Green EFFORTS

Green and Effective Operations at Terminals and in Ports

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Executive summary

The calculation of a terminal's carbon footprint is not a trivial task. Currently, standards for transportation hubs like ports or terminals are missing and only recommendations on the basis of other guidelines exist. This paper will give an overview of the current state of standards and guidelines that are applicable for the calculation of a terminal's carbon footprint. Issues of apportionment come up for which only recommendations exist today. This regards definitions of scopes 1 to 3 according to the Greenhouse Gas Protocol as well as issues of what is counted as a port process. In the course of the paper, these topics will be discussed and a set of suggestions for closing open gaps will be made. More specifically, suggestions for the definitions of process scopes are made to establish boundaries between processes domains in a port and on a terminal to be able to assign energy consumption and resulting carbon footprints to certain processes and emission sources. A process related approach will be introduced and we will argument why we think this is the most favourable and the most practical way for doing carbon footprint calculations in ports. We distinguish between emissions that are climate-relevant under the GHG-Protocol and other air pollutants and come up with an approach suggestion for each of the emission kinds.

1 Introduction

As the title of this deliverable *"Transfer (interfaces) of carbon footprint responsibility between terminal, port and transport modes"* suggests, the purpose of this paper is to discuss and make suggestions about the assignment of CO_2 emissions to certain entities of the port. It is important to state that the description of tasks and deliverables of this work package talk about the Carbon Footprint. The Carbon Footprint is a worldwide known and the most widely used measure to identify impacts on the climate and environment due to human actions. It contains the measurement of climate relevant greenhouse gases, like CO_2, methane and others. However, for the shipping industry and as it regards this project – for ports in particular – not only greenhouse gases but also other air pollutants are of high interest. Hence the need for defining methods of measurement, interfaces and responsibilities also applies for air pollutants other than GHG. In fact there have been several calls for recording particulates due to their high risk for human lives.

We will discuss the similarities and differences of both emission categories with regard to ports and terminals in more details and will - based on these results – suggest a way to define a way for measuring the carbon footprint for ports and terminals on the one hand, and for measuring other air pollutant emissions on the other hand.

2 Greenhouse gas emissions and air pollutants

As in the past several calls also for taking other air pollutants than GHG into account, we want to take a closer look on the –for this purpose – most important air pollutants and their characteristics. Sometimes air pollution is referred to greenhouse gases caused by humans, sometimes to substances like NOx or particulate matter.

2.1 Air pollutants

Air pollution can be defined as a change of the natural air composition, especially by particulates, harmful gases, aerosols, steams and odorants. Some of them do not occur naturally in the air, like particulate matter, for example, whereas some of them are a natural element of the air. Air pollutants can have harmful effects on the environment and/ or on humans.

2.2 Greenhouse gases

Greenhouse gases are defined as gaseous radiation effecting gases which cause the greenhouse gas effect. It is distinct into a natural greenhouse gas effect, without whom no life on earth would be possible, and the anthropogenic greenhouse gas effect, which causes the earth temperature to increase, with all its side effects. Greenhouse gases have a global effect, independent of where they are emitted. By humans excessively emitted greenhouse gases that are actually a natural component

of the air are also defined as air pollutions as it causes a change in the natural air composition.

The table below lists the emissions that are relevant to a port, their effects and geographic relevance:

Emission	Relevant to climate/GHG	Harm to humans or environment	Geographic scope of effect
CO_2	X		global
CH_4	X		global
N_2O	X	Eutrophication, ozone depletion	local, regional
CO		Toxic , respiratory poison	regional
SF_6	X		global
HFCs	X		global
PFCs	X		global
SO_x		Toxic, acid rain, condensation nucleus	Local, regional, global
NO_x	X	Smog, acid rain, condensation nucleus, central to formation of tropospheric ozone which causes premature deaths, and to formation of PM	Local, regional, global
PM	X	Change incoming solar/outgoing terrestrial long-wave radiation	Local, regional, global

Table 1: Air pollutant emissions

2.3 What matters for the port

Two kinds of air pollutions are directly interesting for the port and its processes. On the one side the carbon footprint is an issue for ports like it is for any other business. How the carbon footprint for ports can be calculated is currently not finally decided. Some open questions like defining limits of port processes or geographical borders are still to be solved. Emissions that are included in carbon footprint calculations have a global impact on the greenhouse gas effect independently of where they occur.

