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Module 5: Ship-Port Interface and Energy Efficiency



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Introduction to Ports and Port-area Emissions

Port management and activities

Port management is a complex process

There are a number of chains.

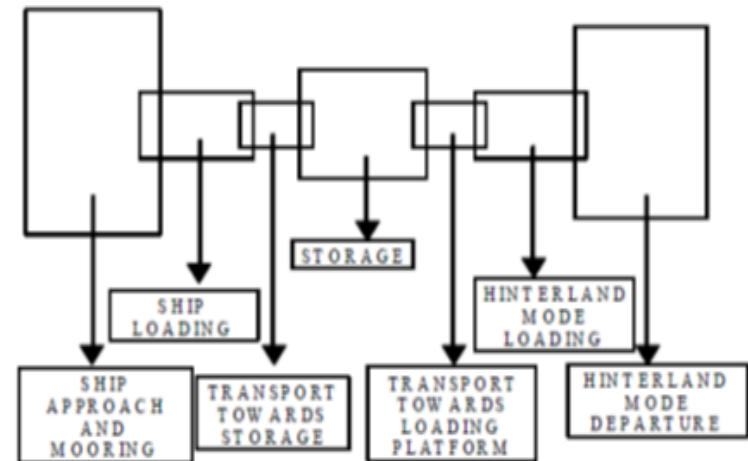
Often different part of the chain are controlled by different players.

Thus decision making structure is complex.

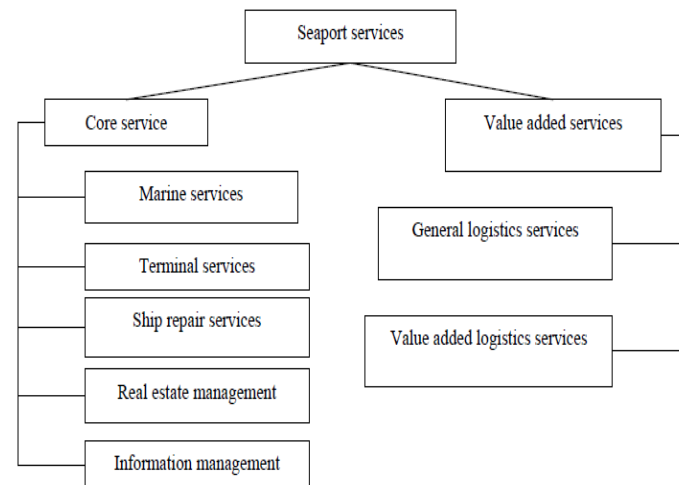
No two ports are physically and economically the same.

Ports provide:

- Core services
- Added value services



Source: Voorde & Elsander



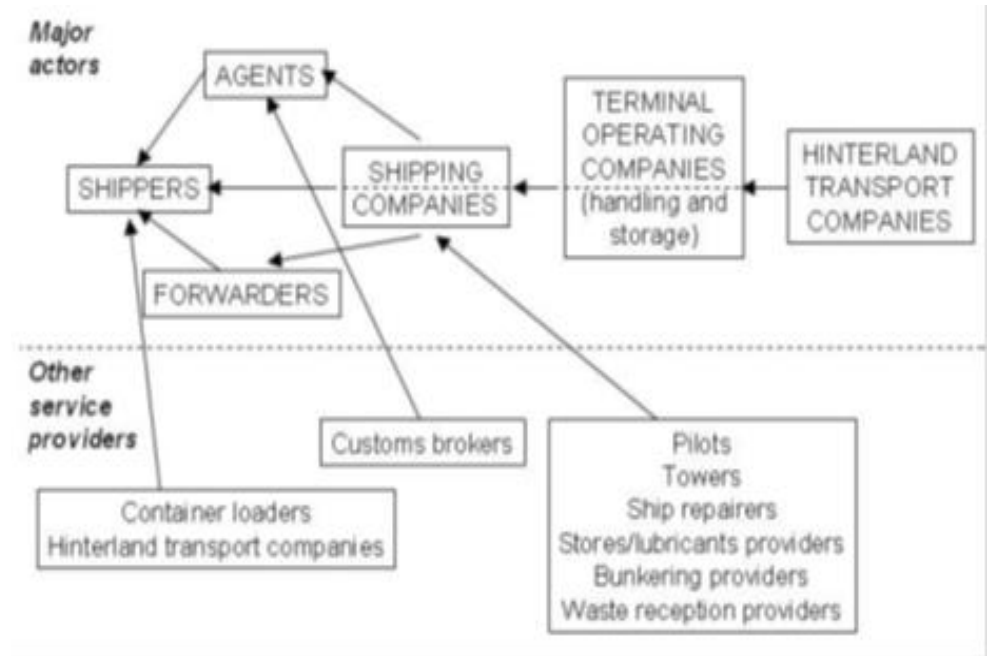
Port operation players

Port management varies:

- From port to port
- From country to country

Shipping companies in ports rely on many players:

- Port itself
- Pilots,
- Towage services,
- Ship repairers, provisioning,
- Waste reception facilities
- Bunkering companies



Source: Meersman, Van de Voorde and Vanelander

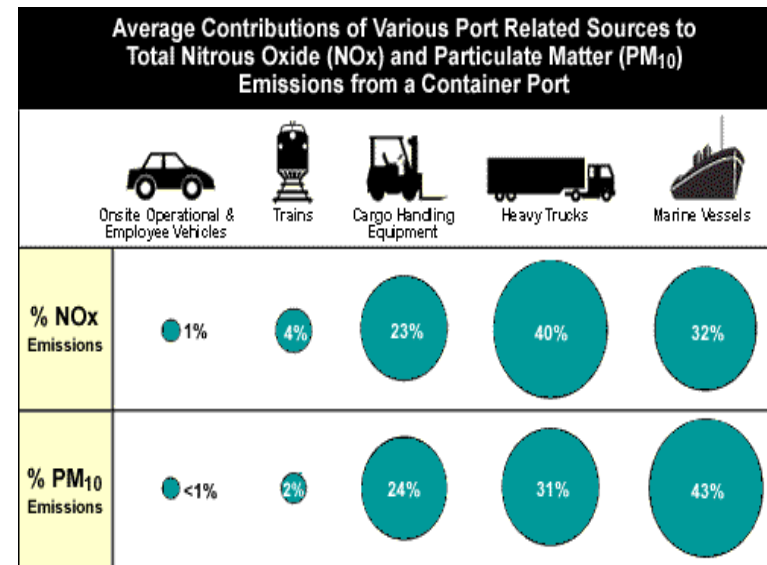
Port's air emissions

Sources:

- Cargo loading and unloading processes/devices.
- Trucks and other land-based transportation units.
- Buildings and building facilities.
- Harbour crafts/vessels.
- Ships calling at port.

Main emissions of concern:

- Nitrogen Oxides (NO_x):
- Particulate Matters (PM):
- Sulphur Oxides (SO_x):
- VOC (Volatile Organic Compounds) - Some ports
- Some carbon monoxide and unburned hydrocarbons



<http://www.nrdc.org/air/pollution/ports1/overview.asp>

Ships to port emissions are only part of the total

Ship-related port emissions reduction

Main measures include:

- **Just in time** operations of ships.
- Ship's **cleaner fuels**.
- Ship's emissions **abatement technologies**.
- Ship-board **energy efficiency** when in port.
- Use of **OPS**.



Land-based operation emissions reductions

Clean Fuel:

- Low or ultra low sulphur diesel (LSD) (ULSD),
- Emulsified diesel
- Bio-diesel,
- CNG, LNG, LPG
- Electric systems

Technology Retrofit: On port trucks with emissions abatement technologies.

