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Science
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WPCAP

Port de Barcelona

POWER-TO-SHIP (P2S) / ONSHORE POWER SUPPLY (OPS) QUESTIONNAIRE RESULTS

WORLD PORTS CLIMATE ACTION PROGRAM (WPCAP)

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Introduction

- The World Ports Climate Action Program (WPCAP) initiative was launched in 2018 to address climate change
- Member ports are working together in reducing greenhouse gas emissions through collaborative actions and joint research.
- Among others, the initiative aims to accelerate the development of power-to-ship (P2S) solutions in ports. This task is controlled by the Working Group 3 of the WPCAP.
- As a first step towards this objective, a state-of-the art analysis of P2S solutions currently in operation has been developed. This analysis is based on the answers to a questionnaire.

Questionnaire

The ports that have been part of the survey are as follows:

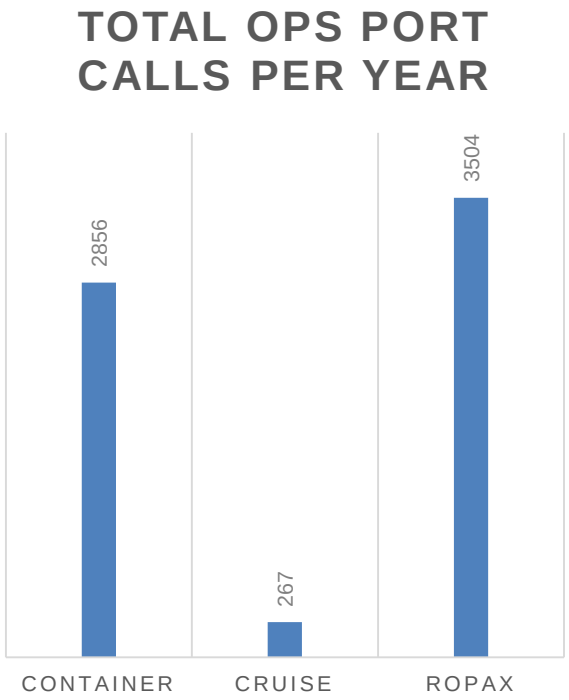
- Port of Rotterdam
- Port of Zeebrugge
- Port of Ystad
- Port of Vancouver
- Port of Seattle
- Port of New York & New Jersey
- Port of Long Beach
- Port of Los Angeles
- HAROPA- Port of Le Havre
- Port of Kristiansand
- Port of Hamburg
- Port of Halifax
- Port of Gothenburg
- Ports of Stockholm
- Port of Barcelona
- Port of Kemi

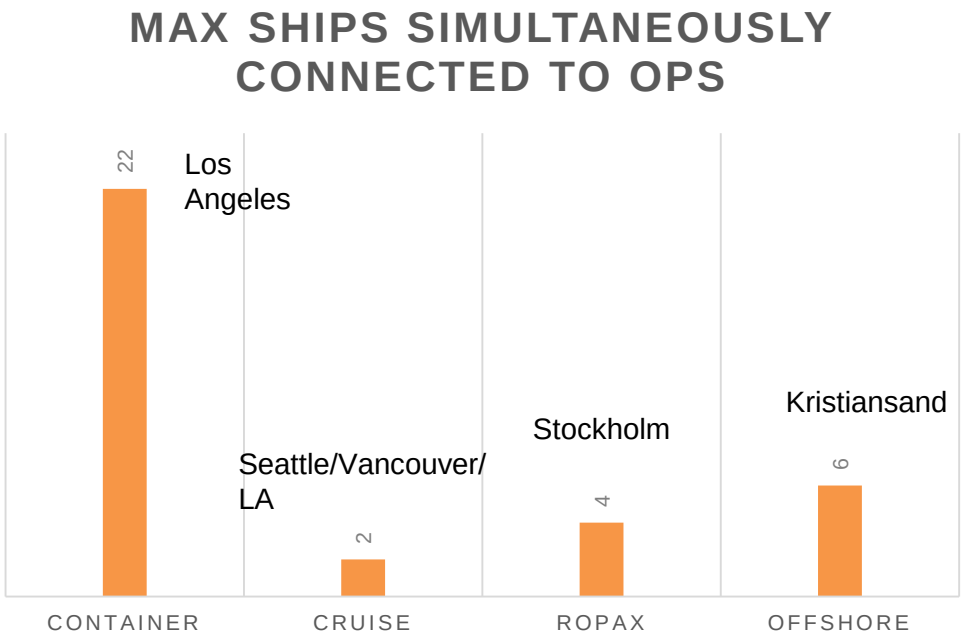
These ports have P2S solutions in place. The sample of 16 ports is considered only partially representative taking into account that approximately 65 ports worldwide declare they have OPS solutions.

1. Port infrastructure

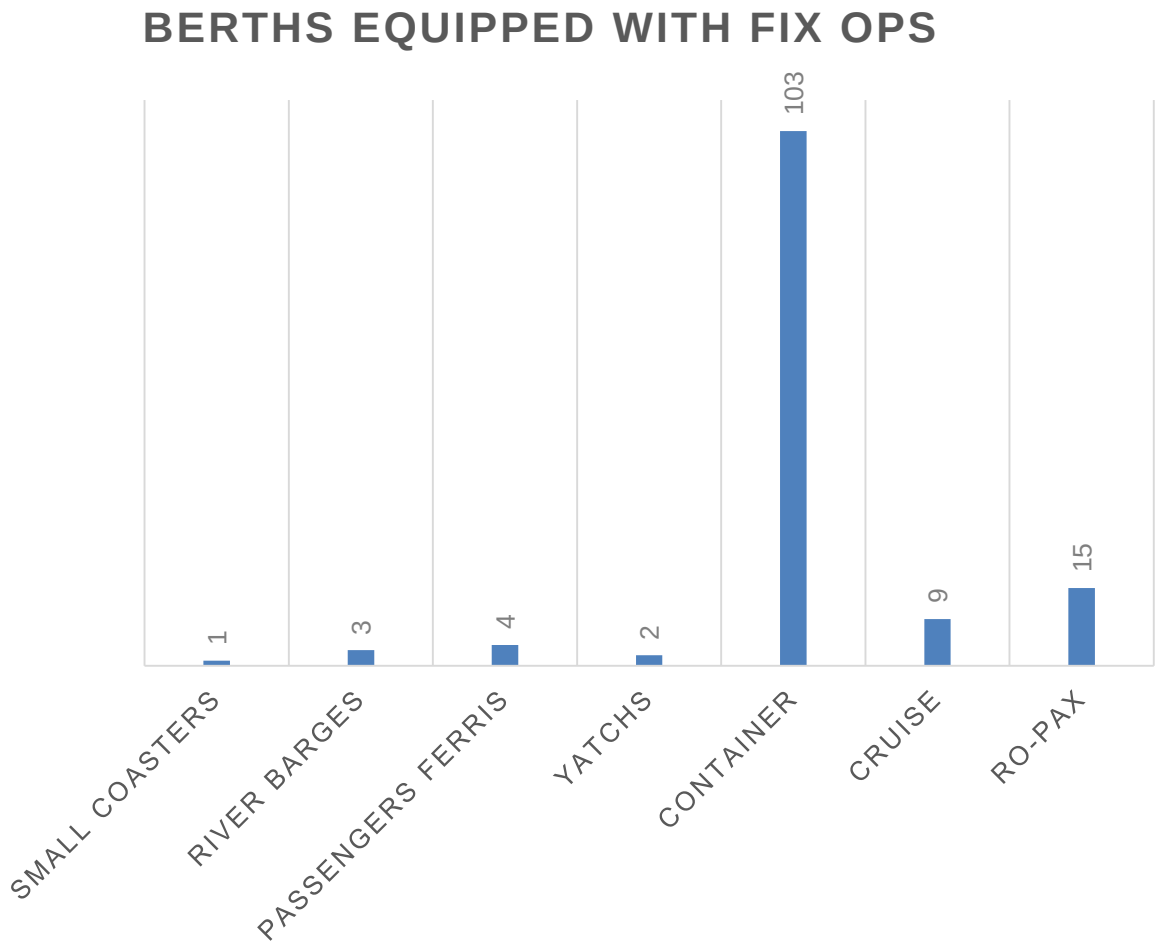
According to the results of the sample selected (n=16):

