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Working Party on National Environmental Policies
Working Group on Transport

ENVIRONMENTAL IMPACTS OF INTERNATIONAL SHIPPING: A CASE STUDY OF THE PORT OF BUSAN

This case study was prepared by Dong-Oh Cho, Institute of International Maritime Affairs, Korea Maritime University, as part of the project "Environmental Impacts of International Shipping: The Role of Ports".

Delegates are invited to provide written comments by 17 May 2010. If no objections are received by that date, the document will be considered declassified and issued as a GD document.

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NOTE FROM THE SECRETARIAT

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TABLE OF CONTENTS

Tables

Figures

ENVIRONMENTAL IMPACTS OF INTERNATIONAL SHIPPING: A CASE STUDY OF THE PORT OF BUSAN

1. Introduction

1. The objective of this case study is to identify (i) environmental impacts of the Port of Busan and of its interactions with the hinterland and (ii) measures that have been taken to reduce environmental impacts of the port by the port itself and the relevant public authorities The study is an input to the project *Environmental Impacts of International Shipping: the Role of Ports* of the Working Group on Transport under OECD's Environment Policy Committee.

2. This report is limited to the Port of Busan and the activities directly related to the port and consist of the following:

- Development of Busan New Port
- Redevelopment of Busan North Port
- National Plan for Low Carbon Green Growth
- National Green Port Project
- Air pollution management
- Water quality management

3. This report is based on available literature sources and interviews with officials of the Busan Port Authority (BPA) and the Busan Office of the Ministry of Land, Transport and Maritime Affairs (MLTM).

2. Institutional Context

2.1 Busan Port Authority

4. In Korea, all the ports are owned by the nation. All the commercial ports have been operated by MLTM and fishing ports have been operated by the Ministry of Agriculture, Food, and Fisheries (MAFF) and local governments, depending on the size of the ports. However, there have been voices that the commercial ports operated by the government is inefficient, so management of port operation should be transferred to local governments or some other organization, like in some other countries.

5. In 2004, the Korean government enacted the *Port Authority Act* to transfer port management to local governments. In the same year, Busan Metropolitan City (Busan City) established the Busan Port Authority (BPA) to take over management of the Busan Port. Basically BPA took over the commercial management on the land side, such as terminal operation, facility construction, facility maintenance and repair.

2.2 Ministry of Land, Transportation and Maritime Affairs

6. In Korea, all the public waters, such as coastal waters, rivers, lakes, etc. belong to the nation. Therefore, although the commercial management of the Busan Port has been transferred to BPA, the management and control of public water, that is, Busan coastal waters, is the responsibility of MLTM.

7. MLTM is in charge of management of the marine environment, including sea water quality, based on the *Marine Environment Management Act*. MLTM is also in charge of management of marine ecosystem based on the "Marine Ecosystem Management Act." Examples of marine environment and ecosystem management in Busan Port are Busan Special Area Management, protection and preservation of wetlands, habitats, and wild lives, dredging, marine debris management, etc.

8. The *Marine Environment Management Act* includes implementation of the MARPOL Convention, so MLTM is in charge of ship-based oil pollution and air pollution. MLTM is also in charge of maritime safety and security management based on the *Maritime Transportation Safety Act* and some other relevant acts. The *Maritime Transportation Safety Act* includes implementation of the SOLAS Convention. Examples of maritime safety management are operation of vessel traffic systems, management of navigation aid systems, dredging for safety, Port State Control, the ISM Code and ISPS Code, etc.

2.3 Ministry of Environment

9. By the *Government Organization Act*, the environmental management in Korea has become a dual system based on spatial divisions: the terrestrial environment and air quality are managed under the Ministry of Environment (MOE) and the marine environment, under MLTM. MOE is charged with the air-environment management based on the *Air-Environment Preservation Act*.

10. The water quality management on land remains under the charge of MOE based on the *Water Quality Preservation Act*. The coastal water quality management, however, is under the charge of MLTM based on the *Marine Environment Management Act*. The jurisdiction of wetlands management is also divided by land-wetlands and tidal-wetlands based on the *Wetlands Preservation Act*. Solid waste management is divided by land waste and marine debris.

2.4 Korean Coast Guard

11. The Korean Coast Guard (KCG) is charged with implementation of laws on maritime security, maritime safety, and marine environment. While the MLTM Port Office is charged with vessel traffic systems within ports, KCG is charged with vessel traffic systems at coastal channels outside ports. KCG is also charged with oil spill response, that is, establishes and implements the National Contingency Plan (NCP) and Regional Contingency Plans (RCG). KCG holds resources for oil spill response, such as manpower, vessels, equipments and materials for oil spill response. KCG is a branch office of MLTM.

2.5 Busan Metropolitan City

12. While the Ministry of Environment (MOE) is charged with the *Air-Environment Preservation Act* and the *Water Quality Preservation Act*, usually MOE establishes standards of air-environment quality and water quality environment and subsidize the local governments for implementation of the above acts. Hence, the Busan Metropolitan City enforces the *Air-Environment Preservation Act* and the *Water Quality Preservation Act*.

3. Restructuring of the Busan Port

3.1 Background

13. Busan is the 2nd largest city, and has the biggest port, in Korea. The population is about 4.5 million. However, the Port of Busan is geographically very limited, facing mountains northwards and the ocean southwards, so it expands narrowly eastwards and westwards.

14. Korea's economy depends on imports of major materials and exports of manufactures, totalling together more than 80% of GDP. As the biggest port in Korea, the Busan Port handled more than 70% of the container traffic (11,955 thousand containers) in 2009. Busan Port also handled 18 million tonnes of general cargo in 2009.

15. Import and export cargo through Busan has continuously increased during the last years. In 1997, a total of 59 million revenue tonnes (RTs) of cargo were imported and 47 million RTs of cargo were exported through the Port of Busan. However, in 2008, import and export cargo had increased to 119 million RTs and 122 million RTs respectively. Import and export cargo volumes increased at the rate of 6.5% and 9.0% respectively during the period 1997-2008.