New technologies: Use of hybrid-electric technologies as replacements for pure diesel engine vehicles and equipment.

Operation management: This could include a large number of measures that helps to reduce fuel consumption and emissions in devices used in ports.

Port's harbour craft policies for emissions reduction

Engine replacement: Move to more energy efficient and low emissions engines.

Clean fuels: Natural gas, low sulphur fuel, biofuels, etc.

Technology upgrade: This option relates to retaining the engines but opting for more advanced available engine controls, fuel additives and after-treatment emission control technologies.

Hybrid electric systems: The harbour crafts are good candidates for use of more advanced technologies such as hybrid technologies to include batteries and electric motor / generators.

Port ship-related emission sources

Ship transit and manoeuvring

- Ship slow speed operation.
- High auxiliary engine loads (safety, thrusters, air scavengers/blowers, etc.
- An additional auxiliary engine is online (safety).
- Auxiliary boilers are on.

At berth or anchored

- Propulsion engines are off.
- Auxiliary engine loads can be high if the ship is self-discharging its cargo.
- Auxiliary boilers are operated to keep the propulsion engine and fuel systems warm in case the ship is ordered to leave the port on short notice.

The Impact of Ports Operations on the 'Efficient Ship Operation'

How ports could reduce ship-in-port emissions

Reducing the time of ship stay in port

Provision of cleaner fuels to the ship

Provision of shore connection to ships

Ship loading with due consideration for air emissions

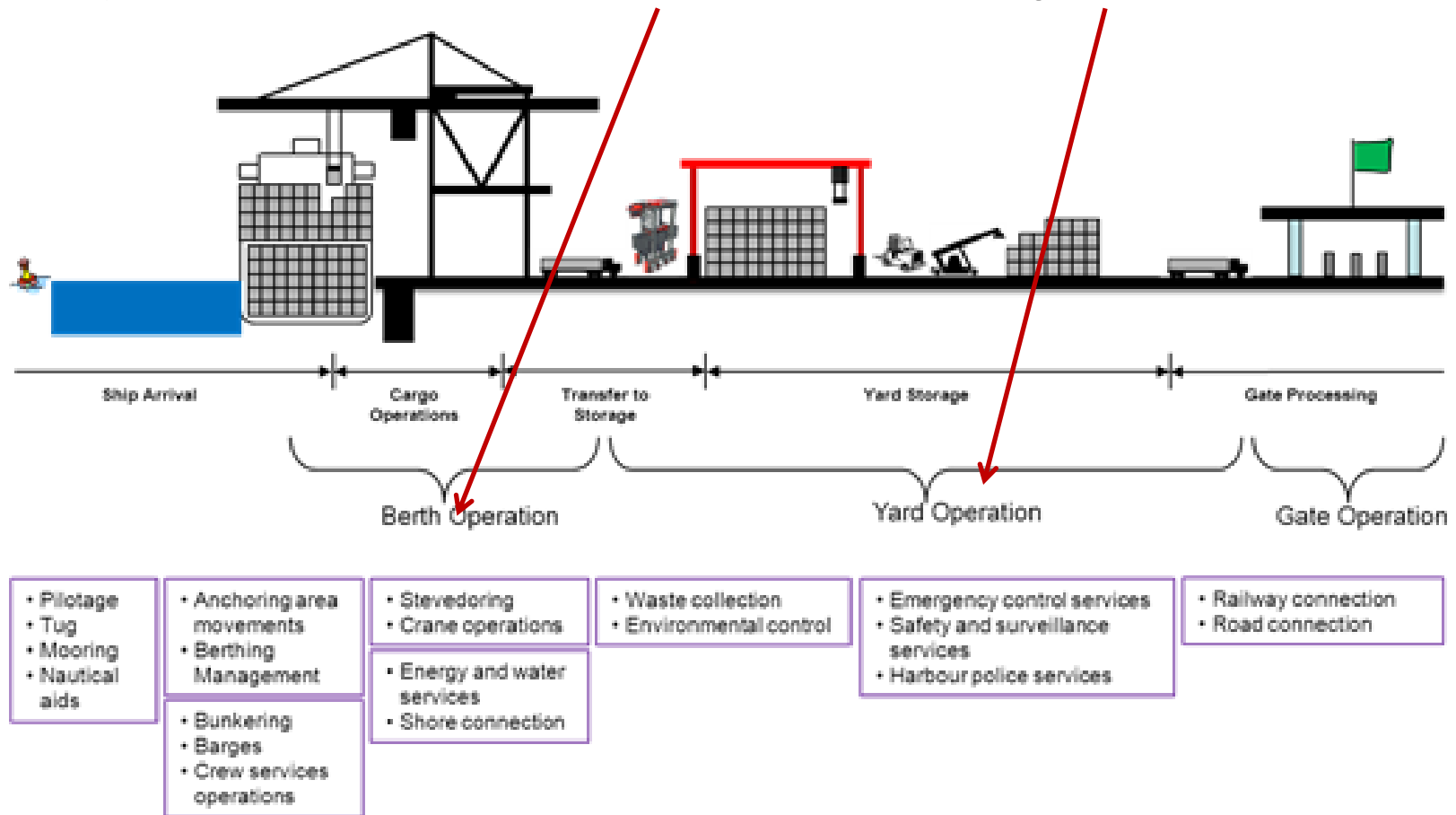
Environmental oriented incentives

Ship Time in Port and Just in Time Operation

Container terminal operation

Diagram shows chain of ship-related activities/processes.

Mainly two parts: (1) ship related activities (2) cargo related ones.