On the other hand other air pollutants that result from the port businesses and processes and that have an local effect are of interest as ports are very often located in densely populated areas, e.g. close to cities. As many of the air pollutants have a

harmful effect on human health and the environment, efforts exist to minimize these emissions. Therefore, the local emissions of these substances are of interest and have to be measured.

As explained above the measurement of GHG emissions and the measurement of other air pollutants that are especially of local interest are two different concepts. In the following paragraph we suggest two separate approaches that account for the differences in the concepts.

2.4 Two concepts for air pollution measurement

The main characteristic, that all GHG share is their effect on the natural greenhouse effect and the climate. The effect of greenhouse gases is a global one for which reason it does not matter where GHG occur. Important is the amount of globally emitted greenhouse gases.

Therefore, we suggest a calculation approach for GHG of ports that is driven by practicability.

A port is a complex formation where many separate entities operate, many processes overlap and its scope and size depend much on random definitions and / or historical and political conditions that cannot be influenced by a port today. A carbon footprint calculation, however should be independent of

- Geographical conditions and its resulting hinterland traffic,
- The legal structure of a port or
- The organizational structure of a port,

e.g. whether the port is organized according to a landlord model or whether it is fully privately or publicly owned as these above mentioned issues are not in the scope of influence of the port.

The geographic conditions are given and grown over decades and todays ports and port authorities can only marginally influence this factor. Hence it is not or only very little possible for a port to influence the hinterland traffic, landward as well as seaward. For this reason, the whole hinterland traffic shall not be included in the carbon footprint calculations of a port. As hinterland we define the occurring traffic and freight movement inbound to and outbound from a port. That means that also the inbound and outbound traffic that occurs within the port area is not assigned to the port but to the transport operator directly.

In contrast, a port can well influence processes within the port. All processes that are port related and occur as port relevant processes shall be recorded and assigned to the carbon footprint of a port. This means that in contrast to inbound-and outbound transport processes, transport processes that occur within a port shall be assigned to a ports CF.

For the other air pollutants, that are not categorised as greenhouse gases another issue is more important. Although some of these emissions have also a global

pollution effect and even might have some effect on the global climate, the regional concentration in the air, water or soil of the logal or regional environment is most important. The emissions of particulate matter can serve as an example. Although particulates also have an influence on the natural global greenhouse effect – they can impact the climate by particles changing incoming solar and outgoing terrestrial long-wave radiation – science is not sure yet which effect predominates - the regional or local concentration of particulate matter in densely populated areas is what worries. Particulate matters are harmful to human health and can cause cancer and cardiopulmonary diseases. To evaluate whether certain upper limits are exceeded, local measurement and monitoring procedures – if necessary on a daily basis like for PMs – are required. As a role model efforts of some cities that introduced environmental zones in certain areas can be taken. In these areas only cars are allowed to enter that fulfil certain emission specifications. The emissions on several measurement points in the city are then measured on a daily basis (see Case study 1 of deliverable D8.3 *Comparison of energy management in transport in general and in the port sector*).

As a conclusion we state that for calculations of the carbon footprint and the measuring and monitoring of other air pollutants separate concepts shall be applied and each of them has other implications on setting boundaries or on the definitions on what is a relevant port process.

Below several standards are introduced for socially and environmentally sustainable behaviour and carbon footprint calculation.

3 Current calculation of carbon footprint for ports and terminals

A variety of standards exists on describing guidelines for a company's favourable socially and environmentally sustainable behaviour and for carbon footprint accounting. The most relevant standards form a comprehensive framework:

