

Energy efficiency and sustainability in ports

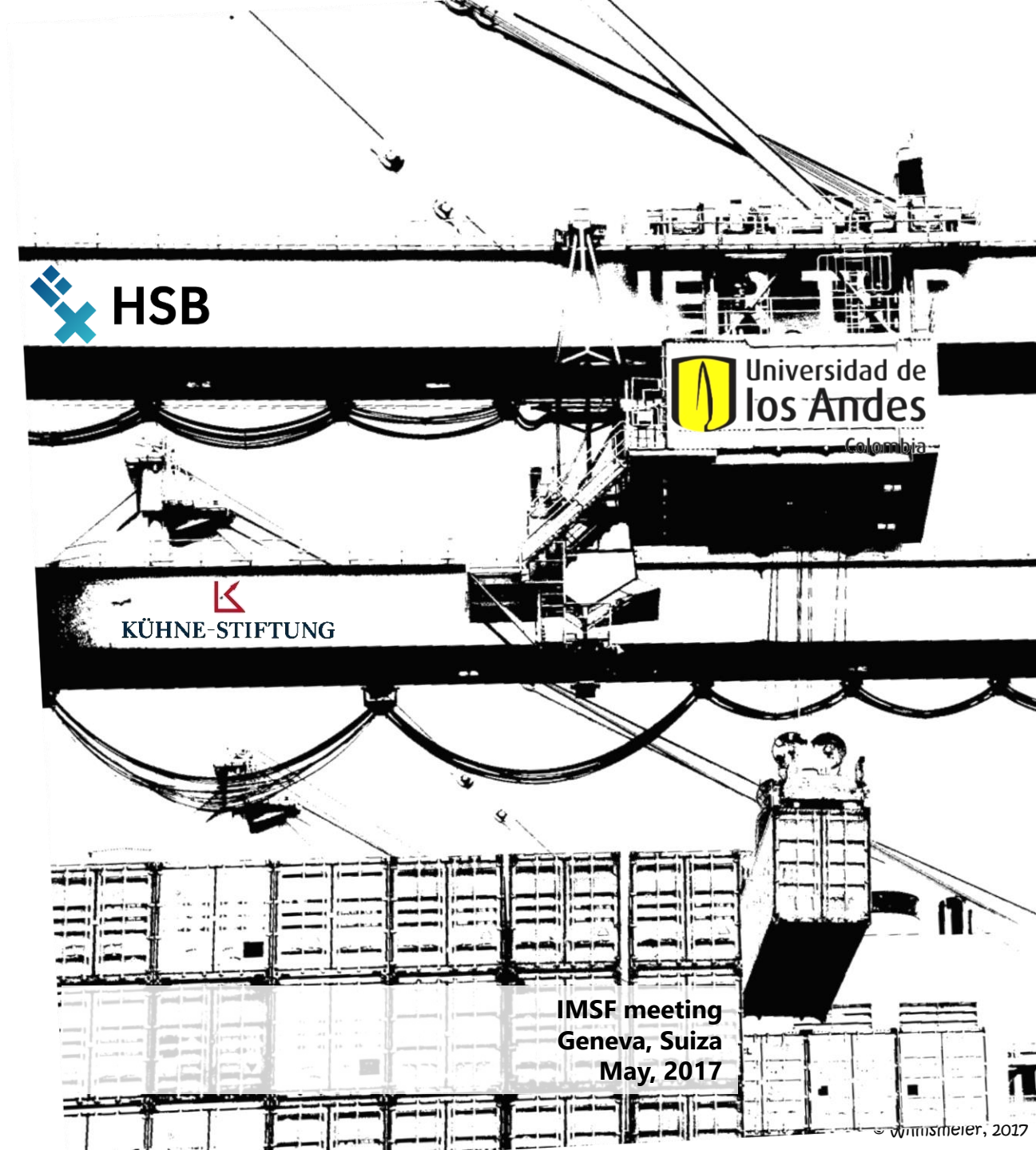