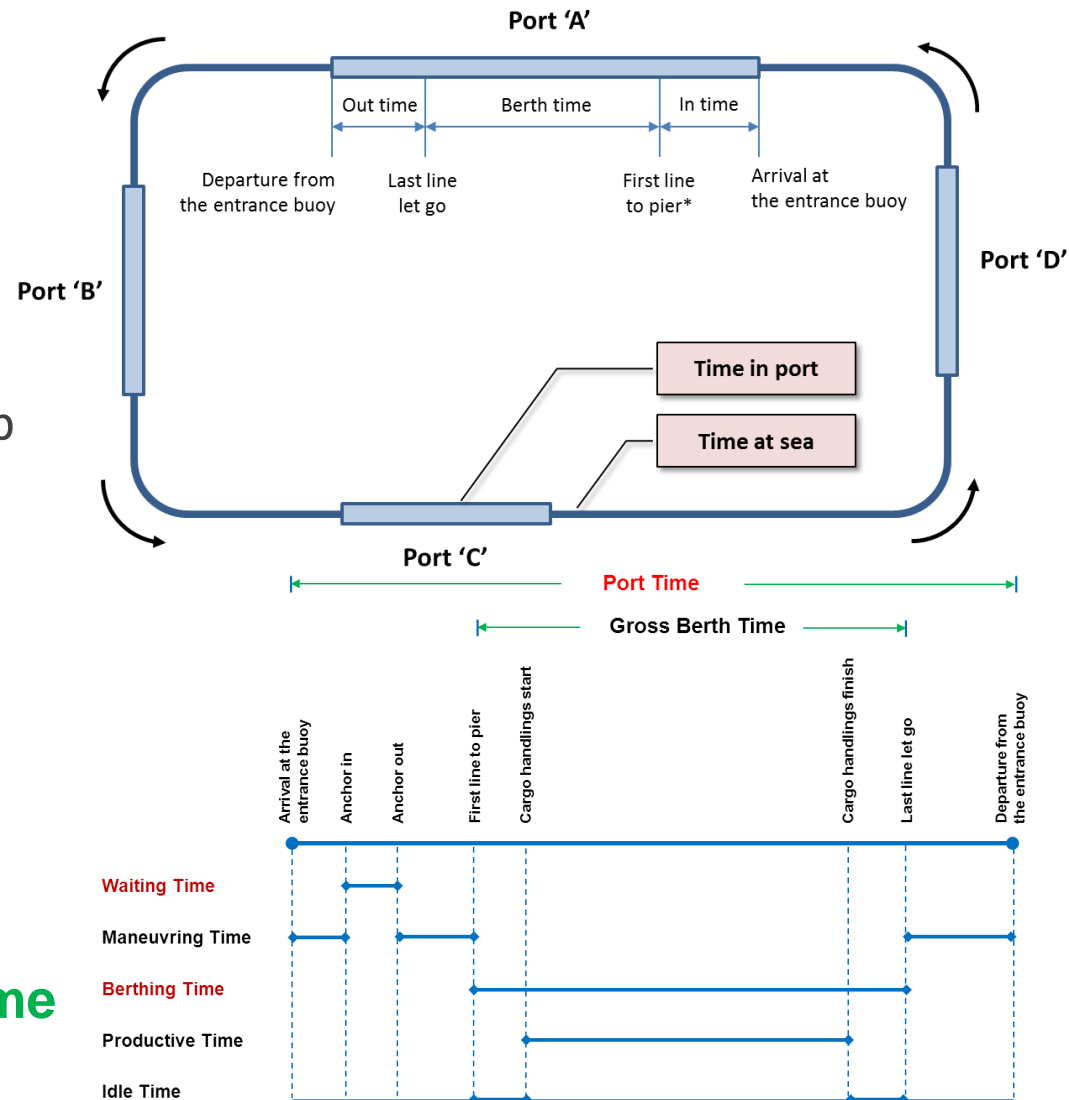
Ship voyage time and time in port

Port time may be assumed to be insignificant compared to overall voyage time.

This varies with ship type, ship size, cargo type, and port facilities.

A good understanding of the **ship port time** can help with energy management and emissions reduction activities of both ships and ports.

$$\text{Ship's time} = \text{Sea time} + \text{Port time}$$



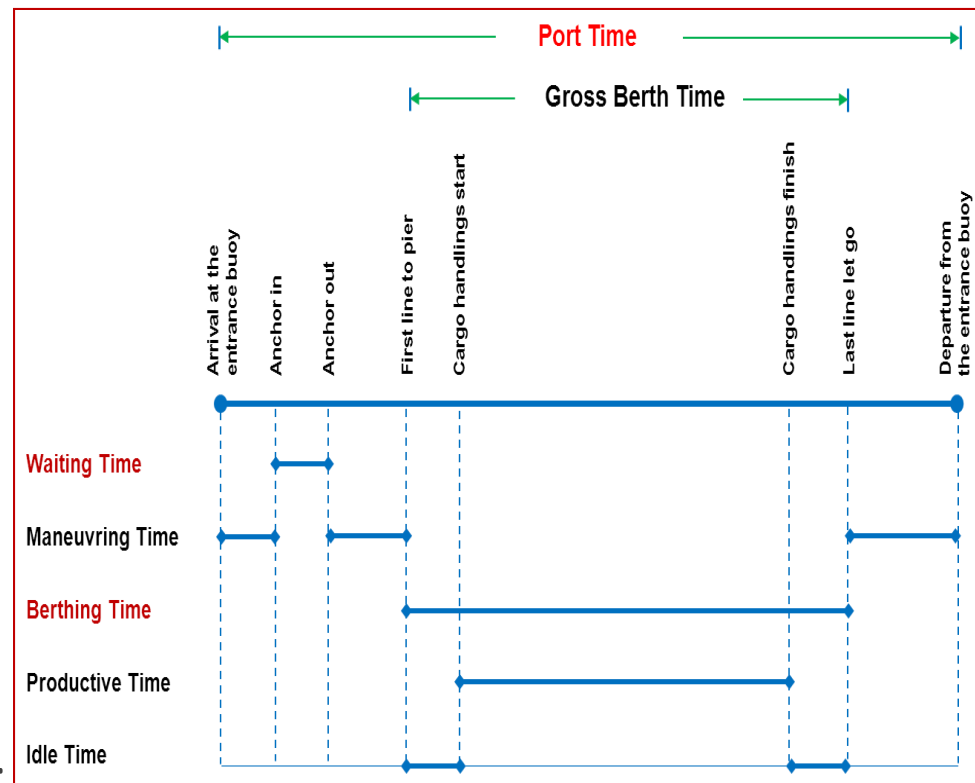
Time in port (port time)

Manoeuvring time: Manoeuvring to reach anchorage or berth or leave.

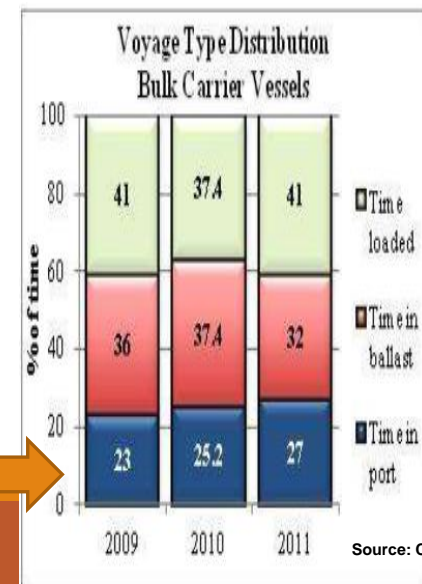
Waiting time: The period the ship waits for berth availability.

Berthing time: Actual time at berth. Berthing time consists of two parts:

- **Productive time:** Actual time from start of cargo handling operation to end of cargo handling operation.
- **Idle time:** Times in berth where there is no cargo handling operations.



Port time

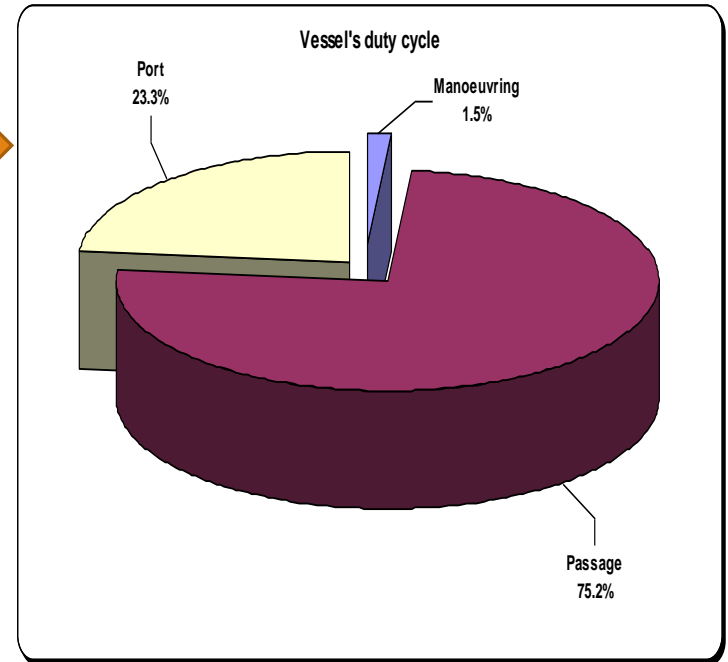


Does “port in time matters? Case impact on a ship’s fuel consumption

A typical tanker operation profile.

Port time” is normally about 25% of the ships’ operation time.

What is the impact on ship’s fuel consumption if “port time” is reduced?