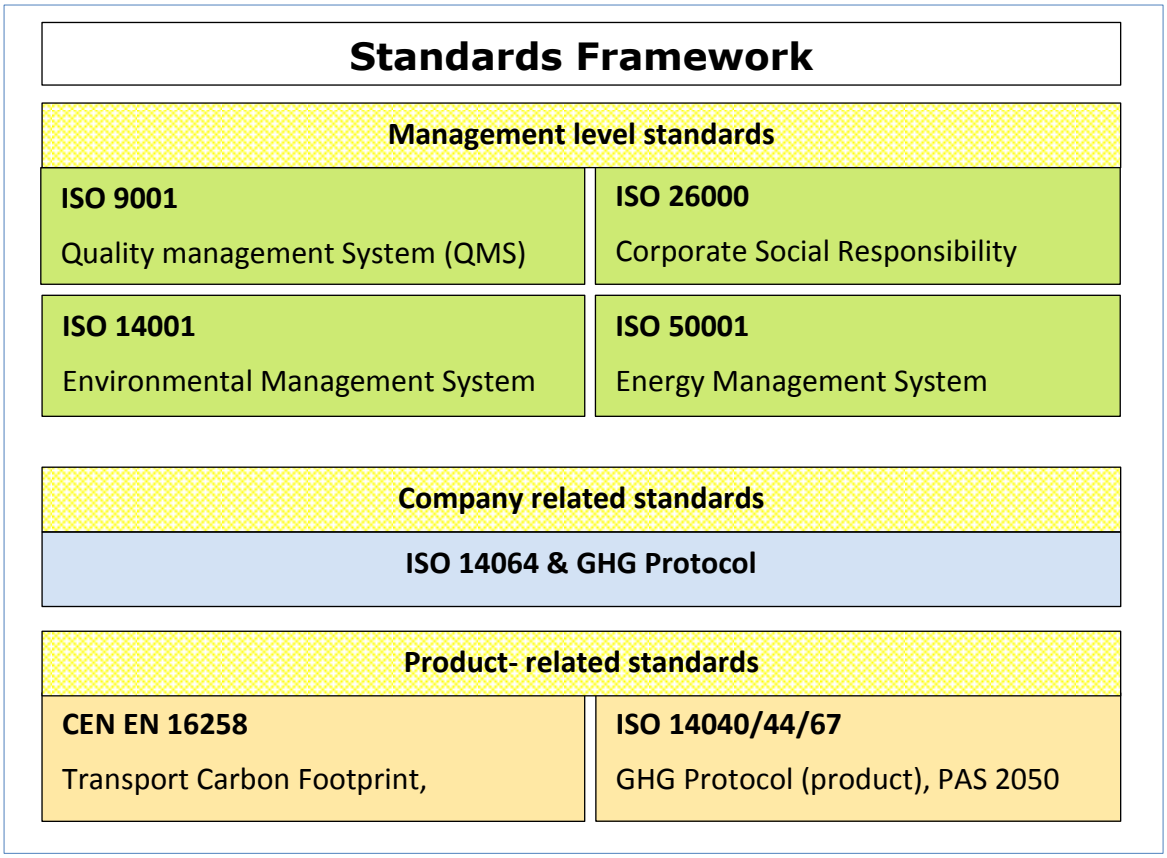

Figure 1: Frameworks for carbon footprint calculation

ISO 9001 and ISO 26000

The two standards ISO 9001 and ISO 26000 define a general framework which describes requirements of Quality Management Systems and Corporate Social Responsibility (CSR).

ISO 14001

Environmental management is described in the ISO 14001 standard which provides a basis for ensuring the sustainable environmental compatibility of

products and processes as well as the behavioural pattern of employees and stakeholders. The standard is applicable to manufacturing companies as well as to service enterprises and operators. ISO 14001 standard is a general standard and does neither include explicit specifications for the transportation sector nor defines specific requirements for transportation hubs, warehouses, etc.

ISO 50001

The setting up or installation of energy management systems for organisations and enterprises is covered by the ISO 50001 norm. This global standard aims to support enterprises to increase their energy efficiency by installing relevant state-of-the-art methodology or techniques. Unutilized energy efficiency potentials shall be used to lower pollutant and greenhouse gas emissions as well as exposition levels. Moreover, the standard aims to implement energy management as a strategic target that shall provide the applying organization with competitive advantages and with a positive image due to saved energy resources and decreased emissions.

ISO 14064

The ISO 14064 standard provides private and public institutions with a basis for the corporate carbon footprint (CCF) calculation to determine an organization's greenhouse gas emissions. The standard instructs organizations to capture all climate-relevant emissions and refers in many places to the GHG protocol. ISO 14064 is divided into 3 parts:

- ISO 14064-1 (2006) describes the basis and requirements for the quantification, monitoring and reporting of greenhouse gas emissions for companies.
- ISO 14064-2 (2006) describes the basis and requirements for quantification, monitoring and reporting of greenhouse gas emissions for climate protection projects.
- ISO 14064-3 (2006) describes the basis and requirements for validation, verification and certification of greenhouse gas emissions according to ISO 14064-1 and 2.

The ISO 14064 is part of a whole set of standards dealing with issues related to environmental management and concerning production processes and services.

The Greenhouse Gas Protocol

The Greenhouse Gas Protocol (GHG Protocol) is the most widely used international accounting tool to quantify and manage greenhouse gas emissions of companies and organisations. It covers 3 scopes of processes that cause emissions.

