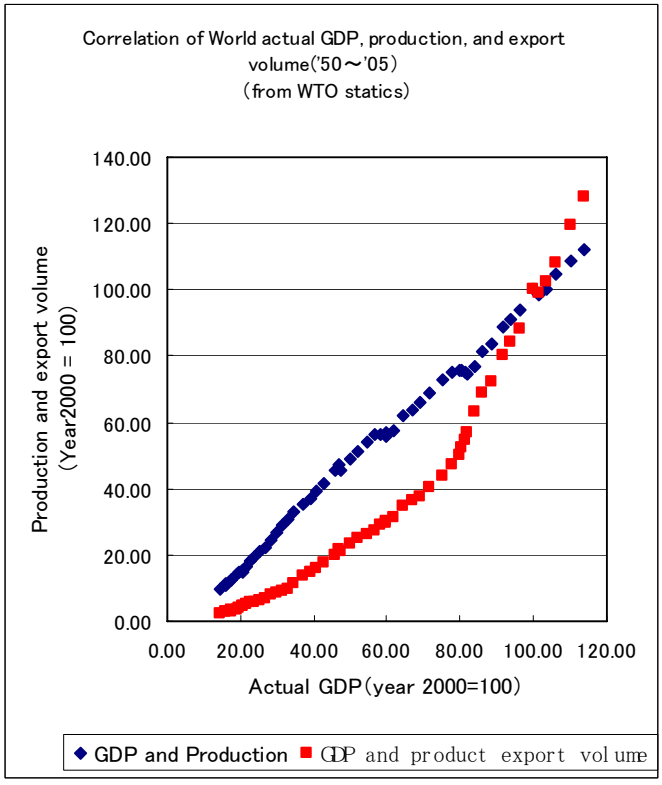


Fig. 2.5 Correlation of actual GDP, production and export

GDP growth rate exceeds, and during stabilized period (95-05) exporting growth rate exceeds.

For the term of relationship between GDP and products trading, it is considered as the effect of globalization of the world economics started 1990's, rather than countries' development. IPCC scenario A1B, which is used for future forecast, is based on the assumption of economic globalization. It is considered that GDP: production of products: export volume of products is close to the ratio of growth of 1:1:1 in globalize society. From that concern, it is assumed to be "GDP growth rate = container cargo volume growth rate" for stochastic of container cargo volume.

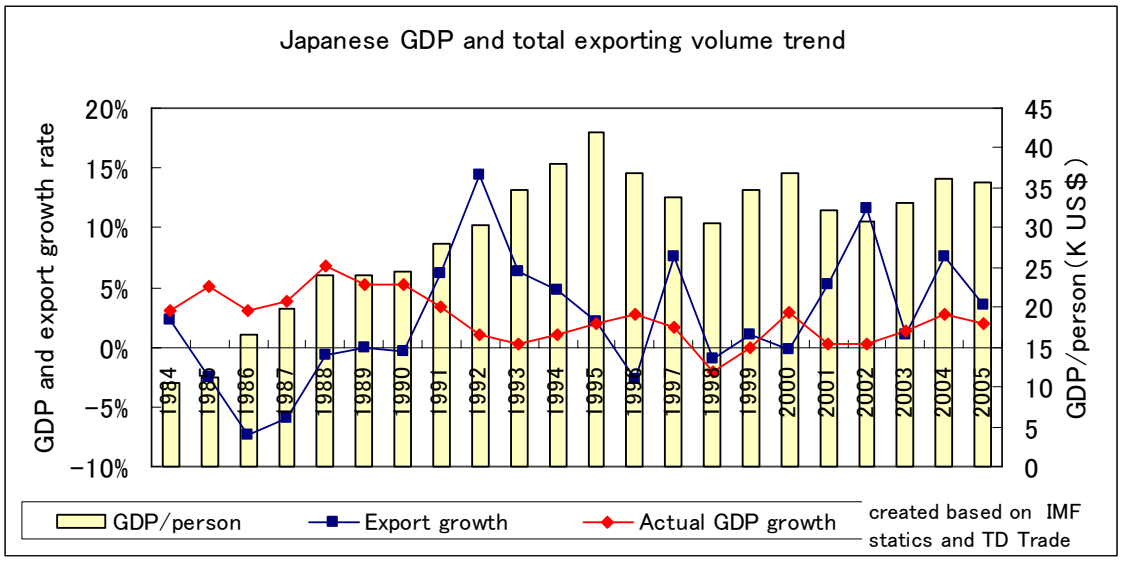


Fig. 2.6 Actual GDP of Japan and Exporting trend

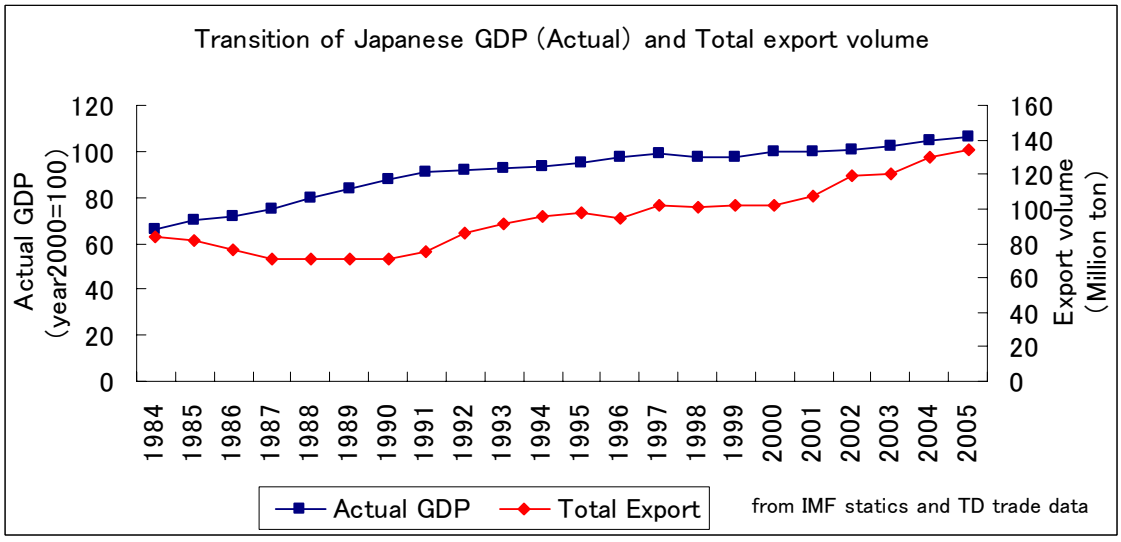


Fig. 2.7 Actual GDP of Japan and Exporting volume trend

Table 2.1 Actual GDP growth rate and Export

	1980～1995	1995～2005	1980～2005
Total export volume growth rate	1.6%	3.3%	2.3%
Real GDP growth rate	3.3%	1.2%	2.4%

As the result of those assumptions above, container cargo volume on sea assumed to be 6 times more than the value of 2010 in 2050, in the future stochastic. However, transition of past world products trade volume is considered to be mostly appropriate when referred to symmetric axis, as shown in figure 2.8.

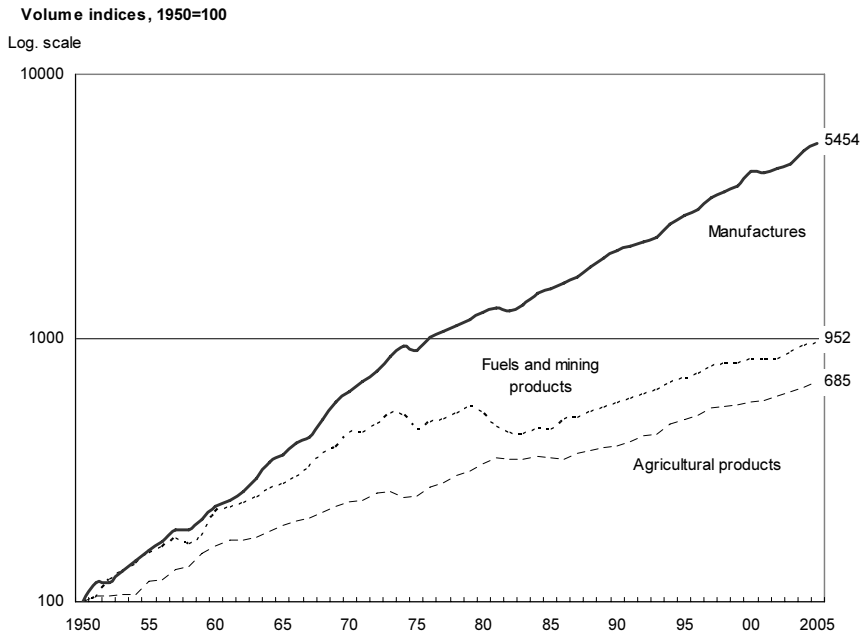


Figure2.8 Transition of world trade volume（assume 1950=100）（reference：WTO）

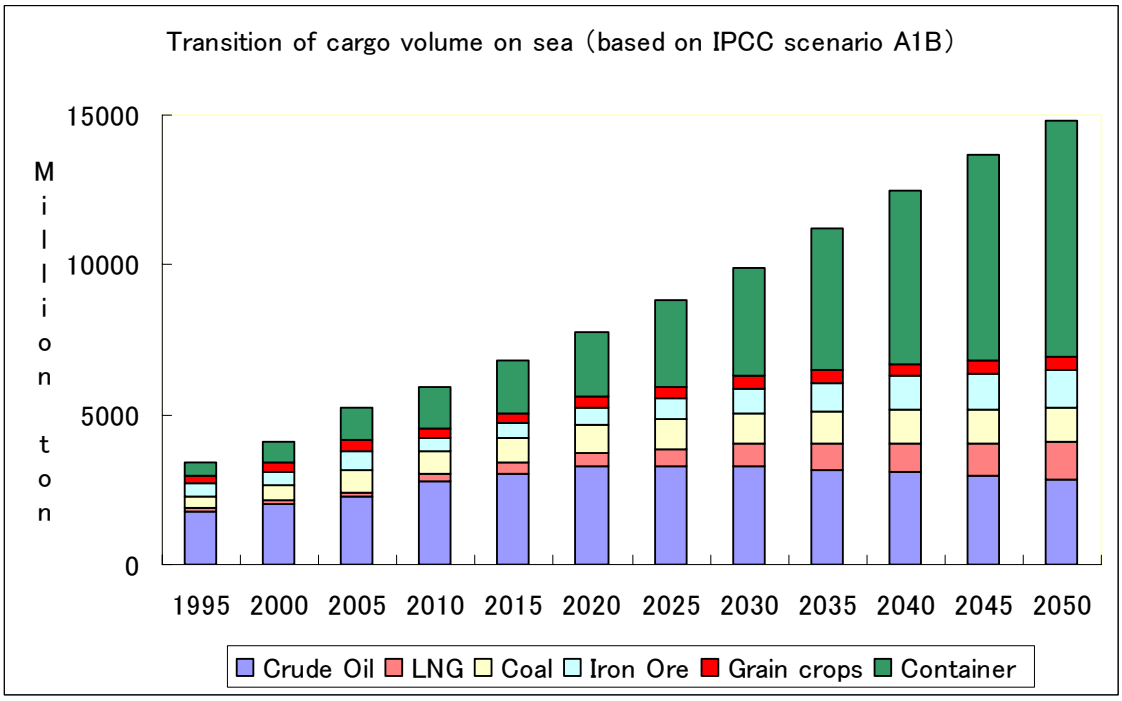


Fig. 2.9 Transition of Seaborne Cargo volume

(2) Stochastic of Shipping Tonnage

The formula to estimate related necessary shipping tonnage by type of vessel out of cargo volume on sea is as below.

- Total annual operation number by type of vessel (Ship・voyage / year) = Σ itemized cargo volume on sea (ton/year) / average loading ratio / average DWT per ship by type of vessel (ton/ship・voyage)
- Annual requisite shipping volume by type of vessel (ship) = Total annual voyage number by type of vessel (Ship・voyage / year) /Annual number of voyages per ship by type of vessel (voyage/year)

Necessary shipping tonnage is estimated with confirmation of correlation based on the past performance, and also with consideration of grow in vessel size.