<i>Passage operation time in passage, current</i>	<i>75.2% of annual</i>
<i>Passage operation time with less port time (see above)</i>	<i>78.2% of annual</i>
<i>Fuel consumption reduction for same distance (estimated)</i>	<i>7.5%</i>
<i>Fuel consumption and emissions reduction</i>	
<i>Main engine fuel consumption reduction</i>	<i>1,065 MT/year</i>
<i>Boilers and auxiliary engines fuel consumption reduction</i>	<i>Assumed negligible</i>
<i>Net fuel consumption reduction</i>	<i>1,065 MT/year</i>
<i>Net CO₂ reduction</i>	<i>3,400 MT/year</i>

Just-in-time port operation

Refers to any action that reduces the idle time in ports via minimizing delays.

- 'Just-in-time' requires good early communication with port and harmonization amongst parties concerned.
 - Give maximum notice of berth availability -> Tug and pilot services -> Berthing window
- Just in time port operation will facilitate the use of optimum speed.
- Optimized port operation:
 - Improved cargo handling. Directly under the control of port.

Measures for avoiding ship's waiting time in port

Improved port management

Virtual Arrival

Improved cargo handling

Improved Port Management

Port related services other than ship loading and unloading

Pilotage services: Using services given by maritime pilots.

Towage services: Using tugboats services

Line handling services by line boats: For berth operation.

Mooring services: To secure a ship to the designated place

Vessel traffic services (VTS) and aids to navigation: Marine traffic monitoring and controlling.

Control of dangerous goods: To ensure safe handling.

Waste management services: Control of ships' waste aspects.

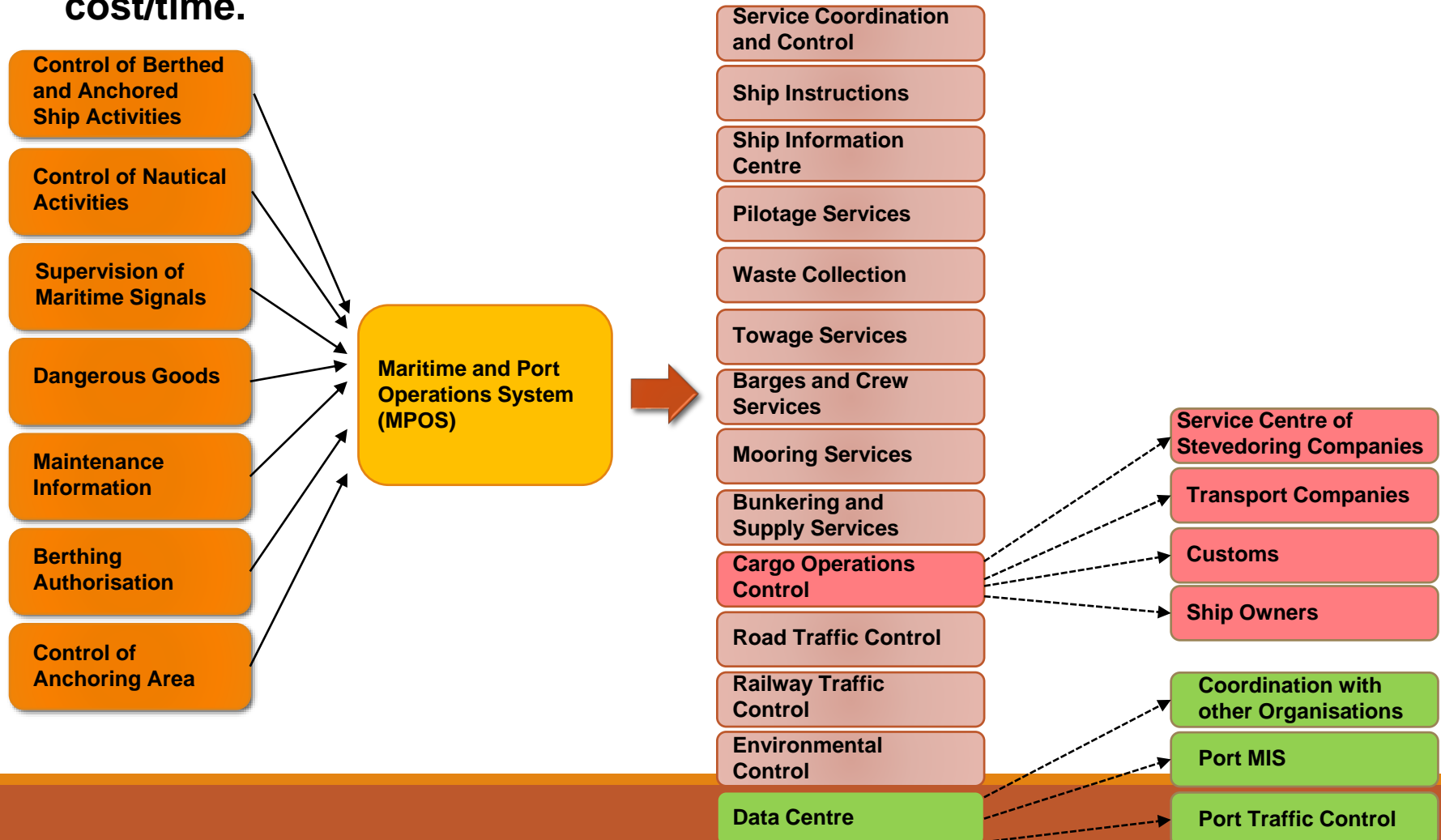
Emergency response services: Like services by fire brigade, etc.

Control of dredging operations: Dredging is usually carried out by private firms.

Managing of the above services plus ships when in port is complex and require a good management system

MPOS for port services coordination

- **MPOS is customised port management system that focuses and optimizes the work of “agents”, “entities” and “port services on ships” by coordinating the actions and controlling them and allowing to analyze how to reduce its cost/time.**

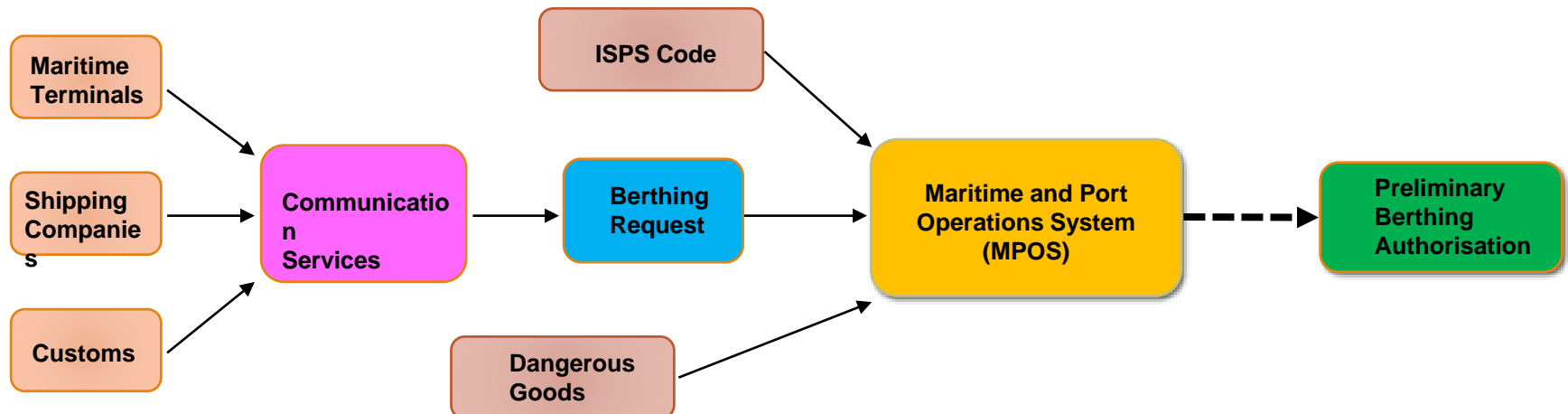


Case example: Use of MPOS for a ship's in-port just-in-time operation

Ships must participate in the MPOS.