Table 1. Trend of import and export cargo volumes through the Busan Port

1,000 Revenue Tonnes

	1997	2000	2002	2004	2006	2008
Import	59,543	67,412	90,943	101,418	115,085	119,536
Export	47,099	49,817	74,734	113,615	114,854	122,146
Total	106,642	117,229	165,677	215,033	215,033	241,682

Source: MLTM, 2010.*The numbers of 2006 and 2008 includes the activities at the Busan New Port.

16. In 1970, a total of 38,633 vessels entered and left Busan for carrying import and export cargo and coastal cargos. The number of vessel increased at an annual rate 3.6%. In 2008, a total of 57,979 vessels (416,338 thousands Gross Tonnes) entered the Busan Port.

Table 2. Number of vessels entering and leaving the Busan Port

	1970	1980	1990	1995	2000	2005	2008
Vessels	38,633	22,873	37,419	61,387	72,022	96,711	115,931

Source: MLTM, 2010.

17. The Port of Busan is also the biggest container port in Korea and 5th largest in the world. In 1993, a total of 2,998 thousand containers were handled in the Port of Busan. However, it increased to 13,453 thousands in 2008; an annual rate of increase of 10.5%.

Table 3. Trend of import and export of containers through the Busan Port

	1993	1996	2000	2002	2004	2006	2008
1000TEU	2,998	4,374	6,383	9,453	11,492	12,039	13,453

Source: MLTM, 2010.

18. The rate of increase in the number of containers passing through Busan (10.5%) is higher than economic development rate of Korea. With the increasing demand for container handling in Busan over the last 1980s, 1990s, and early 2000s, the Korean government developed container berths at the Busan North Port accordingly; that is, the Jaseongdae Container Terminal, the Shinseondae Container Terminal, the Gamman Container Terminal, the Singamman Container Terminal and the Uam Container Terminal. When container berths were not enough for handling increasing demand of container, then those containers were handled at general cargo berths, that is, Pier No.1, 2, 3 and 4 of the Busan North Port.

Table 4. Container Terminals at the Busan North Port

Container Terminal	Quay length	Total area	Handling capacity
Jaseongdae	1,447 m	647,000 m²	1,500,000 TEU
Shinseondae	1,500 m	1,039,000 m²	1,039,000 TEU
Gamman	1,400 m	731,000 m²	731,000 TEU
Singamman	826 m	308,000 m²	308,000 TEU
Uam	500 m	184,000 m²	184,000 TEU

Source: MLTM, 2010.

19. The destination of most containers imported through the Port of Busan is the Seoul Metropolitan City (Seoul City) and the surrounding areas, where about three fourths of total population of Korea lives; that is, most container cargos imported are consumed at the Seoul Metropolitan City and surrounding area. Also most containers exported through the Port of Busan come from the Seoul City and surrounding areas.

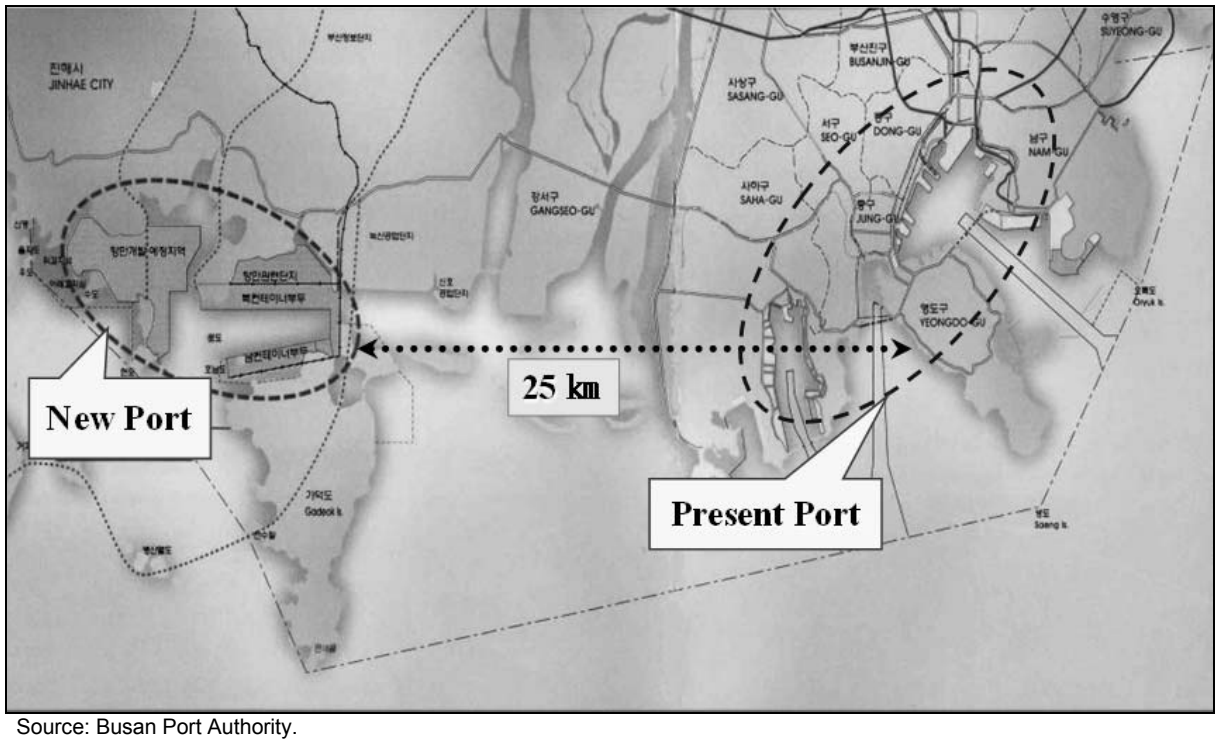
20. Although new container berths were developed for the increasing demand for container cargoes at the Port of Busan, enough terminals were not supplied because of geographical limitation of Busan City. Therefore, many off-dock-container yards (ODCY) were developed for container handling in the downtown of Busan City. There are now 13 ODCYs at Busan City. Many containers were unloaded at the container berths, carried to the ODCYs by container trucks, and then carried to the Seoul City and surrounding area. Many export containers were also handled at ODCYs, and then carried to the container berths and loaded to container vessels.