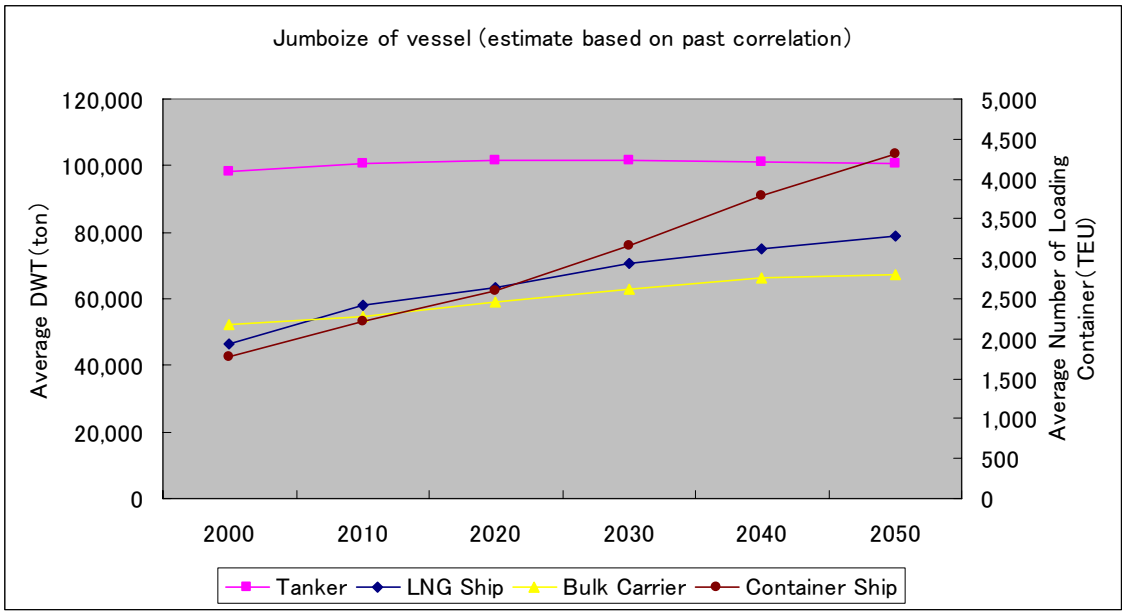


Fig.2.10 Jamboize of vessel

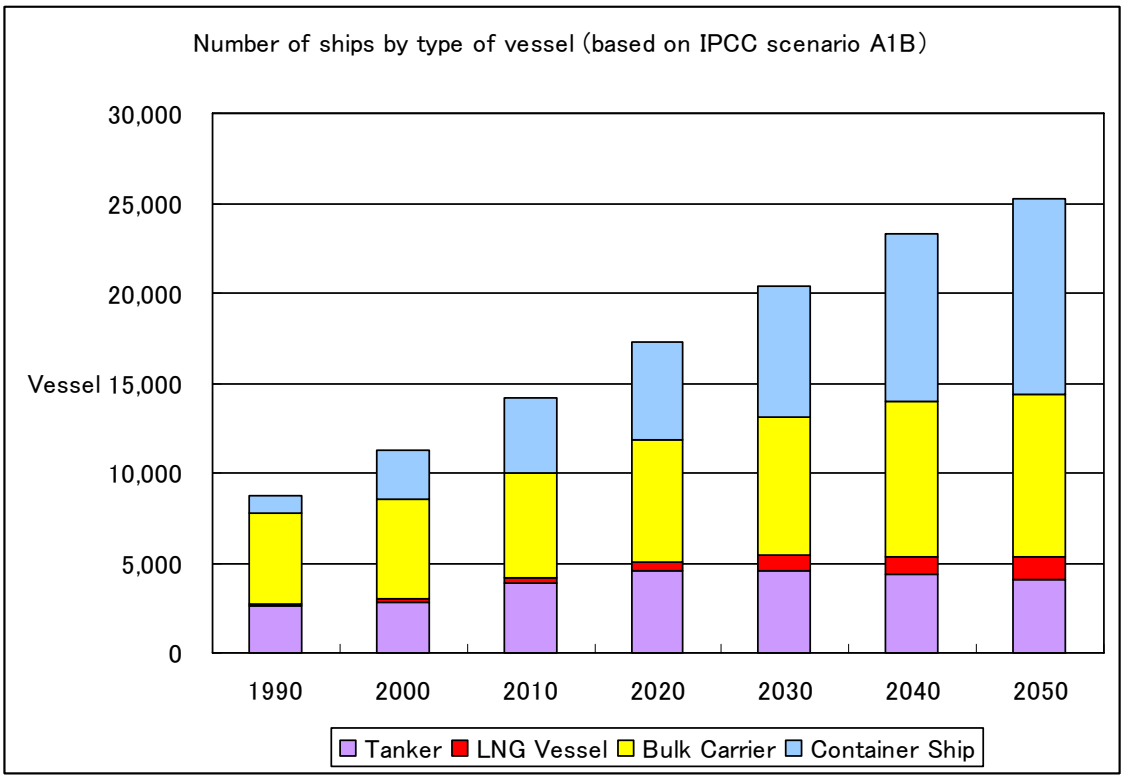


Fig.2.11 Estimate of number of ships by type of vessel

(3) Stochastic of seaborne cargo movement (OD)

・ Oil shipment movement

For 2030, total amount of each areas of "From" and "To" is estimated based on IEA WEO2006, which is based on Fearnley 2005 OD chart. And OD is estimated with use of Freitas method.

For 2050, exporting area (From) is estimated in accordance with growth of 2005-2030. If it excess the amount of deposit confirmed at the point of 2005 (BP materials) it should be decreased. OD is estimated with use of Freitas method.

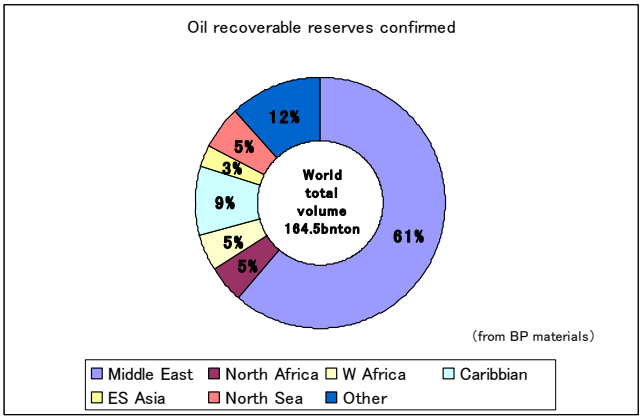


Fig. 2.12 Oil reserves volume

・ LNG seaborne movement

Cargo movement of 2005 is estimated based on LNG One World OD chart, and for 2020, as in the case of IPCC scenario total amount of each area's "From" and "To" is estimated based on 2030 estimate from IEA WEO2006, and then estimate its OD by Fraitas method.

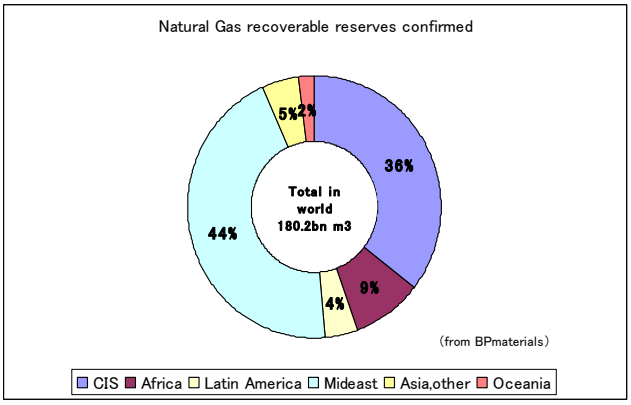


Fig. 2.13 Natural Gas reserves volume

For 2030, total of exporting area (From) is estimated in accordance with the growth between 2005 – 2020 (if it exceeds confirmed preserved amount of BP materials as of 2005, restrained) with the use of Fraitas method.

Estimate of 2050 is done in the same method. Therefore, for Oceania area, preserves are estimated as 1.5 times of BP materials because of future practical use of small gas fields.

・ Coal seaborne cargo movement

Based on 2005 Fearnleys OD chart, each areas (From and To) sum based on IEA WEO 2006, OD 2030 should be estimated by Frator method.

For the year 2050, exporting area (From) should be estimated along with the growth of 2005-2030. If it exceeds reserves amount (BP materials) confirmed as of 2005, it should be restrained and OD should be estimated by Freight method.

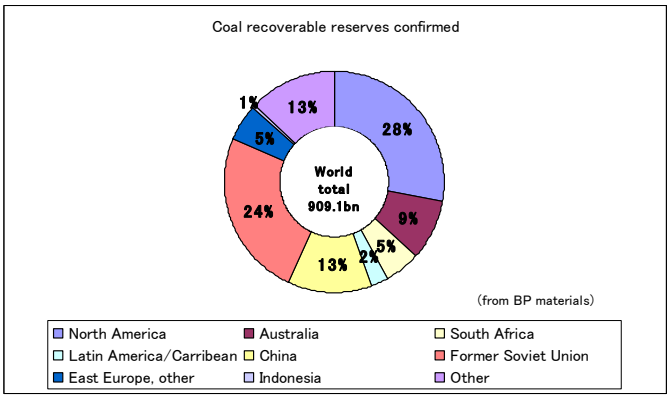


Fig. 2.14 Coal reserves volume

・ Iron Ore seaborne shipment

Estimate of export volume should be calculated based on Fearnleys OD chart of year 2005, with the concern of exporting area (From) and confirmed reserves amount (US Mineral Commodity Summaries 2007). Estimate of importing area (To) should be allocated increase amount divided by correlation of GDP and Iron Ore consumption and estimate OD by Frator method (both year 2030 and 2050).

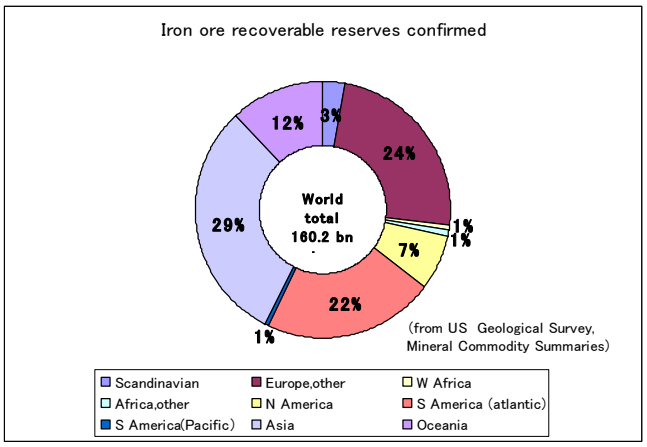


Fig. 2.15 Iron Ore reserves volume

・ Grain Crops seaborne Shipment

Estimate of import volume should be calculated based on Fearnleys 2005 OD chart, with concern of importing area (To), transition of crops consumption per person (by developing/advanced country) based on FAO perspective and population growth. OD should be estimated by Frator method (both year of 2030 and 2050).

・ Container seaborne shipment

Based on 2005 OD chart of Mitsui O.S.K. Line Research dept materials, OD should be estimated by Frator method with the assumption of IPCC scenario A1B GDP growth rate of each importing area (From) = Container cargo increase ratio (both year 2030 and 2050)

(4) Estimate of seaborne movement volume on sea (ton mile)

Itemized shipment movement volume on sea (ton mile) is estimated in consistent with shipment volume in 2005, and also OD estimate above and central port of each area are settled.

Also Cargo movement volume from/to Japan is estimated, but no major growth is not seen comparing to the world growth.

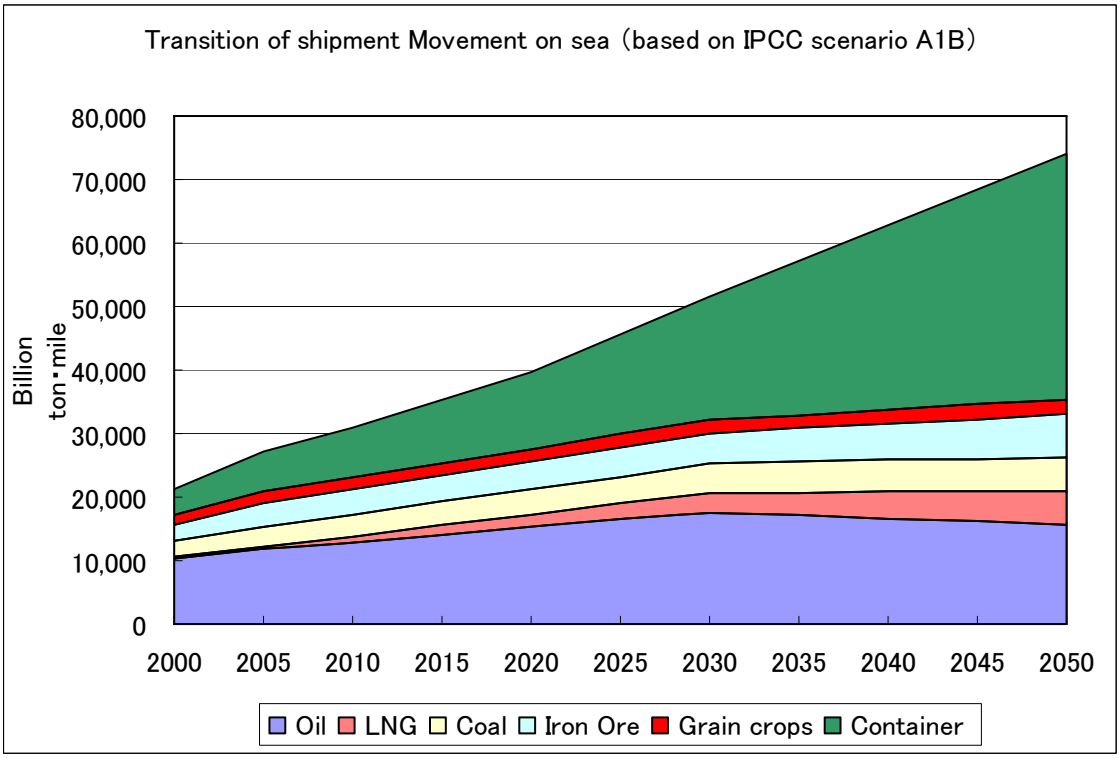


Figure 2.16 Transition of Seaborne cargo movement volume

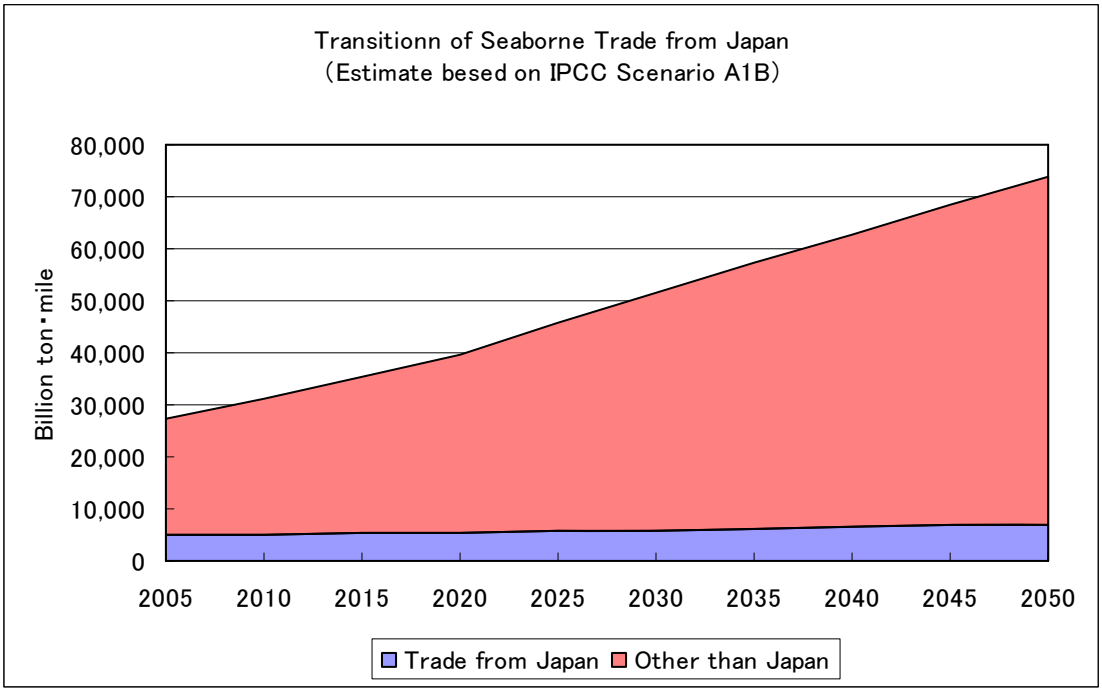


Figure 2.17 Ratio of Japan in Seaborne shipment volume

2.2 OPRF Scenario

The basic data above is estimated based on IPCC scenario A1B. However, to make it effective as future forecast till 2050, some maritime factors, which are not considered in IPCC scenario, should be reflected.