“The **Request for Berth**” is received through MPOS Communication Services and is verified by MPOS against ISPS and Dangerous Goods, before issuing the **Preliminary Authorization to Berthing**.

After issuing the Preliminary Berthing Authorization, MPOS compares it with information from the anchoring area and with activities of any anchored or berthed ships, nautical activities inside the harbour, status of maritime signals, maintenance status of berths, and **informs the berthing operation to the ship and to the pilot service**.



Cargo handling improvement

Operational planning; typically in good time ahead

To improve cargo handling, improve the following:

- Berth planning
- Cargo handling equipment scheduling (all different types of cranes).

Ways to improve cargo handling for less emissions:

- Cleaner and efficient internal movement vehicles
- The introduction of high capacity loading and unloading operations
- The use of eco-friendly and user-friendly cargo handling products
- Well trained shore-staff and ship-staff

Cargo handling: Upgrade of cargo equipment

This could improve the time of cargo loading and unloading.

Upgrade of cargo handling equipment can lead to less time in port.

Energy efficiency of cargo equipment is also important and will depend on their source of power.



Technologies for Port Air Quality and GHG Emissions Reduction

ICCT (International Council on Clean Transportation) study on port air quality

A study conducted and reported in in December 2012.

In this report, the ICCT highlights the technologies that could be used in **diesel engines** as the prime mover for ships and port-side trucks.

The main focus is on **pollutants** considered:

- PM (Particulate Matters), carbon monoxide, SOx, NOx and VOC.

The **types of technologies** identified for reduction of emissions are:

- Diesel oxidation catalysts; Diesel particulate filter; SCR (Selective Catalytic Reduction); Exhaust Gas Scrubbers; Exhaust Gas Recirculation (EGR):

Other options studies:

- Shore power
- Clean fuels
















































ICCT Study outcome

Summary of technologies

Their application to
various port-
operated prime
movers.

Potential emissions
reduction

Associated costs

Type	Technology Name	Application	Potential Emissions Reduction	Cost (US\$)
General Emissions Control Technologies	Diesel Oxidative Catalysts (DOC)	                                              		

IMO ship-port interface study

The MEPC 68/INF.16 presents the results of an IMO commissioned study that deals with a range of topics on ship-port interface.

A systematic approach is used to analyse a number of measures.

Measures categories

- Equipment measures
- Energy measures
- Operational measures

Equipment measures:

- Engine technologies
- Boiler technologies
- After-treatment technologies

Energy measures:

- Alternative fuels
- Alternative power supply

MARINE ENVIRONMENT PROTECTION COMMITTEE 68th session Agenda item 3		MEPC 68/INF.16 4 March 2015 ENGLISH ONLY
AIR POLLUTION AND ENERGY EFFICIENCY		
Study of emission control and energy efficiency measures for ships in the port area		
Note by the Secretariat		
SUMMARY		
<i>Executive summary:</i>	This document provides at annex the report of a Study of emission control and energy efficiency measures for ships in the port area, undertaken to investigate existing control measures to reduce emissions from ships in ports and identify possible future innovative measures to address such emissions	
<i>Strategic direction:</i>	7.3	
<i>High-level action:</i>	7.3.1	
<i>Planned output:</i>	No related provisions	
<i>Action to be taken:</i>	Paragraph 3	
<i>Related documents:</i>	None	

IMO Study outcomes: Engine technologies

	Applicable Emission Source	Retrofittable?	Applicable Operational Modes	NOx	PM	SOx	HC	Energy Consumption
Engine Technologies								
Repower	P/A	Y	All	≤80%↓	↓ cbc	–	–	↕ cbc
Remanufacture Kits	P/A	Y	All	↕ cbc	↓ cbc	–	↕ cbc	↕ cbc
Propulsion Engine Derating	P	Y	STM	↑ cbc	↕ cbc	–	tbd	↕ cbc
Common Rail	P/A	Y	All	≤25%↓	↓ cbc	–	–	≤5%
Exhaust Gas Recirculation	P/A	Y	All	≤60%↓	tbd	–	tbd	tbd
Rotating Fuel Injector Controls	P	N	STM	≤25%↓	≤40%↓	cbc	cbc	cbc
Electronically Controlled Lubrication Systems	P	Y	STM	–	≤30%↓	–	≤30%↓	–
Automated Engine Monitoring/Control Systems	P/A	N	ALL	≤20%↓	tbd	≤3%↓	–	≤5%↓
Valve, Nozzle, & Engine Timing NOx Optimization	P	Y	STM	↓ cbc	↕ cbc	–	↓ cbc	↑ cbc
Slide Valves	P	Y	STM	↓ cbc	↓ cbc	–	↓ cbc	↕ cbc
Continuous Water Injection	P/A	Y	All	≤30%↓	≤18%↓	–	–	–
Direct Water Injection	P/A	Y	All	≤60%↓	↕ cbc	–	↕ cbc	–
Scavenging Air Moistening/Humid Air Motor	P/A	Y	All	≤65%↓	↑ cbc	↑ cbc	–	↑ cbc
High Efficiency Turbochargers	P/A	Y	All	↓ cbc	↓ cbc	–	↕ cbc	↓ cbc
Two Stage Turbochargers	P/A	Y	All	≤40%↓	tbd	–	–	↓ cbc
Turbocharger Cut Off	P	Y	STM	≤40%↓	tbd	–	tbd	↓ cbc
Crank Case VOC Leakage	P	Y	STM	–	tbd	–	≤100%↓	–

IMO Study outcomes: After-treatment technologies

	Applicable Emission Source	Retrofitable?	Applicable Operational Modes	NOx	PM	SOx	HC	Energy Consumption
After-Treatment Technologies								
Selective Catalytic Reduction (SCR)	All	Y	All	≤95%↓	–	–	–	↑ cbc
Exhaust Gas Scrubbers - Wet	All	Y	All	≤5%↓	≤80%↓	≤98%↓	–	↑ cbc
Exhaust Gas Scrubbers - Dry	All	Y	All	≤5%↓	≤80%↓	≤98%↓	–	↑ cbc
Barge-Based Systems	AB	na	B	≤95%↓	≤95%↓	≤95%↓	tbd	↑ cbc

IMO Study outcomes: Alternative fuels measures

	Applicable Emission Source	Retrofittable?	Applicable Operational Modes	NO _x	PM	SO _x	HC	Energy Consumption
Fuels								
Low Sulfur Fuels	All	NA	All	↓ cbc	↓ cbc	↓ cbc	–	↓ cbc
Liquefied Natural Gas - gas only	All	N	All	≤88%↓	≤98%↓	100%↓	↑ cbc	↕ cbc
Liquefied Natural Gas - dual-fuel	All	Y	All	↕ cbc	≤78%↓	97%↓	↕ cbc	↕ cbc
Water in Fuel	All	Y	All	≤30%↓	–	–	–	–
Methanol	All	Y	All	↓ tbd	tbd	100%↓	tbd	↓ cbc
Biofuels	All	Y	All	↑	tbd	↓ cbc	tbd	tbd

IMO Study outcomes: Alternative power system measures

	Applicable Emission Source	Retrofitable?	Applicable Operational Modes	NOx	PM	SOx	HC	Energy Consumption
Alternative Power Systems								
On-Shore Power Supply	A	Y	B	≤95%↓	≤95%↓	≤95%↓	≤95%↓	≤95%↓
Barge Power Supply	A	Y	B	↕ cbc	↓ cbc	↓ cbc	↑ cbc	↕ cbc
Solar Power	A	Y	B	↓ cbc	↓ cbc	↓ cbc	↓ cbc	↓ cbc

Key findings of the report

Numerous technical measures are available for ship-port emissions reduction and energy efficiency.