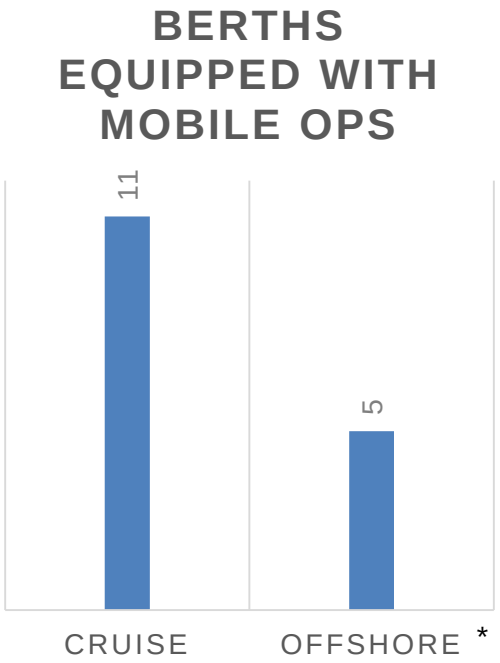
- Global OPS requested calls/year: 6627
- Successful OPS connections: 6488
- % successful OPS connections: 98%





1. Port infrastructure

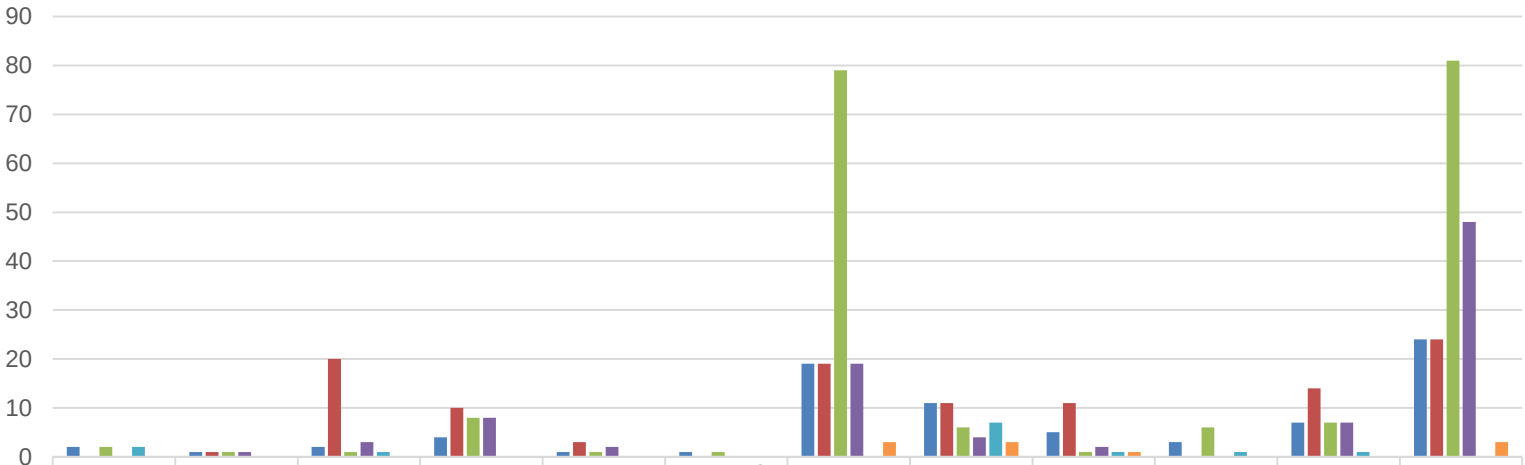




*Offshore refer to shore power that is in use for vessels at anchor

2. OPS equipment

This section presents the information on the OPS equipment currently implemented



	Port of Rotterdam	Port of Zeebrugge	Port of Ystad	Port of Vancouver	Port of Seattle	Port of New York & New Jersey	Port of Long Beach	Port of Kristiansand	Port of Hamburg	Port of Gothenburg	Port of Stockholm	Port Los Angeles
Transformers	2	1	2	4	1	1	19	11	5	3	7	24
Circuit breakers	0	1	20	10	3	0	19	11	11	0	14	24
Connection points	2	1	1	8	1	1	79	6	1	6	7	81
Switchgears	0	1	3	8	2	0	19	4	2	0	7	48
Freq. conv	2	0	1	0	0	0	0	7	1	1	1	0
Mobile cable reel	0	0	0	0	0	0	3	3	1	0	0	3

Transformers Circuit breakers Connection points Switchgears Freq. conv Mobile cable reel

2. OPS equipment

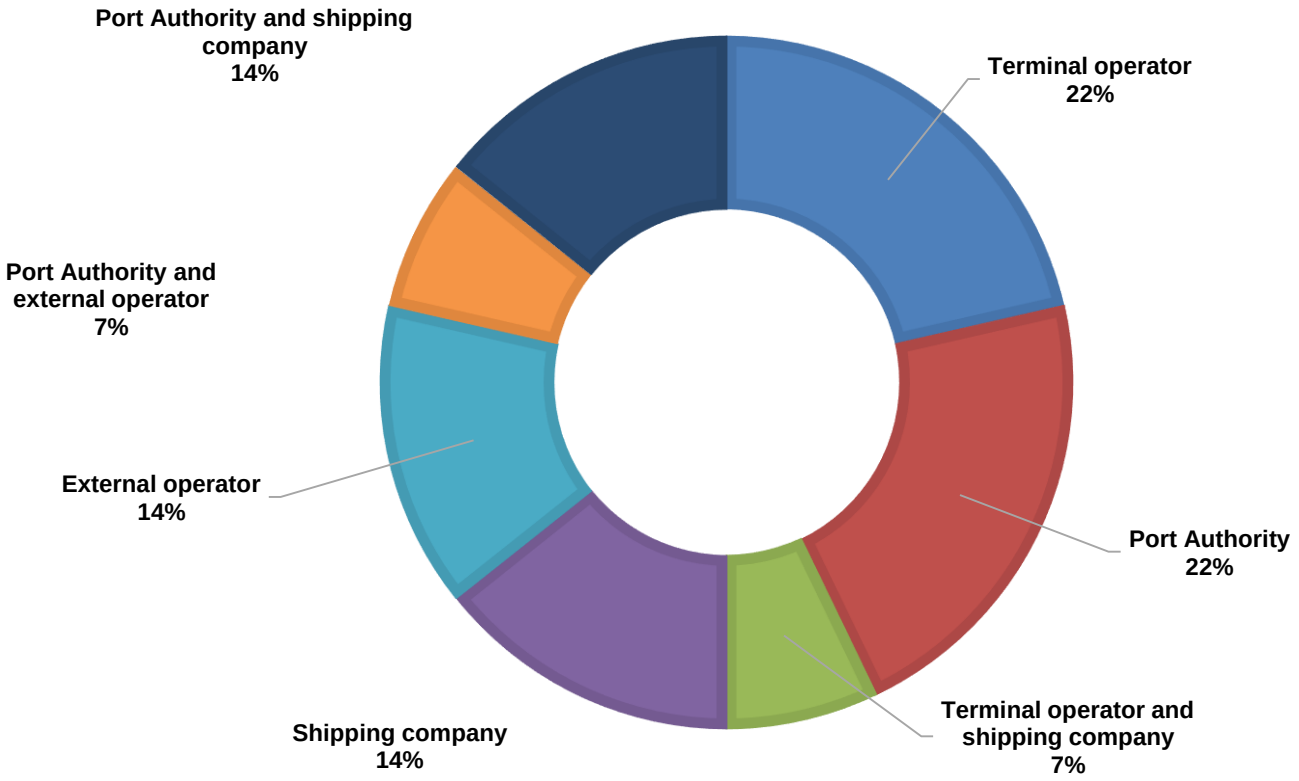
Information of the OPS connections per terminal type

