Establishment and analysis of a global database of initiatives adopted the reduction of maritime air emissions

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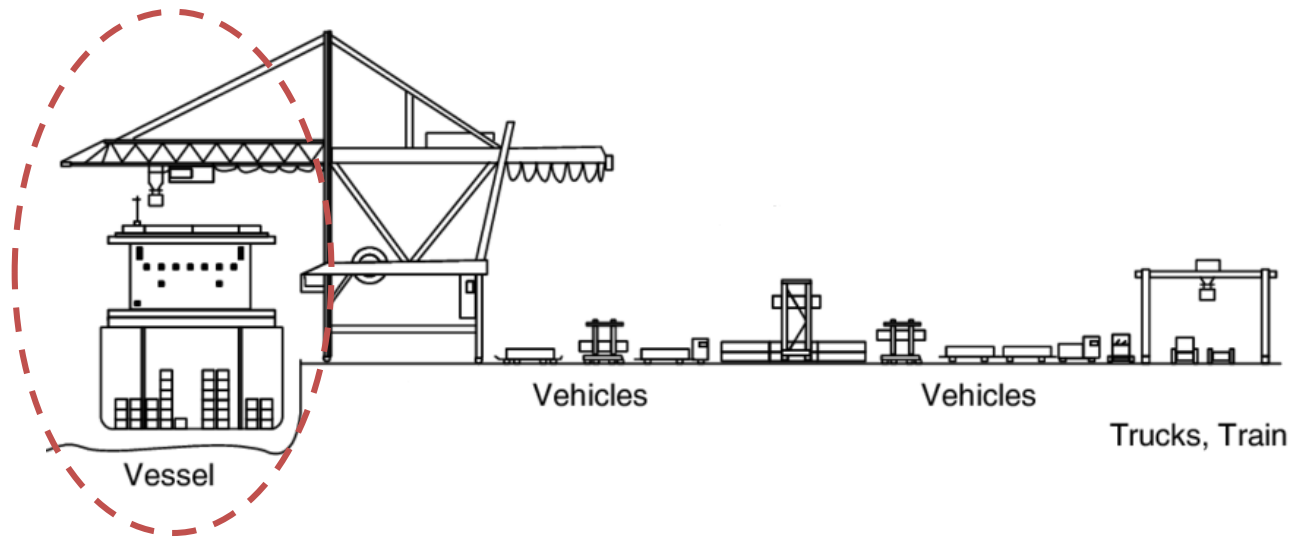
Shipping:

- It is essential for the growth of ***global trade*** and the **least** environmentally damaging mode of long-distance transport *(López-Navarro, 2013; Styhre et al, 2014)*.

- However, it represents around ***2.2% of the global CO_2 emissions*** *(Smith et al, 2014)* and these emissions are forecast to increase by ***50% in 2050*** *(UNCTAD, 2016)*.

    - CO_2 emissions from shipping ***are not covered*** by the Kyoto Protocol, Copenhagen Acord *(UNCTAD, 2010)* or the Paris Agreement *(UNCTAD, 2015)*.

    - Demand for shipping is forecast to ***increase*** in the future *(Smith et al., 2014; UNCTAD, 2016)*.

Ships → Major source of atmospheric emissions that can have significant ***adverse effects on human health and the environment*** *(Cullinane and Cullinane, 2013; Corbett et al., 2007)*.

Several actors have initiated **policies, incentives and measures** to reduce maritime air emissions.

This article aims to **identify and classify policies, incentives and measures** that have been implemented across the globe and are related to the **abatement of shipping air emissions**.

Vessel

Vehicles

Vehicles

Trucks, Train

Specific <u>types of measures</u>, <u>geographical areas</u> or <u>individual policies</u> implemented worldwide. **However**, none of them has dealt with <u>air emissions from shipping as a whole</u>.

Studies on

- **Technical and operational measures** and cost implementation *(Bouman et al., 2017; Miola et al., 2011; Johnson et al., 2013; Smith et al., 2014; Bazari and Longva, 2011; Kontovas and Psaraftis, 2011; Psaraftis, 2018; Eide et al., 2009; Eide et al., 2011)* <u>Improvement of the **operational efficiency** of shipping</u> *(Cullinane and Cullinane, 2013; Wang and Cullinane, 2006; Cullinane and Khanna, 1999)*.

- **Inventory** of environmental performance indices *(Svensson and Andersson, 2012)*

- **Market-based incentives and policies** for innovative technologies or alternative fuels *(Shi, 2016; Wan et al, 2018; Psaraftis, 2012; Nikolakaki, 2013; Davidson and Faber, 2012; Cariou, 2011),* <u>bunker levy schemes</u> *(Kosmas and Acciaro , 2017),* <u>emission trading systems</u> *(Franc and Sutto, 2014; Nikopoulou et al., 2012)*.