Scope 1:
Scope 1 covers all greenhouse gas emissions that occur directly due to the enterprise's business activities. This includes GHG emissions from

- combustion of stationary sources like boilers
- combustion of non-stationary sources, e.g. company-owned vehicle fleet
- production or from chemical processes and volatile GHG emissions

Companies calculating their carbon footprint according to the GHG Protocol usually only calculate Scope 1 emissions. The Scope 1 covers the Tank-to-wheel emissions: emissions that relate directly to the process but not to upstream processes for providing a product, e.g. fuel, chemical pre-product (GHG protocol).

Scope 2:
Scope 2 covers all indirect GHG emissions which occur for the supply of energy for enterprises, that is all GHG emission that are caused by the energy providers for the supply of electricity or long-distance heating.

Scope 3:
Scope 3 covers all remaining business-related GHG emissions of enterprises. Among others these include GHG emissions from outsourced operations, GHG emissions caused by waste disposal and recycling and GHG emissions caused by business trips and commuting traffic.

The graphic below provides an intuitive and comprehensive overview of the classification of the several activities and their scope assignment:

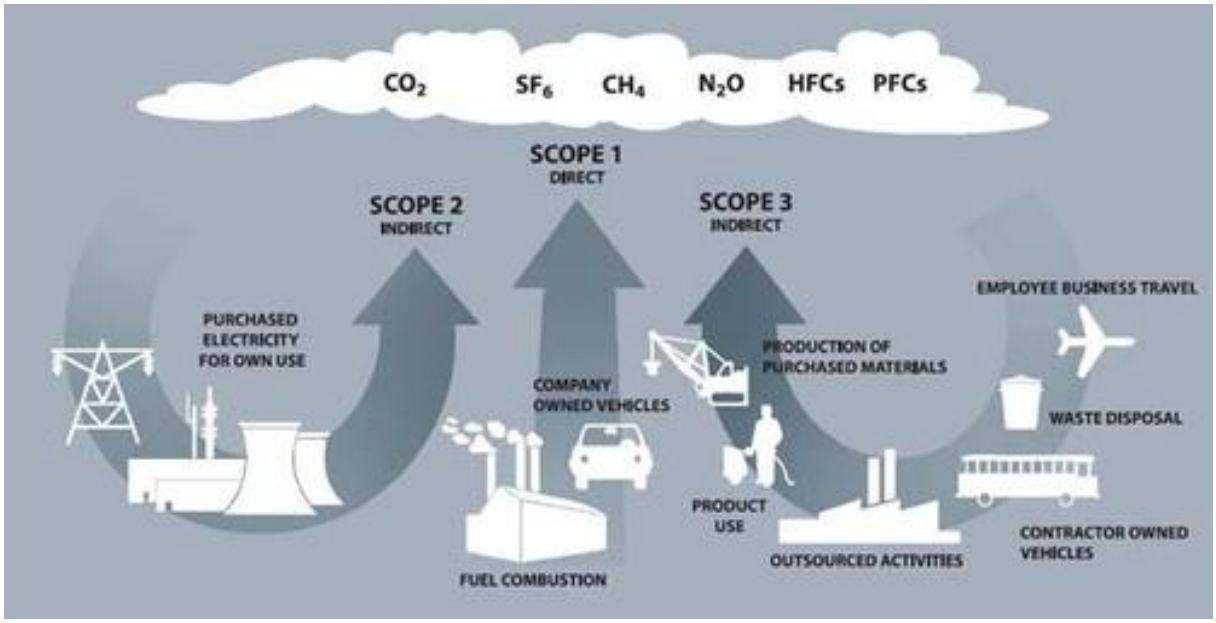

Figure 2: General classification of activities causing emissions according to the Greenhouse Gas Protocol. (Source: http://www.co2ncept-plus.de/strategien/carbon-footprint/corporate-carbon-footprint/greenhouse-gas-protocol/#c1237)

CEN EN 16258

If one wants to know the carbon footprint of a product or a service the CEN EN 16258 is the standard to apply. The CEN EN 16258 is a new product-related European standard which sets a basis for the calculation of the CF per produced unit of material output or per provided service unit for transport services for freight and passengers. It currently covers the transport carriers truck, railway, ship and airplane. It does not cover cargo distribution centres and / or transhipment centres and buildings yet. This, however, is planned as a next step. Until then, emissions for the processes and business activities currently not included in the standard can be calculated separately.