21. These container trailers from ODCYs in downtown Busan to container terminals at the Busan North Port have been lifelong trouble makers in the Busan City, causing heavy traffic jams, air pollution, and noise. There is also a rail transportation system for container cargoes from Seoul to Busan City. However, most customers of container cargos prefer road transportation to rail transportation because of the short distance (less than 500 km) between Seoul and Busan. Citizens of Busan City have always criticized the traffic jams, the air pollution, and the noise. Therefore, the Korean government and Busan City had to solve the problem fundamentally.

3.2 Development of the Busan New Port

22. To respond the increasing demand of container cargo and to solve the traffic jam, air pollution, and noise caused by the container trailers, the Korean government decided to develop a new container terminal at the western part of Busan City, about 25 km from the City centre. In 1996, the Korean government established a development plan where the Busan New Port should be economically highly efficient and also environmentally friendly. Therefore, the Busan New Port should be in a non-residential area, all the container cargoes should be handled in the on-dock container yard and there should be dedicated railways and roads for transporting containers. And eco-friendly technology should be introduced in the Busan New Port, such as Rail Mounted Gantry Cranes (RMTCs) operated by electricity, provision of Alternative Maritime Power (AMP), use of geothermal energy, gate automation, Twin C/C, Tandem-40' C/C, and automated mooring systems.

Figure 1. The Location of the Busan New Port

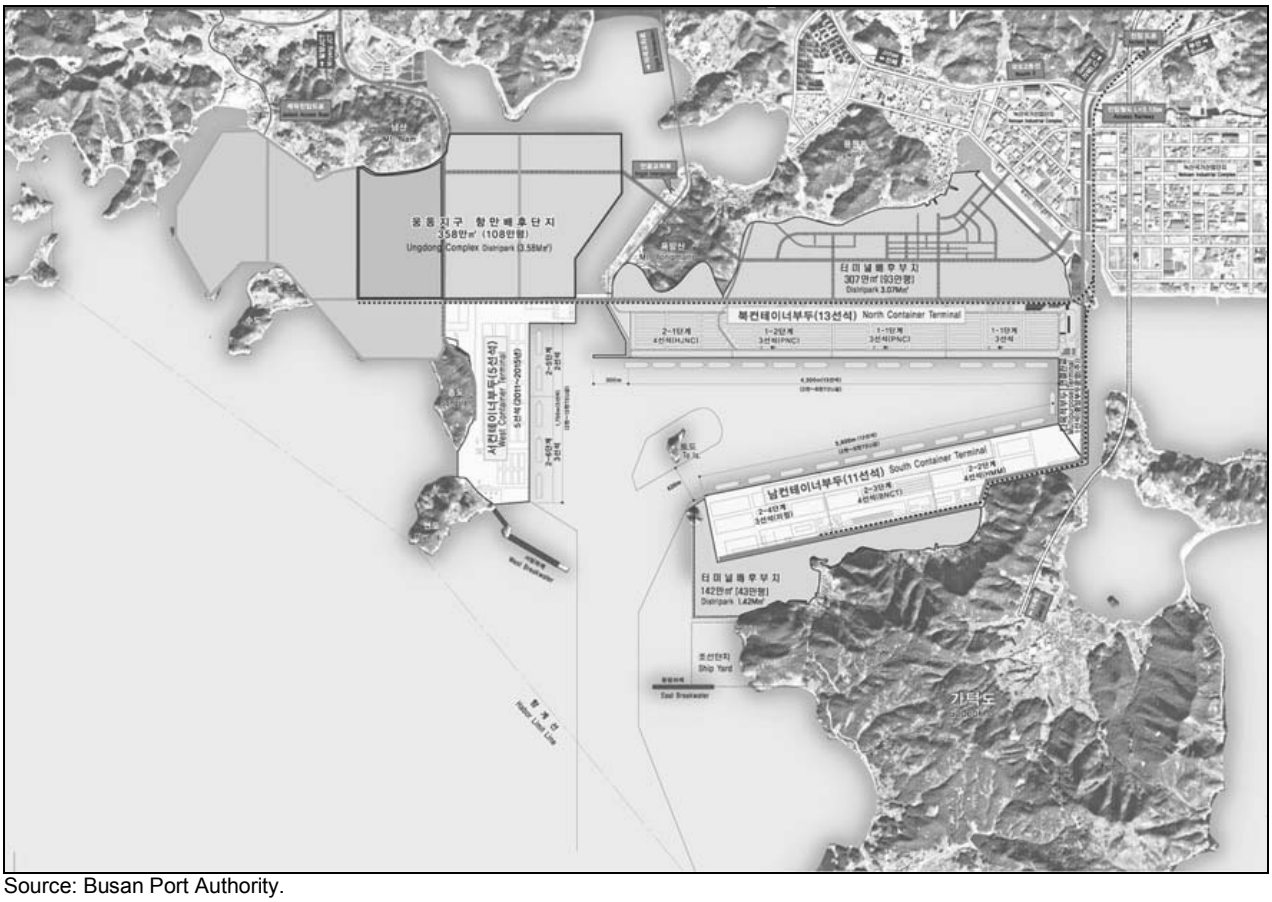


Source: Busan Port Authority.

23. The plan for the Busan New Port includes development of 30 berths from 1995 to 2015, with a capacity of 10.62 million TEU annually. Phase 1-1 (North Container Terminals: 6 berths) and Phase 1-2 (North Container Terminals: 3 berths) were completed in 2006 and 2009 respectively. Phase 2-1 (North Container Terminals: 4 berths) and Phase 2-2 (South Container Terminals: 4 berths) were completed in 2008 and 2009 respectively. Phase 2-3 (South Container Terminals: 4 berths), Phase 2-4 (South Container Terminals: 3 berths) and Phase 2-5 (West Container Terminals: 3 berths) will be completed in 2011. Phase 2-6 (South Container Terminals: 4 berths) will be completed in 2015. The Multi-purpose Terminal (1 berth) was completed in 2007.

24. The container cargo handled in Busan New Port was 579,000 TEU in 2007. However, it increased to 1,579,000 TEU and 2,720,000 TEU in 2008 and 2009 respectively. It is expected that it will increase sharply when construction of Phases 2-2, 2-3, 2-4 and 2-5 are completed in 2011.

Figure 2. Busan New Port Development Plan



Source: Busan Port Authority.