- <u>The use of **alternative fuels**</u> *(Bengtsson et al., 2012; Brynolf et al., 2014)*.

- The potential of individual measures to <u>reduce maritime air emissions **at ports**</u> *(Ahl et al., 2017; Cullinane, 2012; Innes and Monios, 2018; Winnes et al., 2015; Zis et al., 2014)*

- <u>Three-layered approach to vessels emissions based on **geographical area**</u> *(Lindstad et al., 2015)*.

Categorization

Policy instrument / measures ⟶ **Total 249 case studies**

Based on the classification of the Swedish Environmental Protection Agency (SEPA).

a)   their 'nature', the category and subcategory of measures under which they fall

b)   Their geographical level of application,

c)   The continent where the organization is located

d)   The specific type and sector (public or private) of the organization

After their categorization, the initiatives were analysed using the SPSS Statistics software in order to give some insight into their frequencies and the interrelationships between them.

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a)   **Their 'nature', the category and subcategory of measures under which they fall**

Category and subcategory

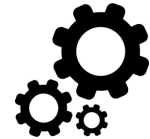| **Administrative**	**Economic**	**Informative**	**Research**	**Infrastructure**
- Legislation - Norms - Limit - Agreement - Inspection - Technical req. - Environ. Class.	- Fee - Grant - Discount - Tax - Tax deduction - Subsidies - Certificates	- Eco-labeling - Training - Advising	- Research - Development - Testing	- Infrastructure investment

Categorization

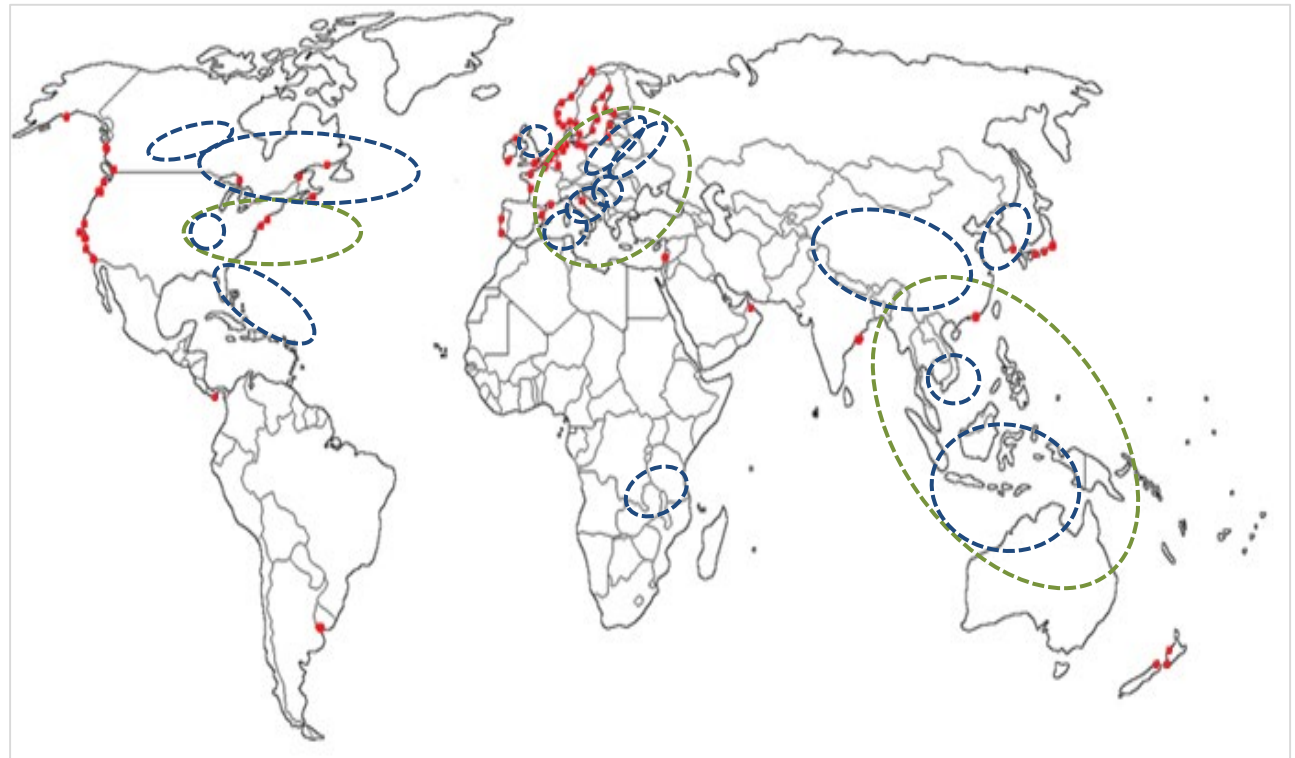**Policy instrument / measures** ⟶ **Total 249 case studies**