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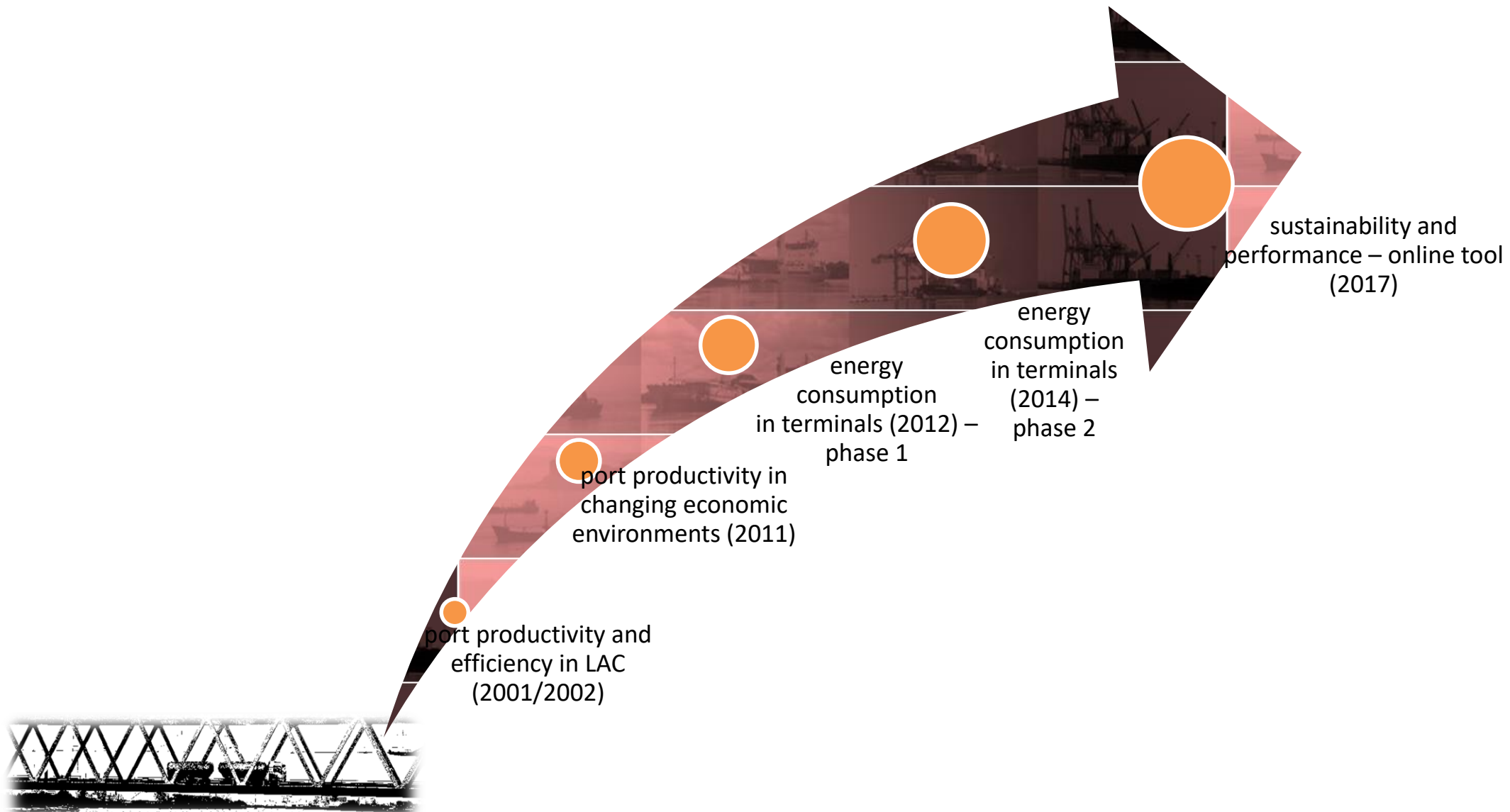