Terminal type	Ports	Voltage [kV]	Frequency [Hz]	Power capacity [MW]
Container	**LA, LB, Vancouver**	6,6	60	7,5
Cruise	**LA, Vancouver, Seattle, Kristiansand, Hamburg**	6,6-12,5	50-60	12-20
RoPax	**Rotterdam, Ystad, Gothenburg, Stockholm**	6,6-11	50-60	0,8-3
Ferries	**Gothenburg, Kristiansand**	0,4-11	50-60	1-2,5
Multipurpose	**Zeebrugge, Kemi**	6,6	50	1,25
Offshore	**Kristiansand**	0,4-0,6	50-60	1-1,4
Mega Yatchs	**Barcelona**	6,6	50	3,4
River barges	**Haropa**	0,4	50	0,025

LA: Los Angeles ; LB: Long Beach

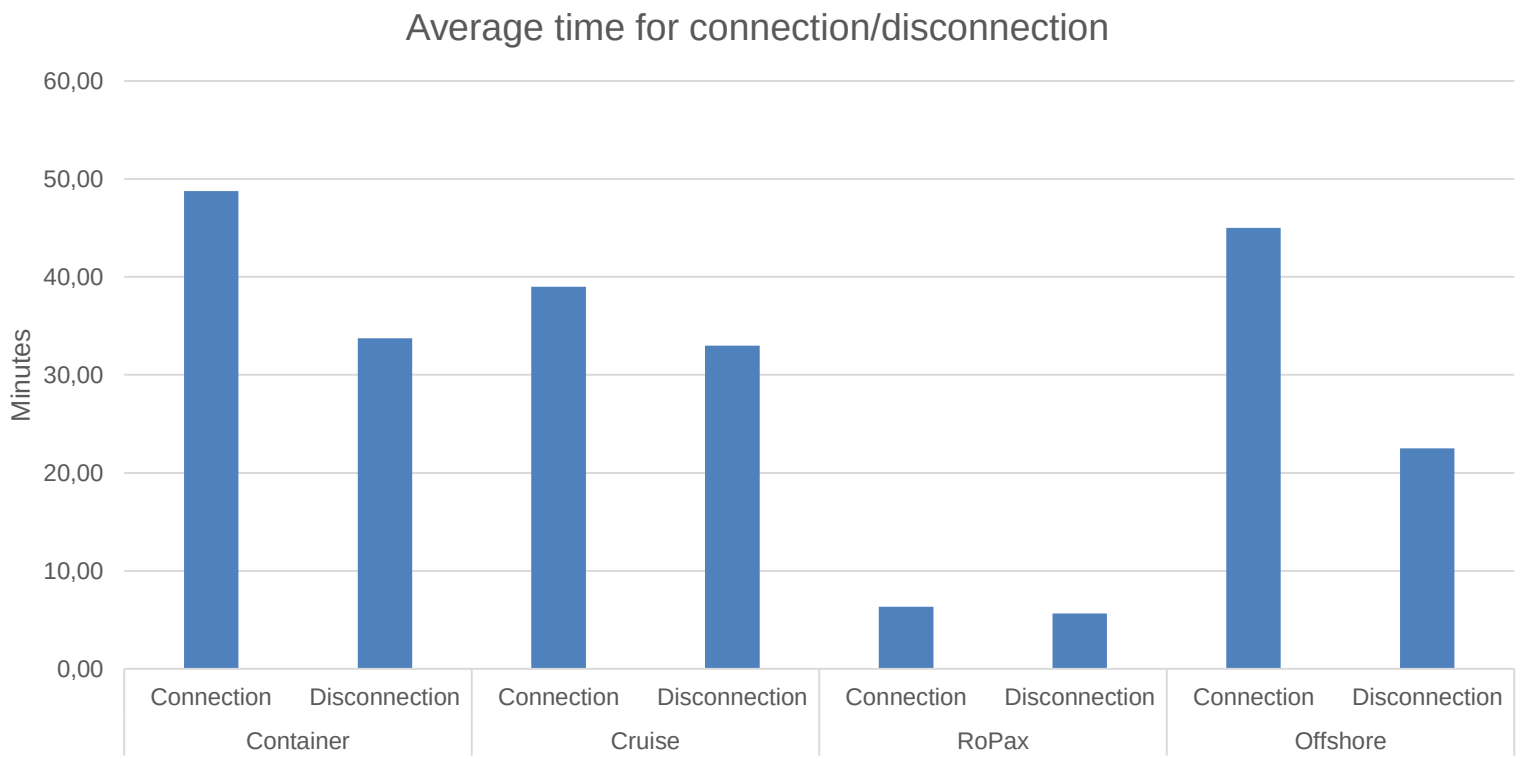
3. Operation

Who runs the OPS system?



3. Operation

- How long does it take to **connect/disconnect** the OPS system from port-to-ship?



The **total connection and disconnection** average time is around **80 minutes for containers**, **70 minutes for cruises**, **65 minutes for offshore** and **10-15 minutes for RoPax**.