As long as product-related standards for cargo distribution centres and / or transhipment centres are missing, such calculations can be done alternatively with the calculation of the total carbon footprint according to the *Corporate Accounting and Reporting Standard* of the Greenhouse Gas Protocol. As this is still the total carbon footprint, the conversion into the product level is still missing to comply with the CEN EN 16258, which is a product-related calculation tool though. By dividing the electricity consumption with the number of containers the

consumption per container is calculated. Factors for accounting for 40 foot or 20 foot containers can be applied to calculate the "per-container" energy consumption.

Though this is a method to start with, it is to say that such an approach is only a rough estimation, which still leaves room for improvements in terms of accuracy.

The CEN EN 16258 standard specifies general principles, definitions, system boundaries, calculation methods, apportionment rules (allocation) and data recommendations for the standardized calculation of energy consumption and GHG emissions related to transport services.

The CEN EN 16258 is compatible with applying the so-called Well-to-Wheel approach, which means that also the upstream emissions are included in the calculations.
The energy consumption for single buildings, terminals and transhipment centres are recorded with the help of electricity meters and other technical measuring devices. It is important to cover all energy consumers, hence also technical equipment like sorting and conveying systems, which usually show high energy needs, have to be included in the calculation.

ISO 14040/44/67

These three ISO standards are international standards to calculate the product carbon footprint. They apply to manufactured products as well as to services.

The environmental life cycle assessment according to ISO 14040 und 14044 is a method to calculate and assess the total impact of products, processes and services on the environment for the whole life cycle of a product, starting with the primary production of raw materials, including the manufacturing of the product as well as its utilisation and finally ending with the product's disposal. For this reason it is often called as accounting from cradle to grave. Currently, the eco accounting according to ISO 14040 and 14044 is the most commonly used standard for product-related carbon footprint accounting.

The international standard ISO 14067 aims at improving the transparency of the calculation and communication of the carbon footprint of products. It specifies how the balance of greenhouse gas emissions for the whole lifecycle of a product should be calculated. Again, the accounting starts with the purchase of the product, accounts for the emissions caused by the product's utilization as well as for its disposal ("cradle to grave").

The ISO 14040 and 14044 standards are standards for the general environmental impact assessment whereas ISO 14067 is the standard for the quantification and benchmarking of CO2-emissions over the entire lifecycle of products and services.

4 Calculation of Carbon Footprint for Ports and Terminals: Process related or area related?

4.1 State of the Art

All of the above mentioned standards have one characteristic in common: they describe in great detail how to implement an environmental or energy management system. The standards define a set key numbers to be calculated. However, they do not specifically relate to transportation processes.

Because of this reason, issues of definition and regulations describing to whom emissions are to be assigned as well as definitions of scope do still remain and have yet to be solved when applying these standards to transportation processes. A major challenge exists especially when applying these standards to transportation hubs, warehouses etc., where processes and responsibilities overlap. In these cases it is not always clearly and unanimously solved how to assign emissions.

For the means of transportation the CEN EN 16258 applies. It aims to apply to any service of transportation. However, transit hubs, warehouses and logistic centres, etc. are explicitly not included (up to now), which leaves also uncertainties about how to calculate and assign emissions caused by cargo handling and transportation in ports and terminals.

The literature provides several suggestions how to deal with these gaps. There are suggestions calling for area-related approaches. An area-related approach has a significant disadvantage. Transportation processes would have to be separated into non-port transportation processes and in-port transportation processes. Exact measures will be difficult and be replaced by estimations and data exchange between the involved parties would cause much administrative work that can be avoided.

Another argument for avoiding an area-related approach is the fact, that an area-related approach can be very random: depending on the official real-estate borders of ports and terminals emissions would change, which leaves no room for exact calculations.

One suggestion of the World Port Climate Initiative (WPCI) is for example to assign all in-port activities as the responsibility of the port. The WPCI assumes that there exists "an overland boundary representing the extent to which the port has influence over, or is accountable for, the emissions associated with goods

moved by truck. In some instances, it has been assumed that the port is responsible for and has influence over the emissions from trucks from the point of entry across the overland boundary on the way to the port, and to the first point of rest (initial destination) upon leaving the port. After the initial destination or the first point of rest, additional emissions associated with the movement of these goods are traditionally assumed to be under the influence of, and therefore, the responsibility of the importer or trans-loading agent." *(Source: Carbon Footprinting for Ports, Guidance Document, June 2010)*

One suggestion is to assign emissions

- to the causal transport modes outside of port areas,
- to ports when emissions occur on the real-estate of port
- to terminals when emissions occur on the terminal real-estate.