What is a sustainable port?

Energy consumption and efficiency in logistics chains

$$? + ? = \text{Footprint} ?$$



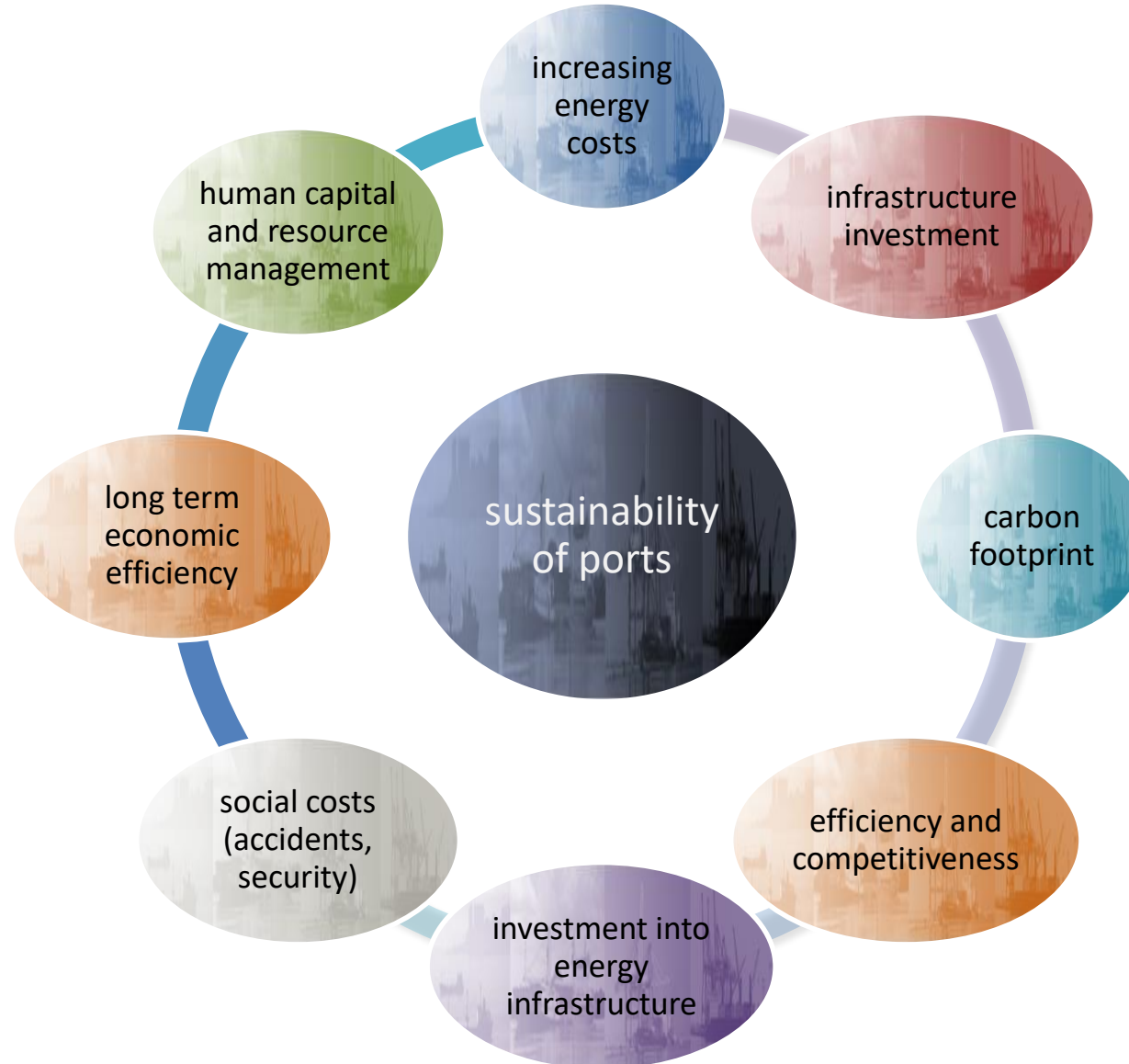


Common themes and principles of responsible businesses and international organizations

- Sustainability includes three dimensions: economic, social and environmental.
- Sustainability is not a phase or a fashion - it is a necessity.
- It is equivalent to being competitive in the long term.
- Sustainability must be measurable (benchmark).
- It requires proactive approaches.
- Sustainability can only be reached when public and private sector co-operate.
- Sustainability means that organizations need to reach beyond their organizational boundaries (co-ordination, we cannot do it alone).



why should sustainability be discussed in the context of ports?