25. A total of 3.07 million m² of Distripark (International Comprehensive Logistics District) of the North Container Terminal will be established to vitalize the Busan New Port, of which 1.7 million m² will be completed in 2011. And a total of 1.42 million m² of Distripark will be completed in 2015 to spur the further development of the Busan New Port by supporting cargo handling of the South Container Terminal and logistics function. Also, a total of 4.7 million m² of the Ungdong Complex Distripark will be established to create new cargo capacity and added value by 2020.

3.3 Redevelopment of the Busan North Port

26. Together with the Development Plan for the Busan New Port, the Korea Government and BPA established the Plan for Redevelopment of Coastal Ferry Terminal, International Passenger Terminal, and Piers No. l, 2, 3 and 4 of the Busan North Port. These berths are situated at the very downtown of Busan City, but there is no space for public access or water front. Especially, Piers No. 1, 2, 3 and 4 are berths for general cargoes which cause heavy traffic jams and air pollution. Therefore, BPA decided to develop general cargo berths at other areas, such as the Gamcheon Harbour, which is in the south of Busan City.

27. The Korean Government and BPA will redevelop the area of Coastal Ferry Terminal, International Passenger Terminal and Piers No. l, 2, 3 and 4 as a heart place of international marine tourism and creating a waterfront for Busan citizens. The area of the Redevelopment Plan of the Busan North Port is 1,527,247 m² and the project period is 2008-2015. A total of USD 8.5 billion will be invested, of which USD 2.4 billion in infrastructure and USD 6.5 billion in superstructure.

Figure 3. Redevelopment of the Busan North Port

Source: Busan Port Authority.

3.4 Hinterland Transportation

28. As described above, the present Busan North Port is in a residential area and the many containers are carried to ODCYs in the downtown, which creates heavy traffic jams, air pollution and noise. However, the Busan New Port is designed to carry container cargoes by dedicated railways and roads which are in the suburb of Busan City, so there is no traffic jams, air pollution, and noise.

29. The "Hinterland Road 1", with a length of 23 km between the Busan New Port and the Chojeong IC, which connects to the Seoul-Busan Expressway and the Namhae Expressway, was completed in 2009. The "Hinterland Road 2" with length of 17.1 km between the Busan New Port and the Jillye IC, which also connects to the Seoul-Busan Expressway and the Namhae Expressway, will be completed in 2011. The "Hinterland Railway", with length of 38.8 km between the Busan New Port and the Samrangjin, which connects to the Seoul-Busan Expressway, will be completed in 2011. All the three hinterland roads start from the Busan New Port, run through non-residential areas, and connect to the Seoul-Busan Expressway and the Namhae Expressway.

30. The "Port Hinterland Road", with length of 25 km between the Busan New Port and the Busan North Port, will be completed in 2011. The "Port Hinterland Road" runs through the South Port Bridge (already completed) and the North Port Bridge (will be completed in 2011), before arriving the Busan North Port, and runs through the Gwangan-Daero Bridge after the Busan North Port and connects to the Seoul-Busan Expressway. The "Port Hinterland Road" is designed to run outside of the Busan City by construction bridges over the seas to avoid traffic jams and air pollution.

Figure 4. Hinterland Transportation of Busan New Port

Source: Busan Port Authority.

4. National Plan for Green Growth

4.1 National Plan for Low-Carbon Green Growth

31. In February 2009, the *Presidential Committee on Green Growth* was established under the direct control of the President to implement the national project of "Low-Carbon, Green Growth", presented as a national vision by President Myeong-Bak Lee in August 2008. In July 2009, the *Presidential Committee on Green Growth* finalized the Five-Year National Plan for Green Growth (2009-2013), which includes the following three objectives and ten policy directions for Green Growth Country.

- Mitigation of climate change & energy independence
    1. Effective mitigation of greenhouse gas emissions
    2. Reduction of the use of fossil fuels and the enhancement of energy independence
    3. Strengthening the capacity to adapt to climate change
- Creating new engines for economic growth
    4. Development of green technologies
    5. The "greening" of existing industries and promotion of green industries
    6. Advancement of industrial structure
    7. Engineering a structural basis for the green economy
- Extension of R&D for ocean energy
    8. Greening the land, water and the building for the green transportation infrastructure
    9. Bringing the green revolution into our daily lives
    10. Becoming a role-model for the international community as a green growth leader

32. In December 2009, the Korean government enacted the *Basic Act for Low-Carbon Green Growth*, which will be the basic and strong support to the Five-Year National Plan for Green Growth (2009-2013).

4.2 National Green Port Project

33. Based on the *Basic Act for Low-Carbon Green Growth*, and the Five-Year National Plan for Green Growth (2009-2013), all the relevant ministries are establishing an action plan for the Five-Year National Plan for Green Growth. In 2008, MLTM (Ministry of Land, Transport, and Maritime Affairs) also established the *Comprehensive Plan for Response to Climate Change in National Land and Ocean*, which is comprised of five parts, such as i) buildings, ii) transportation, iii) national land and cities, iv) ocean, v) water resources. The following are the major contents of the Ocean part of the Comprehensive Plan:

- Extension of R&D for ocean energy
  - Development of practical technology for ocean energy, such as ocean current, tidal current and wave energy
- Development of technology for disposal of CO_2 in oceans
  - Collection of CO_2 generated at power plants and iron mills and storing in ocean sedimentary rocks
- Development of technology for absorption of CO_2 by seaweed
- Enhancement of fuel oil efficiency and reduction of CO_2 emissions from ships
  - Setting assessment methodology of CO_2 and development of CO_2 reduction technology (2008-2012)
  - Establishment of a system for CO_2 emission statistics
  - Analyses of CO_2 generation mechanisms and establishment of reduction plan for CO_2 emissions from ships
  - Development of technology to collect CO_2 emissions form ships (2010-2014)
  - Development of energy-saving ships (2010-2014)

34. MLTM is also establishing an action plan for the National Plan for Green Growth, one of which is the *National Green Port Project*. The National Green Port Project will include i) establishing "Low-Carbon Hinterland Transportation Systems", through enhancing rail and coastal transportation from/to ports, ii) "Transfer to Low-Carbon Energy-Efficient Ports", through reduction of carbon emissions, transformation of engine-power-systems from fuel oil to electricity, and use of renewal resources, iii) establishing "Resources Recycling Port Systems", through eco-friendly management of marine debris, dredging materials, etc., iv) enhancing "Use of Port Space", through securing water front, public access, etc., v) establishing "Response System for Climate Change and Ocean Disaster", vi) enhancing "R&D for Green Growth and Green Growth Industry." Especially, MLTM indicate that the plan for Alternative Maritime Power and high energy-efficiency will be established in 2010 and that the project for a rail transportation system for container to/from Busan Port and Kwangyang Port will be completed in 2011.