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b.) Their geographical level of <u>application</u>,

Geographical location	Initiatives
International	29
Regional	31
National	48
Local	141

Categorization

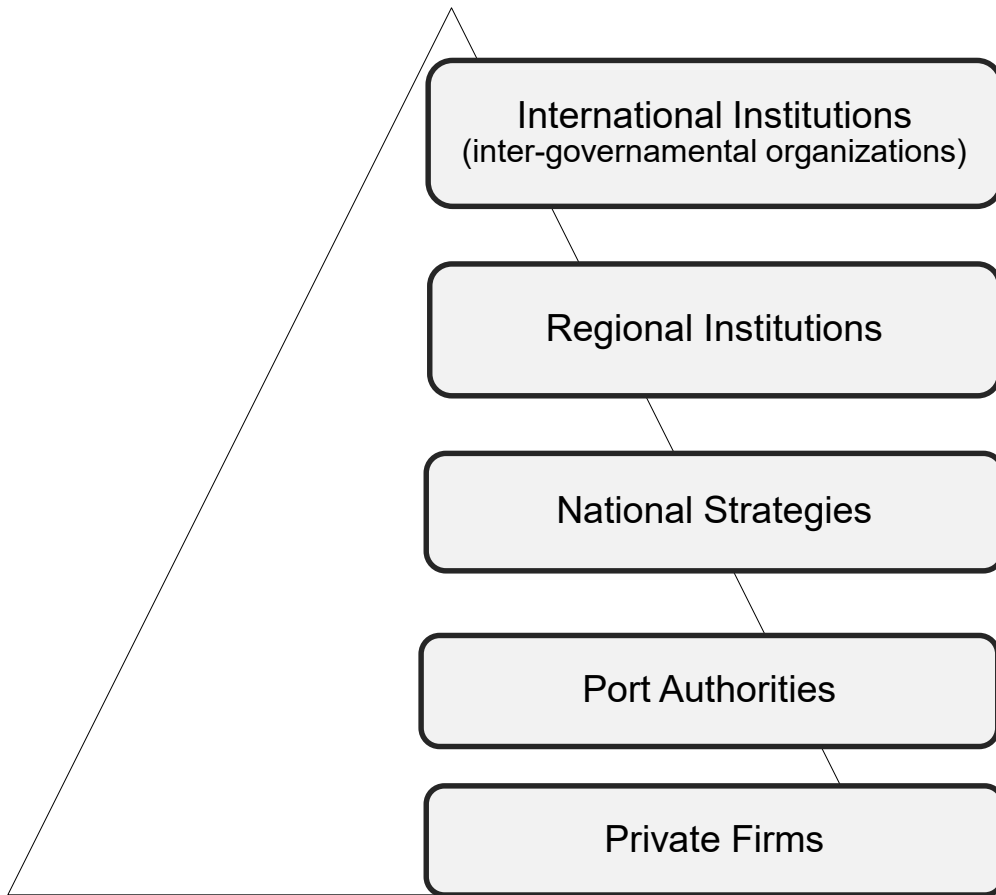**Policy instrument / measures** ⟶ **Total 249 case studies**

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Several actors have initiated **policies, incentives and measures** to reduce maritime air emissions.

International Institutions
(inter-governamental organizations)

Regional Institutions

National Strategies

Port Authorities

Private Firms

d.) The specific type and sector (public or private) of the organization

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Some examples:

| Level	Example
International Institutions (inter-governamental organizations)	*MARPOL; SECAs; EEDI; SEEMP*
Regional Institutions	*EU Regulations; "LNG Directive"*
National Strategies	*Maritime Singapore Green Initiative*
Port Authorities	*Clean Air Action Plan*
Private Firms	*Barges with bio-fuel*