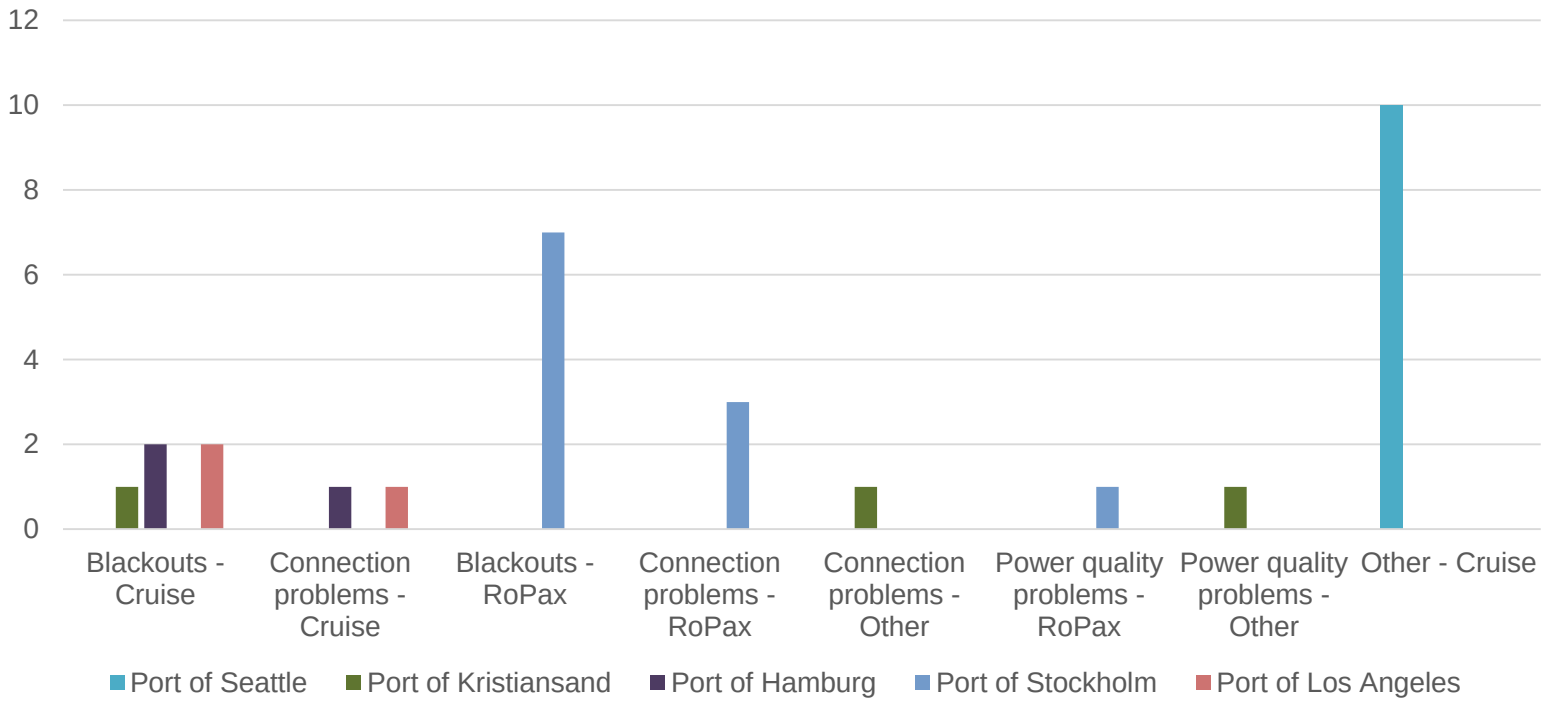
3. Operation

Main **safety and risk preventive measures** implemented in ports

- **Training** of staff
- Proper grounding of faults
- Opening of **circuit breakers** on both ship and shore when faults occur
- **Efficient disconnection during emergencies** for weather or excessive vessel movement relative to pier
- **Efficient communications** between vessel and shore personnel
- **Standardized operating safety procedures** shared by ship crew and shore side operators
- **Indication lights show that the connection is safe to touch**

3. Operation

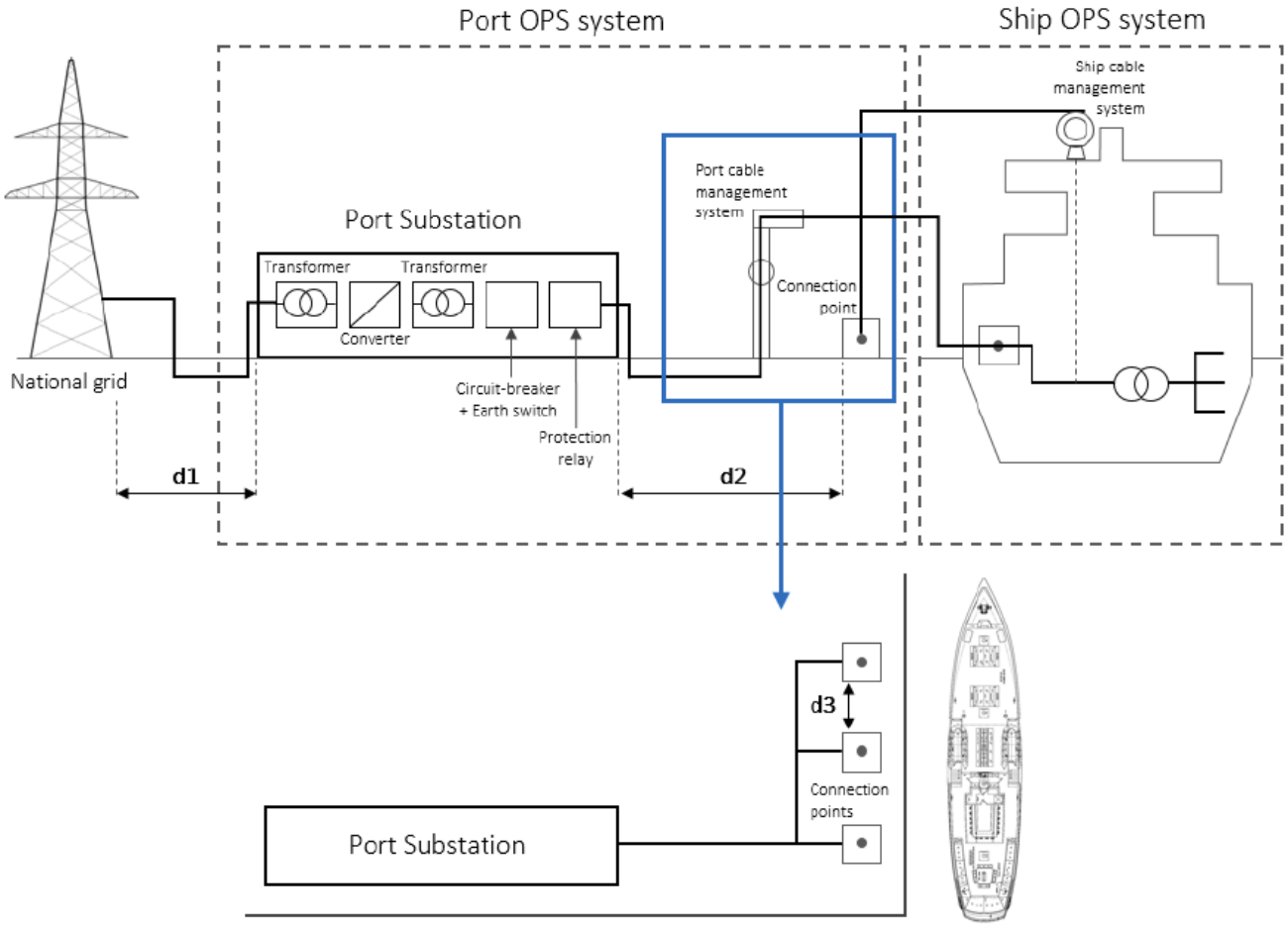
- Incident analysis



- Main problem connections declared: optical cable that manages communication between shore and vessel, ship alignment at berth, sync-module onboard the ship and problems with the city grid.

4. Electricity

- Details of the power grid and OPS system configuration – Global scheme



	Average	Min	Max
d1	2,2	0,1	4,8
d2	0,5	0,1	1,5
d3	0,12	0,1	0,3

*Distances in km

4. Electricity

- Details of the power grid and OPS system configuration – distances of infrastructure

	Rotterdam	Ystad	Vancouver	Seattle	Long Beach	Los Angeles	HAROPA	Kristiansand	Hamburg	Gothenburg	Stockholm
Longest distance from any fixed connection point from the NG to port substation (d1)	3 km	3 km	0,1 km	4,8 km	1,8 km	3 km	2,5 km	0,8 km	1,2 km	0	1,5 km
Distance from the port substation to the connection point (d2)	1,5 km	1 km	0,1 km	<0,1 km	0,8 km	0,6 km	1 km	0,2 km	0,6 km	0,1 km	0,7 km
Distance between connection points at the same berth (d3)	0,3 km	-	<0,1 km	-	0,1 km	<0,1 km	<0,1 km	0,1 km	-	0,1 km	-

4. Electricity

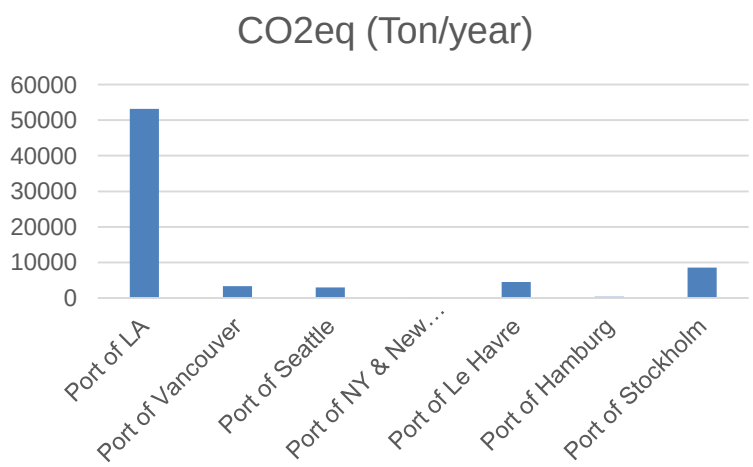
- What is the source of the electricity at port ?

