INTERNATIONAL BEST PRACTICES

Sustainable and Clean Port Program

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Introduction

UNEP has conducted several environmental programs in Indonesia to improve air quality in Indonesia. Among other is the successful lead phasing out program for gasoline and Clean Feet Management. In doing so, UNEP is also supporting the development of policies to improve fuel quality, to reduce mobile emission, and to develop fuel economy standard for motor vehicles.

Since 2012, UNEP has been initiated program to reduce Particulate Matter Black Carbon PM/BC emissions from transport sector, particularly heavy duty diesel vehicles and engines. As part of such initiative, UNEP is now conducting similar projects in Southeast Asia (ASEAN), Africa, Latin America and the Caribbean including Indonesia.

Port is one of major source of PM/BC. Due to busy activities of heavy engines bot in land and sea sides, port incurs significant black carbon that pollute its surrounding area. In particular Hub port, where many international, domestic, and intermodal transport activities take place. Such port in Indonesia is Tanjung Priok, which serve as hub port for both domestic and international sea transport and now is undertaking massive development that will double its output in the next five years.

Following up the CCAC and ASEAN project, UNEP is initiating a small project to support the reduction of PM/BC emissions related to operations at the Port Tanjung Priok in Jakarta. In doing so, this initiative will help Tanjung Priok port in addressing some other challenging issues such as traffic congestion, energy efficiency, port productivity, multimode logistic system, and relation with the surrounding community. As the busiest port in Indonesia which is undertaking substantial development, there are many opportunity for Tanjung Priok to combine infrastructure and system development with effort to improve environment including air quality and at the same time address mitigate climate change. Such effort could place the port as one of prominent port in the world. Therefore, it is critical to link this initiative with ongoing activities/initiatives at the Port of Tanjung Priok to ensure that all the issues are encompassed and addressed in a comprehensive and sustainable manner under clean ports program.

Many ports around the world implemented **successful program** to reduce port air pollution and improve air quality toward more clean and sustainable port. Those international best practices serve as a reference to implement similar program in Tanjung Priok. In term of pollutant, though those program may not necessarily directly address or related to PM/BC, but the environmentally nature of those programs provide valuable information and lesson learned to reduce PM/BC in Tanjung Priok.

This report provides best examples or information of SCP programs world around aiming to improve air quality in port area. First, it will explore samples of similar air quality improvement program, its objective, rationale, result, and impact. Second, this report will focus on analyzing institutional setup of implementing SCP program. Third, it will show co-benefit created by sustainable and clean port program particularly in term of port efficiency and productivity. Last, it will provide recommendation for implementing SCP program in Tanjung Priok, started with emission inventory of local air pollution such as Nitrogen Oxides (NOx), Carbon Monoxide (CO), Particulate Matters (PM10, PM2.5), Black Carbon (BC) and Sulfur Dioxide (SO2).

1. Air Quality improvement as part of Sustainable and Clean Port (SCP) program

1.1. Definition of sustainable and clean port

The definition of sustainable and clean port program varies depending on the implementation context. Abbott in 2008, as mentioned in Hiranandani (2012), defined sustainable port development as a development concept to balance current and future demand of the port itself. This definition is basically derived from the definition of sustainable development mentioned in the Bruthland report in 1987 and focus on development context. It gives a guideline for how port should approach, plan, and do its development. On the other hand, clean port are refer mostly to action to address environment excesses that port operation might cause such as air quality, climate change, water quality , minimum waste dredging, energy conservation, renewable energy, natural resources, and sustainable environmental management systems. Among those issues, air quality program is the most common action for clean port program around the world (IISS, 2010).