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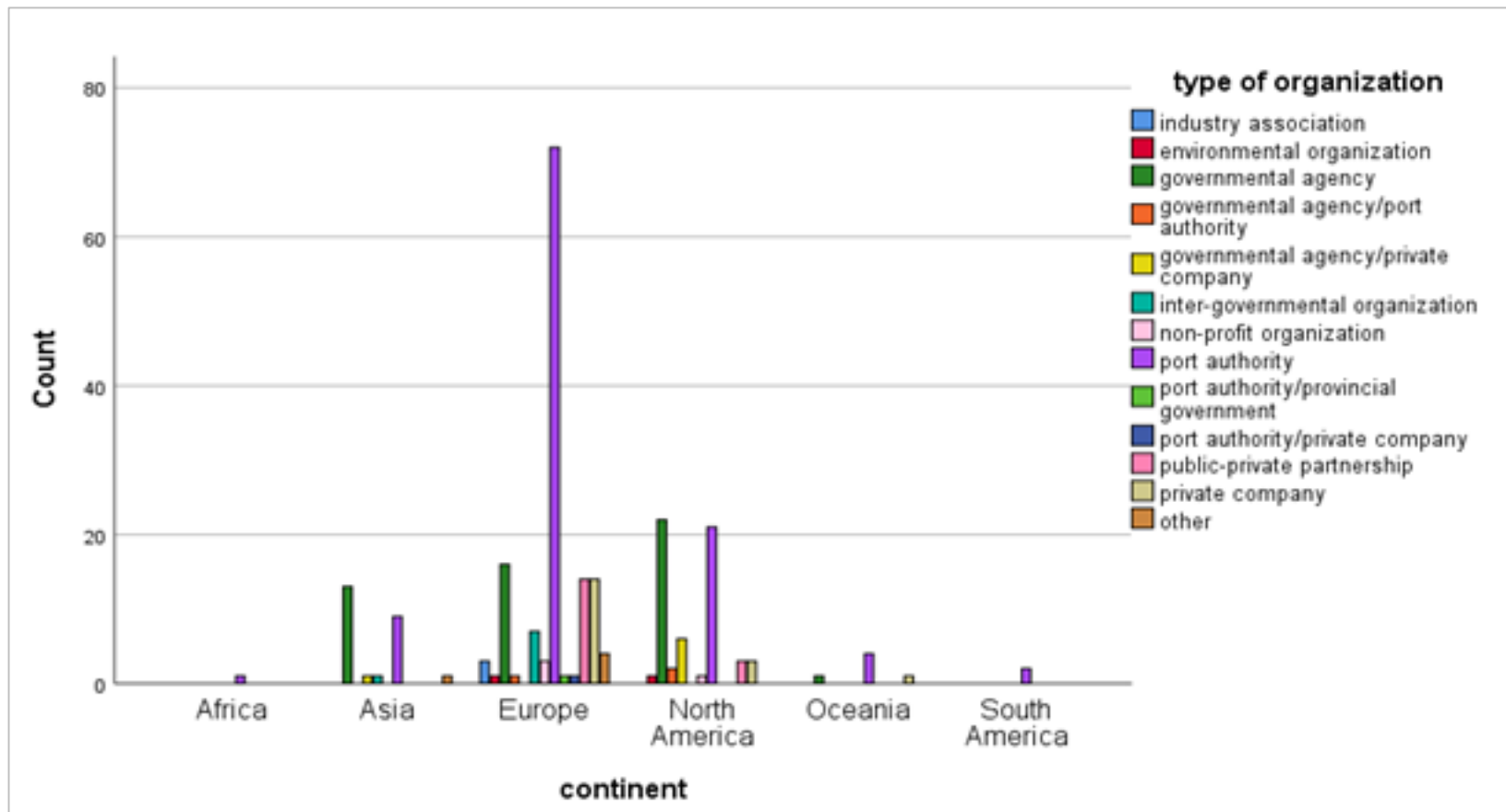
1.) *Organization profile of the institutions* *that have adopted measures, policies and incentives with maritime emission reduction potential*