First, offshore-waiting, the significant problem for iron ore transportation, is considered to be solved in step. Second, impact of transportation infrastructure improvement such as pipeline and railway, and recycle ratio of iron scraps should be considered.

Then, impact of global warming countermeasure should be considered. It is expected that global warming countermeasure will be demanded at an accelerating speed as the time proceeds, so project highly probable countermeasure should be drawn up, and the future scenario in which policy (including research and development) to be realized should be designed.

(1) Items to be considered

i) Maritime Factors

a) Solving Offshore-waiting

Due to oligopoly situation of iron ore supplier, Long-term offshore

waiting increases and it results in CO2 emission increase and air pollution from ships. This problem should be solved, and in OPRF scenario, it is assumed to decrease from 2010 and varnish by 2040.

b) Energy-related infrastructure improvement

Some facts may change transportation demand dramatically such as infrastructure improvement (pipeline network) and engineering development. For this concern, following conditions are reviewed:

-Petroleum / gas pipeline between Myanmar + China was built, supply starts (2030's)

-Gas pipeline between Mid-east + India is built, supply starts (2030's)

-Gas pipeline between China + Russia is built, supply starts (2010's)

-Gas pipeline between North Africa + Europe is expanded, supply starts (2030's)

-Modernization of Siberian rail load completed (2030's) (400K TEU / year in 2004, by container transportation bet East Asia － Europe on sea)

-Arctic sea to be voyagable through the year(2040's) (Transport 1/2 containers on sea bet East Asia+ Europe)

-Decrease of LNG import to Japan due to mining methane hydrate in the sea around Japan or pipeline laying (2030's) (in 2050, it applies 10% of LNG import amount)

c) Extension of Recycle-oriented society

Usage of Iron scrap increased more 15% plus from 80% (estimate) (from 2020～ to 2050) (Equivalent to approx 5% reduction of Iron ore)

ii) Impact of Global warming countermeasure

As the global-warming procession is realized in the future, demanded level of global-warming countermeasure is expected to be increased geometrically. It is necessary to consider impact of dramatic countermeasure conduct.

Possible options for countermeasure against global warming are improvement of navigation method, fuel changeover, and engineering development. Once assume that those actions were not taken at all, then, reduction of estimate of seaborne cargo volume at the same period of time, which is estimated with the reflection of maritime factors on IPCC scenario A1B should be settled.

Provision for reduction is settled to start from 2020, and transportation of

goods to maintain the nation's existence such as energy, resources, and crops shall be controlled. Entire energy demand shall be settled as quarter fifth of the same period of time, and manufactures or products that are requested to be consumed locally is settled as half of seaborne transportation demand of the same period in 2050.

Therefore, amount of down-hold energy transportation should be covered by energy-saving, nuclear power, and recycle energy.

(2) Overview of OPRF scenario

Stochastic was made out of model, which was used to calculate 2.1 basic data, with some process on it. Estimation results of cargo volume on sea, number of ships by type of vessel, volume of seaborne cargo movement are as below. Major output data results are shown on appendix 2.

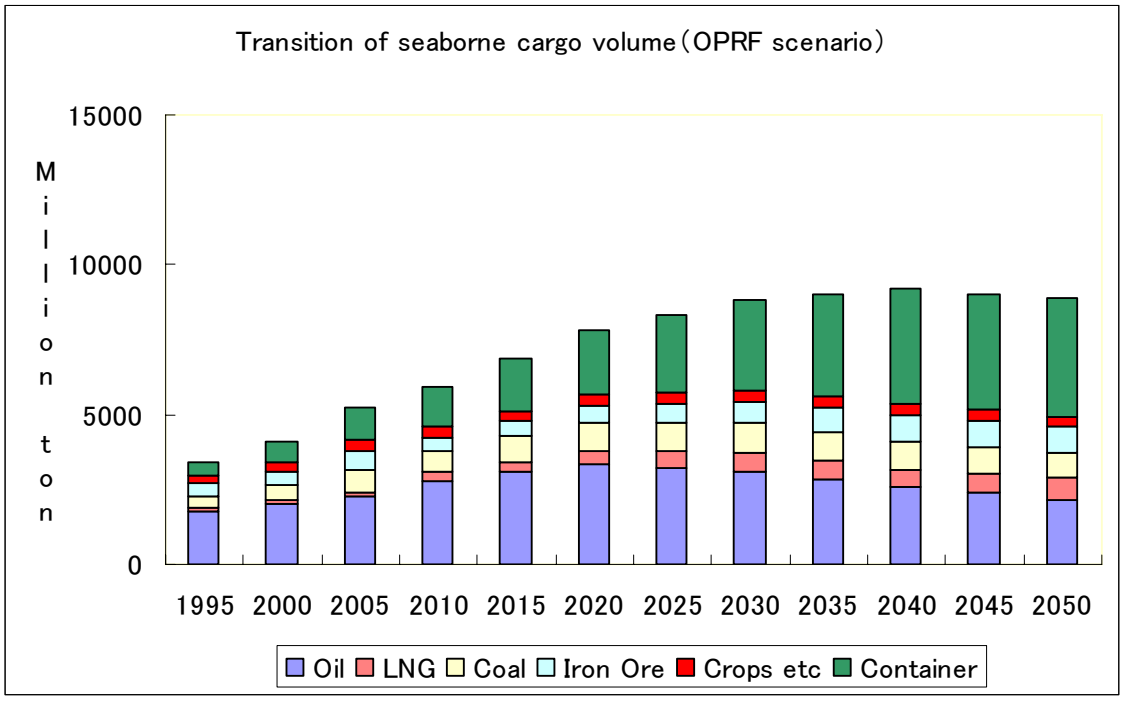


Fig.2.18 Transition of Seaborne cargo volume（OPRF scenario）

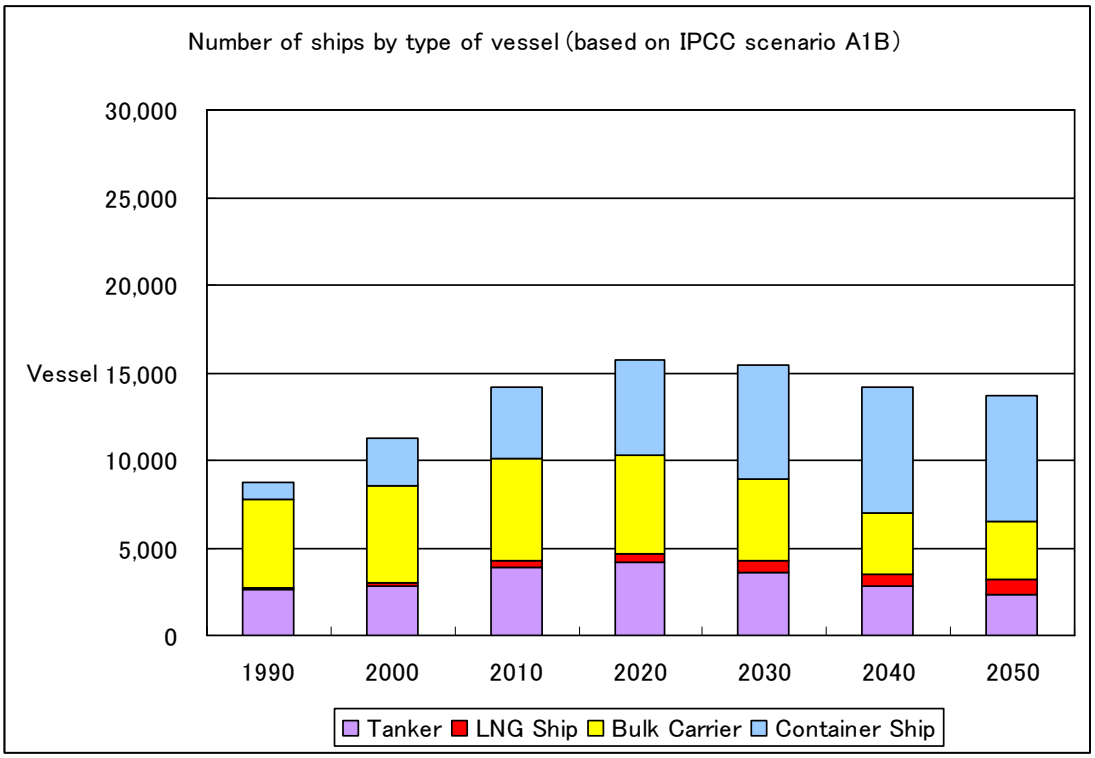


Fig. 2.19 Estimate of number of ships by type of vessel (OPRF Scenario)

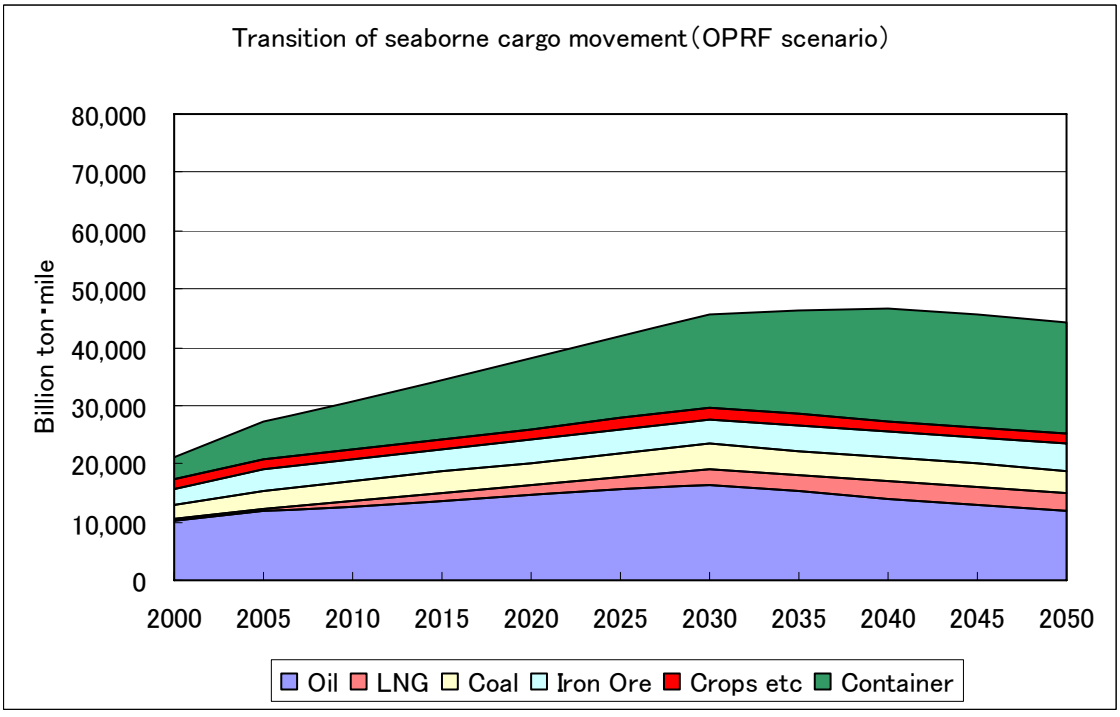


Fig. 2.20 Estimate of Seaborne cargo movement volume (OPRF Scenario)