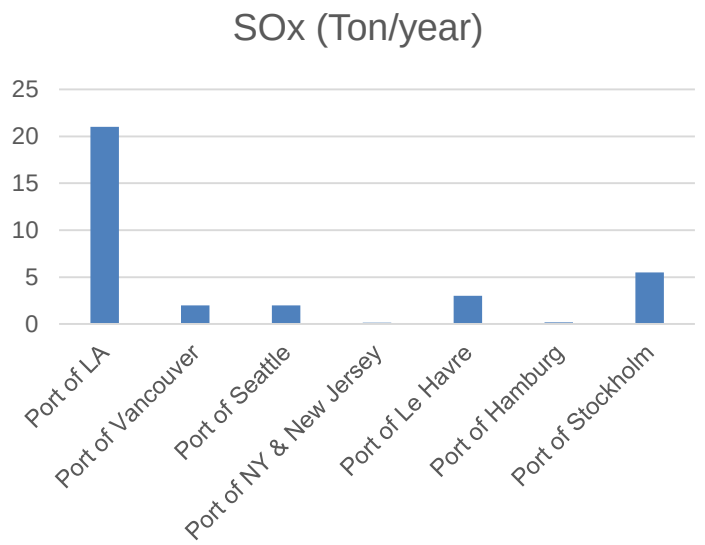
The energy transition in the ports must be an objective to be kept in mind. It is therefore important that the energy should be from renewable sources and that it should be invested in OPS simultaneously.

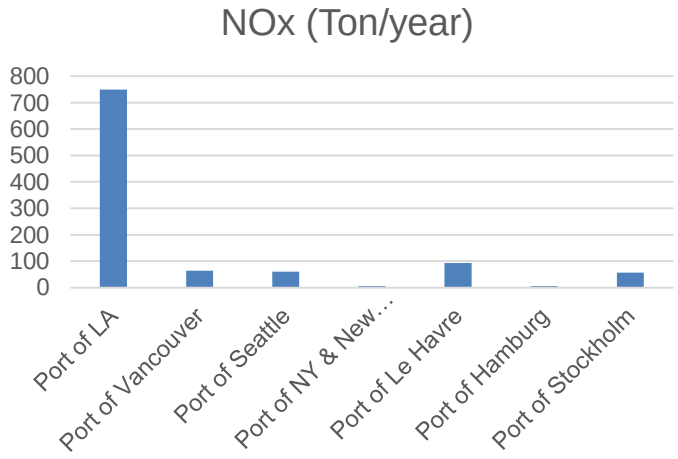
Port	Source of the electricity	Voltage [kV]	Frequency [Hz]
Rotterdam	National grid	25	50
Zeebrugge	National grid	11	50
Ystad	Green energy (Renewable)	11	50-60
Vancouver	British Columbia hydroelectric power	12.5 - 69	60
Seattle	Seattle City Light - 93% clean sources	11	60
Long Beach	Southern California Edison (SCE)	12 or 25	60
Los Angeles	Local city of LA grid.City of LA Dept. of Water and Power	34,5	60
HAROPA Le Havre	National grid	20	50
Kristiansand	Hydro Power	11	50
Hamburg	National grid, renewable	10	50
Gothenburg	National grid	10	50
Stockholm	National grid, 100 % from renewable	11	50
Barcelona	National grid	25	50
Kemi	National grid	6,6*	50

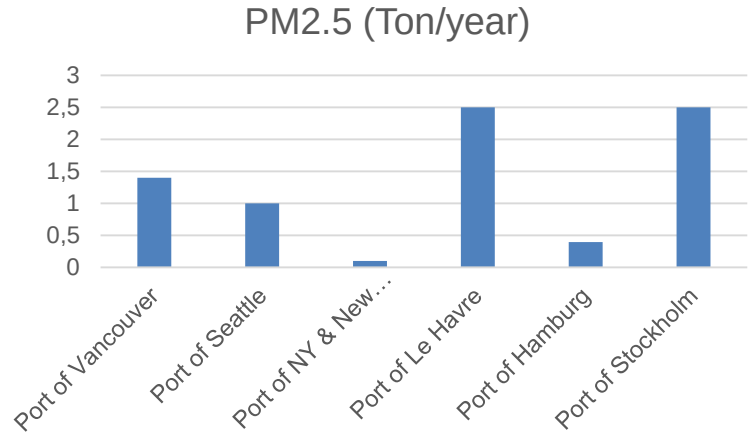
5. Environment

This section presents only the results of emission reductions specifically notified by ports.