Environment regulation or trade globalization are the main two driving forces behind SCP program. Environment regulation directly drives ports around the world to take action on SCP program. Those regulations were either as a respond to public pressure, an implementation of central government plan, or an implementation of international agreement. Many port in the U.S. initiated SCP program as a respond to public pressure such as law suit from local community. Another port in the U.S. implement SCP program to get grant funding from central government. While in the Europe, Australia, and other developed country, the SCP program was initiated to respond international agreement that requires port around the world to take a real action to safeguard the environment *(AIVP, 2008; MISL, 2009a; Tillman, 2008).* On the other hand, ports in developing countries implement SCP program mainly as a joint program with other ports in developed country or as an implementation of technical assistance from international donor. However, only SCP program that in line with or enhance development agenda of the local port that proven to be sustain in developing world.

1.2. Air Quality improvement in SCP programs

Two of major environment issues for SCP program around the world are air quality and climate change. Different approaches and strategies have been implemented according to variation in regulatory framework, financial and managerial capacity, scale of productivity, operation and business practice, and cooperation between port stakeholders (IISS, 2010).

Air quality is a domestic environmental issue and its mitigation actions are mostly driven by growing concern or regulatory change on its impact to public health. Those regulations require ports sector to implement air quality improvement program through wide range of actions according to various context and need. Among others are 1) emission inventory, 2) use of alternative and renewable fuel, 4) replacement of old polluting equipment, 5) improvement of port process efficiency, and 6) retrofit of old equipment with emission control tools.

While on the other hand, **climate change is a global environment issues** driven by international agenda. Central government, international donors, or global port association pose more pressure to port sector to address climate change issues. Some international cooperation or non-profit organization have been established to streamline climate change issues in the port development,

management and operation. Though actions in climate change program might quite similar to that of air quality, e.g. emission measurement, equipment replacement, and efficiency improvement, but it is different in term of pollution parameters and program design. Climate change program for port sector also require reduction target over certain period of time. It might or might not co paly or contribute to GHG emission reduction target at both national and global level to keep threshold level of carbon in the atmosphere to avoid greater negative impact to the climate. Among others actions for port climate change program are 1) carbon footprint measurement, 2) intermodal green transport system, 3) innovative equipment, and 4) fuel reduction technology.

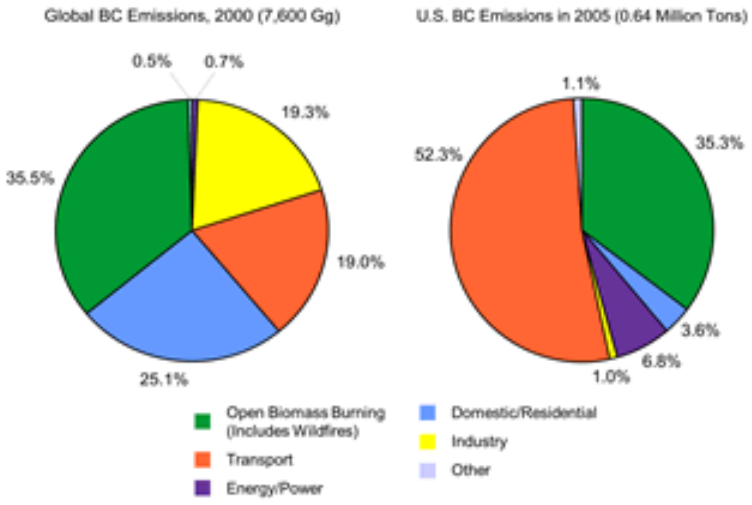
Emission inventory is one most important action in both air quality and climate change program for port. It is deemed as the first step to mitigate air pollution and address climate change, for it give information on the source and magnitude of the air quality problems, as well as help to identify priority of mitigation action. Tools and method to conduct inventory are now developed internationally. As such, emission inventory will provide baseline to monitor change of emission level over time (IISS, 2010).

1.3. Pollutant PM/BC in the SCP program

Black Carbon (BC) **is** particulate matter (PM) that has the strongest light absorbing character. Though it is short lived in the air, because it will quickly change to other substance, but due to its characteristic in absorbing light it has the highest content of energy per mass, that can have energy content millions time higher than CO2.