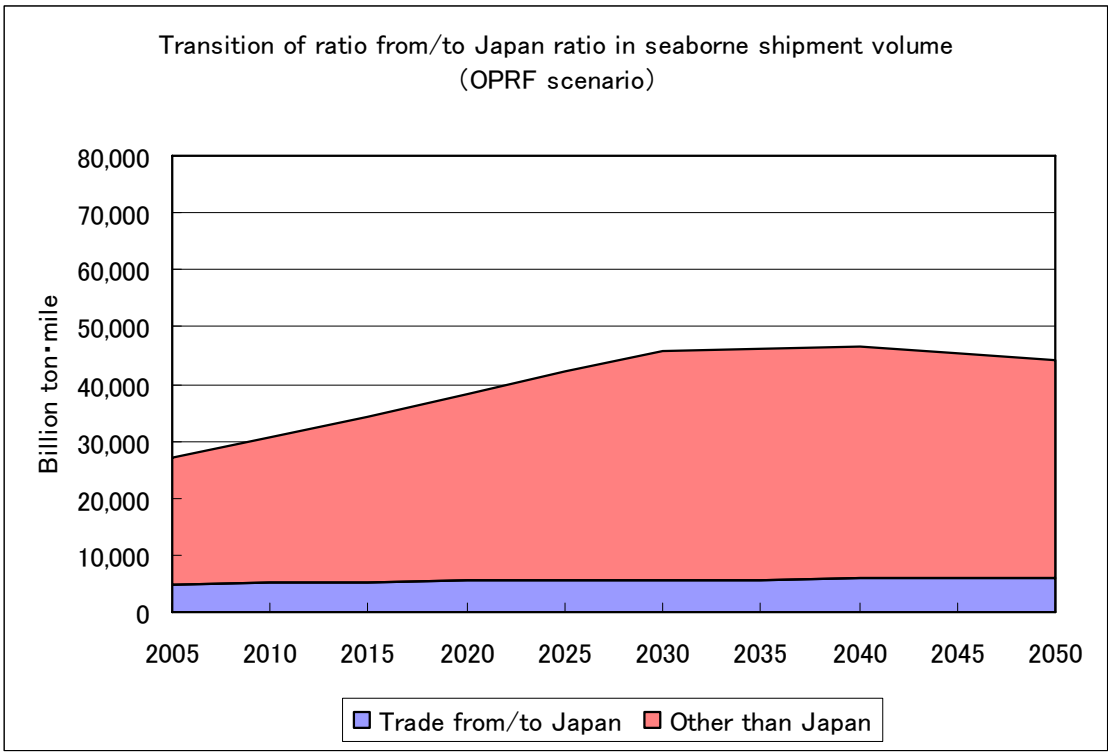


Fig. 2.21 Ratio of Japan in Seaborne shipment movement (OPRF scenario)

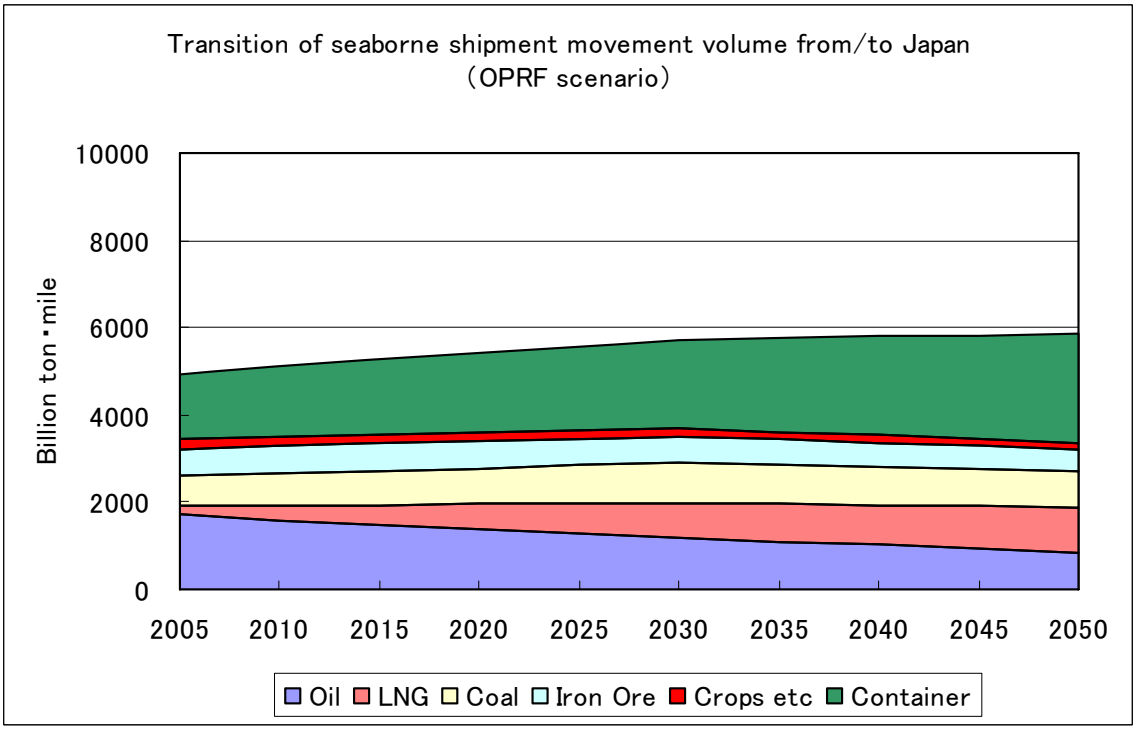


Fig. 2.22 Breakdown of cargo from/to Japan (OPRF scenario)

2.3 Consideration based on the trend of world seaborne till 2050 (OPRF scenario)

In OPRF scenario, i) transportation infrastructure development such as pipeline and ii) countermeasure for global warming were considered beside basic data in accordance with IPCC scenario A1B. However, i) scarcely effect to the macro, which apply to the world seaborne transportation, and it is more like due to global warming (fig 2.23-2.25)

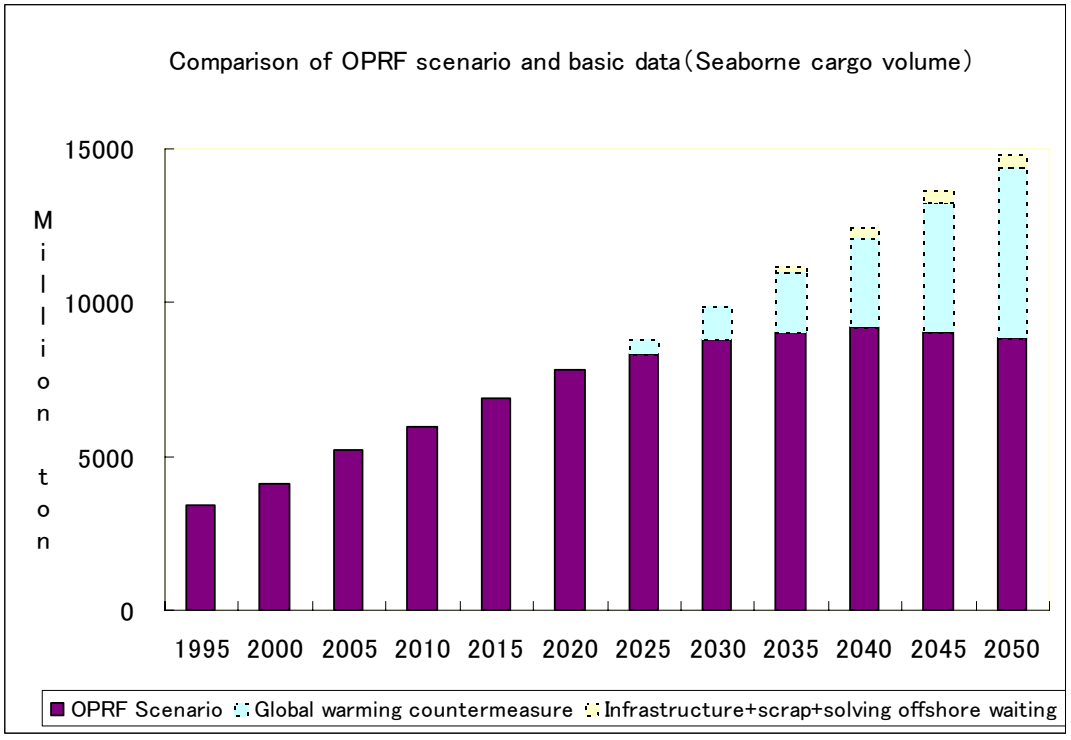


Fig. 2.23 Estimate of Seaborne cargo volume (OPRF scenario + base data comparison)

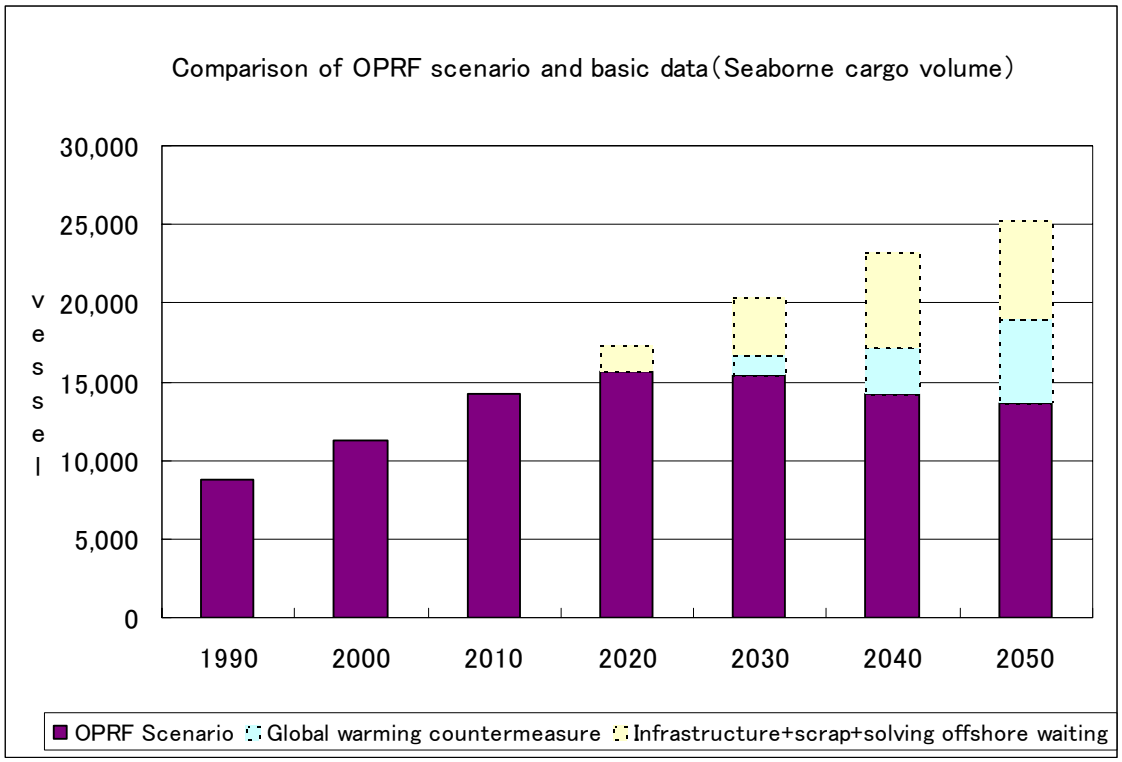


Fig. 2.24 Estimate of number of ships by type of vessel（OPRF Scenario+ Base data

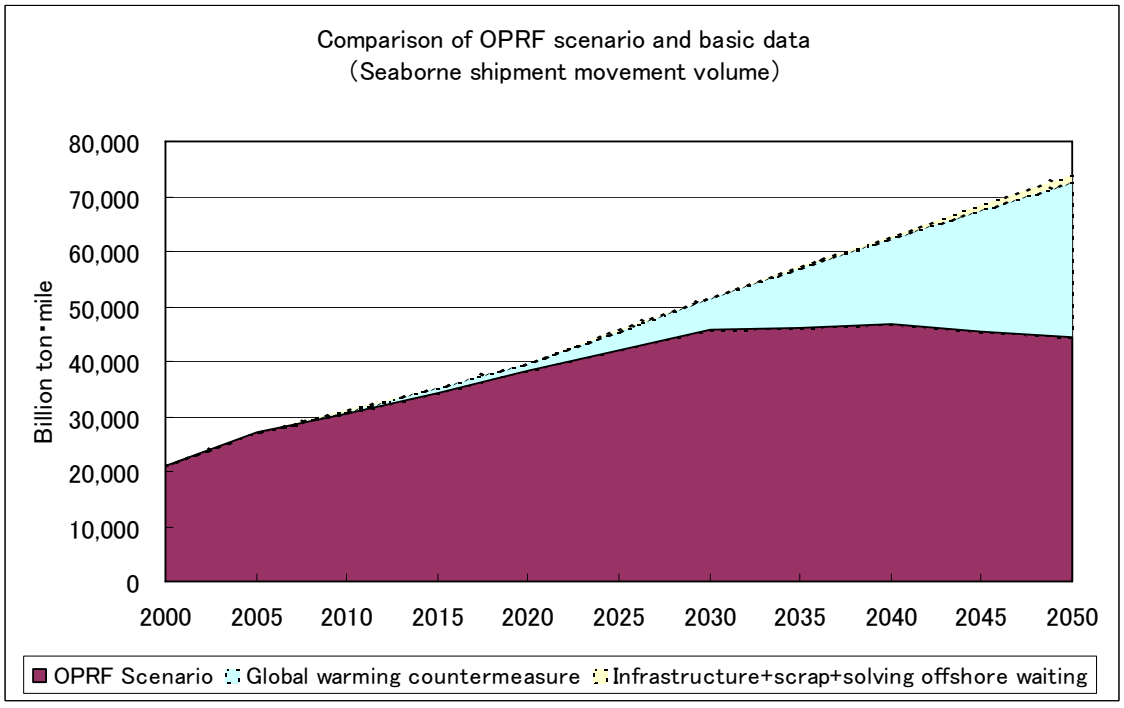


Fig. 2.25 Estimate of seaborne cargo movement volume（OPRF scenario + base data comparison）

2.4 Estimate of CO2 emission volume from Overseas vessel

Most dominant condition in OPRF scenario is the countermeasure for global worming. Trial calculation of transition of CO2 emission volume from overseas vessel was done based on the data cargo movement at sea (ton mile)

In the case of Bunker C usage CO2 emission coefficient has been adopted as 2.999 $\times 10^3$g (CO2)/kg(Fuel) （1994 Japanese report based on "UN Framework Convention on Climate Change".） Data of 1997 "Research and study for GHG emission reduction from ships" (Ship & Ocean Foundation, 1999) was used for Calculation of Fuel Consumption per type of ships per type of ships. The research estimated Fuel Consumption Rate based on world seaborne movement (ton mile) in 1997 as shown table2.1. Moreover, estimation of all CO2 emission in each State is calculated based on IEA data (Fig.2.26) and plotted in graphs. The result is shown as Fig. 2.27 – 29.

