CHEMICAL ENGINEERING TRANSACTIONS
VOL. 56, 2017
A publication of AIDIC
The Italian Association of Chemical Engineering
Online at www.aidic.it/cet
Guest Editors: Jiří Jaromír Klemeš, Peng Yen Liew, Wai Shin Ho, Jeng Shiun Lim

ISBN 978-88-95608-47-1; **ISSN** 2283-9216
DOI: 10.3303/CET1756115

Framework for Greenhouse Gas Accounting towards Green Port

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Several ports worldwide have been implementing green port initiatives such as switching to shore power or renewable energy to replace fossil fuel usage, control vessel speed reduction in order to meet Emissions Reduction Standard target. As for Malaysia, the Johor Port Association (JPA) has launched a Green Port Policy (2014-2020) that serves as a guide for decision making and establishing a framework for environmentally friendly port development and operation. However, this policy is lacking of empirical analysis to illustrate port's environmental sustainability performance. Due to this limitation, weak performing indicator is also difficult to identify for improvement of the port performance. This study discusses a comprehensive and systematic green port framework to evaluate an environmental performance that would be able to highlight the potential improvement for the port.

1. Introduction

In line with the international effort under the United Nations Framework Convention on Climate Change (UNFCCC) on climate change, nations are focused on keeping the average rise in global temperature to below 2 °C compared to their pre-industrial levels. In Malaysia, 26 pilot organisations are currently engaged with MYCarbon's greenhouse gas (GHG) reporting program since MYCarbon was officially launched in 2013. The 26 pilot organizations include those from transportation, energy, telecommunication, banking, and several other sectors but no ports are involved in this program yet. This shows that the awareness of climate change among port authorities in Malaysia is still low and thus they do not participate in emission reduction actions.
In the current reporting system in Malaysia, there is no standard framework for carbon accounting specifically for ports. This would lead to inconsistent methods of reporting that would in turn complicate mitigation efforts that rely on consistent data to be compared year by year. This situation would make reporting a burden for port authorities and governments and could discourage ports to participate in carbon accounting. Hence, a framework for GHG accounting at ports should be developed to allow a systematic and quantitative evaluation of the GHG emissions at port and enable mitigation efforts be planned and conducted.

2. Green Port Initiatives Worldwide

In their study, Roh et al. (2016) identified the criteria that are necessary in sustainable port development. They found that a sustainable development port should have internal and external environmental management, optimised operation planning, cost savings, internal social programmes, environmental collaboration with shipping companies, external social programme, and external evaluation collaboration. Greenhouse gas accounting would play a big part in making a port sustainable in the aspect of internal and external environmental management.
Presently, several ports worldwide have started implementing initiatives towards green port with the objectives of protecting the environment and minimising environmental impacts caused by port activities.

Please cite this article as: Jusoh L.S., Hashim H., Lim J.S., Mansor N.N.A., 2017, Framework for greenhouse gas accounting towards green port, Chemical Engineering Transactions, 56, 685-690 DOI:10.3303/CET1756115

The policy guidelines are categorised into five different aspects, namely clean shipping, shore power, port emissions, CO_2 footprint, and use of renewable energy. Table 1 shows the different aspects that have been taken into consideration by each port.
Under the policies mentioned in Table 1, specific programmes have been designed by the ports to support the said policies. Some of the programmes implemented are listed in Table 2 below.