BC comes from incomplete combustion of fuel (oil, biofuel, and biomass) and being emitted as ultrafine particulate matter ($PM_{2.5}$). In 2000, global BC emission was mainly came from open burning in the first place, followed by domestic/residential in the second place and industry coupled with transport both in third place. In transport and industry sector, BC mostly came from diesel combustion, especially diesel with from high sulfur content.

Figure 1 Global and US BC Emission by sector, 2000



Source: Lamarque et .al 2010

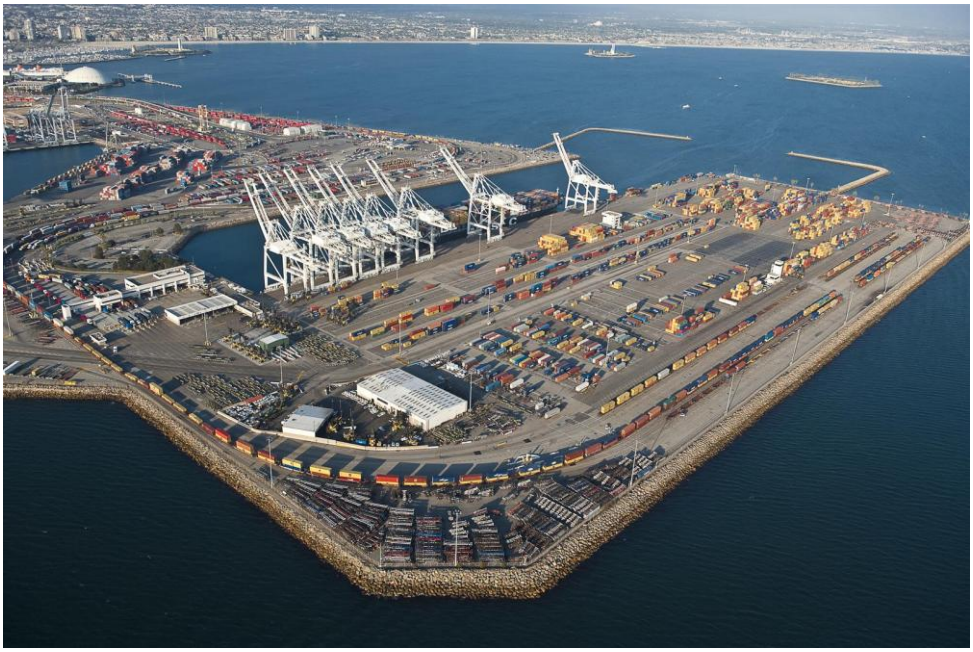
Due to its size and heat absorbing characteristic, **BC harm our health and our climate**. Particulate matter as big as PM2.5 micron is small enough to directly penetrate into blood stream and contaminate it. With energy content millions higher than CO2, it will greatly pollute the atmosphere and impact to our climate.

For long, BC is **neither considered in public health and environmental sector**, **nor included in the climate change actions**. In 2012 Climate and Clean Air Coalition (CCAC) initiated a global action to address BC pollutant, in which UNEP became one of the major player in its implementation. From that time, UNEP initiated program in ASEAN started with inventory of BC emission in major source of BC including port.

2. Air quality program in ports around the world.

2.1. Port of Long Beach

Figure 2. Terminal B of Port of Long Beach



Source: HDR Consulting, 2014

The Port of Long Beach belongs to the City of Long Beach and being operated under land lord regime, where the city lease port terminal to private shipping and stevedoring enterprises. Due to increasing growth of port traffic, the port is under continuous expansion and imposing greater impact to the environment and public health (*Bailey, et. al., 2004*).

In 2005, the port enacted Green Port Policy as a respond to a lawsuit from local community and pressure groups. The policy requires the port to continue obtain economic benefit from international trade while at the same time reduce its environmental impact (Musser, 2008; POLB, 2011d). The policy has change the way the port develops and implements its business culture, fiscal allocation, and stakeholder engagement.