Table2.1 Fuel Consumption per type of ships by Ship & Ocean Foundation in 2000

	ton/year	TEU-mile	ton-mile	Fuel Consumption ton/ ton-mile	CO2 Emission ton/ ton-mile
97 Oil Tanker	35,151,000		1.16E+13	3.02765E-06	9.07992E-06
LNG Carrier				※9.7244E-06	2.91635E-05
97 Coal	16,541,000		2.36E+12	7.01187E-06	2.10286E-05
97 Iron Ore	15,743,000		2.52E+12	6.24722E-06	1.87354E-05
97 Other Bulk	4,785,000		1.37E+12	3.50549E-06	1.0513E-05
97 Container	45,011,000	3.52E+11	4.63E+12	9.7244E-06	2.91635E-05

※LNG is set as the same as Container on fuel consumption due to no data.

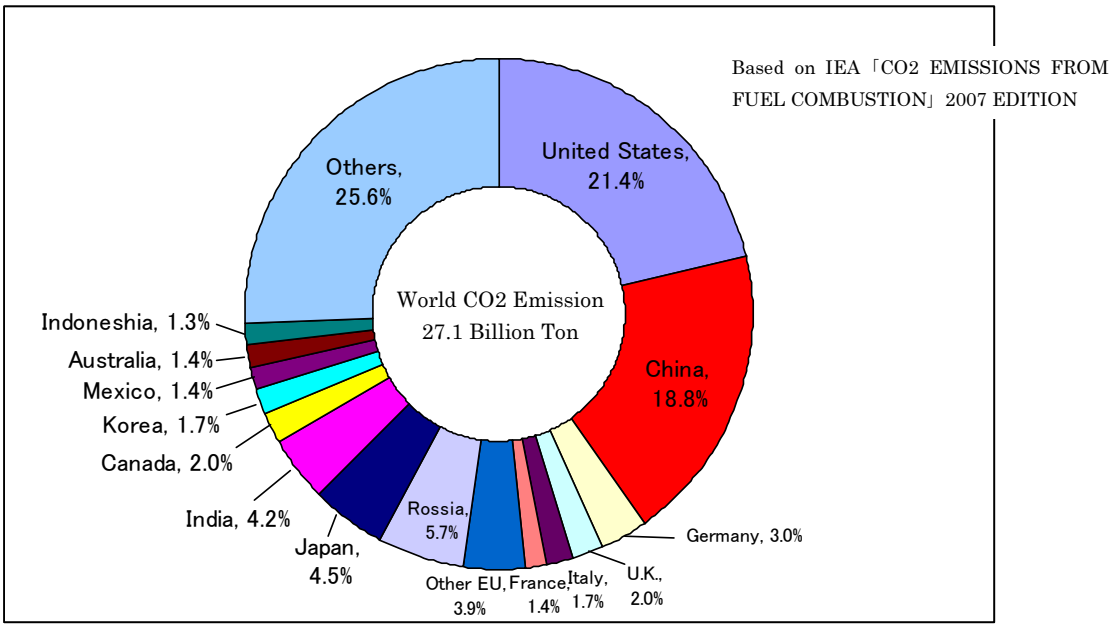


Fig2.26 CO2 Emission by nation in the World

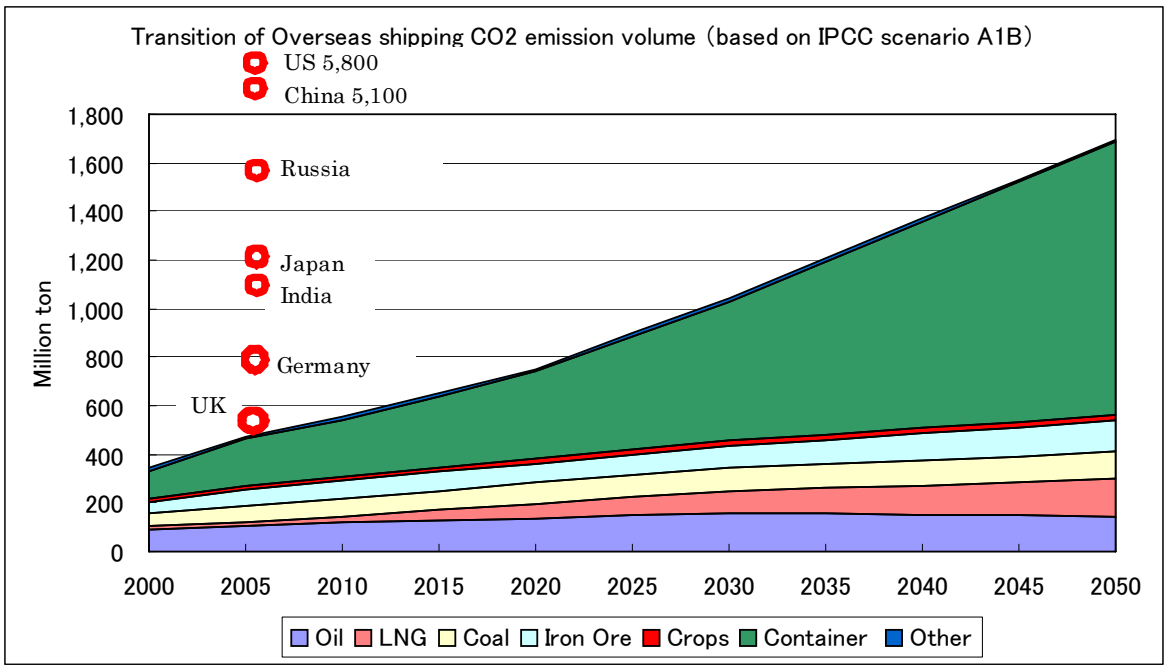


Fig. 2.27 CO2 Emission estimate (IPCC scenario A1B)

Table 2.2 CO2 Emission estimate (IPCC scenario A1B)

CO2 Emission (Million ton)	2000	2010	2020	2030	2040	2050
Other	13	13	13	13	13	13
Oil	93	117	139	160	151	143
LNG	9	28	58	88	122	156
Coal	53	72	85	97	104	110
Iron Ore	48	73	81	89	108	127
Crops etc	17	19	21	22	23	24
Container	114	233	356	570	848	1124
Total	346	556	752	1040	1370	1697

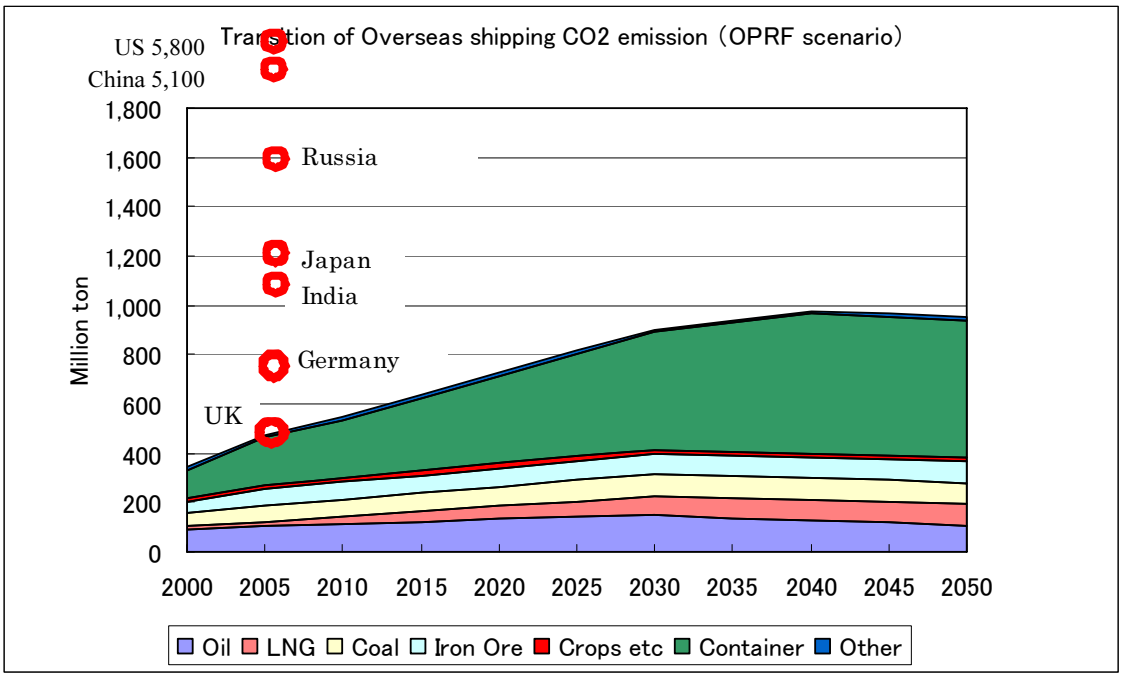


Fig. 2.28 CO2 Emission estimate (OPRF scenario)

Table 2.3 CO2 emission estimate （OPRF scenario）

CO2Emission（Million ton）	2000	2010	2020	2030	2040	2050
Other	13	13	13	13	13	13
Oil	93	115	132	149	128	107
LNG	9	26	52	78	84	91
Coal	53	71	81	91	87	83
Iron Ore	48	71	73	76	82	87
Crops etc	17	19	20	21	20	19
Container	114	233	356	475	564	555
Total	346	548	728	903	977	954

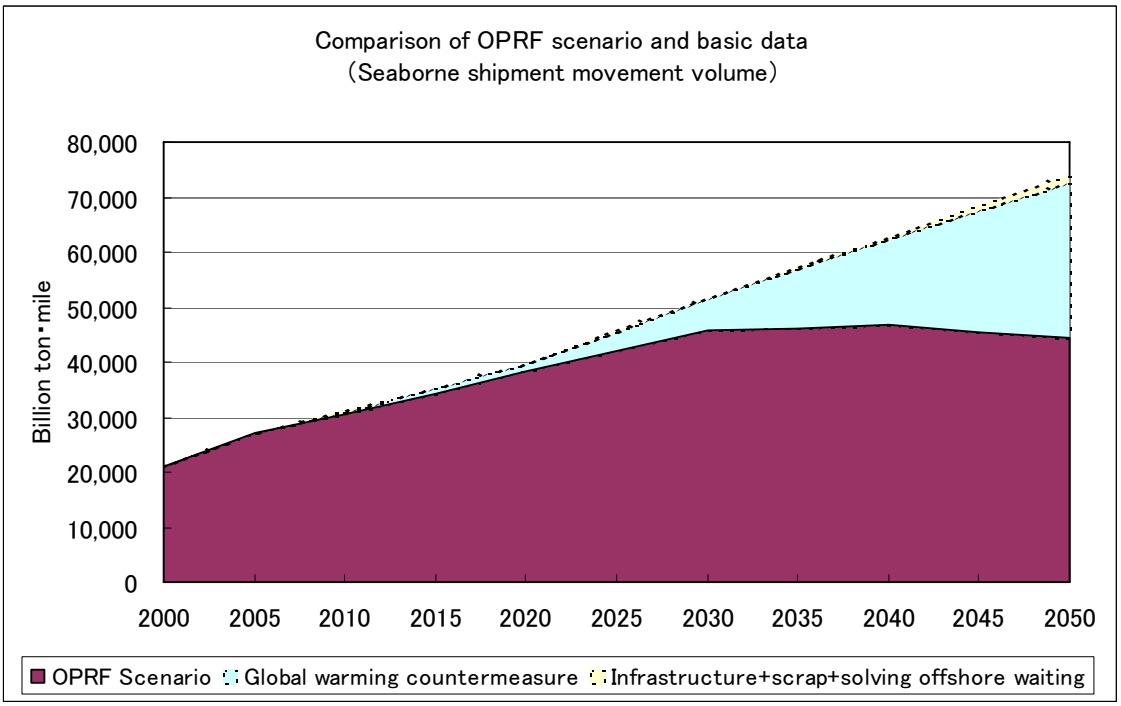


Fig. 2.30 CO2 Emission volume comparison

2.5 Standard establishment and its conditions in OPRF scenario

CO2 Emission volume in OPRF scenario is determined as in Fig.2.30. For maritime activities, which has critical tasks such as transportation of energy and goods, and has limitation to make efficient improvement, it is difficult to reduce emission. However, OPRF would propose draft of CO2 emission as shown in Fig.2.30 as the long-term standard that maritime society should observe, as the borderline emission volume to be compatible with stable world economy and CO2 countermeasure. And to achieve this standard, it is essential that the entire maritime society try to review the procedure toward the issue.

Although, in the transition of CO2 emission volume of OPRF scenario, it is far inferior to CO2 reduction by half by 2050 that is the target currently discussed. As the correspondence for the excess volume of CO2 emission, emission trade is considered.

As a major critical condition of this standard establishment, it is concerned that the realization of CO2 countermeasure by seaborne transportation renovation based on technology is not considered. If maritime society has no correspondence toward CO2, the last resort is only the reduction of transportation volume itself. To put it the other way around, if the seaborne transportation reformation based on technology such as fuel changeover in order to reduce CO2 emission drastically

come true, maritime activities shall be prosperous for long time. However, on the other hand, if it would not come true, maritime activities shall grow sluggishly after its peak of 2020 – 2030.

The impact of seaborne transportation reformation trend shall be brought out further interview and vision planning.