Continent

- Europe
- North America
- Asia
- Oceania
- South America
- Africa

60%
25%
11%
3…
1%
0%

Sector

- Public
- Private
- Public / Private

84%
12%
4%

1.) *Organization profile of the institutions* *that have adopted measures, policies and incentives with maritime emission reduction potential*
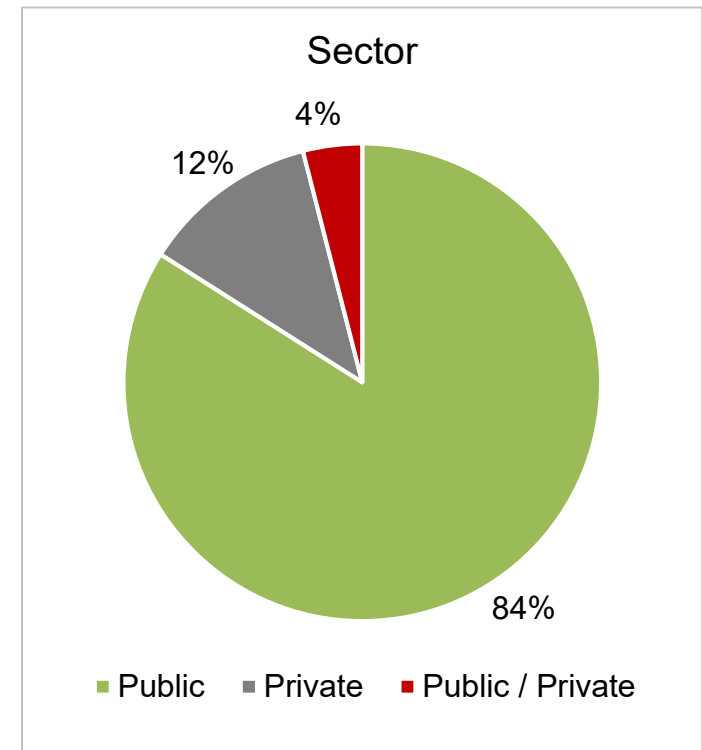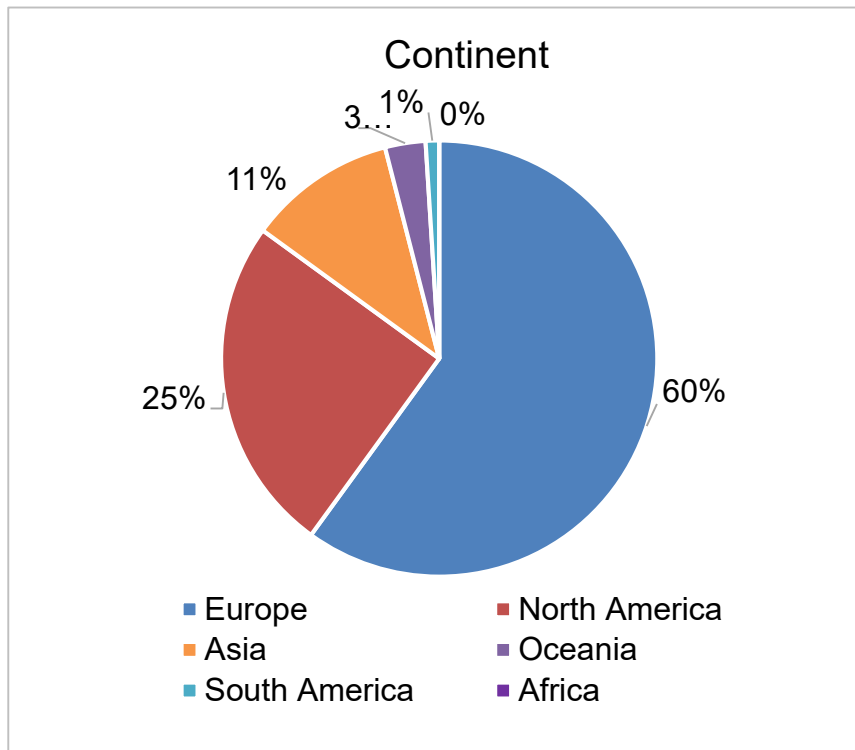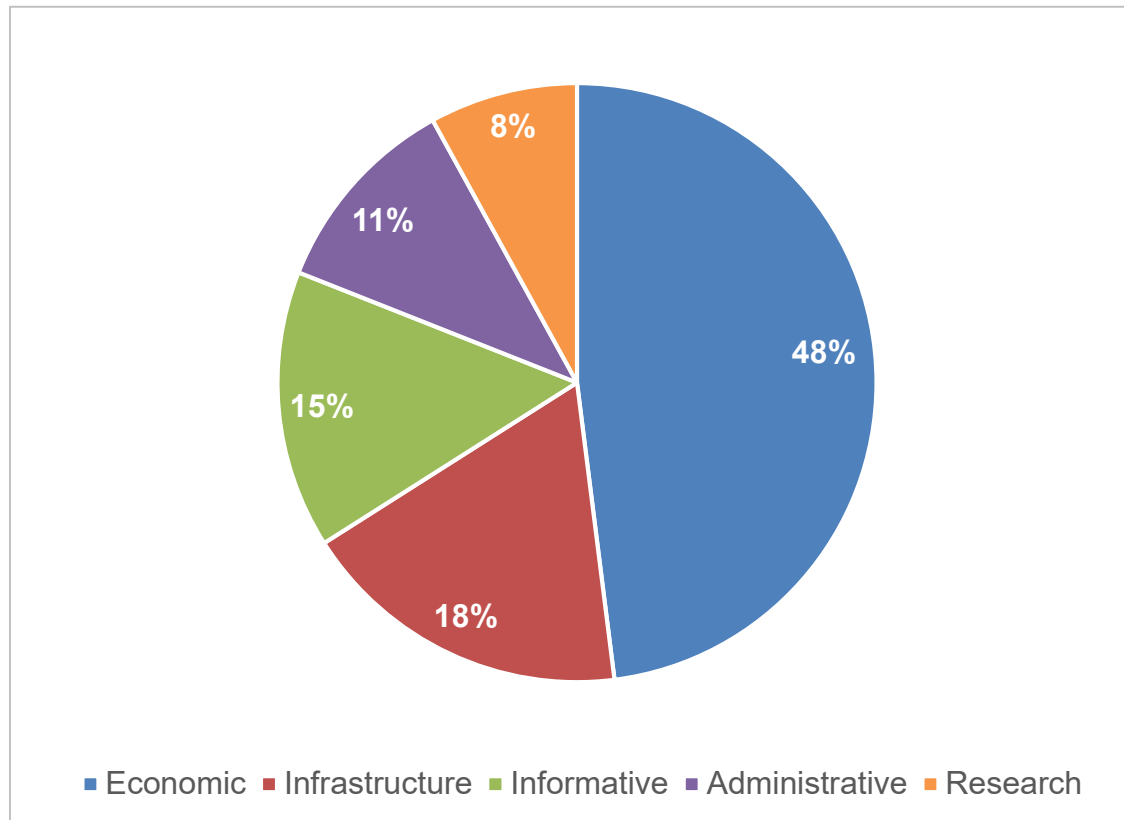
Type of organization
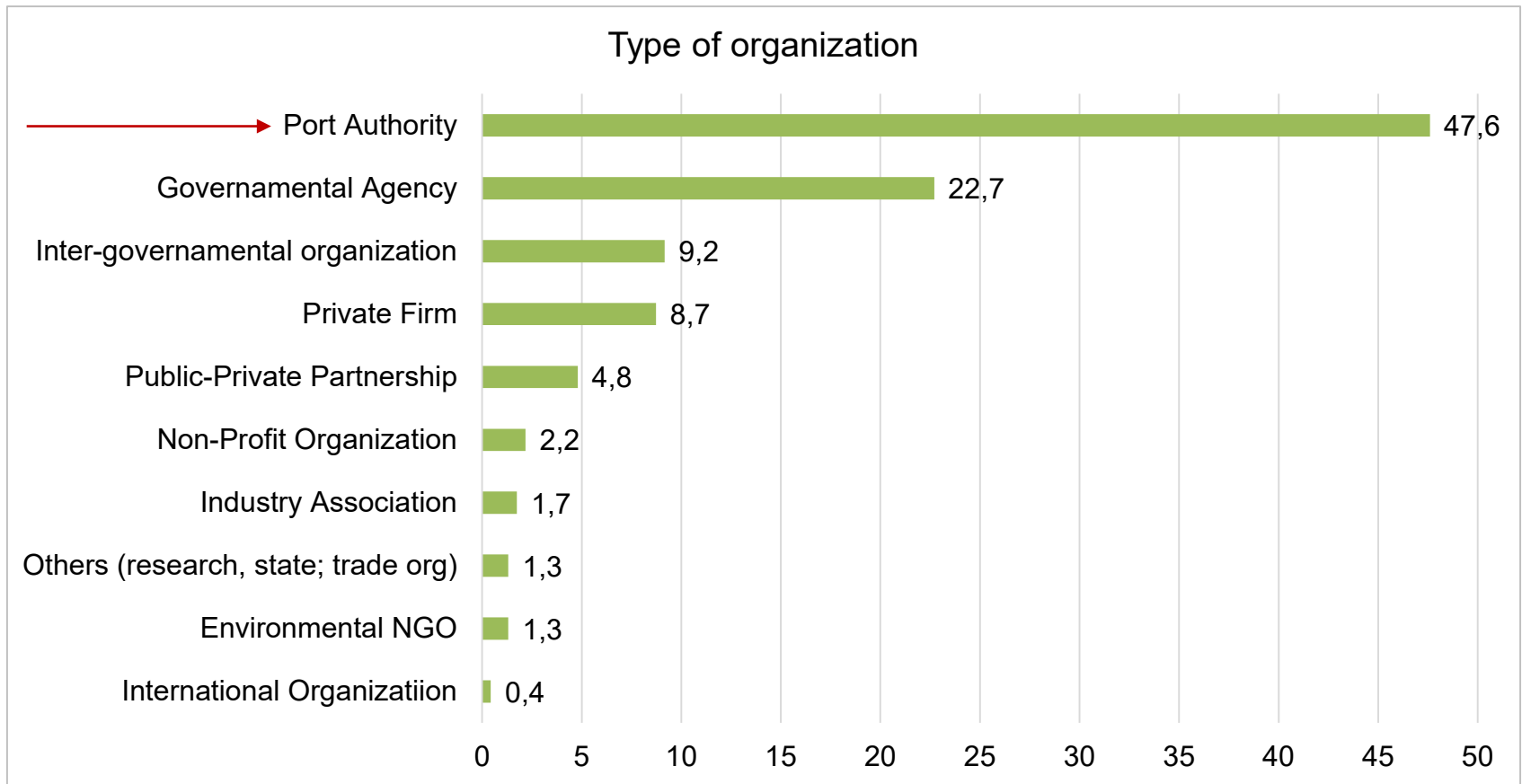
1.) Organization profile of the institutions that have adopted measures, policies and incentives with maritime emission reduction potential