To address air pollution problem, in cooperation immediate adjacent Port of Los Angeles, POLB initiated San Pedro Bay Ports Clean Air Action Plan (CAAP) in 2006 to reduce operation related air pollution by 45% by 2012 while maintaining growth (Ellis, 2007; GreenPort, 2009b; IAPH, 2007; POLB, 2011e).

The CAAP covers actions of 1) Clean Truck Program (TCP), 2) Clean Flag Program, 3) Shore side electricity, 4) Green lease, 5) Cleaner vehicles, and 6) other clean technology adaptation.

Hiranandani (2012) in his study **summarized aforementioned actions to improve port air quality in more detail**. Clean truck program bans diesel truck older than 1998 from operating in the port. As an incentive, trucking companies can get subsidy to replace their truck fleet with fraction of fee for POLB. The program also subsidized procurement of LNG truck that cost almost twice as high compare to modern clean-diesel truck. Green flag program provide discount and environmental certificate to vessel that approach the port with speed less than 12 knots (22 km/h) within 32 km radius from the harbor. The shore-side electricity (cold-ironing) sytem supplies electric power to container ships, so they can shot down their engine while approaching the harbor. Green lease requires terminal operator to implement cold-ironing, clean fuel use in berth facility, and cargo handling replacement to meet more stringent standard of Environment Protection Agency (EPA). Cleaner vehicle program plan to replace all locomotive, retrofit maintenance equipment, use more biodiesel, use CNG fleet, and developing hybrid tugboat. PLOB also initiated adaptation of other clean technologies such as ultra-low sulfur diesel of construction equipment, intermodal transport system (Hiranandani, 2012).

2.2. Port of Los Angeles

Figure 3 Port of Los Angeles

Source: Courtesy of POLA, 2011

The Port of Los Angeles (POLA) is the largest port in the U.S. POLA is situated in the immediate adjacent to POLB and with similar arrangement of land-lordship. It belongs to City of Los Angeles that is appointing five harbor commissioners to oversee the work of POLA Executive Director.

As with POLB, POLA also entitle to CAAP and implement six actions of 1) Clean Truck Program (TCP), 2) Clean Flag Program, 3) Shore side electricity, 4) Green lease, 5) Cleaner vehicles, and 6) other clean technology adaptation. Particularly for cold-ironing, POLA has implemented it to all of its three berths.

In addition to CAAP program, POLA also initiated zero-emission technology for on road heavy duty vehicles and cargo handling equipment. Among other technologies are battery-electric engine, hybrid engine, and fuel-cell.

Regularly, POLA conducts air quality monitoring by setting up real time monitoring equipment placed within port areas.

2.3. Sydney Ports Corporation (SPC), Australia

Figure 4 Port of Sydney

Source: Courtesy of Sydney Port, 2014

Sydney Port Corporation (SPC) was established in 1995 as a privatization of State Maritime Board. It contribute to one third of national container traffic. It is operated under land-lord system and lease terminal and facilities to different companies.

The main action to improve air quality is the utilization of ultra-low sulfur which vastly available. Compare to ordinary diesel, ultra-low sulfur diesel in Australia only content 10% of sulfur. Pollution for construction activities is addressed by water spray, re-vegetation, and the use of construction wind break.

To reduce traffic congestion, SPC use rail between ports as much as possible, and plan to regulate more stringent freight train emission. This is a partial implementation of 2010 Integrated Transport action plan and NSW Government target to increase share of rail freight to 20% of total national and 40% of container movement in the Botany Port.

2.4. Transnet National Ports Authority (TNPA) and Transnet Port Terminals (TPT), South Africa (SA)

Transnet National Ports Authority (TNPA) and Transnet Port Terminals (TPT) are state owned conglomeration, dominating all ports industry in South Africa. It is the only land lord of all ports and dominate all container handling with only minor private sector participate in the commodity handling industry.