4.3 Task Force Team for a Green Busan Port

35. As described below in Section 5 and 6, BPA is working very hard to establish and implement plans for a Green Busan Port under the National Green Port Project. For further efficient and comprehensive driving forward Green Busan Port, in February 2010, BPA established a Task Force Team which will exclusively focus on new ideas and policies for Green Growth of the Port of Busan.

4.4 A Study on Response to Climate Change in Port Area

36. As all the ministries are trying to establishing action plans for the "National Plan for Green Growth," the relevant institutes are also carrying out studies to support the action plans. In 2009, Korea Maritime Institute (KMI), a government-owned and operated ocean-related institute, carried out a "Study on Response to Climate Change in Port Area" to support MLTM in establishing the National Green Port Project.

37. The study assessed that total CO_2 emission from Korea ports were 1,890,000 tonnes CO_2 in 2008, of which ships' share was 34.8%, vehicles' share 33.9%, and cargo handling 31.3%. And the study shows that CO_2 emission from ports are set to increase to 2,760,000 tonnes CO_2 in 2020; so 830,000 tonnes CO_2 should be reduced to reach a target of 30% reduction compared to Business-as-Usual in 2020.

38. Finally, the study recommended the following alternatives to reach a target of 30% emission reduction by 2020, which will give much influence to MLTM in establishing the National Green Port Project;

- Reduction of vessel speed in port area
- Supply of Alternative Maritime Power to vessels at berths
- Conversion of Rubber Tired Gantry Crane's oil engine system to electric engine system
- Establishment of a prevention system of truck idling
- Education and training of port-related labourers
- Establishment of real-time operating system
- Establishment of public notice system of CO_2 emissions.

5. Air Pollution Management

5.1 Air Pollution and Busan City

39. As described in Sections 2.3 and 2.5, the Ministry of Environment establishes the national standards of air-environment and water quality in the country and the local governments enforces the relevant laws to achieve the national environment standards. As seen in the Table 1, most air quality parameters in Busan City, such as SO_2, PM_{10}, CO, NO_2 and O_3, meet the national environmental standards. This is because there are neither many manufacturing factories, nor heavy and chemical industry, in Busan City.

40. However, emissions from automobiles are a major air pollution source. Therefore, Busan City has been addressed to reduce emissions from automobiles. From 2006 through 2014, Busan City has invested USD 140 million in conversion of diesel-using-engine to CNG-using-engine of large vehicles, in attaching diesel particle filters and diesel oxidation catalysts in diesel-using vehicles, and in scrapping of old vehicles. (Seoul City has invested about USD 200 million annually for reduction of emissions from vehicles.) The Ministry of Environment has covered half of the costs and Busan City has covered the other half.

Table 5. Trends in Air Pollution in Busan City

	Standard	2001	2002	2003	2004	2005	2006	2007	2008	2009
SO_2	<0.02 ppm	0.008	0.006	0.006	0.007	0.006	0.006	0.006	0.006	0.005
PM_{10}	<50 ug/m³	59	69	55	60	58	59	57	51	49
CO	<9 ppm	0.7	0.7	0.6	0.5	0.5	0.4	0.4	0.4	0.4
NO_2	<0.03 ppm	0.027	0.028	0.026	0.024	0.023	0.023	0.022	0.022	0.021
O_3	<0.06 ppm	0.025	0.024	0.023	0.024	0.023	0.024	0.024	0.026	0.027

Source: http://www.busan.go.kr/share/inc/printpage.html.

5.2 e-RTGC at the Busan North Port

41. There are a total of 186 Rubber Tired Gantry Crane (RTGC) units at Busan North Port (Container Berths). RTGCs are owned and operated by the terminal operators, not by BPA. RTGCs are operated by fuel oil, which produce air pollution and noise.

42. BPA decided to convert oil-using RTGCs to electricity-driven RTGCs (e-RTGC). The total cost of converting from oil to electricity per unit is about USD 400 thousand, half of that (USD 200 thousand) is for converting the engine system of the RGTCs and the other half is for the construction of the electricity supply system.

43. The terminal operators and BPA agreed to share the total cost half and half, that is, half of the cost (the cost for converting the engine systems of the RGTCs) is covered by the terminal operators and the other half (the cost for the construction of the electricity supply system) is covered by BPA.

44. A total of 73 units of RTGCs had been converted to e-RTGC until 2009 and 21 units will be converted to e-RTGC in 2010. The remaining 78 units will be converted to e-RTGC after 2010. BPA estimates that converting 94 (73+21) units of RTGC to e-RTGC reduces CO_2 emissions by 28,000 tonnes, and saves USD 16 million in operating cost, annually. The reduction of 28,000 tonnes of CO_2 were calculated taking into account the CO_2 emission caused in the production of the electricity for e-RTGC. The share of nuclear power generation to total electricity is more than 40%. BPA estimated operating cost of RTGC is USD 18,000 per month in a case with an oil price of USD 1.2 per litre; however, the operating cost of e-RTGC is estimated to USD 2,000 per month.

45. Also BPA estimates that e-RGTC reduces noise levels from 85 dB to 65 dB, and the breakdown rate of an e-RGTC is about half of a RTGC. Following BPA's e-RGTC plan, Incheon Port Authority, the 2nd largest port in Korea, will also convert their RTGC to e- RTGC.

Table 6. Number of RTGC converting to e-RTGC

	2007	2008	2009	2010	Total
Units	9	35	29	21	94

Source: Busan Port Authority.

5.3 Rail Mounted Gantry Cranes

46. The Busan New Port is planned to be constructed environmentally friendly and cost-efficiently. A total of 267 Transfer Cranes will be equipped at the Busan New Port if a total of 30 berths are developed by 2015. From the beginning of the Busan New Port Planning, BPA decided to install Rail Mounted Gantry Cranes, which is operated by electricity, not by fuel oil as RTGC.