Table 1: Aspects covered by the port policies

Port	Initiatives				
	Clean Shipping	Shore Power	Port Emissions	Use of Renewable Energy	CO_2 Footprint
Port of Long Beach, Los Angeles, USA (Port of Long Beach, n.d.)	√	√	√	√	√
Port of Baku (Port of Baku, 2016)					√
Main ports in India (Energy Digital, 2016)				√	
Korea Ports (Park, 2010)				√	√
Port of Singapore (MPA Singapore, 2016)	√		√		
Johor Ports (JPA, 2014)			√		

Table 2: Programmes carried out by ports to support their green port policies

Port	Programme	Target/Implementation
Port of Long Beach, Los Angeles (Port of Long Beach, n.d.)	Clean Air Action Program	Reduce health risk to communities surrounding the ports. Targets based on San Pedro Bay Standard: - Health Risk Reduction Standard Reduce port-related cancer risk by 85% by 2020. - Emissions Reduction Standard By 2023, reduce DPM emissions by 77 %, NO_x by 59 %, and SO_x by 93 %.
	Green Flag Program	Encourages vessel operators to slow down to 12 knots or less within 20 or 40 nautical miles of Point Fermin.
	Green Ship Incentive Program	Rewards operators that bring the newest and cleanest ships to the port
Main ports across India	Set up of renewable energy projects	Installation of almost 83 MW of solar photovoltaic panels at 12 major ports in the country. Currently, 7 MW has been installed, a large part of it being at Visakhapatnam Port and another 16 MW will be commissioned by March 2017. (Energy Digital, 2016) Wind energy projects at Kandla Port, V.O. Chidambaranar Port, and Kamarajar Port totalling up to estimated 70 MW. (The Times of India, 2016a)
	Use of biodiesel	At Haldia Dock Complex, railway engines, trucks, and other vehicles are run on biodiesel made at the palm oil refineries located at the port. (The Times of India, 2016b)
Singapore (MPA Singapore, 2016)	Green Port Programme	Ocean-going ships using approved abatement/scrubber technology or burn clean fuels (with sulphur count less than 1.00 % m/m), will be granted reductions in port dues.
	Green Technology Programme	Encouraging the development and adoption of green technological solutions/systems by providing a grant of up to 50 % of total qualifying costs. This is capped at S$2 million per project and is increased to S$3 million per project for those that can achieve reduction emissions more than 20 %.
	Green Ship Programme	Singapore-flagged ships that help to reduce carbon dioxide and SO_x emissions will be rewarded with tax and fee reductions.

In Malaysia, the JPA Green Port Policy comprises of three elements, namely Environment, Community engagement, and Promote Sustainability, with Air Quality being covered in the Environment element. The overall objective of the Air Quality aspect is to reduce harmful air emission from port activities and from

vessels (JPA, 2014). This policy however, is lacking of empirical analysis to illustrate port's environmental sustainability performance.

3. Background on Greenhouse Gas Inventory

The Intergovernmental Panel on Climate Change (IPCCC), an international body for assessing the science related to climate change, was established by the World Meteorological Organization (WMO) and United Nations Environmental Programme (UNEP) in 1988. It was set up to provide assessments of the scientific basis of climate change, its impacts and future risks, and options for adaptation and mitigation for policymakers.

Later on, in 1992, at the Earth Summit in Rio De Janeiro, the UNFCCC was established. Its objective is to stabilise greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. The UNFCCC is the parent treaty to the Kyoto Protocol. The Kyoto Protocol is an international agreement adopted in Kyoto, Japan in 1997. It commits its Parties by setting internationally binding emission reduction targets. The protocol holds on to the principle of "common but differentiated responsibilities" and puts more burden on developed nations seeing that they are mainly responsible for the current high levels of GHG emissions in the atmosphere.

When it comes to the matter of greenhouse gas inventory, the Greenhouse Gas Protocol (GHG Protocol) acts as a guidance for almost every GHG standard and program in the world. The GHG Protocol was initiated by the World Resource Institute (WRI) and World Business Council for Sustainable Development (WBCSD) as it was seen to be necessary to cater to the evolving climate change policy. In Malaysia, the Ministry of Natural Resources and Environment (NRE) with support from the United Nations Development Program (UNDP) has developed MYCarbon, a National Corporate GHG Reporting Programme (MYCarbon GHG Guidelines).