Such an approach might not be very practical, as assumptions and calculations on average distances outside and inside the port area for the special freight movement have to be made and done which causes a lot of administrative work. It is also not clear whether such data is available and that the quality is good enough is such assumptions and calculations are done.

The definitions of scopes according to the Greenhouse Gas Protocol and applied to a port are also not clear yet. Below is a graphic of a report of the WPCI that interprets the scopes 1 and 2 according to the GHG Protocol. The interpretation of scope 3, however, leaves room for discussion. The WPCI classifies all port-related processes within a port as scope 3 that are not executed by the port authority itself, e.g. the cargo handling of terminal operators.

This has several major implications. First of all: scope 3 is rather an awareness scope. Emissions in this scope can be recorded but do not have to be recorded necessarily. But terminal operations are indeed the major task of a port. To classify them the same as business travels does not seem to be appropriate.

Such a classification might be due to terminal operations being defined as an "outsourced" activity. Outsourced activities are indeed classified as scope 3. But if a port is organised as a landlord model port, terminal and other port operations are not *outsourced.* Such an organisational model is rather a – politically - wanted result of breaking natural monopolies and separating the supply of infrastructure from the supply of services that use these infrastructures. Such regulations by public authorities are also known as unbundling and have nothing to do with outsourcing

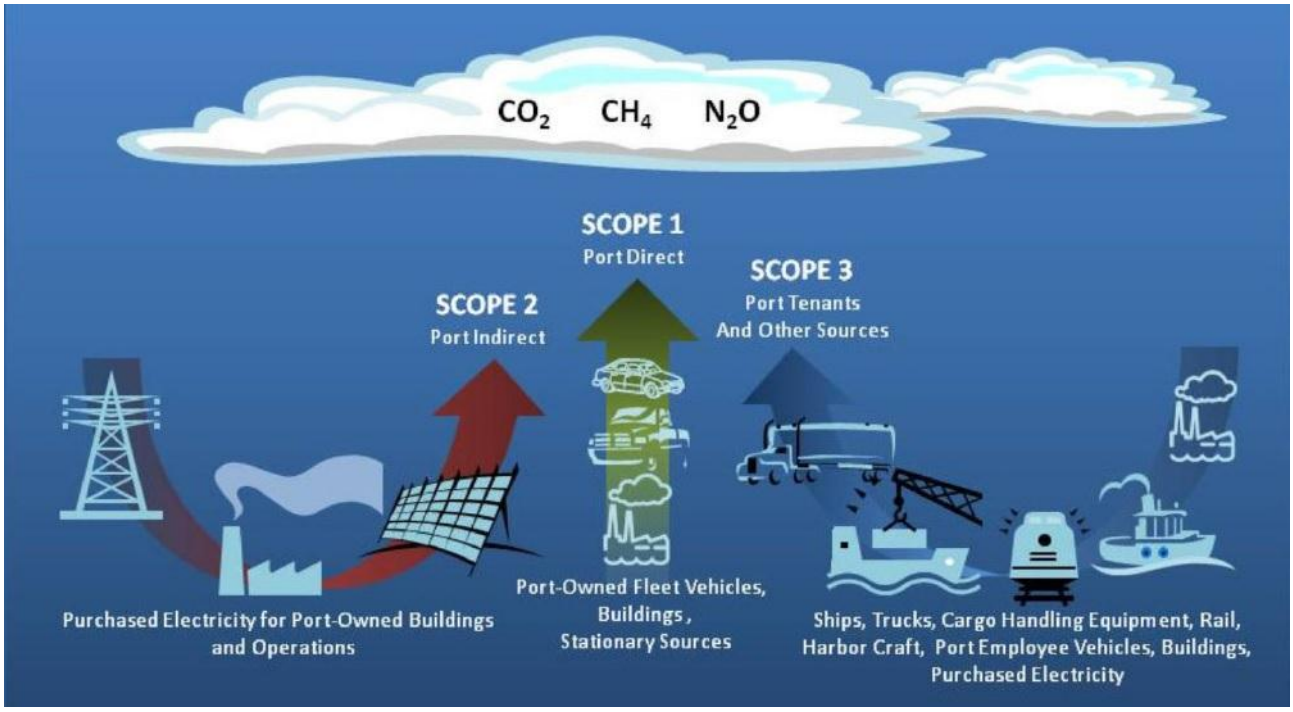

Figure 3: Port-related emission sources according to WPCI (Source: Carbon Footprint for Ports, Guidance Document 2010)