47. BPA estimates that 267 units of RMGC reduce CO_2 emissions by 80,000 tonnes and saves USD 80 million annually. And BPA estimates that the productivity of the Busan New Port Terminal will be 20 to 30% higher than traditional port terminals, like the Busan North Port.

Table 7. Plan of construction of Rail Mounted Gantry Cranes at the Busan New Port

	Until 2009			After 2010				Total
Phase	**1-1/1-2**	**2-1**	**2-2**	**2-3**	**2-4**	**2-5**	**2-6**	
Units	80	42	32	38	28	19	28	267

Source: Busan Port Authority.

5.4 Alternative Maritime Power

48. The Busan New Port berths are equipped with Alternative Maritime Power (AMP) for supplying land-based electricity to vessels at berth. However, using land-based electricity is not mandatory, and until now, there is no vessel using AMP.

5.5 Gate Automation and Container Handling Automation

49. ***Gate Automation***: As described above, the Busan North Port is very limited geographically and there are not enough yards for container handling. Therefore, 13 off-dock-container yards (ODCY) are operated for container handling before loading and after unloading.

50. When container trucks arrived at Busan North Port from an ODCY, there was usually heavy traffic at the gate, because of container information limitation, resulting in air pollution and time-losses by long lines of container trucks into the Busan Downtown.

51. BPA invented a Gate Automation System using Radio Frequency Identification (RFID) for container trucks to pass the gate to designated berths without delay. At present there is not a long line of container trucks at the gates waiting information to designated berths.

52. ***Container Handling Automation***: BPA and terminal operators have introduced Tandem Container Cranes which can load and unload 4 containers of 20 feet at the same time. BPA also introduced a Yard Tractor Pooling System at container berths for operating container trucks effectively at loading and unloading.

5.6 Light Emitting Diode lighting system

53. BPA has decided to change all of the old lighting systems of the Port of Busan to Light Emitting Diode (LED) systems. The total number to be changed is 22,723 (inside buildings: 22,450; outside buildings: 273). BPA estimates that the old lighting system consumes one unit of energy to produce 10% of lighting and 90% of heat; however, LED system consumes one unit of energy to produce 30% of temperature and 70% of lighting. BPA estimates that the energy savings from using LEDs are 60% compared to the old lighting system. And the life-span of an LED system is much longer than the old lighting system, about ten times longer. However, the price of one unit of LED is around USD 50 to 80, while that of the old lighting system is around USD 0.3.

54. BPA estimates that changing the old lighting system to LED will reduce CO_2 emissions by 2,000 tonnes and save electricity worth USD 370,000 annually.

Table 8. Plan of changing the old lighting systems to LED systems

	2009	2010	2011	2012	after 2012	Total
Inside buildings	1,598	2,225	3,196	1,915	13,516	22,450
Outside buildings		49	28	78	118	273

Source: Busan Port Authority.

5.7 New energy sources: Solar energy and geothermal energy

55. BPA uses new energy sources in the buildings at the Busan New Port Terminal, such as solar energy and geothermal energy. Buildings at Phase 2-1 of Busan New Port use geothermal energy in heating and air-conditioning, by circulating waters in the depth of 150 meters underground. Buildings at Phase 2-2 and other areas use solar energy, by constructing new solar energy systems on the roofs and

windows. BPA estimates that solar energy will produce 10 MW, which is about 10% of total energy consumed in the Busan New Port when the development of the Busan New Port Distripark is completed.

56. BPA estimates that the new energy systems will reduce CO_2 emissions by 300 tonnes per year. BPA will spend five percent of the total cost of every new construction project in new renewal energy systems from now on.

Table 9. Plan of construction of a renewal energy system at the Busan New Port

	Until 2009			After 2010
	Phase 2-1	**Supporting Blds.**	**Phase 2-2**	**Int'l Ship Chandlers Centre**
System	Geothermal	BIPV Solar	BIPV Solar	BIPV Solar
Energy	90RT	19.8kW	49kW	over 80kW (estimated)

Source: Busan Port Authority. RT: Refrigeration Tonne (3,320 calories per hour). BIPV: Building Integrated Photovoltaic System.

5.8 Regulations for the Prevention of Air Pollution from Ships

57. Korea is a member of MARPOL, so ozone depleting substances, NO_x (Nitrogen Oxides), VOCs (Volatile Organic Compounds) are regulated according to MARPOL Annex VI and the relevant domestic law, the *Marine Environment Management Law*.

58. However, from 1 January 2012, the sulphur content of fuel oil will be regulated as following;

1. The sulphur content of diesel is to be less than 1.0%, however, the sulphur content of diesel used in ships operating only in territorial water and EEZ is to be less than 0.05%,
2. The sulphur content of heavy oil A, heavy oil B, heavy oil C is to be less than 2.0%, 3.0% and 4.5% respectively.

59. The *Marine Environment Management Law* stimulates that fuel oil suppliers should submit the samples of fuel oil with the specification of fuel oil to the ship-owner. And the Korean Government officials will carry out ship inspections to check the oil samples and specification. Although the *Marine Environment Management Law* does not give any obligation to oil refineries, they will make and sell fuel oils that meet the regulation to the fuel oil suppliers.

5.9 Coastal Transportation

60. ***Shuttle voyage between the Busan New Port and the Busan North Port***: After the Busan New Port started handling container cargoes in 1996, demand for transhipment of containers between the Busan New Port and the Busan North Port has continuously increased. The distance between the Busan New Port and the Busan North Port is 25 km. The cost of transhipping containers by truck is about UDS 80 per TEU and the cost of transporting the containers by shuttle ship is higher than that. However, the container trucks must run through the downtown of Busan City, which creates traffic jams, air pollution and noise. BPA estimates that the social cost of truck transport, though pollution, road damages, traffic jams and road accidents, is USD 9.5 million per year.

61. In 2007, BPA started to support one private business for shuttle coastal transportation by Pusher Tug and Hold Barge between the Busan New Port and the Busan North Port. The cash incentive to the private business is USD 200,000 as basic cost and USD 41 per TEU. From October 2007 to December 2009, a total of 79,370 TEUs were transported by the shuttle transportation, that is, an average of 210 TEUs daily. At present, the share of truck and coastal shuttle transportation of containers between the two ports is about 70% and 30% respectively.