Up to 2008, TNPA and TPT reported action to improve health, safety, and environment (HSE) as part of their sustainable port program. Transnet reduce black smoke by not allowing ship to produce smoke in the port confine areas. And conduct reduce dust pollution trough conveyor covers; a sprayer system on stockpiles, online moisture analyzers, surfactant sprays, paving of loading areas, and using dust monitors (TPT, 2008, 2011b).

2.5. Port of Portland

Port of Portland (POP) is a part port distric in Portlan Oregon than consist of both air and sea port. The sea port established in 1891 by Oregon legislative assembly and recreated in 1970 to include Portland Commission of Public Dock established latter in 1910. Since 1970, the port is running under landlord system where the commission leases the terminal to private operators.

The **Port of Portland** started its air quality program by conducting baseline air emissions inventory in 2000 followed by a greenhouse gas emissions inventory in 2009. This action assisted the Port of Portland in identifying and prioritizing actions that can best reduce emissions. In doing so, the Port's emission inventory helped other organizations such **The Climate Registry** a multilevel government cooperation covering states, provinces, and native sovereign nations to set consistent and transparent standards to calculate, verify, and report GHGs.

Subsequently, the Port of Portland takes several actions for improving air quality such as 1) replacement of older equipment to lower emission, 2) reduce emission from the newly procured fleet, 3) retrofitting old equipment with emission reduction devises, 4) shore power for approaching vessel, 4) improvement of rail facility and capacity, 5) regulation of equipment operation during break, 6) and the use of renewable energy.

Port of Portland replace older equipment with hybrid and alternative fuel powered motor. While for reducing emission from the fleet, the port include emission as a procurement criteria for its new fleet. Some collaborations with manufactures and regulation agencies has been taken to pilot retrofit project for old cargo handling equipment with diesel oxidation catalyst and anti-idling features. To reduce emission from incoming vessel, the port provide shore power for tug boat and dredging equipment. The improvement of rail facility reduce congestion and improve train assembly efficiency. The port also regulate operating hour of cargo handling equipment to reduce emission during schedule break.

The implementation of air quality action partly conducted as a joint program with environment authority which provide funding and technical assistance.

2.6. Port of Rotterdam Authority, The Netherland

Port of Rotterdam Authority (POR) is a private company running in commercial basis with the City of Rotterdam as the major shareholder. The port operation is using land-lord system, in which POR as the land owner lease to port operators. It is the busiest port in Europe and leader for cleaner technology and efficient port operation in the region.

PoR conducts environment program as part of their corporate social responsibility defined in their 2007 business plan to ensure port sustainability. The most recent program is part of their reclamation plan to increase 20% of its current area *(PoR, 2008b; Visser, 2007)*.

Strategy to improve air quality was introduced in 2007 covering several action such as 1) the utilization of cleaner fuel (CNG), biomass for , and biofuel 2) development of sustainable shipping index and provision of financial incentive to cleaner ships, 3) shore-based electricity 4) switch to low sulfur fleet, 5) replacement of diesel engines with electric motors or small diesel engines, 5) improving intermodal facilities of road, rail, inland waters, pipelines and barge, and 6) carbon capture for agriculture.

All those action were preceded by emission inventories to identify source and amount of air pollution and greenhouse gas (GHG) emissions generated from port activities.

2.7. Port of Singapore

Port of Singapore operated by Maritime and Port Authority (MPA) of Singapore established in 1996. The authority takes role as port authority, port regulator, and port planner. The port is running under landlord system which MPA lease the port terminal to public and private operators.

Since 2011, the authority initiated Maritime Singapore Green Initiatives to reduce environment impact of shipping and related activities. It consist of three programmes namely 1) Green Ship Programme, 2) Green Port Programme, and 3) Green Technology Programme.