Experience with some of them is over ten years.

The technical measures are quite extensive including engines, boilers, after treatment technologies, fuel options, etc.

There are no “one size fit all” technical measure solution for ships and ports.

Case by case studies are needed due to numerous variables such as pollutant(s) targeted, port configuration, cargos handled, drivers, barriers, and ships calling the port.

There are initiatives underway that focuses on the demonstration of emerging technologies and measures.

Ship In-port Operational Energy Efficiency Measures

Overview

Limited scope for the ship to reduce its in-port fuel consumption.

Despite this fact , the ship's impact on port air quality could be significant.

Main question:

- Can ship-board staff do anything to support a more efficient ship-in-port operation?"

Answer:

- To some extent and a number of measures exists for this purpose.

The aspects covered in this section are simple day to day ship-board operational measures.

In fact, some of them could be implemented also by harbour crafts and port support vessels.

Machinery usage in port

The main ship-board systems working when ship is at anchor or at berth include:

- Auxiliary machinery and equipment
- Diesel generators,
- Boilers
- Cargo handling equipment (only on some ships).

The main activity will constitute on how to reduce their usage?

Usage of auxiliary machinery - Examples

Minimising the number of running auxiliary machinery based on port operation requirements and ship safety.

Examples are:

- Minimising the number of A/C units operated or switch them off when conditions permit.
- The number of engine room ventilation fans should be reduced in port or brought to slower speed.
- The fuel treatment machinery need to be reviewed if they all needed to run in the same way as sea-going condition.
- Minimisation of use of compressed air and its use where required.
- Minimisation of lighting loads.
- Etc.

The above will reduce the need for auxiliary power and number of auxiliary engines running.

Use of boilers

Use of parallel operation of two boilers should be avoided.

This improves the efficiency of the working boiler and reduces electrical requirements for the second auxiliary boiler.

Planning and optimisation of cargo discharge operation if it relies on steam driven cargo pumps.

Plan and optimise ballast operation if it relies on steam driven ballast pumps.

If boilers are used for Inert Gas generation, this aspect need to be managed.

Cargo holding equipment upgrade for energy efficiency

This is not an in-port measure but applies to passage as well.

For upgrade of ships' cargo holding equipment to reduce GHG emissions. For example:

- Ventilation (all ships)
- Mooring (all ships)
- Cargo and hold lighting (all ships)
- Reduction of CFCs (reefer)
- Heating coils (tankers)
- Cooling system (reefer)
- Cooling system (container)
- Cargo temperature optimization (tanker)
- Insulation of heating pipes (tankers)
- Optimization of reefer container stowage

Onshore Power Supply (OPS)

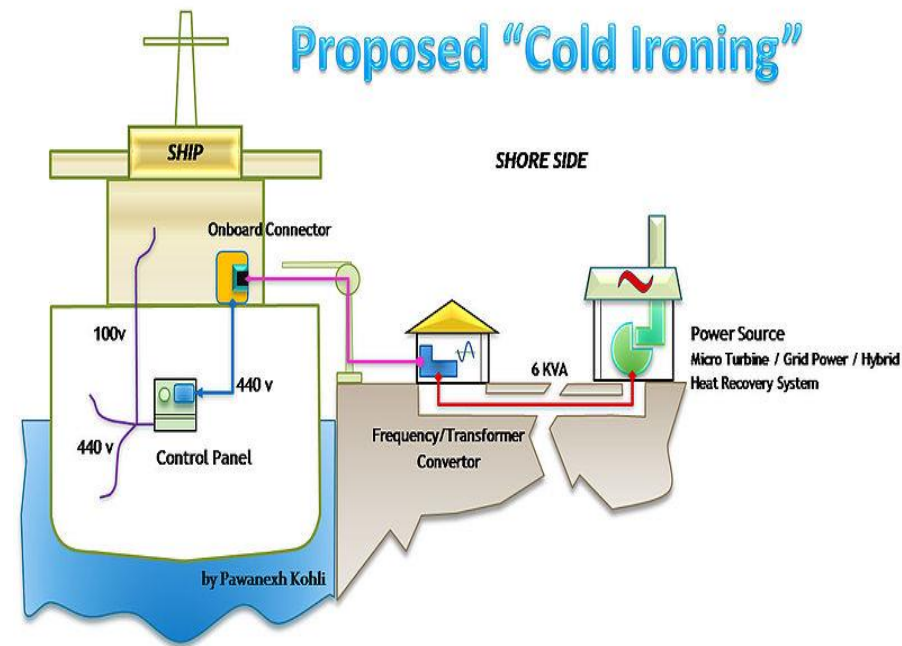
Onshore Power Supply (OPS) – What?

What is OPS?

- Supply of power from onshore (port) to ship.
- Allows ships to turn off their engines when in port.

OPS is known in industry by a variety of names including:

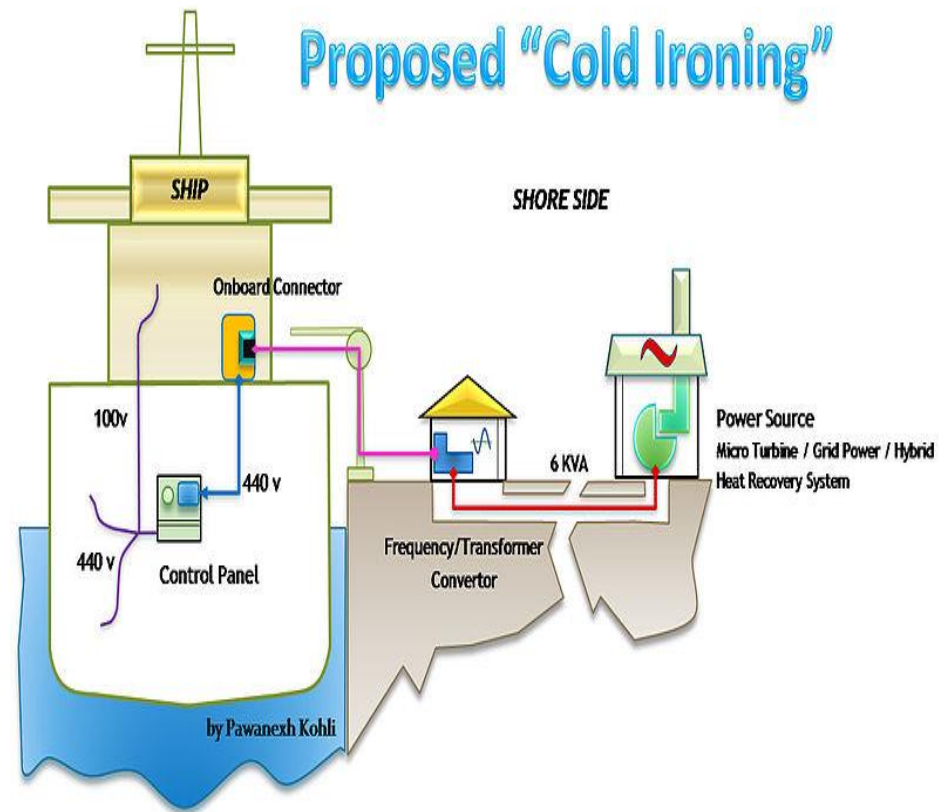
- Cold ironing system
- Alternative Maritime Power (AMP)
- Shore side electricity
- Shore power



Onshore Power Supply (OPS) – Why?

Why OPS is advocated?

- Reduce exhaust emissions in port.
- Reduce overall GHG emissions.
- Some additional energy saving and economic saving are also claimed?