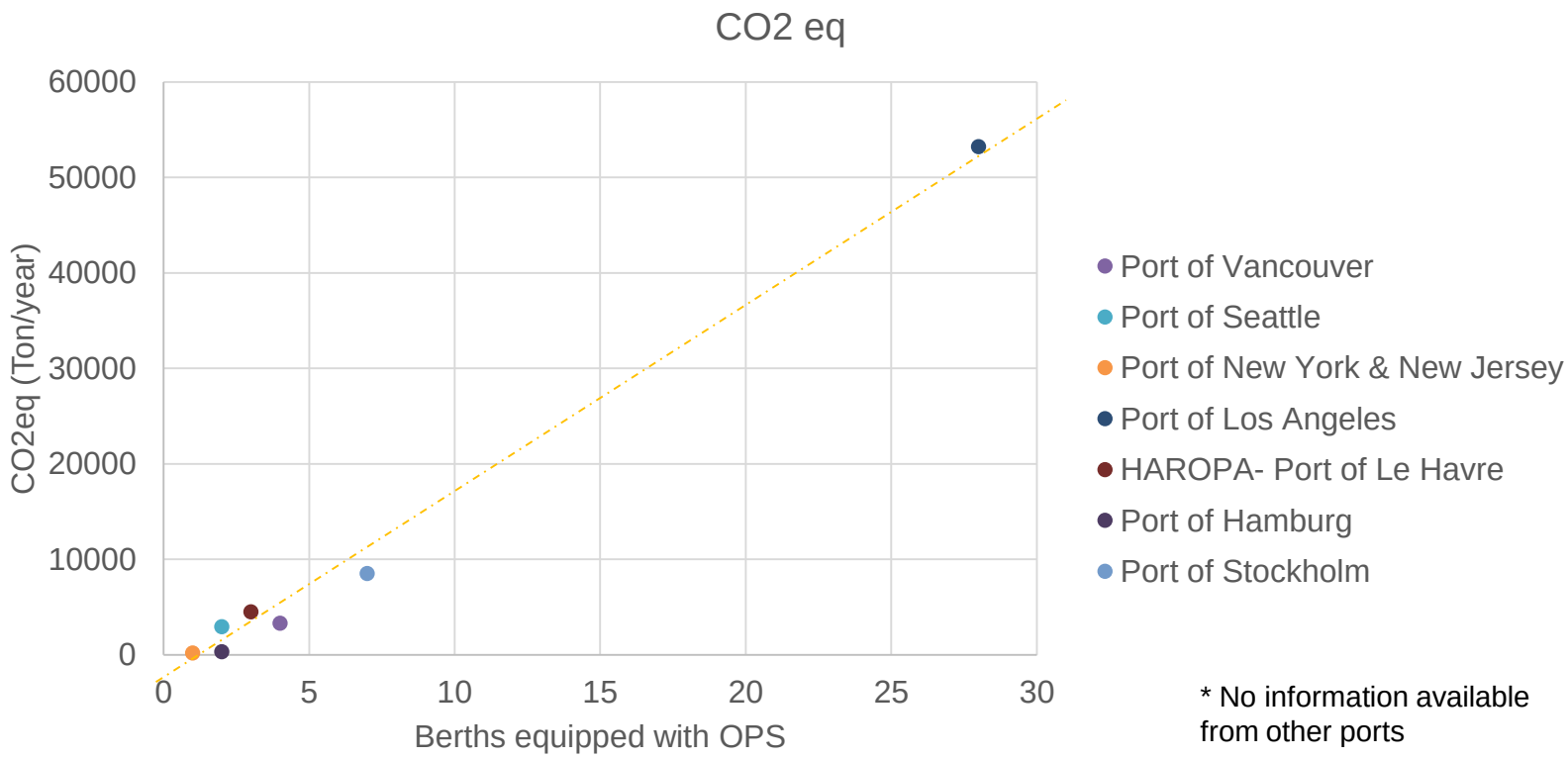




* To calculate the Nox and SOx of the port of Le Havre, an estimation has been made based on the average pollution.
To obtain the SOx of the port of Hamburg an estimation has also been carried out.

5. Environment

- Reduction of emissions according to the number of OPS connections:



* No information available from other ports

5. Environment

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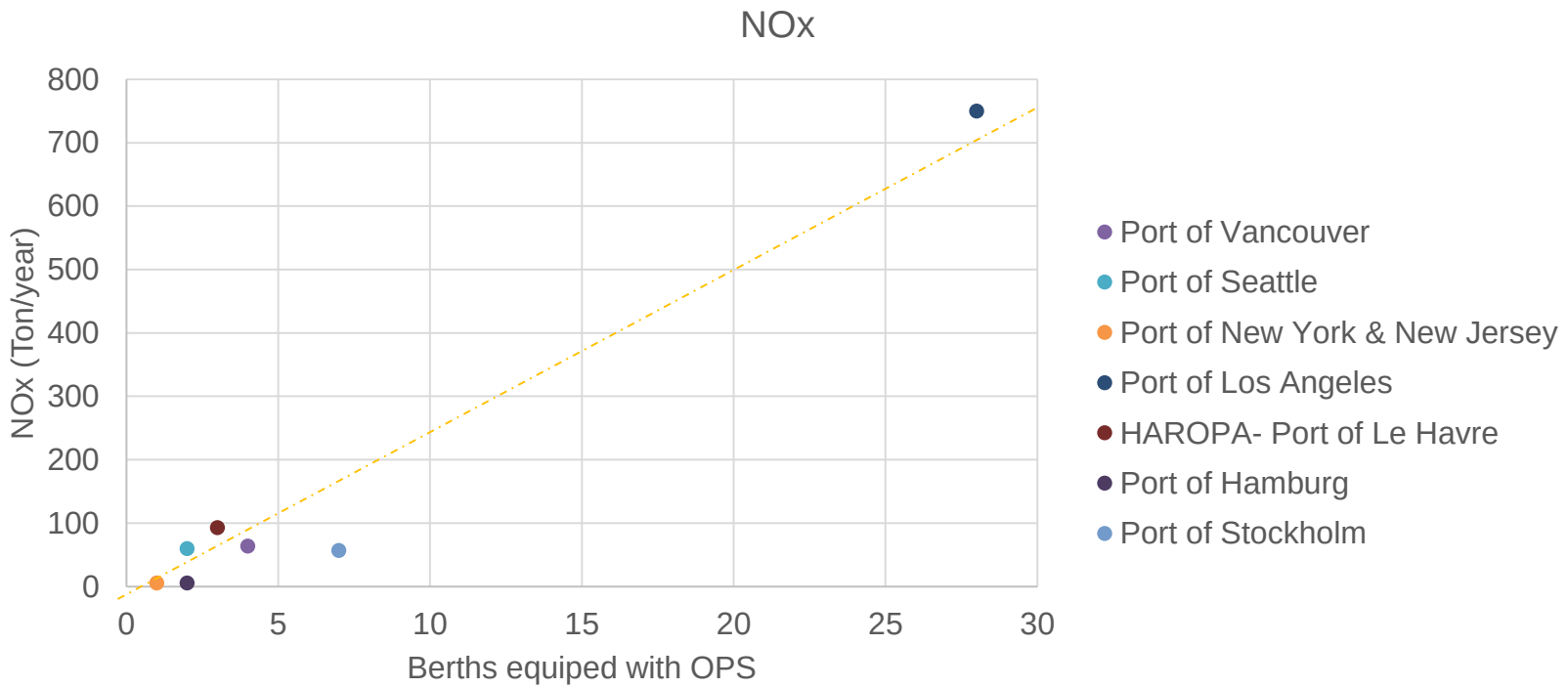

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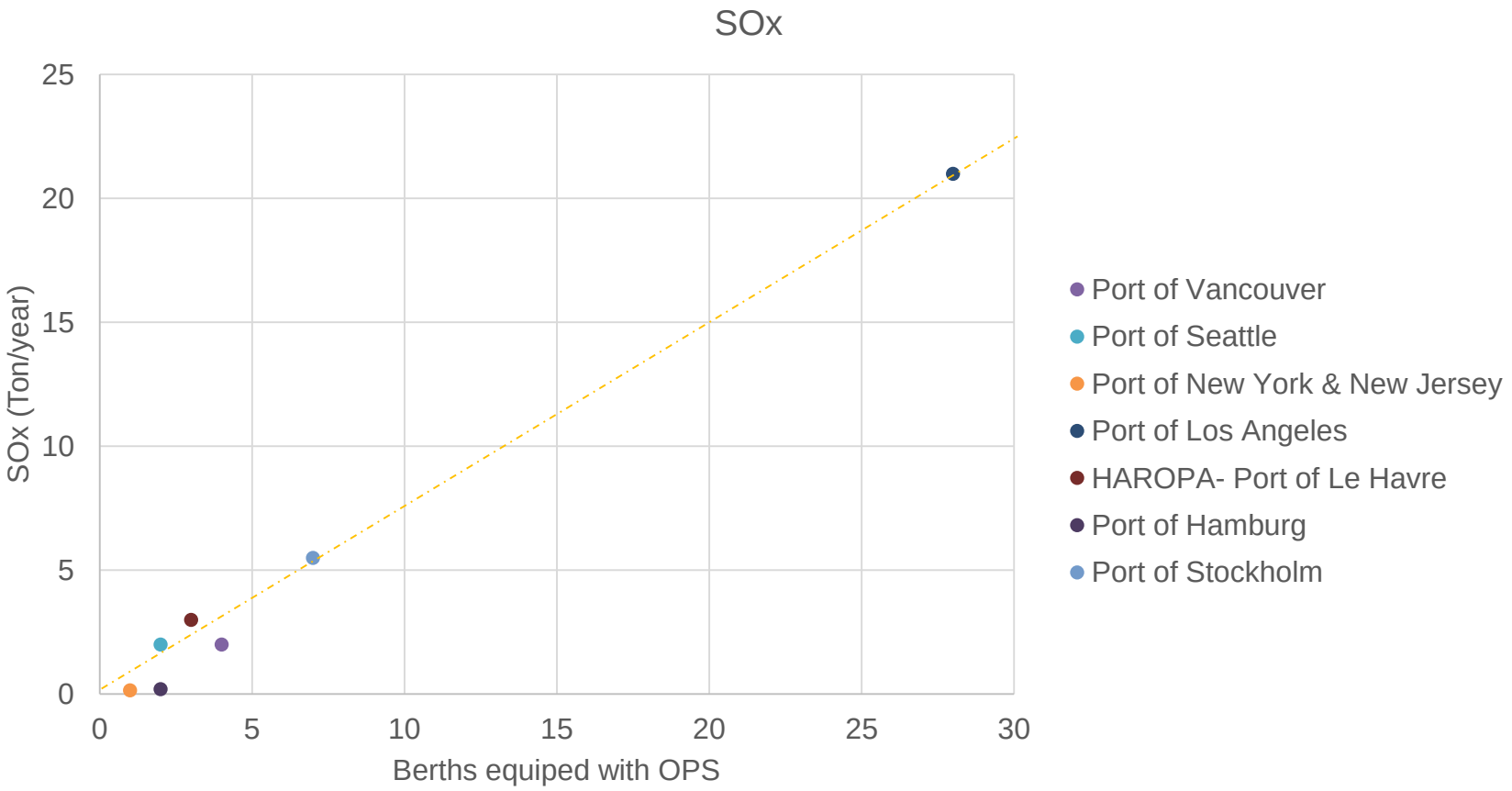