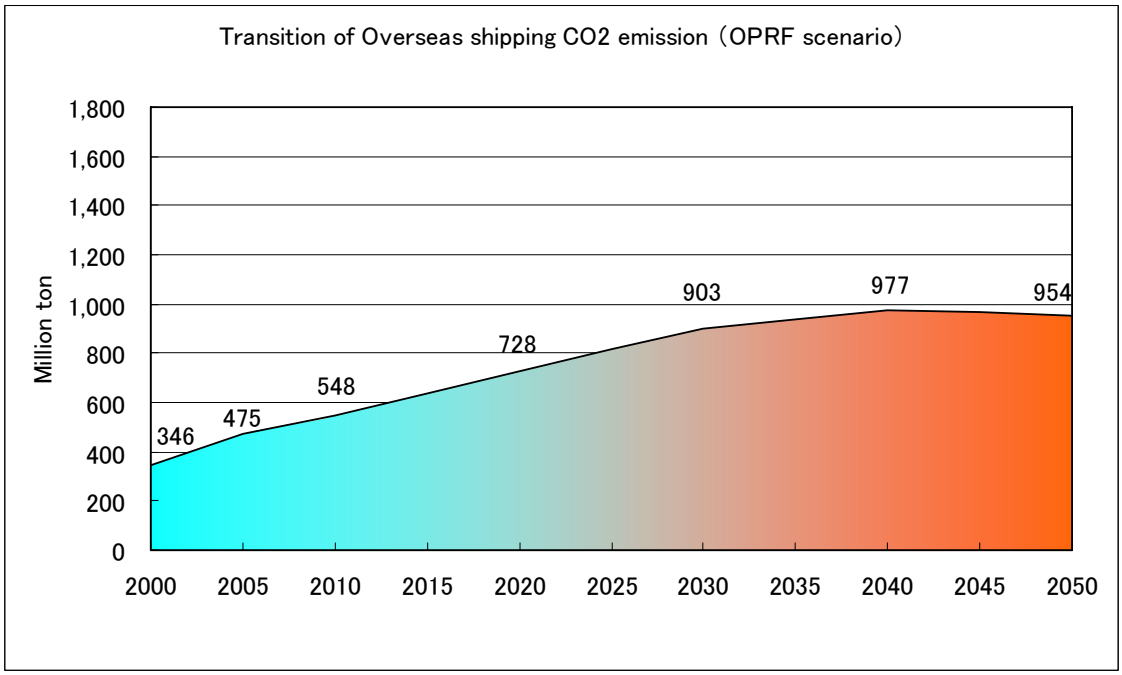


Fig. 2.30 CO2 emission volume in OPRF scenario

Base Data of Shipment Movement on sea OD List

→IPCC scenario(A1B)

		1980	1990	2000	2010	2020	2030	2040	2050
World population (million)		4,442	5,280	6,086	6,774	7,462	8,150	8,407	8,673
World GDP ($1Billion)		11,775	22,797	31,759	42,933	61,514	94,093	132,110	186,355
Primary Energy Consumption in world (Million Ton Oil-Equivalent = TOE)	Petroleum	2975.1	3153.8	3556.2	4569.2	5254.2	5263.9	4964.6	4681.1
	Natural Gas	1311.0	1792.1	2193.2	3529.5	4690.7	7146.9	8917.7	11128.1
	Coal	1807.4	2237.2	2364.3	3217.7	3892.9	4289.7	4363.8	4439.3
	Nuclear	161.0	453.2	584.5	771.8	1126.9	1676.1	2334.4	3332.1
	Renewal energy	387.4	495.3	610.5	447.3	1210.6	2193.4	4217.3	7791.4
	Total	6641.9	8131.6	9308.7	12535.5	16175.4	20570.0	24797.8	31372.1
Primary Energy Consumption in world (Million ton)	Petroleum	2975.1	3153.8	3556.2	4569	5254	5264	4965	4681
	LNG Conversion	1055.4	1442.6	1765.6	2841	3776	5753	7179	8958
	Coal	2711.1	3355.7	3546.4	4827	5839	6435	6546	6659
Iron Ore Consumption (Million Ton)	Iron Ore	968.7	1009.8	1098.2	1127	1285	1794	2382	2623
Crops Consumption (Million Ton)	Crops	1452.8	1718.3	1864.3	2161	2381	2658	2684	2769
World Cargo Volume on sea (Million Ton)	Petroleum	1596.0	1526.0	2027.0	2768.1	3299.8	3286.1	3075.1	2855.0
	LNG	22.9	52.7	100.1	273.7	424.4	728.0	950.3	1227.9
	Coal	188.0	342.0	523.0	716.6	950.8	1029.5	1114.1	1140.3
	Iron Ore	314.0	347.0	454.0	436.5	527.1	814.4	1134.6	1261.6
	Crops	198.0	192.0	230.0	256.0	280.2	310.2	313.0	322.1
	Phosphate ore, almina, bauxite	96.0	87.0	81.0	92.7	97.1	105.0	114.1	127.1
Containner Volume (Million TEU)		–	–	52.786	102.863	163.414	276.937	438.429	599.921
Container volume on sea (Million ton)				694.3	1352.9	2149.3	3642.4	5766.4	7890.4
(Trade/Consumption) * usage rate of transportation on sea (%)	Petroleum	53.6%	48.4%	57.0%	60.6%	62.8%	62.4%	61.9%	61.0%
	LNG	2.2%	3.7%	5.7%	9.6%	11.2%	12.7%	13.2%	13.7%
	Coal	6.9%	10.2%	14.7%	14.8%	16.3%	16.0%	17.0%	17.1%
	Iron Ore	32.4%	34.4%	41.3%	38.7%	41.0%	45.4%	47.6%	48.1%
	Crops	13.6%	11.2%	12.3%	11.8%	11.8%	11.7%	11.7%	11.6%
Average DWT (ton/vessel)	Tanker	105,388	93,581	98,467	100,425	101,844	101,810	101,268	100,671
	LNG vessel	–	39,667	46,423	57,837	63,334	70,793	74,786	78,830
	Bulk Carrier	41,930	47,690	52,167	54,798	58,792	62,669	66,127	67,453
(TEU/vessel)	Container Ship	–	–	1,777	2,214	2,602	3,169	3,800	4,322
Average loading ratio (weight) (%)	Tanker	98%	98%	98%	98%	98%	98%	98%	98%
	LNG vessel	98%	98%	98%	98%	98%	98%	98%	98%
	Bulk Carrier	96%	96%	96%	96%	96%	96%	96%	96%
	Container Ship			100%	100%	100%	100%	100%	100%
Total number of operation / year (vessel・voyage)	Tanker	15,453	16,639	21,006	28,126	33,061	32,936	30,985	28,938
	LNG vessel		1,355	2,200	4,829	6,838	10,493	12,967	15,895
	Bulk Carrier	19,775	21,143	25,719	28,549	32,872	37,549	42,150	44,028
	Container Ship			29,700	46,462	62,805	87,399	115,379	138,804
Average date of operation (yea/voyage)	Tanker	0.1574	0.1426	0.1376	0.1372	0.1383	0.1395	0.1405	0.1416
	LNG vessel		0.0600	0.0624	0.0687	0.0730	0.0774	0.0787	0.0799
	Bulk Carrier	0.2145	0.2160	0.2083	0.2046	0.2050	0.2054	0.2049	0.2043
	Container Ship			0.0861	0.0888	0.0865	0.0834	0.0802	0.0786
Annual neccesary shipping tonnage (vessel)	Tanker	2,433	2,373	2,890	3,858	4,573	4,593	4,354	4,097
	LNG vessel		81	137	332	499	812	1,020	1,270
	Bulk Carrier	4,242	4,567	5,357	5,840	6,738	7,712	8,635	8,997
	Container Ship			2,558	4,125	5,434	7,291	9,255	10,914
Annual neccesary shipping tonnage (Million ton)	Tanker	256.4	222.1	284.6	387.4	465.7	467.7	440.9	412.4
	LNG vessel		3.2	8.6	19.2	31.6	57.5	76.3	100.1
	Bulk Carrier	177.9	217.8	279.5	320.0	396.1	483.3	571.0	606.9
(Million TEU)	Container Ship			4.5	9.1	14.1	23.1	35.2	47.2
World volume of shipping movement on sea (Billion ton・mile)	Petroleum	–	7821.0	10265.0	12920	15263	17606	16662	15717
	LNG	–	–	306.8	964	1997	3031	4197	5364
	Coal	–	1849.0	2509.0	3425	4028	4630	4935	5240
	Iron Ore	–	1978.0	2545.0	3918	4332	4747	5762	6778
	Crops	–	1073.0	1244.0	1454	1592	1731	1765	1799
	Phosphate ore, almina, bauxite	–	359.0	340.0	352	369	399	433	483
	Container	–	–	3915.0	7993	12208	19551	29088	38544

(reference:actual performance)
Population referred to UN record
GDP performance referred to IMF World Economic Outlook Database
Energy record is based on BP statistic (Renewal energy such as wind-power partially excluded)
Iron ore consumption is estimated with pig iron production (statistics by Int'l Iron and Steel Institute) × coefficient
Crops consumption is based on US Ministry of Agriculture statistics
Cargo volume on sea, average DWT, Shipment movement are Feanleys Review(10,000DWT or more(LNG vessels = 1,000m2))
LNG cargo volume on sea = Cedigas
Average date of operation is settled with concern of speed by type and age of vessel, in-dock period, offshorewaiting situation et

・ Petrol shipment movement on sea

OIL TOTAL SEABORNE TRADE 2005 (Unit:Million ton)

From \ To	North/West Europe	Mediterranean	North America	Latin America	Japan	Asia, other	Other	Total
Mideast	66	106	155	14	236	486	28	1,091
N Africa	36	68	32	13	0	11	0	159
W Africa	16	24	127	15	11	72	4	269
Caribbean	9	13	230	10	0	8	0	270
Southeast Asia	0	0	6	0	15	48	20	89
North Sea	2	10	54	1	0	7	0	74
Other	122	75	69	11	7	37	6	327
Total	252	295	673	63	269	668	58	2,279

(Estimated based on Review 200

OIL TOTAL SEABORNE TRADE 2030

From \ To	North/West Europe	Mediterranean	North America	Latin America	Japan	Asia, other	Other	Total
Mideast	69	132	252	3	178	1112	24	1769
N Africa	37	84	52	2	0	24	0	200
W Africa	12	21	145	2	6	116	2	303
Caribbean	4	6	140	1	0	6	0	156
Southeast Asia	0	0	12	0	14	136	22	183
North Sea	3	13	88	0	0	16	0	119
Other	164	122	144	3	7	110	7	556
Total	287	378	833	10	205	1519	55	3,286

OIL TOTAL SEABORNE TRADE 2050 (Unit:Million ton)

From \ To	North/West Europe	Mediterranean	North America	Latin America	Japan	Asia, other	Other	Total
Mideast	119	196	310	4	172	1204	36	2,042
N Africa	20	40	21	1	0	8	0	90
W Africa	1	2	13	0	0	9	0	27
Caribbean	8	12	217	2	0	9	0	247
Southeast Asia	0	0	3	0	3	33	7	47
North Sea	4	17	100	0	0	16	0	137
Other	96	61	60	1	2	40	3	265
Total	249	328	724	9	178	1,319	48	2,855

・ LNG shipment movement on sea

LNG TOTAL SEABORNE TRADE 2005 (Unit :Million ton)

From \ To	N. America	Europe	L. America	India	Japan	Korea	China	Asia,other	Total
North America	0	0	0	0	1	0	0	0	1
CIS	0	0	0	0	0	0	0	0	0
Africa	2	31	0	0	0	0	0	0	33
Latin America	9	0	1	0	0	0	0	0	10
Mideast	1	2	0	0	15	12	0	0	29
Asia, other	0	0	0	0	41	9	6	0	56
Oceania	0	0	0	0	8	0	0	0	9
Total	12	33	1	0	65	21	6	0	138

(Estimated from LNG One World 2003)

LNG GAS TOTAL SEABORNE TRADE 2030 (Unit : Million ton)

To / From	N. America	Europe	L. America	India	Japan	Korea	China	Asia,other	Total
CIS					4				4
Africa	81	86		0	1	0	0	0	168
Latin America	70	30	2	0	0	0	0	0	102
Mideast	89	29		42	119	44	0	0	323
Asia, other	0	0		1	49	3	10	1	64
Oceania	0	0		0	30	4	34	0	67
Total	240	146	2	43	203	51	44	1	728

LNG TOTAL SEABORNE TRADE 2050 (Unit : Million ton)

To / From	N. America	Europe	L. America	India	Japan	Korea	China	Asia,other	Total
CIS					8				8
Africa	131	143		0	1	1	0	0	276
Latin America	108	47	3	0	0	0	0	0	158
Mideast	166	55		71	244	78	0	0	614
Asia, other	0	0		0	51	3	14	1	70
Oceania	0	0		0	38	4	60	0	102
Total	405	246	3	72	342	86	74	1	1228

・ Coal shipment movement on sea

COAL TOTAL SEABORNE TRADE 2005 (Unit:Million ton)

To / From	W Europe	Mediterranean	Other Europe	S America	Japan	Other Far East	Other	Total
N America	12	7	5	7	9	8	3	51
Australia	18	4	5	13	104	56	24	225
S Africa	34	6	13	1	0	0	13	67
S America/Car	16	6	6	2	0	0	32	63
China	1	2	0	0	24	45	3	75
Former Soviet	26	18	10	0	11	4	1	69
E europe other	10	2	3	0	0	0	1	16
Indonesia	3	7	6	2	27	62	19	126
Other	2	0	1	1	3	10	1	19
Total	121	52	50	27	179	184	97	710

(Review2006)

COAL TOTAL SEABORNE TRADE 2030 (Unit:Million ton)