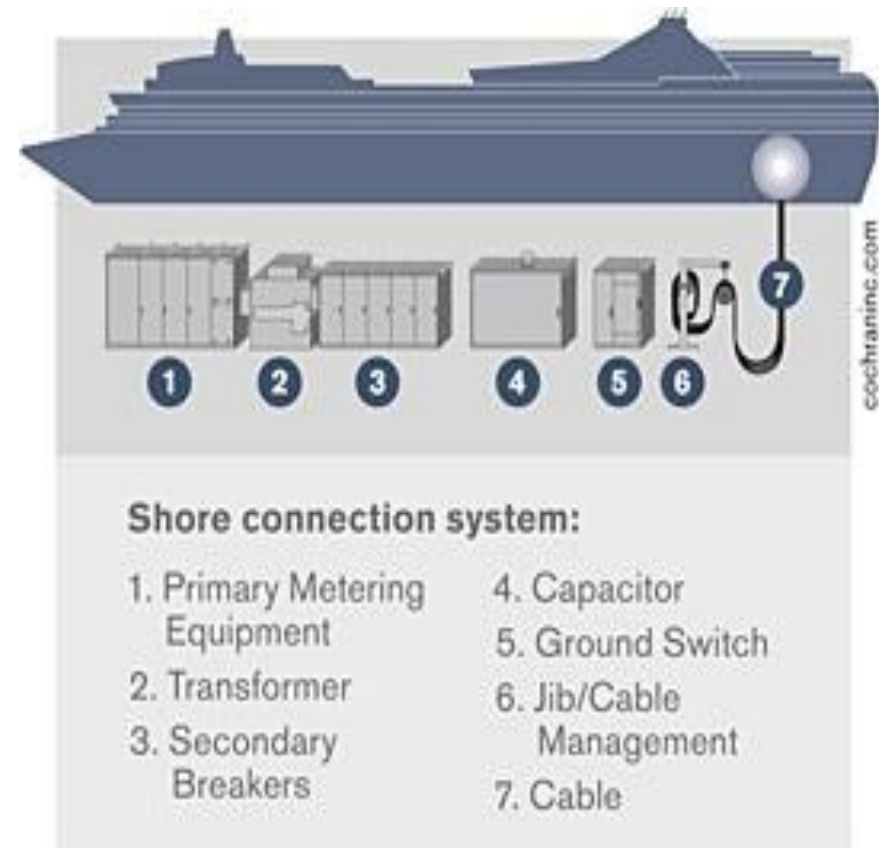
Onshore Power Supply (OPS) – The case?

A simple calculation:

- **A ship uses its own generated power**
- **A typical mid-size tanker would consume 400 kW.**
 - **For a 30h port stay, This means 12 MWh of electricity.**
- **An average cruise ship consumes about 8 MW.**
 - **For a 12 hours port stay, This means 96 MWh of electric.**
- **These power generations are accompanied by NOx, SOx, PM and CO2 emissions.**
- **The environmental profile of electricity generated by land-based power plants vs. ships' diesel electric generators are different:**
- **In land-based power plants:**
 - **High energy efficiency**
 - **Use of clean fuel or scrubber.**
 - **Renewable energy**
 - **Remote from population centres.**
- **For ports:**
 - **Electricity supply to ships (utility function).**
 - **Port air quality improvement.**
 - **Longer term economic benefits.**
- **The above are the main justifications for OPS.**

Onshore Power Supply (OPS) – Shore-side infrastructure

- Transformer for voltage reduction
- Switchgear for electrical safety
- Frequency converter
- Automation system



Source: <http://www.cruisecritic.co.uk/>

Onshore Power Supply (OPS) – Other aspects

Need for standardisation:

- The IEC, ISO and IEEE have joined forces.
- International standard "ISO/IEC/IEEE 80005-1 Cold ironing -- Part 1: High Voltage Shore Connection (HVSC) Systems -- General requirements" is in final preparation.

Pioneering ports

- Some ports have been pioneering this technology.



Port	Country	High Voltage	Low voltage	Frequency
Antwerp	Belgium	6.6 kV		50 Hz/60 Hz
Goteborg	Sweden	6.6 kV/10 kV	400 V	50 Hz
Helsingborg	Sweden		400 V/440 V	50 Hz
Stockholm	Sweden		400 V/690 V	50 Hz
Piteå	Sweden	6 kV		50 Hz
Kemi	Finland	6.6 kV		50 Hz
Oulu	Finland	6.6 kV		50 Hz
Kotka	Finland	6.6 kV		50 Hz
Lübeck	Germany	6.6 kV		50 Hz
Zeebrugge	Belgium	6.6kV		50 Hz
Los Angeles	U.S.A	6.6 kV/11 kV		60 Hz
Long Beach	U.S.A	6.6 kV	480 V	60 Hz
San Francisco	U.S.A	6.6 kV/11 kV		60 Hz
San Diego	U.S.A	6.6 kV/11 kV		60 Hz
Seattle	U.S.A	6.6 kV/11 kV		60 Hz
Juneau	U.S.A	6.6 kV/11 kV		60 Hz
Pittsburgh	U.S.A		440 V	60 Hz
Vancouver	Canada			

Ports with OPS at 6 June 2012

Source: <http://wpci.iaphworldports.org/onshore-power-supply>

Onshore Power Supply (OPS) – Regulatory aspects?

- No IMO regulations on OPS yet.
- There have been proposals to add some new regulations to MARPOL Annex VI; but mainly on the following topics:
 - **Exemptions:**
 - For ships with low emissions or high ship-board energy efficient power generation as compared to OPS.
 - Period in port: Not required to connect to OPS when the berth stay is less than some hours.
 - **Availability of OPS:** The port shall provide sufficient electrical power to sustain all operations including peak consumptions.
 - **Cost of OPS electricity:** The electricity costs for the ship to connect to shore power at berth should not exceed the cost of supplied electricity.

Onshore Power Supply (OPS) and energy efficiency?

- The overall energy efficiency of the OPS and also the cost of energy to ship-owner is not yet clearly established.
- The OPS is likely to be beneficial from CO₂ perspective if:
 - Land based power generation is quite efficient.
 - Low carbon fuel such as LNG are used.
 - The above will vary from ship to ship and from port to port.
 - For each case, there is a need for further investigation.
- There is evidence that the overall cost of OPS electricity may be higher:
 - Tax on OPS electricity.
 - Base cost of electricity as supplied to ports may be high.
 - Port charges in order to recover its CAPEX and OPEX of OPS.