The maritime Singapore Green Initiative targets emission from domestic and international vessel as well as maritime related business. Green ship program target to reduce emission from Singapore flagged ships by providing rebate for initial registration fee and annual tonnage tax for any compliance of green ship qualification. The green port program target to reduce emission from ocean going vessel by providing 15% concession of port dues for any OGV that implement clean emission technology (SOx abatement/scrubber technology of IMO) and utilize cleaner fuel (<1%m/m sulfur content). The green technology program target to reduce emission from maritime related businesses like terminal operations, ship owning and/or operations and harbour craft operations. It provide up to 50% grant for total qualifying costs of green technology.

3. Institutional framework for SCP implementation

From the practices around the world, the implementation of sustainable and clean port program depends on various aspects such as policy, institutional arrangement, and stakeholders.

3.1. Policy approach

There are two approaches of policy framework for SCP program. The first approach is command and control. In some ports, SCP programs are mainly forced by policy requirement imposed by local or national authorities. In this case, the authority set a standard or requirements for port operators and

business players to comply on their own cost. In return, they will get business license or permit. This approach gives no economic incentive for new business practice, on the contrary it could impose higher economic cost for the port operation.

The second is voluntary policy. Under this approach, the authority set standard and requirement then provide economic incentives to port players to comply it. The economic incentive can be form of grant for piloting program implementation, rebate or concession of fees and dues. In this approach though it seems that the port authority loss income partially, but they usually get more incomes from more efficient and more productive port operation. On the other hand, port players will get incentive to initiate investment or implement behavioral change.

3.2. Institutional arrangement

There are two type of institutional arrangement of SCP program. First is led by central government agency to implement either national agenda or international agreement. The central agencies then cooperate with port authority as port land lord that then develop more detail program. The second type of arrangement is local government agency led the program as part of local policy measures. The local agency then cooperates with port authority or directly cooperates with port operator and players.

The main difference between these two arrangements is coverage of cooperation. Because the initiation and leadership of the second arrangement fall to local government, it has better understanding to local context and institutional constellation in the port operation. While in the first arrangement, as part of national wide program, the SCP institutional set up will be constrained by the limited resource and capacity to collaborate with wide range of local stakeholder.

3.3. Port stakeholder

In regard to SCP program, there are many stakeholders involve from program development, implementation and evaluation. And if we stretch quite further, local community and pressure groups in some cases play a very significant role to demand SCP program.

In the port governance side, there will be port regulator, port authority, environmental protection agency, and local government. In the port business and operation side, there will be port operator, equipment manufacture, shipping companies, cargo handling operators, trucking companies, rail freight business, and some business association. In the community side, local community group, port labor union, port driver union, and local environmental NGO.

From the best practices around the world, the implementation of SCP program mainly require good cooperation between stakeholder on the governance and operation side with close engagement from local community.

4. CO-Benefit and side effect of SCP

It is important to identify the impact to port stakeholder, business and operation when implementing SCP. Implication of SCP program implementation could be positive and negative.

4.1. Co benefit:

Co Benefit become important isssue in the port opeartion sector. This is in regards to the fact that port facilities and all the operational activities hold a tremendouslly important economic interest for all the

stakeholder involved. Such condition become even more important when talking about the nation main port. This conditions naturally creates a condition where the stakeholders become extremely reluctant to make changes or improvement that might negatively affect the operation of the port itself. Thus in such condition it is important to get the stakeholders attention, interest and trust by showing them fact that the SCP program posseses Co Benefit other than the direct benefit in environmental sector.

Some of the Co Benefit of the SCP program are as follows :

1. Better efficiency in the port operation process.

Cleaner and much more efficient port equipment operations mean the reduction of energy consumption. This will lead into much better port operation due to reduced cost from enegy consumoption.The opportunity to attain this is especially highlited in the IISS (2010) which explains that it is become very common practice for high volume seaport to replace their older equipments during port upgrade or development with the new one which have better better performance both on efficiency (less energy consumption) and cleaner operation (reduced polutant emission). Another example from The Port of San Diego (IISS, 2010) further shows that the installation of much more efficient plumbing system can reduce the water consumption for about 10% compared to the older system.