To / From	W Europe	Mediterranean	Other Europe	S America	Japan	Other Far East	Other	Total
N America	10	6	5	6	7	6	2	42
Australia	34	8	10	23	172	99	42	388
S Africa	46	9	18	1	0	0	16	91
S America/Car	24	10	9	4	0	0	47	93
China	1	1	0	0	19	37	2	61
Former Soviet	38	28	14	1	14	5	1	101
E europe other	12	2	3	0	0	0	1	18
Indonesia	5	11	9	2	37	90	27	181
Other	7	1	4	3	9	30	2	56
Total	176	75	72	40	259	267	140	1029

COAL TOTAL SEABORNE TRADE 2050 (Unit:Million ton)

From \ To	W Europe	Mediterranean	Other Europe	S America	Japan	Other Far East	Other	Total
N America	7	5	4	4	6	6	2	33
Australia	40	10	13	27	217	146	53	506
S Africa	52	11	22	1	0	1	20	107
S America/Car	28	13	11	4	0	0	59	115
China	0	1	0	0	13	31	2	48
Former Soviet	43	35	17	1	18	7	2	123
E europe other	12	2	4	0	0	0	1	20
Indonesia	3	6	5	1	20	56	14	104
Other	8	1	5	4	13	48	3	83
Total	195	83	80	44	287	296	155	1140

・ Iron Ore shipment movement on sea

IRON ORE TOTAL SEABORNE TRADE 2005 (unit:Million ton)

From \ To	W Europe	Mediterranian	Other Europe	US	Japan	China	Other E Asia	Other	Total
Scandinavian	6	1	1	0	0	0	0	7	15
Other Europe	0	0	0	0	0	4	1	4	9
West Africa	7	2	1	0	0	0	0	1	11
Other Africa	6	2	2	0	7	11	1	0	29
North America	13	4	1	0	1	3	2	3	26
South America	41	13	7	6	26	59	19	33	205
South America	0	0	0	0	4	5	3	2	14
Asia	0	0	0	0	22	70	3	2	99
Oceanea	14	1	0	0	75	113	35	4	244
Total	89	24	12	6	135	265	65	56	652

(Review2006)

IRON ORE TOTAL SEABORNE TRADE 2030 (unit:Million ton)

From \ To	W Europe	Mediterranian	Other Europe	US	Japan	China	Other E Asia	Other	Total
Scandinavian	6	1	1	0	0	0	0	13	22
Other Europe	0	0	0	0	0	3	1	8	13
West Africa	7	3	1	0	0	0	0	1	12
Other Africa	5	2	2	0	5	8	1	0	23
North America	18	5	1	0	1	3	3	7	38
South America	53	17	10	23	28	64	26	76	296
South America	0	0	0	1	3	4	3	3	13
Asia	1	0	0	0	30	97	6	7	141
Oceanea	16	2	1	0	73	112	44	9	257
Total	107	29	15	25	140	291	83	125	814

IRON ORE TOTAL SEABORNE TRADE 2050 (unit:Million ton)

From \ To	W Europe	Mediterranian	Other Europe	US	Japan	China	Other E Asia	Other	Total
Scandinavian	11	2	2	0	0	0	0	45	60
Other Europe	1	0	0	0	0	3	2	28	34
West Africa	7	3	1	0	0	0	0	2	12
Other Africa	5	2	2	0	3	4	1	1	18
North America	40	14	4	0	1	4	7	33	103
South America	51	20	14	57	15	34	29	148	368
South America	0	0	0	2	1	2	2	5	12
Asia	3	2	0	0	70	226	29	56	386
Oceanea	22	3	1	2	57	86	70	26	267
Total	140	46	25	60	147	359	141	344	1,262

・ Grain shipment movement on sea

GRAIN TOTAL SEABORNE TRADE 2005 (Unit:Million ton)

From \ To	W Europe	Mediterranean	E Europe	Europe other	Africa	SN America	Middlee ast	Indian Ocean	Japan	Far East other	Other	Total
US	2	3	0	0	14	30	2	2	23	27	0	105
Canada	1	1	0	0	2	3	0	2	2	5	0	16
S America	7	6	0	1	7	8	1	5	1	22	0	59
Australia	0	1	0	0	2	0	0	5	2	8	0	18
Other	0	5	3	1	20	0	4	9	1	11	0	54
Total	10	15	3	2	46	42	8	23	29	72	1	251

(Review2006)

GRAIN TOTAL SEABORNE TRADE 2030 (Unit:Million ton)

From \ To	W Europe	Mediterranean	E Europe	Europe other	Africa	SN America	Middlee ast	Indian Ocean	Japan	Far East other	Other	Total
US	2	4	0	1	25	37	4	3	23	30	0	129
Canada	1	2	0	0	3	4	0	2	2	5	0	19
S America	7	8	0	2	13	10	2	7	1	24	0	73
Australia	0	1	0	0	4	0	0	6	2	9	1	22
Other	0	6	3	1	29	0	7	10	1	10	0	67
Total	11	20	3	3	74	51	12	29	28	78	1	310

GRAIN TOTAL SEABORNE TRADE 2050 (Unit:Million ton)

From \ To	W Europe	Mediterranean	E Europe	Europe other	Africa	SN America	Middlee ast	Indian Ocean	Japan	Far East other	Other	Total
US	3	4	0	1	27	39	4	4	23	31	0	134
Canada	1	2	0	0	3	4	0	3	2	5	0	20
S America	7	9	0	2	13	10	3	7	1	24	0	76
Australia	0	1	0	0	4	0	0	7	2	9	1	23
Other	0	6	3	1	31	0	7	11	1	10	0	69
Total	11	21	3	3	78	53	14	31	29	79	1	322

・ Container shipment movement on sea

Container Cargo Volume Estimate 2005 (Unit:K TEU)

From \ To	N America	E Asia	Europe	S America	Middleeast	India etc	Africa	Oceanea	Total
N America	437	5,193	1,947	1,754	287	241	214	244	10,317
E Asia	13,138	12,632	9,587	1,484	1,537	1,115	1,033	1,130	41,656
Europe	3,006	4,766	2,240	1,391	1,582	818	1,890	342	16,035
S America	1,972	664	2,204	1,121	136	26	153	30	6,306
Meddleeast	150	325	586	5	322	157	55	13	1,613
Indea etc	619	636	853	61	282	150	137	30	2,768
Africa	158	404	1,346	63	82	150	568	39	2,810
Oceanea	207	880	263	51	81	55	36	455	2,028
Total	19,687	25,500	19,026	5,930	4,309	2,712	4,086	2,283	83,533

(Mitsui O.S.K.Line Reserch Div)

Container Cargo Volume Estimate 2030 (Unit:K TEU)

From \ To	N America	E Asia	Europe	S America	Middleeast	India etc	Africa	Oceanea	Total
N America	370	8774	1962	4956	761	637	421	207	18,088
E Asia	30697	58884	26654	11567	11238	8134	5604	2648	155,426
Europe	2792	8833	2476	4311	4599	2372	4077	319	29,779
S America	6300	4232	8378	11947	1360	259	1135	96	33,707
Meddleeast	403	1740	1871	45	2704	1315	343	35	8,456
Indea etc	1977	4052	3241	650	2818	1495	1016	96	15,344
Africa	411	2094	4162	546	667	1217	3427	102	12,625
Oceanea	213	1808	322	175	261	177	86	470	3,512
Total	43,162	90,418	49,067	34,197	24,406	15,607	16,108	3,972	276,937

Container Cargo Volume Estimate 2050 (Unit:K TEU)

To / From	N America	E Asia	Europe	S America	Middleeast	India etc	Africa	Oceanea	Total
N America	370	13176	2009	7038	1439	1041	1291	224	26,588
E Asia	46949	135146	41720	25108	32485	20318	26280	4365	332,372
Europe	2649	12573	2404	5803	8244	3675	11856	326	47,529
S America	9090	9163	12372	24465	3708	611	5021	149	64,579
Meddleeast	695	4508	3306	110	8823	3709	1814	65	23,030
Indea etc	3224	9918	5411	1504	8687	3984	5080	169	37,978
Africa	1143	8748	11855	2157	3508	5532	29246	305	62,493
Oceanea	226	2871	349	263	522	306	279	536	5,352
Total	64,346	196,103	79,425	66,449	67,415	39,177	80,867	6,139	599,921

OPRF Scenario of Shipment Movement on sea OD List

→IPCC Scenario(A1B)

		1980	1990	2000	2010	2020	2030	2040	2050
World population (million)		4,442	5,280	6,086	6,774	7,462	8,150	8,407	8,673
World GDP ($1Billion)		11,775	22,797	31,759	42,933	61,514	94,093	132,110	186,355
Primary Energy Consumption in world (Million Ton Oil-Equivalent = TOE)	Petroleum	2975.1	3153.8	3556.2	4569.2	5254.2	5263.9	4964.6	4681.1
	Natural Gas	1311.0	1792.1	2193.2	3529.5	4690.7	7146.9	8917.7	11128.1
	Coal	1807.4	2237.2	2364.3	3217.7	3892.9	4289.7	4363.8	4439.3
	Nuclear	161.0	453.2	584.5	771.8	1126.9	1676.1	2334.4	3332.1
	Renewal energy	387.4	495.3	610.5	447.3	1210.6	2193.4	4217.3	7791.4
	Total	6641.9	8131.6	9308.7	12535.5	16175.4	20570.0	24797.8	31372.1
Primary Energy Consumption in world (Million ton)	Petroleum	2975.1	3153.8	3556.2	4569	5254	5264	4965	4681
	LNG Conversion	1055.4	1442.6	1765.6	2841	3776	5753	7179	8958
	Coal	2711.1	3355.7	3546.4	4827	5839	6435	6546	6659
Iron Ore Consumption (Million Ton)	Iron Ore	968.7	1009.8	1098.2	1127	1285	1721	2221	2320
Crops Consumption (Million Ton)	Crops	1452.8	1718.3	1864.3	2095	2284	2658	2544	2617
World Cargo Volume on sea (Million Ton)	Petroleum	1596.0	1526.0	2027.0	2802.9	3351.0	3067.0	2589.6	2143.2
	LNG	22.9	52.7	100.1	273.7	424.4	668.1	588.6	736.0
	Coal	188.0	342.0	523.0	733.5	978.7	960.9	938.4	854.7
	Iron Ore	314.0	347.0	454.0	436.5	527.1	709.4	886.7	848.7
	Crops	198.0	192.0	230.0	248.6	269.5	291.1	260.8	248.4
	Phosphate ore, almina, bauxite	96.0	87.0	81.0	92.7	97.1	98.0	98.9	101.7
Containner Volume (Million TEU)		–	–	52.786	102.863	163.414	230.781	291.886	299.561
Container volume on sea (Million ton)				694.3	1352.9	2149.3	3035.3	3839.0	3939.9
(Trade/Consumption) * usage rate of transportation on sea (%)	Petroleum	53.6%	48.4%	57.0%	61.3%	63.8%	58.3%	52.2%	45.8%
	LNG	2.2%	3.7%	5.7%	9.6%	11.2%	11.6%	8.2%	8.2%
	Coal	6.9%	10.2%	14.7%	15.2%	16.8%	14.9%	14.3%	12.8%
	Iron Ore	32.4%	34.4%	41.3%	38.7%	41.0%	41.2%	39.9%	36.6%
	Crops	13.6%	11.2%	12.3%	11.9%	11.8%	11.0%	10.3%	9.5%
Average DWT (ton/vessel)	Tanker	105,388	93,581	98,467	100,524	101,971	101,247	99,899	98,445
	LNG vessel	–	39,667	46,423	57,837	63,334	69,553	67,759	70,954
	Bulk Carrier	41,930	47,690	52,167	54,914	58,971	60,827	62,001	60,773
(TEU/vessel)	Container Ship	–	–	1,777	2,214	2,602	2,956	3,234	3,267
Average loading ratio (weight) (%)	Tanker	98%	98%	98%	98%	98%	98%	98%	98%
	LNG vessel	98%	98%	98%	98%	98%	98%	98%	98%
	Bulk Carrier	96%	96%	96%	96%	96%	96%	96%	96%
	Container Ship			100%	100%	100%	100%	100%	100%
Total number of operation / year (vessel･voyage)	Tanker	15,453	16,639	21,006	28,452	33,533	30,911	26,451	22,215
	LNG vessel		1,355	2,200	4,829	6,838	9,802	8,864	10,585
	Bulk Carrier	19,775	21,143	25,719	28,669	33,076	35,265	36,707	35,199
	Container Ship			29,700	46,462	62,805	78,081	90,262	91,706
Average date of operation (yea/voyage)	Tanker	0.1574	0.1426	0.1376	0.1372	0.1246	0.1148	0.1049	0.1060
	LNG vessel		0.0600	0.0624	0.0683	0.0719	0.0755	0.0769	0.0783
	Bulk Carrier	0.2145	0.2160	0.2083	0.2044	0.1689	0.1307	0.0950	0.0950
	Container Ship			0.0861	0.0888	0.0865	0.0834	0.0801	0.0781
Annual neccesary shipping tonnage (vessel)	Tanker	2,433	2,373	2,890	3,902	4,179	3,549	2,775	2,354
	LNG vessel		81	137	330	491	740	681	828
	Bulk Carrier	4,242	4,567	5,357	5,861	5,588	4,609	3,489	3,344
	Container Ship			2,558	4,125	5,434	6,513	7,232	7,160
Annual neccesary shipping tonnage (Million ton)	Tanker	256.4	222.1	284.6	392.3	426.1	359.3	277.2	231.7
	LNG vessel		3.2	8.6	19.1	31.1	51.5	46.2	58.8
	Bulk Carrier	177.9	217.8	279.5	321.8	329.5	280.4	216.3	203.2
(Million TEU)	Container Ship			4.5	9.1	14.1	19.3	23.4	23.4
World volume of shipping movement on sea (Billion ton･mile)	Petroleum	–	7821.0	10265.0	12686	14559	16432	14116	11799
	LNG	–	–	306.8	892	1783	2674	2895	3116
	Coal	–	1849.0	2509.0	3363	3842	4321	4124	3928
	Iron Ore	–	1978.0	2545.0	3781	3922	4063	4352	4642
	Crops	–	1073.0	1244.0	1433	1528	1624	1503	1381
	Phosphate ore, almina, bauxite	–	359.0	340.0	352	369	372	376	386
	Container	–	–	3915.0	7993	12208	16292	19332	19026