Green Port Initiatives and Port Environmental Programs

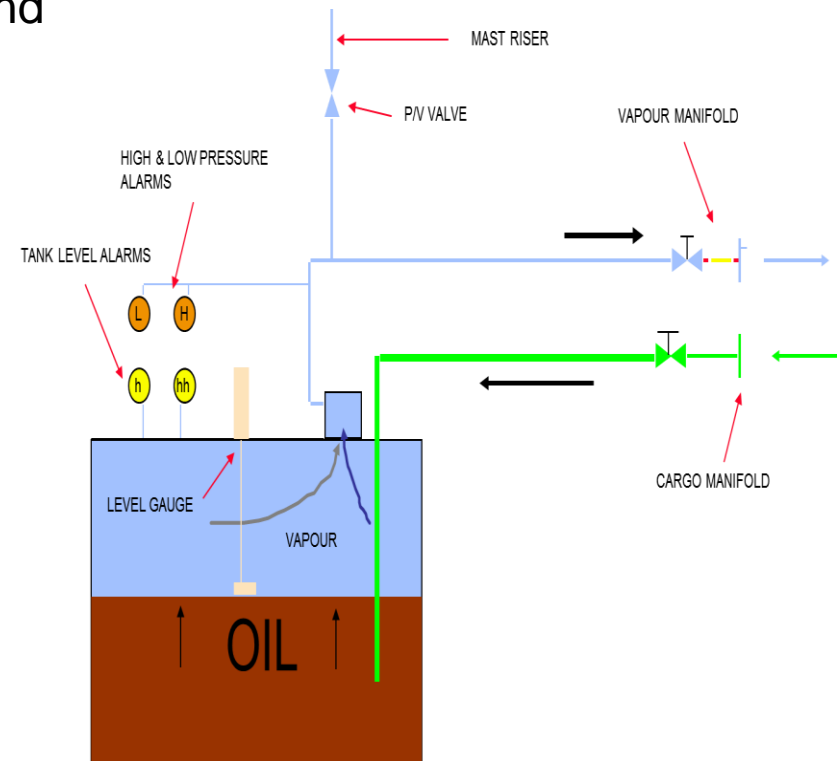
Green Port Initiatives - Introduction

- **Green port initiatives** aim to reduce air emissions from ships (plus other environmental aspects).
- **Green port initiatives** are in place in particular in USA, Europe and to some extent Asia.
- In the majority of cases, air pollution is at the core of the green port initiatives.



Green Port Initiatives – Volatile Organic Compounds (VOC)

- IMO MARPOL Annex VI regulations allows the Flag State to designate ports that intend to control and reduce VOC from tankers (Regulation 15).
- For compliance purposes:
 - The port should be able to safely collect, use or dispose of these gases).
 - Tankers that visit such ports also should have Vapour Emissions Control System (VECS).
 - Additionally, crude oil tankers are required to have an approved Vapour Emission Control Management Plan.



Ship-board VECS

Green Port Initiatives – Differentiated port dues

- Some ports provide incentives for efficient and clean ships.
- This is done via a reduced port dues based on their regulated emissions levels.
- For example in Gothenburg, Sweden:
 - The port dues are reduced if the NO_x emission level is lower than 10 g/kWh.

Emission level in grams of NO _x /kWh	Reduction in SEK per unit of the ship's gross tonnage (GT)
6.0-9.9	0.05 SEK/GT
2.0-5.9	0.10 SEK/GT
0-1.9	0.20 SEK/GT

NO_x reduction incentives in port of Gothenburg

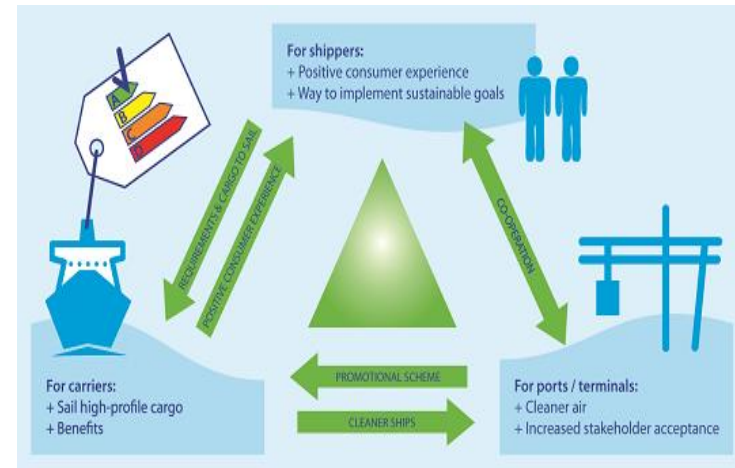
Green Port Initiatives – Differentiated flag administration fees

- Some administrations have taken or are evaluating the use of EEDI for differentiated registration fees or tonnage taxation.

- Example - Singapore MPA initiative (2011)
 - Singapore-flagged ships registered on or after 1 July 2011, which go beyond the requirements of the IMO's EEDI, will enjoy a 50% reduction on the Initial Registration Fees and a 20% Annual Tonnage Tax rebate.

Green Port Initiatives – Environmental Ship Index (ESI)

- Some ports have committed themselves to reducing the port-related GHG within an initiative called the World Port Climate Initiative (WPCI)).
- Ships receive incentives, via calculation and reduction of WPCI's Environmental Ship Index (ESI).
- The ESI identifies seagoing ships that perform better the IMO requirements.
- ESI relies on various formulas to cater for NO_x, Sox, CO₂ and OPS elements.



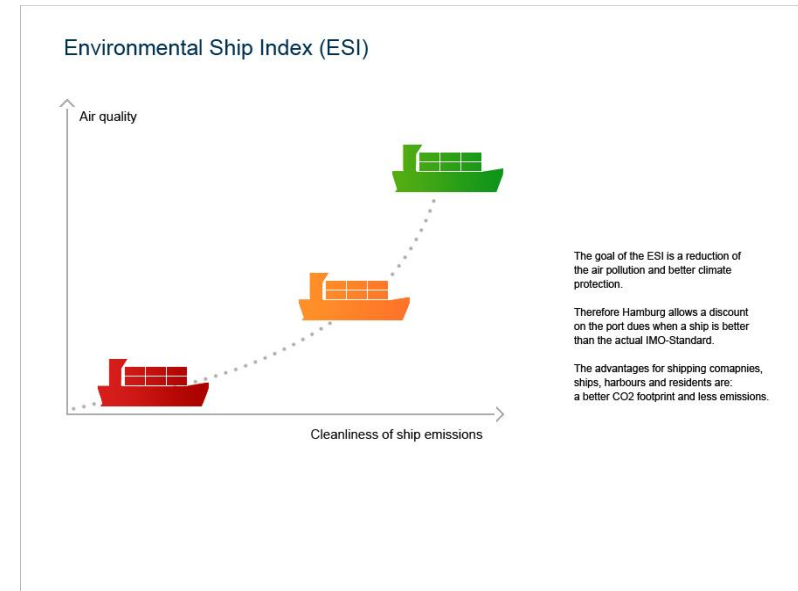
<http://www.environmentalshipindex.org/Public/Home>

The formula for the ESI Score is:

$$\frac{2 \times \text{ESI NO}_x + \text{ESI SO}_x + \text{ESI CO}_2 + \text{OPS}}{3.1}$$

Green Port Initiatives – Environmental Ship Index (ESI)

- ESI gives a bonus for use OPS and reporting / monitoring of energy efficiency.
- The ESI Score ranges from 0 (for a ship meeting IMO regulations) and 100 (for a ship that emits no SOx and no NOx and reports or monitors its energy efficiency).
- Currently the best performing ships score at around 40 points.



http://www.hafen-hamburg-2025.de/en/Green_port/Seiten/Environmental-objectives.aspx

Port clean air program

A comprehensive initiative used by some ports to address air emissions from shipping and port operations.

Mainly advocated and implemented by a port authority with input from other stakeholders.

Program normally includes:

- A set of specific emission reduction targets
- A roadmap to achieve those targets.

To ensure success, the management system style continuous improvement is applied during implementation

Commitment by the management and staff of port authorities and regulatory agencies are essential for success.

Monitoring and benchmarking will be part of the implementation process.

This could be comparable to another management plans (e.g. SEEMP) but a different scope (port environment)

This is a NOx tax applicable mainly to national industries including shipping.

The NOx tax is collected from participating industries and is fed into a NOx fund.

The NOx fund then provides finances to those organisations that want to implement NOx reduction measures including shipping industry.

This scheme is only applicable to domestic shipping around Norway.

It is an example of an effective local program that tries to create a financial scheme and business case for NOx reduction.

On the basis of the scheme, a large number of ships have so far been equipped with NOx reduction technologies.

This fund has also widely financed major Norwegian initiatives such as the move to LNG as fuel for ships operating in Norwegian water.

Thank you for your attention

ANY QUESTIONS?