*2.)* ***Identification*** *of measures, policies and incentives targeting the abatement of maritime air emissions*

2.) *Identification* *of measures, policies and incentives targeting the abatement of maritime air emissions*

| Administrative	38	Economic	119	Informative	29	Research	20	Infrastructure	43
Legislation	6	Fee	1	Eco-labelling	20	Development	2	Infrastructure Investment	43
Limit	12	Penalties	1	Advising	9	Technique evaluation	18		
Agreement	2	Grant	17						
Inspection	4	Discount	85						
Technical requirements	10	Tax	2						
Environmental classification	4	Tax deduction	2						
		Subsidies	5						
		Reimbursement	2						
		Trade with emission allowances	4						

3.) *Inter-relationships* between *categories* of measures, *geographical* level of *application* and *type* of institutions

Category of measure and type of the organization
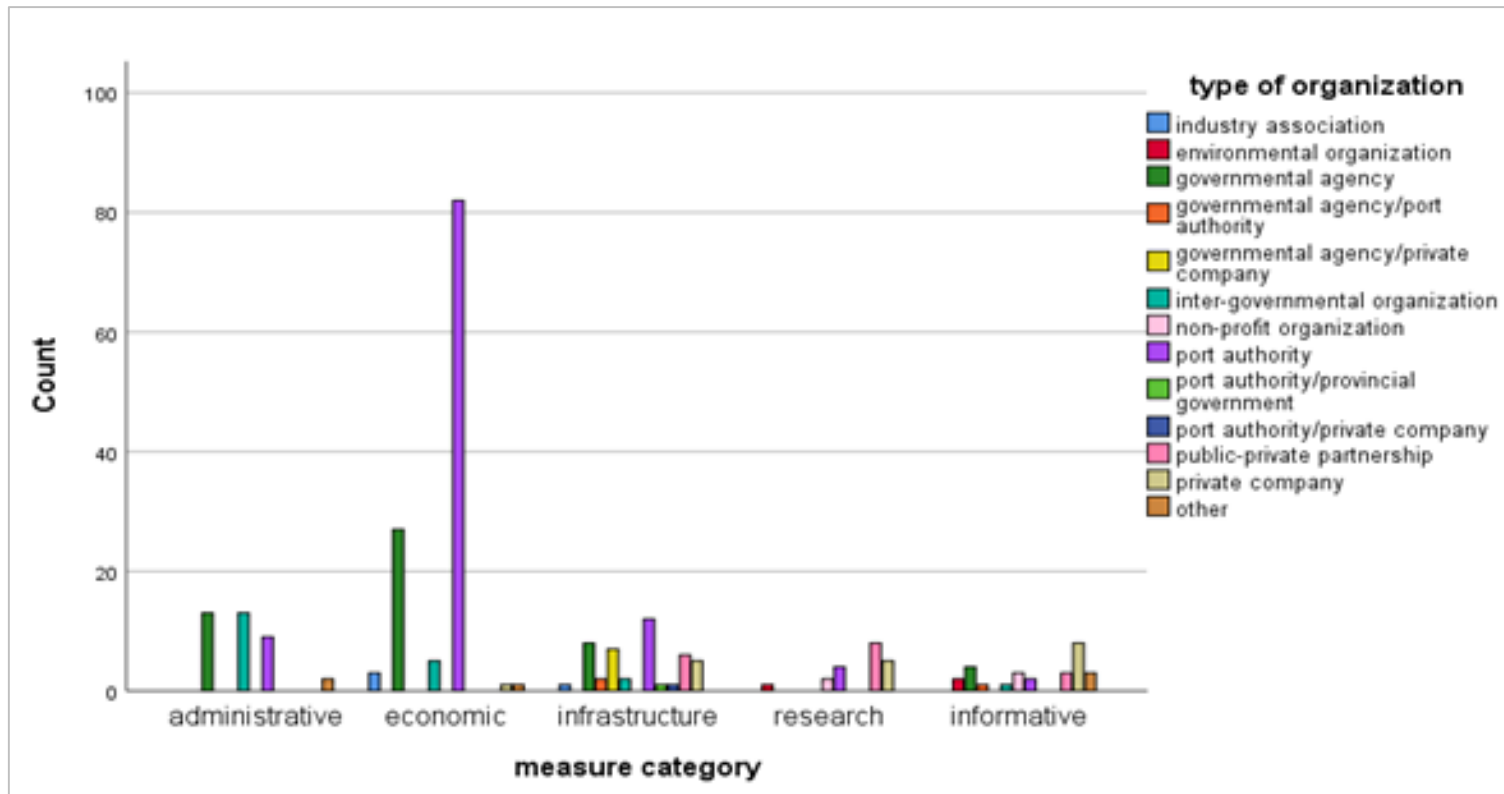
*3.) **Inter-relationships** between **categories** of measures, **geographical** level of application and **type** of institutions*