5. Environment

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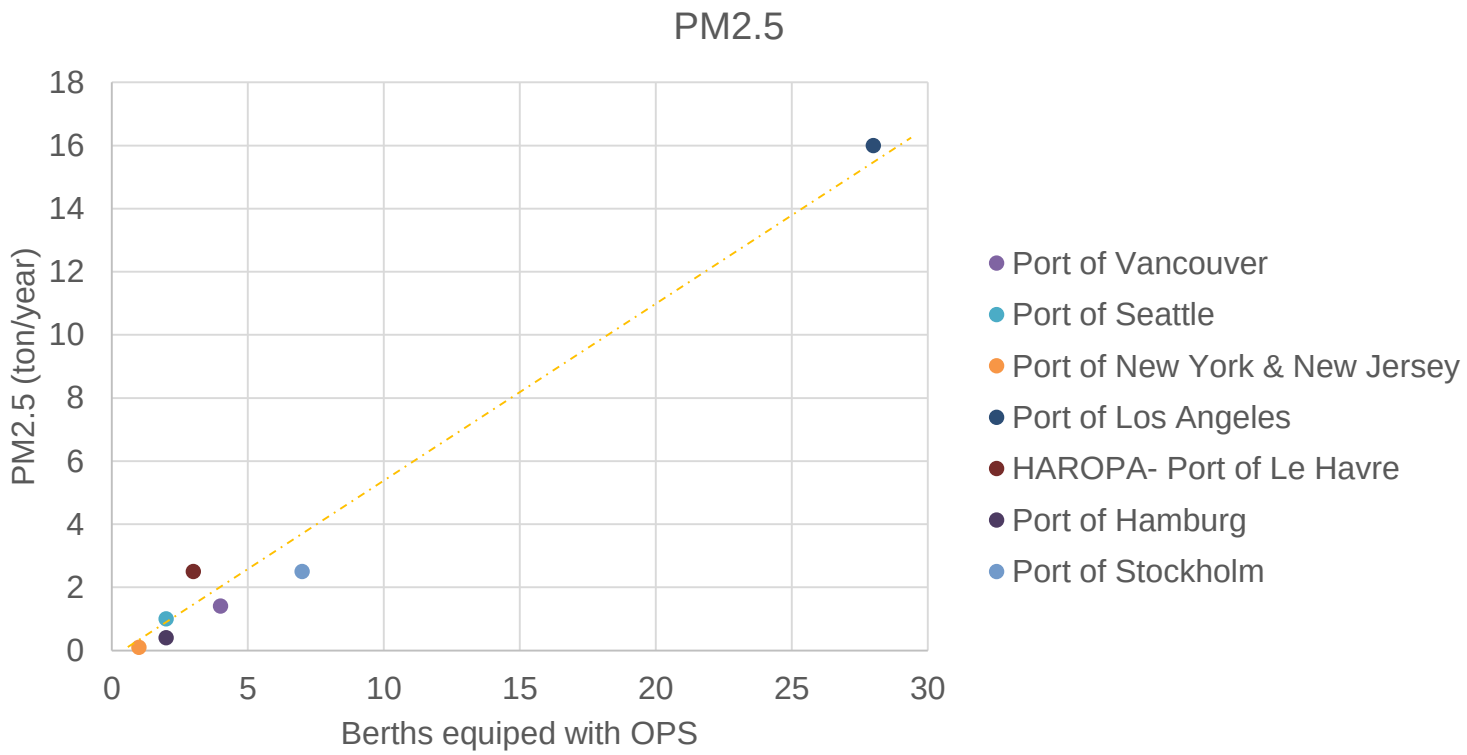
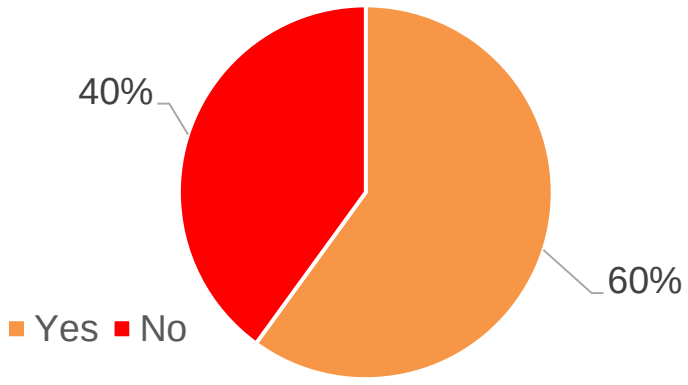
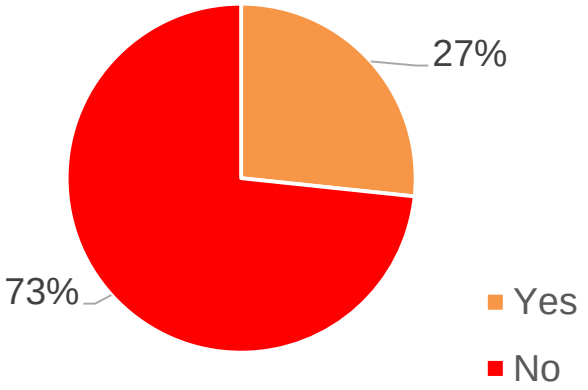