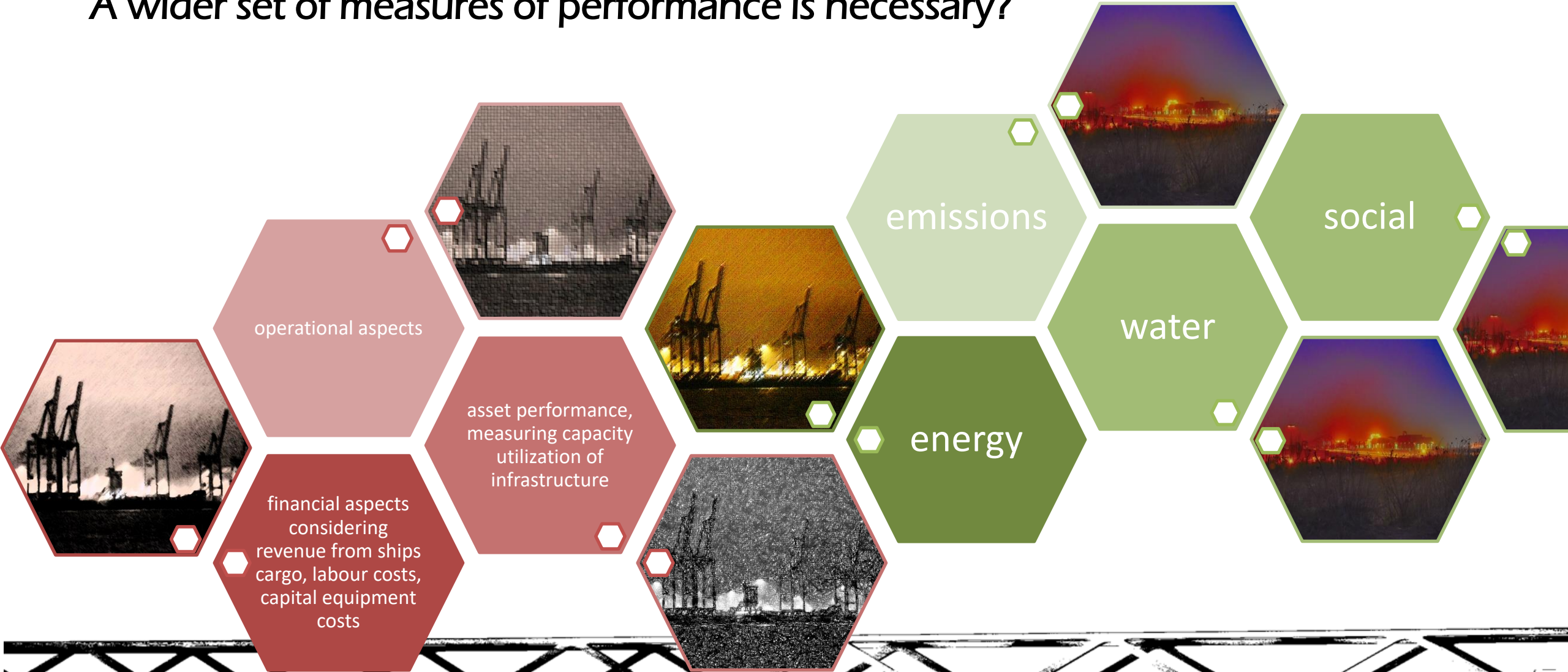


To reach efficient, sustainable and coordinated port performance the practitioner and governments need:

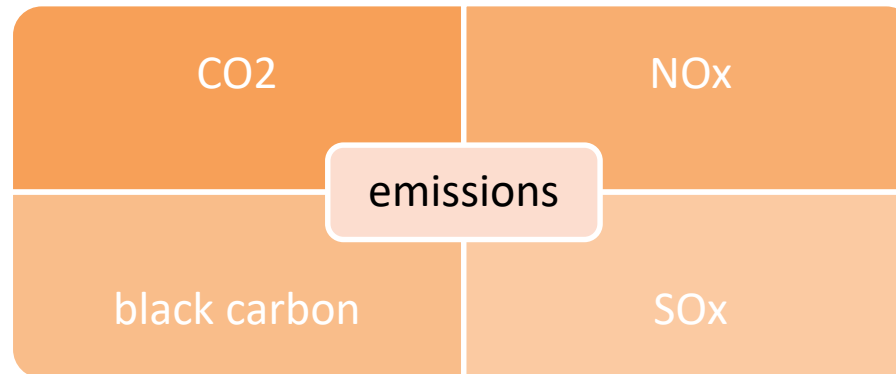
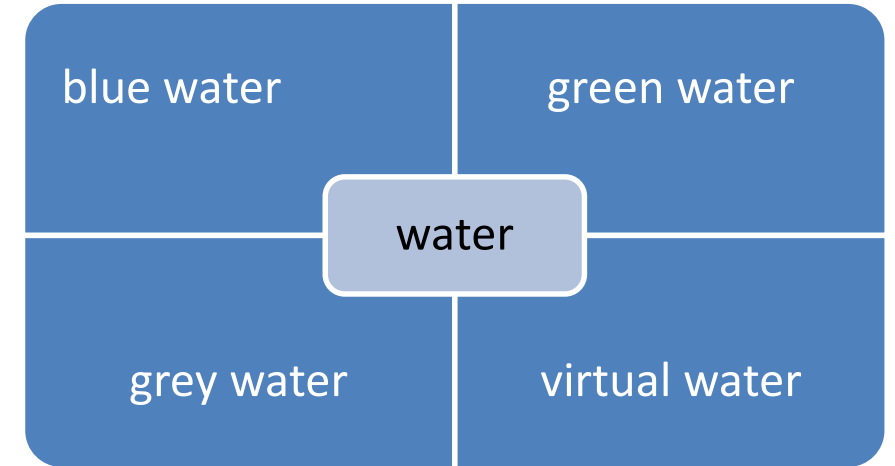
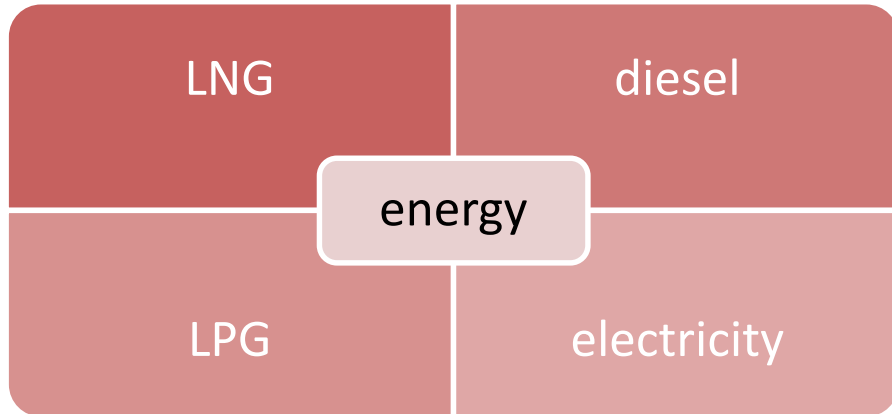
- Measurable outcomes;
- Commitment from the boardroom to the shop-floor;
- Effective and predictable public administration and policies;
- Collaboration;
- CSR (corporate social responsibility).



A wider set of measures of performance is necessary?