62. ***Shuttle voyage between Incheon and Busan Ports***: As described above, the final destination of most containers unloaded at the Port of Busan is the Seoul Metropolitan City and surrounding cities, and most of the containers are transported between these two regions by trucks, which create traffic jams and air pollution. Road transportation of containers consumes much oil compared to coastal transportation, and damages roads. Therefore, there were numerous voices that coastal transportation should be activated.

63. And there were actually coastal transportation of containers between the Port of Busan and the Port of Incheon, and between the Port of Busan and the Port of Kwangyang, in the 1990s and early 2000s. Coastal transportation between the Port of Busan and the Port of Incheon started in 1996 and transported 80,223 TEU. It peaked in 1999 with 132 thousand TEU. However, cargo volumes decreased after 1999 and it stopped from 2006. Coastal transportation between the Port of Busan and the Port of Kwangyang started in 1998 and continued until 2004, peaking in 2001 with 43 thousand TEU.

Table 10. Coastal transportation of containers
(Thousand TEU)

	1996	1998	1999	2001	2002	2003	2004	2005
Busan/Incheon	80	114	132	118	100	98	94	79
Busan/Kwangyang	-	38	25	43	39	38	6	-

Source: Busan Port Authority.

64. The cargo owners preferred road transportation to coastal transportation because the transportation time was shorter. Coastal transportation between the Port of Busan and the Port of Incheon takes 47 hours, while road transportation and rail transportation between Seoul and Busan take 13 hours and 19 hours respectively. Also, transportation by coastal shipping lost its competitiveness compared to ocean-going shipping and road transportation. Therefore, coastal transportation between the Port of Busan and the Port of Incheon has stopped since 2006, and between the Port of Busan and the Port of Kwangyang since 2005.

65. Recently, the Korean Government established a plan for support to coastal transportation under the National Plan for Low-Carbon Green Growth and the National Green Port Project. The Korean Government found that i) coastal transportation produces only 8% of the carbon emissions compared to road transportation, ii) the share of large vehicles is only 9.1% of the total number of vehicles but their share of road damages is 61.8%, and iii) the cost of coastal transportation to total national logistic cost share is only 1.0% while cost of road transportation share is 96.4 %.

66. Therefore, the Korean Government has decided to support private business (coastal shipping) for coastal transportation, such as through i) exemption of port charges, ii) subsidy to fuel oil, and iii) a USD 20 cash incentive per TEU, with USD 10 coming from BPA and USD 10 from IPA. The coastal shipping industry claims that carrying one TEU make loss of USD 100. About 40% of the total loss is covered by the incentive under the government plan. In 2009, coastal transportation for containers between the Port of Busan and the Port of Incheon resumed under the support scheme described above, with 25,000 TEUs of containers transported. It is expected that more than 40,000 TEUs will be transported in 2010.

6. Water Quality Management

6.1 Port Reception Facilities

67. The port reception facilities for garbage and oily waste have been installed by the private companies in large ports such as the Ports of Busan and Incheon. However, those facilities have been installed by the Korea Organization of Environment Management (KOEM), the government-owned and managed organization, in small ports in Korea. There are 45 oily waste cleaning companies in the Busan Port, of which 22 companies also can clean oil spilled at sea. There are recommended prices for reception

of oily waste, however, the private companies are competing for business of reception of oily waste. Between 2007 and 2009, a total of 107.6 million litres of liquid oil waste and 52.6 million litres of solid oil waste were collected from vessels in the Busan Ports.

Table 11. Collected oily waste in the Busan Port
(Thousand litres)

2007		2008		2009		Total	
Liquid	Solid	Liquid	Solid	Liquid	Solid	Liquid	Solid
39,850	18,143	34,555	19,206	33,166	15,218	107,571	52,567

Source: Korean Coast Guard, 2010.

6.2 Single Hull Tanker

68. Korea is a member of MARPOL, so single hull tankers of less than 25 years of age in 2010 were scheduled to be regulated according to MARPOL options. However, after the Hebei Spirit accident which occurred in December 2007, the Korean Government revised the relevant domestic law, the *Marine Environment Management Act*, and accordingly, no single hull tanker will be allowed to enter Korean ports after 1 January 2011.

6.3 Busan Special Area Management Plan

69. The Busan area is the largest port area in Korea and produces 5.6% of GDP in 2006. However, the environmental impacts on the Busan coastal area are very severe. About 19.3 km² of the Busan coastal area was reclaimed for berths and terminals. Although the water quality of small rivers entering the Busan coastal area is getting better, some of the port areas are heavily polluted by heavy metals and organic-toxic substances. The environment and biological situation is as follows:

- The Busan coastal area is biologically very highly productive, with sea water circulation and Taiwan warm current but threatened by reclamation.
- The man-made shore line is about 48% of the total shore line, 275km, and the reclamation area is 19.3 km². About 32.7 km² is planned to be reclaimed for development in the near future.
- Most of the watershed of the Busan coastal area is mountains and the land area for houses, factories, etc. is 175.6 km², which represents only 15.2% of the total land area.
- The population of the Busan coastal area is 4.23 million and the population density is 3,669 per km², which is higher than that of Busan City, 2,457 per km² and much higher than the national average, 397 per km².
- The fisheries industry is very active in the western coastal sea of the Port of Busan, including Gangseo-Gu, Saha-Gu, Youndo-Gu, of which fishery production is 55,000 tonnes annually. There are 50 small fisheries ports, 2,689 fishery families, 4,624 coastal fishing vessels, 385 ocean-going fishing vessels, and 36 fishery villages.
- The sewage treatment coverage is 96.2%; however, 3rd grade treatment of sewage treatment coverage is only 25.7%, with focus on Busan City and the Nagdong River.
- 51% of a total of 2,790 waste water discharge plants are in the western part of Busan City, such as Sasng-Gu, Sahh-Gu, Kimhae-Si, so the water quality in that area is very low.
- However, the general water quality in the Busan coastal area is getting better. Recently there occurs one harmful algal bloom (HAB) on average annually, while there were about 10 HABs annually in the early 2000s.
- Compared with water quality, the sediment of the Busan Port is severely polluted, with heavy metals such as cadmium, chromium, copper, etc. in the Sooyoung-Bay, the Busan North Port and the Busan South Port.