Such a carbon footprint calculation approach has direct implications on the size of a port's carbon footprint. Depending on the organisational structure the carbon footprint of a port differs. If a port is an "one-entity" port all the occurring emissions are related to the port. This is the case for public ports as well as for private ports. In both models the port owner executes all operations; the only difference is the ownership, which is either public or private. For a landlord model port there are two groups of entities, first the publicly owned port authority and second the privately owned port operating companies. A landlord port stating its carbon footprint only from the port authority and not from the operating companies as they are outsourced would communicate a picture that is far from reality.

This means that the result of a carbon footprint calculation is critically dependent on the organisational model and the legal form of a port according to the suggestion of the WPCI. Whether a port is organised according to the landlord model or whether a port is a fully public port operating terminals itself makes thus a huge difference with respect to the carbon footprint calculations. A port managed according to the landlord model would show the emissions of the port activities excluding the emissions caused by terminal operations. It would include only the emissions caused by buildings, the port's vehicle fleet, its administrative activities and other activities a public port authority is responsible for (e.g. safety tasks). Emissions from the main business of a port, the cargo handling itself,

would not be reflected in such numbers. They would have to be calculated separately by the terminal operators and be shown as Scope 3 emissions.

For a public port, the picture would look quite different. With such approaches applied, a public port would have much higher emissions as they operate usually terminals by themselves and hence emissions would show up in their own emission balance.

Hence, the carbon footprint numbers of such an approach would not be comparable. We suggest here another approach – a process related calculation approach which aggregates the carbon footprint results of all port operators that execute operations on the port area and which delivers comparable results regardless of the organisational structure of a port or other parameters.

4.2 Process Related Approach for Carbon Footprint Calculations of Ports and Terminals

In contrast, process related calculation of the carbon footprint can be very accurate as energy consumption figures of the consumers are usually easily available. Regardless of the borders that are crossed and regardless of the ownership of real estate property, energy consumptions and hence emissions are assigned to the sources of emission, independent whether it regards the hinterland transport process, crane processes of terminals, other supporting operations or whether it regards other consumption facilities like houses, terminal lighting, , etc. The operator or the management of technical applications and transport vehicles usually have full access to fuel or electricity consumption data. The port authority will have to collect all scope 1 and 2 emission results from all the port operating companies to receive an aggregated and comprehensive Port Total Carbon Footprint (PTCF).

This process-related approach is hence independent of the legal status and organization of a port. In order to make emissions of services among similar entities and processes comparable and to unhide the existing potential for emission savings, it is preferable to follow a process related approach.