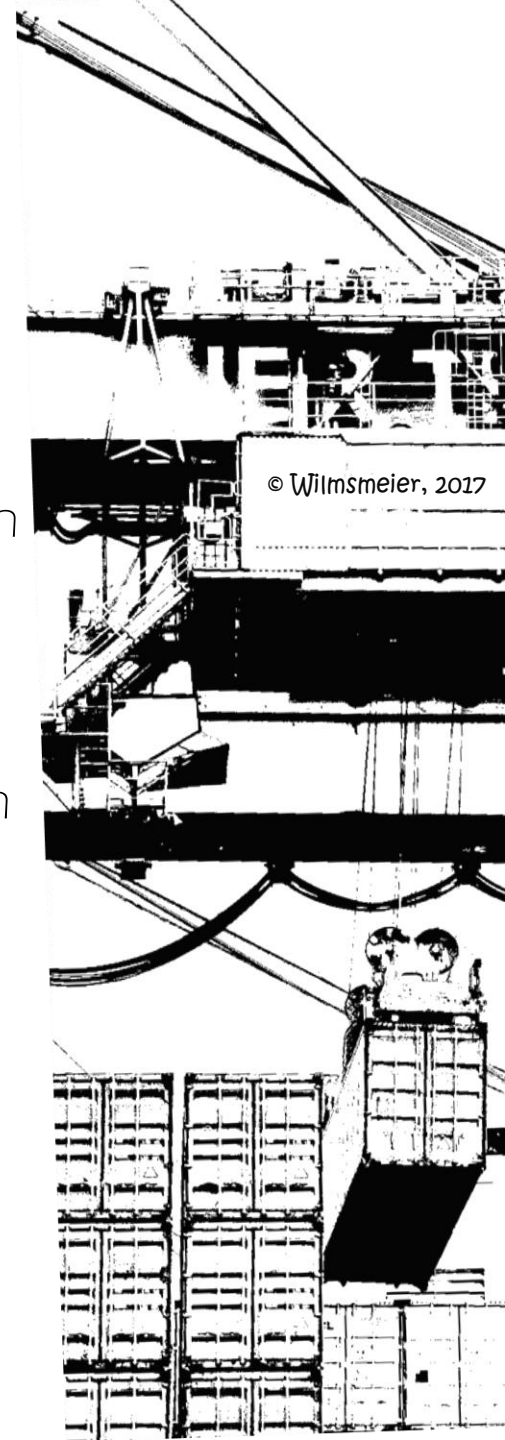


New data and measures are not simple



Relevant certifications

- ISO 14001: this is a group of management system standards which are applied to improve the environmental performance in organizations.
- Green Ports: a certification that shows balancing between environmental protection and economic demand.
- Ecoports: This is integration between two concepts: effective environmental and port management.
- ISO 50001 - Energy management standards target to use energy efficiently through the development of an energy management system (EnMS).
- CEN 16258
- GHG Protocol (adopted by ISO 14064-1)
- ISO 14046 –Water footprint





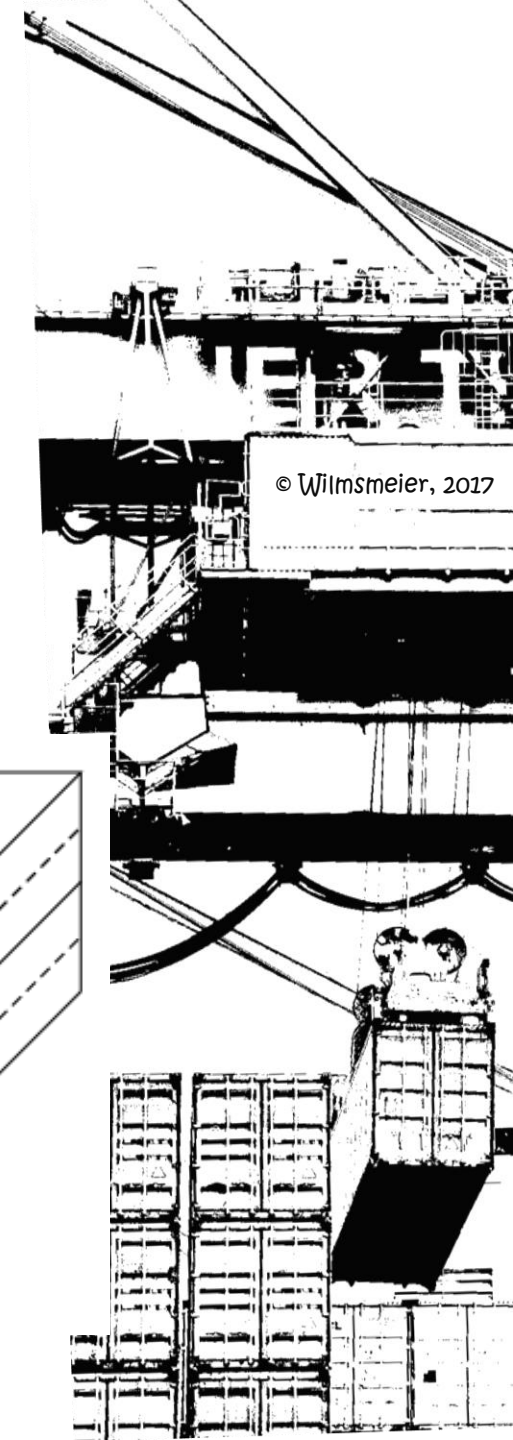
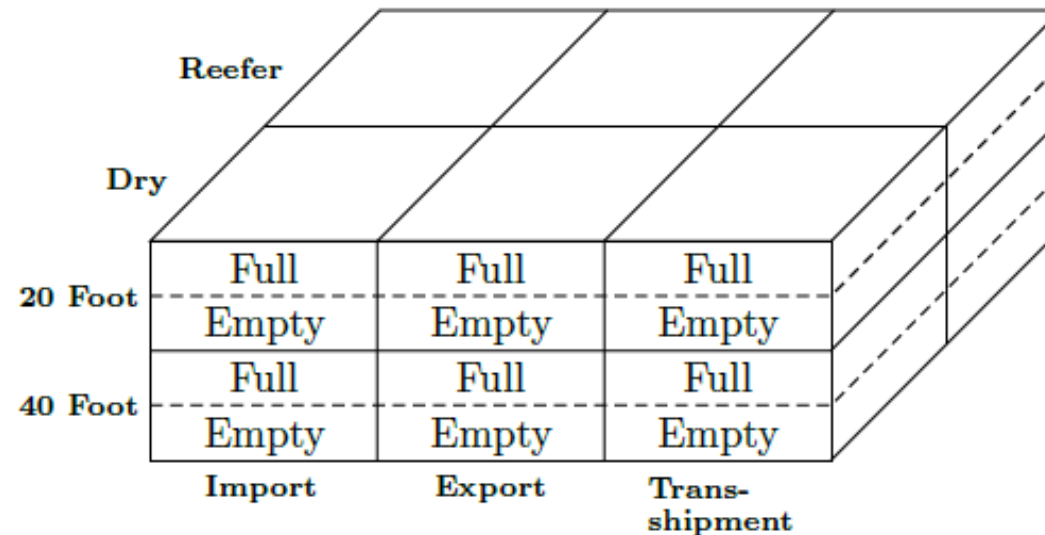
energy consumers inside a container terminal