2. Better Port productivity resulted from better efficiency in port operation.

The example of this case can be seen the Massachusetts Port (IISS, 2010) where the efforts to increase the port operation efficiency from the reduction of vehicle idling time resulted in the reduction of gate processing time for truck. This means that from productivity side of view, the Massachusetts Port itself can increase the number of trucks they can serve at one time compared to the previous port operation system by implementing the SCP concept.

3. Port Tourism

Clean port program enhance the unique character to the coastal area. Many ports get a great benefits from this by promoting it as tourist destination and developing it surrounding tourism industry. It is not only the natural beauty that worth selling, but also vibrant port activities are also good and unique tourist attraction. In a way, with good management, tourism industry created by clean and environmental sound port is a good revenue stream for the port and could sustain port business and operation.

4.2. Side effect:

It is undeniable that every concept possesses its own merit and weakness. Such things also applied for the SCP concept. Despite of its benefits and Co Benefit, the SCP also posesses some weakness, negative side effects which are still become concern and obstacle for the implementation of the “Green Port “ idealisation in SCP concept.

Some of the side effect for the SCP program are :

1. Investment cost.

This negative side of SCP concept is discussed several times in IISS(2010) report where the investment cost of providing better,cleaner and more energy efficient equipments is so high that it makes

economically unfeasible to implement SCP concept on relatively small port. While it may be posssible to create a wholly new "green" small or medium port, such conditions will make retrofitting existing small or maybe medium port into a green port will be difficult as it will less likely to attract interest from the port operater themselves.

2. Resistance from multiple stakeholders inside port.

It is undenieable that there are many stakeholders operating inside port area. These stakeholders can potentially prevent the implementation of SCP program in the port. Due to this condition IISS (2010) stressed the importance of incorporating all port operation stakeholder in order for the SCP program can be Successfully implemented. IISS (2010) further underlined that innitiatives for the implementation of Sustainable Clean Port to be successful, it require the participations of all tenants operating inside the port area and jurisdiction.

5. Recommendation for Tanjung priok to address PM/BC

5.1. Piloting the initiative.

The initiative to conduct emission inventory in Tanjung Priok Port is very timely. Since 2012, Indonesia Port Company (IPC) as port operator of Tanjung Priok initiated sustainable port program. The latest effort is plan to implement ISO 14000 on environment quality. In the near future, IPC decided to pilot new policy and practice to improve environmental condition starting at Terminal Operation III (TO3). This terminal serves as a pilot case for the port in adopting new.

Figure 5. Layout of Port of Tanjung Priok

For long, central and local governments has been implementing air quality program in the Port of Tanjung Priok from ambient air quality monitoring to emission test of pollution sources in the port area. None of them include emission inventory.

Learning from experiences from other ports, the emission inventory project can benefit the Port of Tajung Priok in two ways. First, it will enhance the ongoing port policy in environment agenda. Second, it

will provide the port with more comprehensive understanding on the pollution source as a basis to set priority of actions to improve air quality.

5.2. Approach for Project initiation

There are three approaches to initiate emission inventory project in the Port of Tanjung Priok, which all three could be complementing to each other. First approach is to use port business and operation process as an entry point to initiate emission inventory project. In this approach emission inventory method and data collection will be designed based on port business and operation process. Any potential source of pollution are identified when the business process is traced and documented. This approach assuming that any inefficiency in port business and operation process will emit more emission. Develop Baseline and basic method for PM/BC emission inventory. Engage stakeholder, work together and develop common vision for PM/BC mitigation

The second approach is to use port ongoing environment program as an entry point to initiate emission inventory project. In this approach, emission inventory will be combined with current air quality monitoring program, conducted by MoE and BPLHD Jakarta, to evaluate the ongoing and prioritize incoming air quality program. The methodology and data collection for emission inventory will be designed to be in line with the ongoing air quality program. Since that Tanjung Priok is now only have ambient air monitoring as then one and only air quality program, there is great opportunity for the emission inventory to enhance the program.