4. Greenhouse Gas Inventory at Ports

In 2008, under the request of the International Association of Ports and Harbors (IAPH), its Port Environment Committee, in consultation with regional Port Organisations, drew up the C40 World Ports Climate Declaration as a guide for the ports to combat global climate change and improve air quality. Later that year, the World Port Climate Initiative (WPCI) was officially launched with the goals to deepen the support for WPCI among the world's ports, promote information sharing, establish a framework for CO_2 footprint inventory and management, establish Environmental Ship Indexing and increase support for this measurement, and organise global support for WPCI goals among regional and global organisations.

According to WPCI (2010), ports can be divided into two types in terms of ownership and responsibility. Landlord Ports are ports that own the land or are given the responsibility for managing the land on which the port is located. On the other hand, Operating Ports are ports that develop, own, and operate the marine terminal facilities and the equipment used on the terminals. Some ports, however, may be considered as both types. The determination of the type of port is important to be done prior to carrying out the carbon footprinting in order to be able to determine what emissions fall under the port's responsibility. The GHG Protocol states that emissions are categorised into three different scopes; scope 1 – direct emissions from the organisation's activities and owned buildings and transports, scope 2 – indirect emissions from purchased utilities, and scope 3 – other indirect emissions (WRI, 2013). In the specific case of a port, the emissions are divided into the scopes as shown in Table 3 and is illustrated in Figure 1.

A GHG inventory can be drawn up for many reasons. And these reasons would determine the level of detail and accuracy that an inventory needs to be. Therefore, it is important to determine the motivation behind the GHG inventory earlier on. According to WPCI (2010), there are three different approaches that ports can take in developing their inventory. They are Activity-Based approach, Surrogate-Based approach, and Hybrid approach. The Activity-Based approach uses source specific data, the Surrogate-Base approach uses surrogates to estimate activity and/or emissions, and the Hybrid approach uses combinations of the two former approaches. The flow of each of the approach is shown in Figure 2.

Apart from the WPCI carbon footprinting guideline, the United States Environment Protection Agency (USEPA) have also provided a guideline for port emissions inventory. However, the guideline from USEPA is focused on emissions from mobile sources only that include ocean-going vessels, harbour craft, cargo handling equipment, and rail and heavy-duty trucks.

Table 3: The different scopes of emissions at ports (WPCI, 2010)

Scope 1	Scope 2	Scope 3
Port Direct Sources Sourced directly under the control and operation of the port administration entity and include port-owned fleet vehicles, port administration owned or leased vehicles, buildings, port -owned and operated cargo handling equipment, and any other emissions sources that are owned and operated by the port administrative authority.	Port Indirect Sources Port purchased electricity for port administration owned buildings and operations. Tenant power and energy purchases are not included in this scope.	Other Indirect Sources Tenant operations and include ships, trucks, cargo handling equipment, rail locomotives, harbour craft, tenant buildings, tenant purchased electricity, and port and tenant employee commuting.

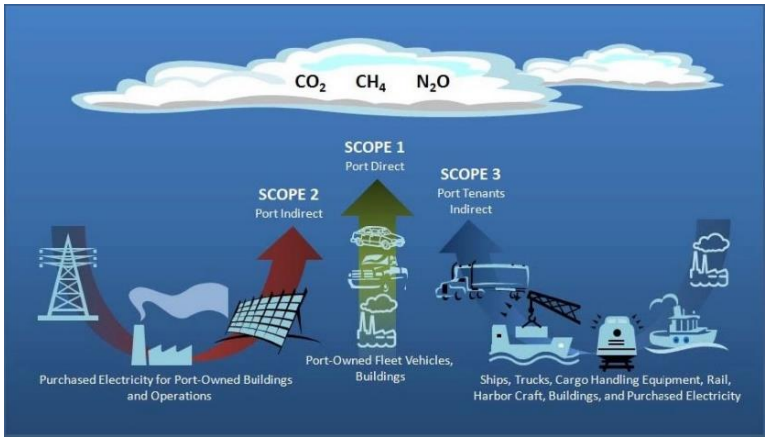

Figure 1: Port-related emissions sources (WPCI, 2010)

5. Framework Development

The process of developing this new framework consists of three main steps, namely data gathering, system formulation, and implementation of the proposed framework. The first part, data gathering, involves collecting data on greenhouse gas accounting in general from GHG Protocol, IPCC, MYCarbon as well as port specific information from WPCI, USEPA. Apart from that, information from the port such as port area (area under their management and control), port activities, and emission sources will also be collected.