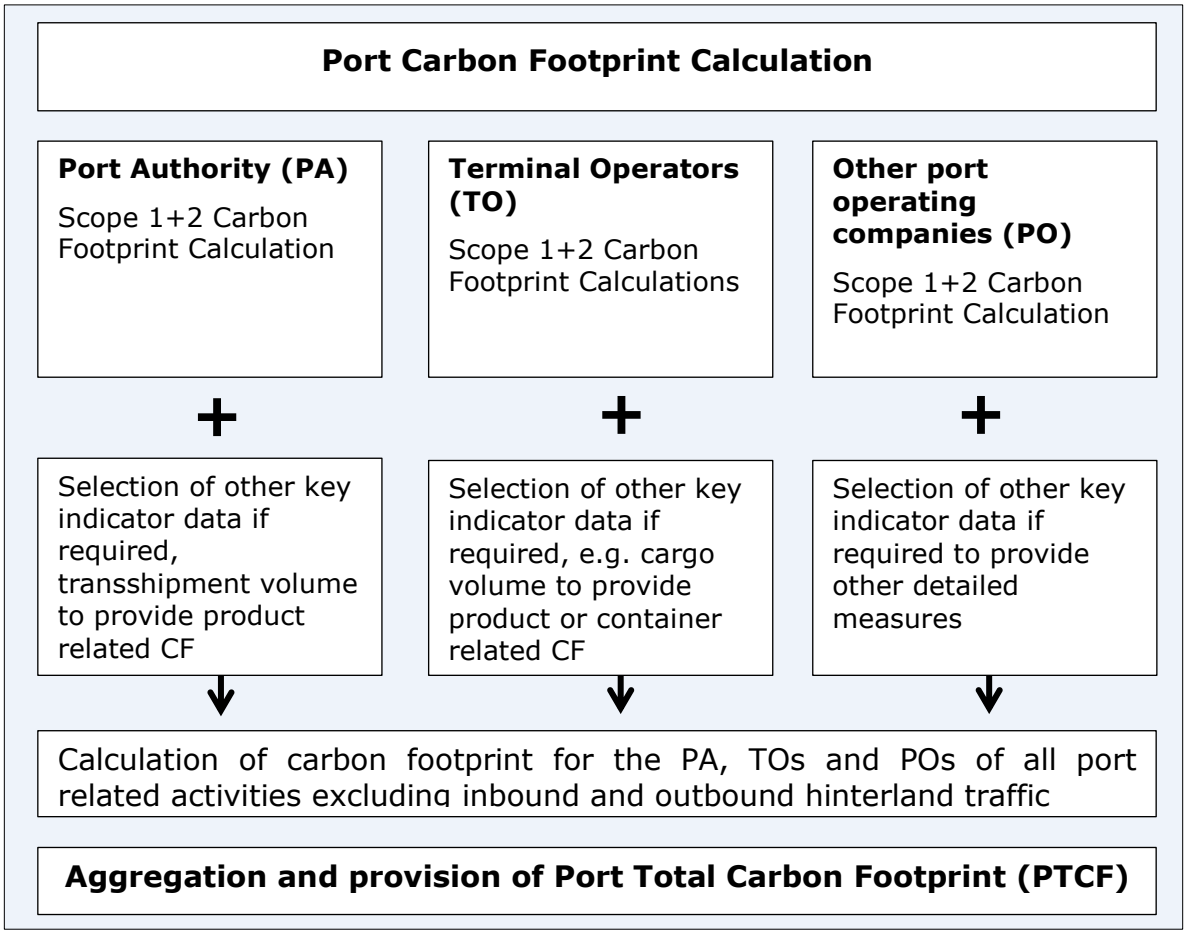

Figure 4: Carbon footprint calculation for ports

The main business activity (defined as the main source of income) of logistic enterprises including terminal operators is the transportation and the movement of goods, e.g. with a crane; hence their transportation activities must be assigned to scope 1. This is also valid for public and private ports as these ports provide transportation services like terminal operations themselves. Also all other companies whose main business activity is transport related must classify its emissions from its business activities as scope 1 emissions.

We believe that the advantages of a process-related approach

- Direct energy consumption and hence emissions can be measured for the emitting entity
- Low administrative efforts compared to area-related approach
- Source of emission identifiable
- Comparability among ports
- Independent of port organization
- Independent of ownership structure

Put this approach much in favour compared to an area-related approach that has several fundamental disadvantages like

- No exact measures possible
- Port and terminal boarders randomly set
- High administrative efforts
- Low comparability among ports
- Dependence on port organization
- Dependence on ownership structure.

5 Area-related approach for measuring and monitoring other air pollution

As described in chapter 2.4 for air pollutants like SO_X, NO_X or PM the regional or even local concentration in or close to the port area is the relevant measure. The main effects occur directly where the pollutants are emitted, be it on the environment or on human health. Hence the main efforts must be on reducing the local emissions. This can be done for example with introducing port-wide environmental areas like some cities or regions in Europe have done so for city-areas.

For this purpose the area-related approach is superior as for local emissions and environmental and health effects emissions of the local traffic entering and leaving the port area are indeed important and account much for the local air pollution besides the ship traffic.

The Port of Los Angeles can serve as an example. In 2006 the port adopted its Clean Air Action Plan which was a plan of how the two ports that belong to the Port of Los Angeles would reduce their air pollution. This came in a time where the shipping traffic and hence all related hinterland traffic was increasing which also caused ever increasing emissions. In 2008, harbour-area communities still suffered an average cancer risk from air pollution that was more than 60 percent higher than the average in the region. In 2008, the Port of Los Angeles began successfully implementing its Clean Truck Program which reduced emissions by nearly 90% in truck-generated air pollution in the following three years. Under that program, licensed motor carriers—the companies that haul port goods—must comply with the Port's business standards if they want to do business at the Port which means mainly using less polluting trucks and avoiding parking in residential areas.

6 Conclusion

Emissions are an important issue for ports. Though there exist many standards and guidelines for carbon footprint calculations special guidelines port transport hubs like ports are missing. We suggest – also for reasons of practicability – a process-related approach for carbon footprint calculations and a separate, area-related approach for all harmful emissions relevant in ports and transportation in general.