(reference：actual performance)
Population referred to UN record
GDP performance referred to IMF World Economic Outlook Database
Energy record is based on BP statistic (Renewal energy such as wind-power partially excluded)
Iron ore consumption is estimated with pig iron production (statistics by Int'l Iron and Steel Institute) × coefficient
Crops consumption is based on US Ministry of Agriculture statistics
Cargo volume on sea, average DWT, Shipment movement are Feanleys Review(10,000DWT or more(LNG vessels = 1,000m2))
LNG cargo volume on sea = Cedigas
Average date of operation is settled with concern of speed by type and age of vessel, in-dock period, offshorewaiting situation et

・ Petrol shipment movement on sea

OIL TOTAL SEABORNE TRADE 2005 (Unit：million ton)

From \ To	NW Europe	Mediterranean	N America	S America	Japan	Asia,other	Other	Total
Mideast	66	106	155	14	236	486	28	1,091
N Africa	36	68	32	13	0	11	0	159
W Africa	16	24	127	15	11	72	4	269
Caribbean	9	13	230	10	0	8	0	270
Southeast Asia	0	0	6	0	15	48	20	89
North Sea	2	10	54	1	0	7	0	74
Other	122	75	69	11	7	37	6	327
Total	252	295	673	63	269	668	58	2,279

(Estimated based on Review 2006)

OIL TOTAL SEABORNE TRADE 2030

From \ To	NW Europe	Mediterranean	N America	S America	Japan	Asia,other	Other	Total
Mideast	64	123	235	2	166	1037	22	1651
N Africa	34	78	49	2	0	22	0	186
W Africa	11	19	135	2	5	108	2	283
Caribbean	3	6	130	1	0	6	0	146
Southeast Asia	0	0	11	0	13	127	20	171
North Sea	2	12	82	0	0	15	0	111
Other	153	113	135	2	7	102	6	519
Total	268	352	777	9	191	1417	51	3,067

OIL TOTAL SEABORNE TRADE 2050 (Unit：million ton)

From \ To	NW Europe	Mediterranean	N America	S America	Japan	Asia,other	Other	Total
Mideast	90	147	232	3	129	904	27	1,533
N Africa	15	30	15	1	0	6	0	68
W Africa	1	2	10	0	0	7	0	20
Caribbean	6	9	163	1	0	7	0	185
Southeast Asia	0	0	3	0	2	25	6	36
North Sea	3	13	75	0	0	12	0	103
Other	72	46	45	1	2	30	3	199
Total	187	246	543	7	134	990	36	2,143

・ LNG shipment movement on sea

LNG TOTAL SEABORNE TRADE 2005 (Unit：Million ton)

From \ To	N America	Europe	L. America	India	Japan	Korea	China	Asia,other	Total
North America	0	0	0	0	1	0	0	0	1
CIS	0	0	0	0	0	0	0	0	0
Africa	2	31	0	0	0	0	0	0	33
Latin America	9	0	1	0	0	0	0	0	10
Mideast	1	2	0	0	15	12	0	0	29
Asia, Other	0	0	0	0	41	9	6	0	56
Oceanea	0	0	0	0	8	0	0	0	9
Total	12	33	1	0	65	21	6	0	138

(Estimated from LNG One World 2003)

LNG GAS TOTAL SEABORNE TRADE 2030 (Unit:Million ton)

To / From	N America	Europe	L. America	India	Japan	Korea	China	Asia,other	Total
CIS					4				4
Africa	83	84		0	1	1	0	0	168
Latin America	71	29	1	0	0	0	0	0	102
Mideast	66	20		38	99	39	0	0	263
Asia, Other	0	0		1	50	3	9	1	64
Oceanea	0	0		0	32	4	32	0	67
Total	220	134	1	39	186	47	40	1	668

LNG TOTAL SEABORNE TRADE 2050 (Unit:Million ton)

To / From	N America	Europe	L. America	India	Japan	Korea	China	Asia,other	Total
CIS	0	0	0	0	7	0	0	0	7
Africa	141	0	0	0	2	2	0	0	145
Latin America	114	42	2	0	0	0	0	0	158
Mideast	58	16	0	0	136	55	0	0	265
Asia, Other	0	0	0	1	50	4	9	1	64
Oceanea	0	0	0	0	43	6	48	0	97
Total	313	59	2	1	238	66	57	1	736

・ Coal shipment movement on sea

COAL TOTAL SEABORNE TRADE 2005 (Unit:Million ton)

To / From	W Europe	Mediterranean	Other Europe	S America	Japan	Other Far East	Other	Total
N America	12	7	5	7	9	8	3	51
Aistralia	18	4	5	13	104	56	24	225
S Africa	34	6	13	1	0	0	13	67
S America・Car	16	6	6	2	0	0	32	63
China	1	2	0	0	24	45	3	75
Former Soviet	26	18	10	0	11	4	1	69
E Europe,other	10	2	3	0	0	0	1	16
Indonesia	3	7	6	2	27	62	19	126
Other	2	0	1	1	3	10	1	19
Total	121	52	50	27	179	184	97	710

(Review2006)

COAL TOTAL SEABORNE TRADE 2030 (Unit:Million ton)

To / From	W Europe	Mediterranean	Other Europe	S America	Japan	Other Far East	Other	Total
N America	9	5	4	5	7	6	2	39
Aistralia	32	7	9	21	161	92	39	362
S Africa	43	8	17	1	0	0	15	85
S America・Car	23	9	8	3	0	0	43	87
China	1	1	0	0	17	35	2	57
Former Soviet	35	26	13	1	13	5	1	94
E Europe,other	11	2	3	0	0	0	1	17
Indonesia	5	10	9	2	35	84	25	169
Other	6	1	3	3	9	28	2	52
Total	164	70	68	37	242	249	131	961

COAL TOTAL SEABORNE TRADE 2050 (Unit:Million ton)

To / From	W Europe	Mediterranean	Other Europe	S America	Japan	Other Far East	Other	Total
N America	5	3	3	3	4	4	1	23
Aistralia	30	7	10	21	163	109	40	379
S Africa	39	8	16	1	0	0	15	80
S America・Car	21	9	8	3	0	0	44	86
China	0	1	0	0	9	22	1	34
Former Soviet	33	26	13	1	13	5	1	91
E Europe,other	9	2	3	0	0	0	1	14
Indonesia	2	5	4	1	16	45	12	84
Other	6	1	4	3	10	36	2	63
Total	146	62	60	33	215	222	116	855

・ Iron Ore shipment movement on sea

IRON ORE TOTAL SEABORNE TRADE 2005 (Unit:Million ton)

To / From	W Europe	Mediterranean	Other Europe	US	Japan	China	Other Far East	Other	Total
Scandinavia	6	1	1	0	0	0	0	7	15
Europe,other	0	0	0	0	0	4	1	4	9
W Africa	7	2	1	0	0	0	0	1	11
Africa,other	6	2	2	0	7	11	1	0	29
North America	13	4	1	0	1	3	2	3	26
S America(Atla	41	13	7	6	26	59	19	33	205
S America (Pac	0	0	0	0	4	5	3	2	14
Asia	0	0	0	0	22	70	3	2	99
Oceanea	14	1	0	0	75	113	35	4	244
Total	89	24	12	6	135	265	65	56	652

(Review2006)

IRON ORE TOTAL SEABORNE TRADE 2030 (Unit:Million ton)

To / From	W Europe	Mediterranean	Other Europe	US	Japan	China	Other Far East	Other	Total
Scandinavia	6	1	1	0	0	0	0	9	18
Europe,other	0	0	0	0	0	3	1	5	10
W Africa	8	3	1	0	0	0	0	1	12
Africa,other	5	2	2	0	5	8	1	0	23
North America	15	4	1	0	1	3	2	5	30
S America(Atla	45	15	8	13	26	59	21	49	235
S America (Pac	0	0	0	1	3	4	3	3	13
Asia	1	0	0	0	24	79	4	4	113
Oceanea	16	2	1	0	76	116	40	7	256
Total	95	26	13	14	135	272	71	83	709

IRON ORE TOTAL SEABORNE TRADE 2050 (Unit:Million ton)

To / From	W Europe	Mediterranean	Other Europe	US	Japan	China	Other Far East	Other	Total
Scandinavia	6	1	1	0	0	0	0	20	29
Europe,other	1	0	0	0	0	3	1	12	16
W Africa	7	3	1	0	0	0	0	1	12
Africa,other	4	2	2	0	3	5	1	0	18
North America	21	7	2	0	1	3	3	13	49
S America(Atla	41	15	10	26	17	40	20	88	258
S America (Pac	0	0	0	1	2	3	2	4	12
Asia	1	1	0	0	37	122	10	16	186
Oceanea	20	2	1	1	68	106	53	17	267
Total	102	31	16	28	128	281	91	172	849

・ Grain shipment movement on sea

GRAIN TOTAL SEABORNE TRADE 2005 (Unit:Million ton)

From \ To	W Europe	Mediterranean	E Europe	Other Europe	Africa	NS America	Medeast	Indian Ocean	Japan	Other Far East	Other	Total
US	2	3	0	0	14	30	2	2	23	27	0	105
Canada	1	1	0	0	2	3	0	2	2	5	0	16
S America	7	6	0	1	7	8	1	5	1	22	0	59
Australia	0	1	0	0	2	0	0	5	2	8	0	18
Other	0	5	3	1	20	0	4	9	1	11	0	54
Total	10	15	3	2	46	42	8	23	29	72	1	251

(Review2006)

GRAIN TOTAL SEABORNE TRADE 2030 (Unit:Million ton)

From \ To	W Europe	Mediterranean	E Europe	Other Europe	Africa	NS America	Medeast	Indian Ocean	Japan	Other Far East	Other	Total
US	2	4	0	0	23	35	3	3	21	29	0	121
Canada	1	1	0	0	3	4	0	2	2	5	0	18
S America	7	8	0	2	12	9	2	6	1	23	0	68
Australia	0	1	0	0	3	0	0	6	2	8	1	21
Other	0	5	3	0	28	0	6	10	1	9	0	63
Total	10	19	3	3	69	48	12	27	27	73	1	291

GRAIN TOTAL SEABORNE TRADE 2050 (Unit:Million ton)

From \ To	W Europe	Mediterranean	E Europe	Other Europe	Africa	NS America	Medeast	Indian Ocean	Japan	Other Far East	Other	Total
US	2	3	0	0	17	30	2	2	20	27	0	103
Canada	1	1	0	0	2	3	0	2	2	5	0	16
S America	6	7	0	1	9	8	1	4	1	22	0	58
Australia	0	1	0	0	3	0	0	4	2	8	0	18
Other	0	5	3	1	23	0	3	7	1	10	0	53
Total	9	17	3	3	54	41	6	19	25	72	1	248

・ Container shipment movement on sea

Container Cargo Volume Estimate 2005 (Unit:K TEU)

From \ To	N America	E Asia	Europe	S America	MiddleEastern	India etc	Africa	Oceania	Total
N America	437	5,193	1,947	1,754	287	241	214	244	10,317
E Asia	13,138	12,632	9,587	1,484	1,537	1,115	1,033	1,130	41,656
Europe	3,006	4,766	2,240	1,391	1,582	818	1,890	342	16,035
S America	1,972	664	2,204	1,121	136	26	153	30	6,306
MiddleEastern	150	325	586	5	322	157	55	13	1,613
India etc	619	636	853	61	282	150	137	30	2,768
Africa	158	404	1,346	63	82	150	568	39	2,810
Oceania	207	880	263	51	81	55	36	455	2,028
Total	19,687	25,500	19,026	5,930	4,309	2,712	4,086	2,283	83,533

(Mitsui O.S.K.Line research Div)

Container Cargo Volume Estimate 2030 (Unit:K TEU)

From \ To	N America	E Asia	Europe	S America	MiddleEastern	India etc	Africa	Oceania	Total
N America	308	7312	1635	4130	634	531	351	173	15,073
E Asia	25581	49070	22212	9640	9365	6778	4670	2206	129,522
Europe	2327	7361	2063	3592	3832	1977	3397	265	24,816
S America	5250	3527	6982	9956	1133	216	946	80	28,089
MiddleEastern	335	1450	1559	37	2254	1096	286	29	7,047
India etc	1647	3376	2701	541	2348	1246	846	80	12,786
Africa	342	1745	3468	455	556	1014	2856	85	10,521
Oceania	178	1507	269	146	218	147	72	392	2,927
Total	35,968	75,348	40,889	28,498	20,339	13,006	13,423	3,310	230,781

Container Cargo Volume Estimate 2050 (Unit:K TEU)

From \ To	N America	E Asia	Europe	S America	MiddleEastern	India etc	Africa	Oceania	Total
N America	185	6583	1001	3524	720	522	647	112	13,294
E Asia	23507	67524	20592	12573	16268	10175	13160	2186	165,986
Europe	1325	6077	1197	2904	4126	1839	5933	163	23,564
S America	4550	4577	6164	12248	1856	306	2514	75	32,290
MiddleEastern	348	2251	1647	55	4417	1857	908	33	11,515
India etc	1614	4954	2696	753	4349	1995	2543	85	18,989
Africa	572	4369	5906	1080	1756	2769	14641	153	31,247
Oceania	113	1435	174	132	261	153	140	268	2,676
Total	32,215	97,771	39,378	33,269	33,753	19,615	40,486	3,074	299,561

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