System formulation includes defining boundaries, selection of appropriate calculation approach, and GHG emission analysis. There are three types of boundaries that need to be determined before carrying out GHG reporting. They are geographical boundary, organisational boundary, and operational boundary. The geographical boundary determines what area is covered by the emissions report as well as default values to be used in the calculation. Organisational boundaries can be determined by three different approaches. The first one being equity share approach by which an organisation accounts for GHG emissions according to its share of equity in the operation. The other two approaches are categorised under control approach. In this type of approach, the GHG that an organisation accounts for is determined by whether it has control over the operations or not. It can be either based on financial control or operational control. Operational boundaries of the organisation determine which activities that the organisation is responsible for the GHG emissions. These emissions are then categorised into scopes, scope 1, scope 2, and scope 3.

Figure 3 shows the five stages of the proposed green port GHG accounting framework. Once the process has reached stage 3 of the framework, if any weak performing indicators are identified (stage 4), recommendations for improvements will be proposed and the process will loop back to stage 2. On the other hand, if no weak performing indicators are identified, it will proceed to stage 5, establishment of the new GHG profiling.

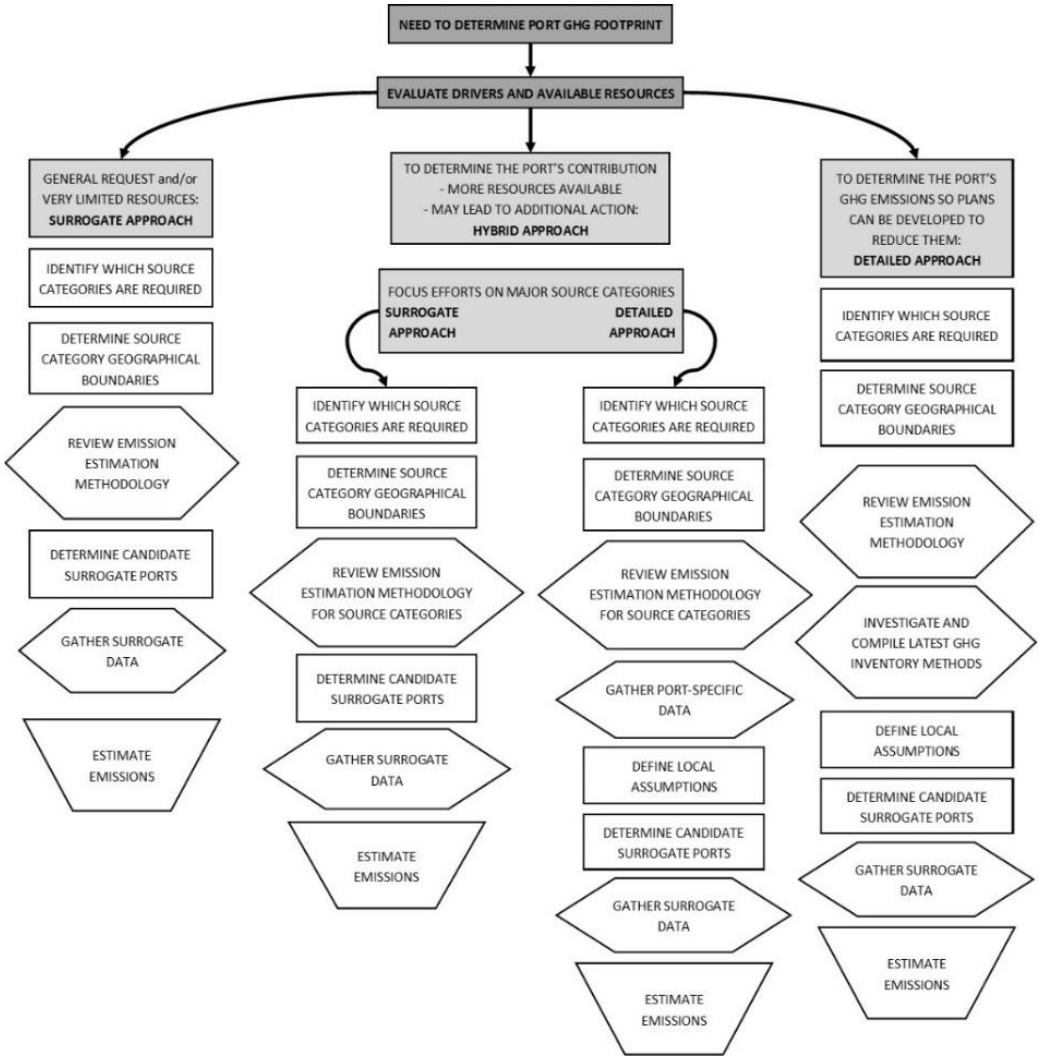

Figure 2: Process flow diagram for GHG emission assessment for port (WPCI, 2010)

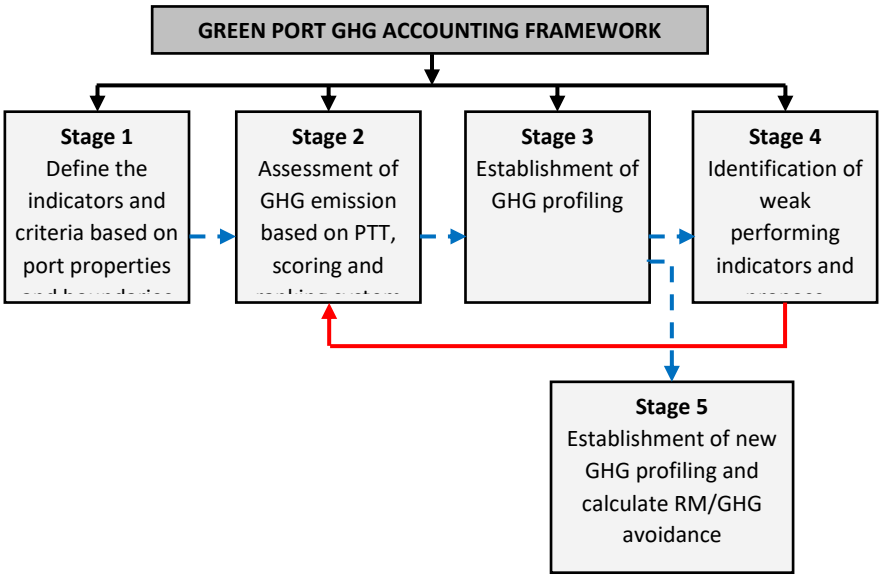

Figure 3: Green port GHG accounting framework

6. Conclusion

Malaysia has already mapped out MYCarbon as a specific guide for GHG accounting in Malaysia. However, this guideline is made by referring to the Corporate Standard by GHG Protocol which is more focused on GHG accounting at the industries sector. A guideline specific for carbon accounting at ports is yet to be drawn out. In order to ensure uniformity in carbon accounting inventories across the nation, the port-specific guideline should be made in accordance to the MYCarbon guidelines as well as GHG Protocol. The existing policies and programmes highlighted in this paper together with the stages of framework development should be considered as guidance in the development of the framework for GHG accounting at ports in Malaysia.

Acknowledgements

This study was supported by the Ministry of Higher Education (MOHE) Vot. No 7301.4B145 and 2546.15H01 and the JICA SATREPS programme.

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