Category of measure and geographical level of application
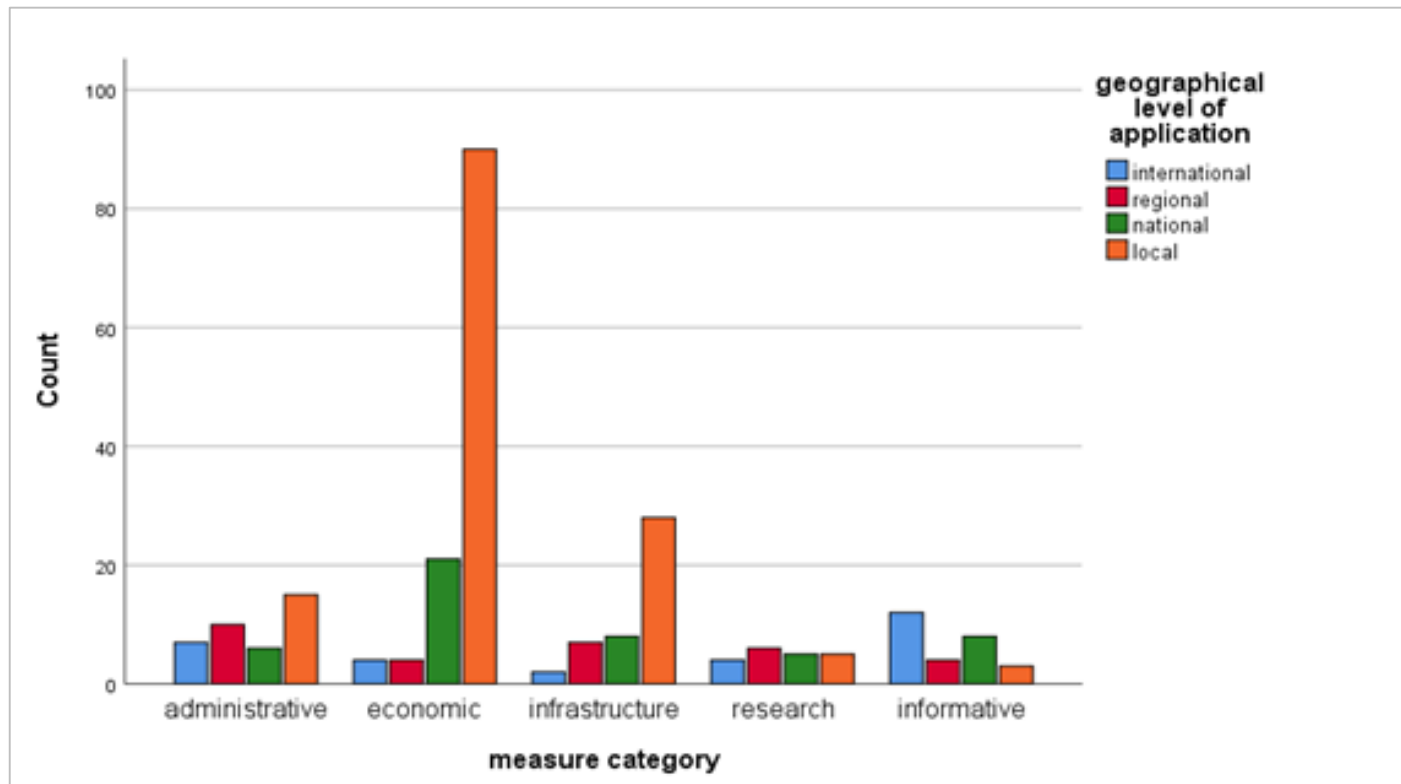
According to our results:

- **Europe** is the region where the majority of measures, policies and incentives have been developed
- Almost half of the initiatives were implemented by **port administrations**, followed by governmental agencies and inter-governmental organizations.
- **Economic incentives** are the most commonly used initiative, mainly introduced by port authorities in the form of **discounts** ('environmentally differentiated port dues').
- Infrastructure investments (LNG refuelling points and OPS in ports) represent another popular category of measures.
- In general, administrative policies (regulations and mandatory measures) are developed by inter-governmental institutions and governmental agencies, while the 'informative' and 'research' initiatives are mostly implemented by private firms and public-private partnerships.

Further research:

- Depth analysis of the ports' policies for the reduction of maritime air emissions.
- An evaluation of initiatives applied on a large scale to map their emissions reduction potential for shipping.

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