70. Therefore, in 2002, the Korean government designated the Busan coastal area as a Special Management Area based on the *Marine Environment Management Act*. In addition to the Special Management Area, there are 4 kinds of Marine Protective Areas in the Busan coastal area, such as Natural Environment Protective Area, Ecological and Landscape Protective Area, Wetland Protective Area, and Cultural Properties Protective Area. In October 2009, the Korean government established a draft Busan Special Area Management Plan (SAMP). The Busan SAMP is in the final stages of preparation after consultation with relevant ministries and organisations and public hearing in 2009. The draft Busan SAMP includes 4 policies of 12 projects:

- Reduction of land-based pollution
    1. Establishment of a plan for reduction of land-based pollution by large areas
    2. Establishment of infrastructure for management of non-point sources
    3. Project for construction of natural-typed ecological river and enlargement of river-rehabilitation
- Improvement of marine environment
    4. Reinforcement of infrastructure for management of polluted sediment
    5. Project for marine debris collection and removal
    6. Implementation of oil pollution management
- Ecosystem restoration and securing of water front
    7. Enhancement of public access and securing of water front
    8. Reinforcement of management system for beach
    9. RAMSAR registration of the wetland of the Nakdong-River estuary
    10. Restoration and preservation of marine ecosystems
- Reinforcement of marine environment management
    11. Reinforcement of scientific decision-making system: survey, research and management
    12. Reinforcement of coastal environment management and governance

6.4 Marine Debris

71. With industrialisation, population growth, and dense activity in coastal areas, large quantities of marine debris are generated, harming the marine environment and causing a large number of maritime accidents in Korea. Most of the land-based marine debris comes from rivers, such as the Han River, the Keum River, the Youngsang River, the Seomjin River and the Nakdong River during flooding in the summer when more than three fourths of the yearly precipitation occurs in Korea. The origin of land-based marine debris is large cities. Also, the fishing industry is active in the coastal waters of Korea, and a huge quantity of marine debris is generated at sea. Currently, the aquaculture industry is very dense in coastal areas, and large quantities of Styrofoam buoys, nylon ropes, and nets are generated.

72. The *Marine Environment Management Act* stipulates that the Korea Government should establish a National Marine Debris Management Plan and local governments should establish local marine debris management action plans. Based on those plans, the MLTM office in Busan operates 4 vessels for marine debris collection and removal in the Port of Busan area. In 2009, a total of 246 tonnes of marine debris was collected and removed and 12 derelict vessels removed. And 20 organizations joined in the coastal cleaning of Busan coastal area under the campaign of *One Company, One Coastal Cleaning*.

6.5 Oil spill response

73. Before the Sea Prince Accident in 1995, the Korean Government had not established a National Contingency Plan (NCP) or any Regional Contingency Plan (RCP), all of which were essential for effective oil spill response. The NCP is a national oil spill response plan, by which all personnel and equipment of related government agencies and the private sector could be mobilised in the case of a big oil

spill accident. The RCP is an action plan, by which the actual oil spill response is conducted at the oil spill site. Without a NCP, the Korean Government did not have a plan to manage large oil spills in the coastal waters in Korea.

74. After the Sea Prince Accident, the Korean Coast Guard (KCG), as the responsible agency for oil spill response, established the NCP in 2000, and RCPs for twelve major coastal waters were established from 1999 to 2002. Also, the KCG planned to maintain resources for oil spill management capable of responding to a large oil spill of 20,000 tonnes. Then the Korean Government ratified the OPRC Convention in 2000 and has tried to co-operate with neighbouring nations through the Northwest Pacific Action Plan to respond a large oil spill accidents.

75. The Busan coastal area is biologically very productive, but the risk of oil spills from vessels is very high because of the dense vessel traffic. Therefore, KCG has established a RCP of the Busan coastal area and secured resources for effective oil spill responses. Also, the *Marine Environment Management Act* stipulates that a *Shipboard Oil Pollution Emergency Plan* should be onboard the vessels and an *Oil Pollution Emergency Plan* should be established for marine facilities such as oil refineries. Usually marine facilities have a contract with the Korea Marine Environment Organization for cleaning oil spills in case of accidents.

6.6 Dredging

76. The Busan Office of MLTM is dredging at the semi-enclosed bay of the Busan South Port to restore the marine ecosystem and improve the marine environment. The project period is five years from 2009 to 2014. The area for dredging is 367,215 m² and the volume of the sediment is 255,000 m³. The total budget is USD 28.5 million. The dredged sediments are reclaimed at a designated area of the Busan North Port for development of berths and terminals.

7. Port State Control

77. Korea is a member of the Tokyo Memorandum on Port Stage Control (PSC) and is actively trying to eliminate sub-standard ships for maritime safety and marine environment protection. In 2009, the Korean Government carried out port state control of 2,852 ships, with faults detected at 2,497 ships. 274 ships were banned from leaving the ports due to serious faults. In 2010, the Korean Government will carry out port state control of about 3,000 ships, which will meets the goal of a 32% of inspection rate. The inspection rate has increased annually; 26.7% in 2008, 30.3 % in 2009, and 32% in 2010. In order to increase the rate of port state controls, the Korean Government will increase the number of control officials from 35 officials in 2010 to 56 officials in 2014.

78. The PSC is carried out based on the *Ship Targeting System* that is focused on the sub-standard ships. Until 2009, ships with a targeting factor (TF) of 100, which considers ship's age, numbers of faults, numbers of bans of leaving ports, etc., got a PSC inspection every three months in Korean ports. However, in 2010, ships with a targeting factor of 80 will get a PSC inspection every three months. And the ships with a targeting factor of 40-79 will get a PSC inspection every six months. The ships with a targeting factor of less than 40 will get a PSC inspection based on the individual port office's discretion.

Table 12. The plan for increasing numbers of PSC officials in Korea

	2010	2011	2012	2013	2014
Inspection rate (%)	32.0	39.1	42.6	45.1	47.3
PSC officials	35	46	50	53	56

Source: MLTM, 2010.

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