The third approach is to use port efficiency and productivity as an entry to initiate emission inventory project. This approach is quite similar to the first approach with different scope. As the Port of Tanjung Priok is growing in term of throughput and productivity, business and operation challenges can no longer be address only within port area. As shown by many port around the world that multimodal system will improve port efficiency and productivity. In this approach the emission inventory initiative should show the co-benefit of mitigating air pollution to overall port efficiency and productivity. Start from the use of diesel heavy vehicle and engine in major port activities that significantly affect port efficiency and productivity.

Glossary

ASEAN	: Association of Southeast Asian Nations
BC	: Black Carbon
BPLHD	: Badan Pengelolaan Lingkungan Hidup Daerah
CAAP	: Clean Air Action Plan
CCAC	: Climate and Clean Air Coalition
CNG	: Compressed Natural Gas
CTP	: Clean Truck Program
EPA	: Environment Protection Agency
GHG	: Greenhouse Gas
HSE	: Health, Safety, and Environment
IMO	: Infrastructure Maintenance and Operation
IPC	: Indonesia Port Company
LNG	: Liquefied Natural Gas
MoE	: Ministry of Environmental
MPA	: Maritime and Port Authority
NGO	: Non-Governmental Organization
OGV	: Ocean-going Vessel
PM	: Particulate Matter
PM_{10}	: Particulate Matter up to 10 micron
$PM_{2,5}$	: Particulate Matter up to 2.5 micron (ultrafine particulate matter)
POLA	: Port of Los Angeles
POLB	: Port of Long Beach
POP	: Port of Portland
POR	: Port of Rotterdam Authority
PUSTRAL-UGM	: Pusat Studi Transportasi dan Logistik – Universitas Gadjah Mada
SCP	: Sustainable and Clean Port
SPC	: Sydney Port Corporation
TNPA	: Transnet National Ports Authority
TO3	: Terminal Operation III
TPT	: Transnet Port Terminals
UNEP	: United Nation for Environmental Protection

References

Abbott,at Hiranandani (2012). Sustainable Development in the Maritime Industry: A Multi-Case Study of Seaports

AIVP, 2008; MISL, 2009a; Tillman, 2008, at Hiranandani (2012). Sustainable Development in the Maritime Industry: A Multi-Case Study of Seaports

Breitling, et al., (2010). ASEAN / GTZ Project: Sustainable Port Development in the ASEAN, RegionReport on the Initial Review of Safety, Health and EnvironmentalManagement at Tanjung Priok Port 22 - 25 March 2010

Bailey, et. al., 2004, at Hiranandani (2012). Sustainable Development in the Maritime Industry: A Multi-Case Study of Seaports

Ellis, 2007; GreenPort, 2009b; IAPH, 2007; POLB, 2011e, at Hiranandani (2012). Sustainable Development in the Maritime Industry: A Multi-Case Study of Seaports

Martin Cox, (2011). The Los Angeles Quartet picture taken on January 5th 2011 http://maritimematters.com/wpcontent/uploads/2011/01/portoflaJan_5_2011portlashot.jpg

Musser, 2008; POLB, 2011d, , at Hiranandani (2012). Sustainable Development in the Maritime Industry: A Multi-Case Study of Seaports

Lamarque et .al (2010). BC Emissions by Major Source Category, 2000

Port of Rotterdam, 2008b; Visser, 2007, at Hiranandani (2012). Sustainable Development in the Maritime Industry: A Multi-Case Study of Seaports

Sydney Port (2014). http://www.australiakorea50years.com/business/business-directory/item/488-sydney-ports-corporation.html

The International Institute for Sustainable Seaports Global Environment & Technology Foundation (2010). Environmental Initiatives at Seaports Worldwide: A Snapshot of Best Practices

Transnet Port Terminal, 2008, 2011b, at Hiranandani (2012). Sustainable Development in the Maritime Industry: A Multi-Case Study of Seaports