6. Discounts, rebates and penalties

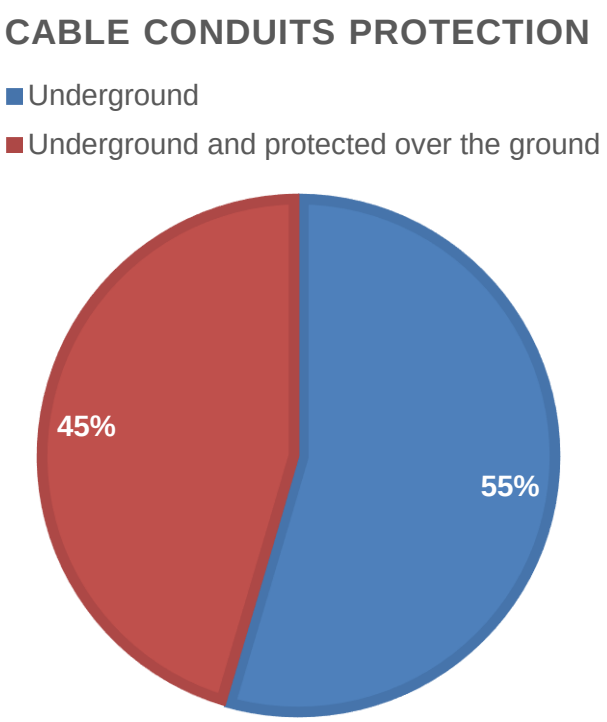
Discounts/rebates to ships for using OPS systems in port



Penalty if the ship does not connect to the OPS system available at berth

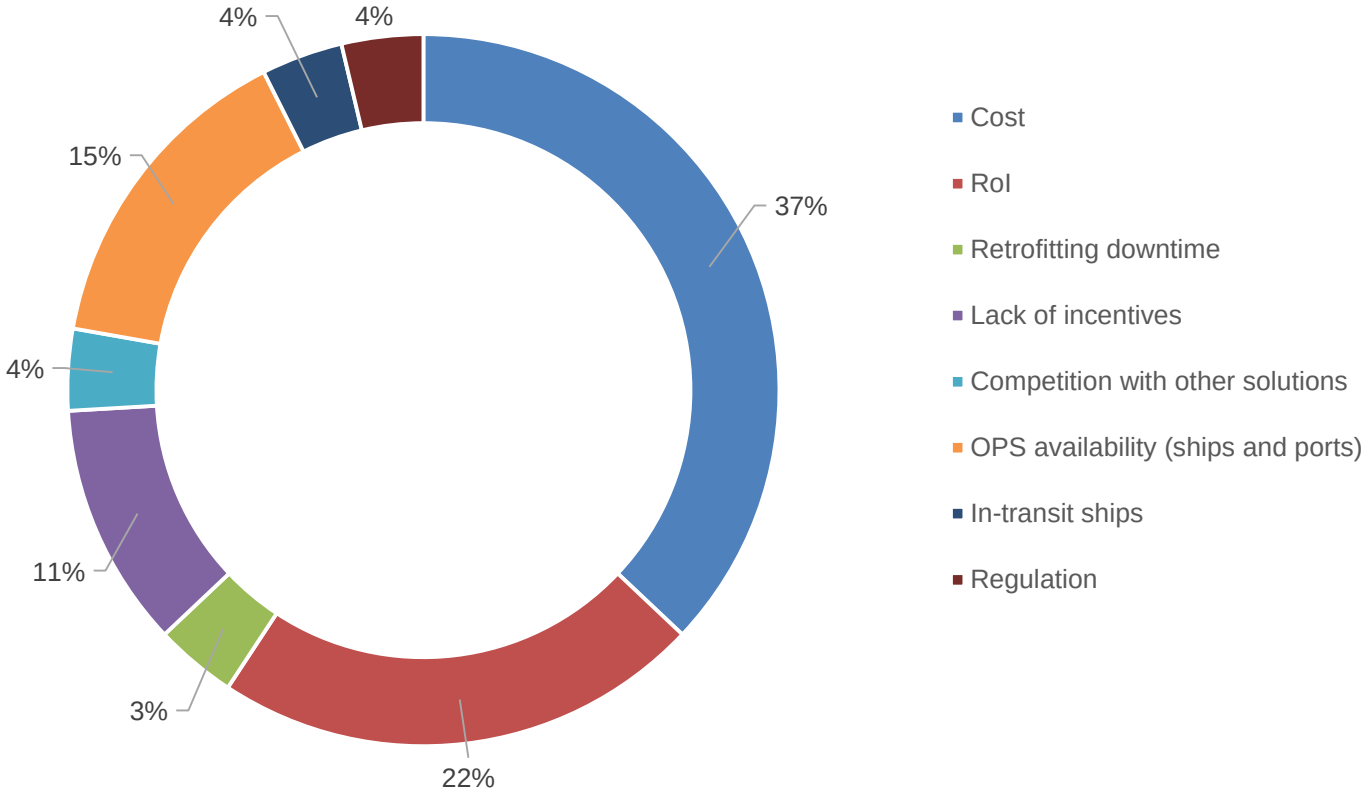


7. Port Works


CABLE CONDUITS PROTECTION
Underground
Underground and protected over the ground
45%
55%

8. Recommendations (1)

- The main barriers for ship owners to adapt their vessels so they can connect to the OPS system



8. Recommendations (2)

Port	Recommendations to a port that is considering to install an OPS system	If you had to install an OPS system again, what would you have done differently?	Success factors
Vancouver	- Government **grants** needed - Favorable Utility rate is essential - Planning to recover for cost for shore power - Port insist it is very important to verify that container vessels to be connected to OPS installations have automated tensioning systems installed	- Install **mobile cable reel** systems at cruise terminal because of variety of cruise ship sizes and congested terminal. - Install more receptacle pits at one of the container terminals (there are currently 2, 3 would be optimal)	✓ Secured predictable, favorable **electricity rate** with Utility provider ✓ **Taking advantage of terminals' expansion** projects and installed cable ducts from terminal substations to berth face in anticipation of OPS ✓ **Negotiated contracts** with terminal operators for construction support and future OPS operation ✓ **Communication of OPS** projects with public to gain support and increase **pressure on terminal** operators for well-timed installation
Seattle	- **Flexible cable** management system that allows ships to connect in multiple configurations - Ensure using **industry-standard** connection equipment that aligns with majority of customers - Engage utility to develop **rate structures** that **incentivize** ships to plug in		✓ **Engaging the utility provider early** and working closely with cruise lines.
Los Angeles	- Coordinate with shipping lines on all possible OPS ship layout (**standardization**) - Determine OPS connection points that would accommodate most ships	- **OPS point of connections to be more flexible** - Implement **moving OPS plug** box along wharf	✓ Early on deployment of "Schneider" PL SCADA where PLC monitors almost all electrical points of interest like breaker status, fault status, and generate events logs

8. Recommendations (3)

Port	Recommendations to a port that is considering to install an OPS system	If you had to install an OPS system again, what would you have done differently?	Success factors
Zeebrugge	- OPS installation is **only economically viable if it is used a lot**		
Kristiansand	- The port need electro-technical **competent personnel** - Evaluate the implementation with an economic calculation and incorporate some risk - Start with a select group of ships, for example container or bulk.		✓ People in the harbor with **knowledge of OPS** who have close dialogue with connecting ships.
New York & New Jersey	- Negotiate advantageous electricity **rate**		✓ Vessel carrier partnership
Hamburg	- Using the **IEC/IEEE 80005-1. Standardization**. - Working together on a level-playing flied - Working on a standardized billing model - One face to the customer	- Automatic tide tracing OPS systems (considering cruise vessels) - **Smart measuring** - Flexible connections e.g. cruise also suitable for expedition ships	✓ Offer a little lower **price** due to fundings of the CAPEX
Stockholm	- It is difficult to make an OPS installation **economically viable**. - Seek funding for the installations - Include costs for the OPS-installations in the port fees	- Have an active, continuous and constructive **dialogue with shipping companies** and other involved ports from the start. - A joint procurement process for forthcoming installations.	✓ An active, continuous and constructive **dialogue** with shipping companies and other involved ports.
Ystad	- Have a **good dialog with the operators** (ships and vessels)		✓ Having frequency converter in the port and not on each vessel.

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