Energy Consumer	Energy Source			
	Diesel	Petrol	Gas	Electricity
Ship-to-shore cranes	•			•
Mobile cranes	•			•
Rail-mounted gantry cranes	•			•
Rubber-tyred gantry cranes	•			•
Reachstackers	•			•
Straddle carriers	•			•
Tractor-trailer units and lorries	•		•	•
Generators	•		•	
Consumption by buildings				•
Lighting				•
Consumption by reefer containers				•
Other port vehicles	•	•	•	•

container terminals are multi product operations

- differentiation necessary between:
 - container types (i.e. dry, reefer)
 - transshipment and impo/expo cargo
 - full and empty

Thus, different products have different requirements and performance

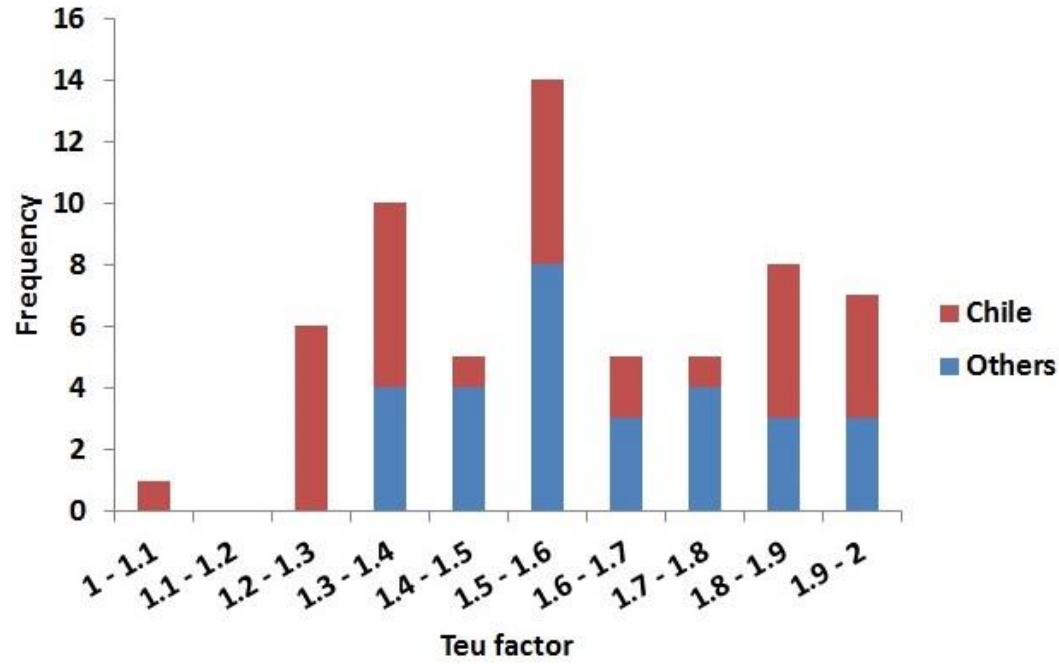


Boxes or TEU?

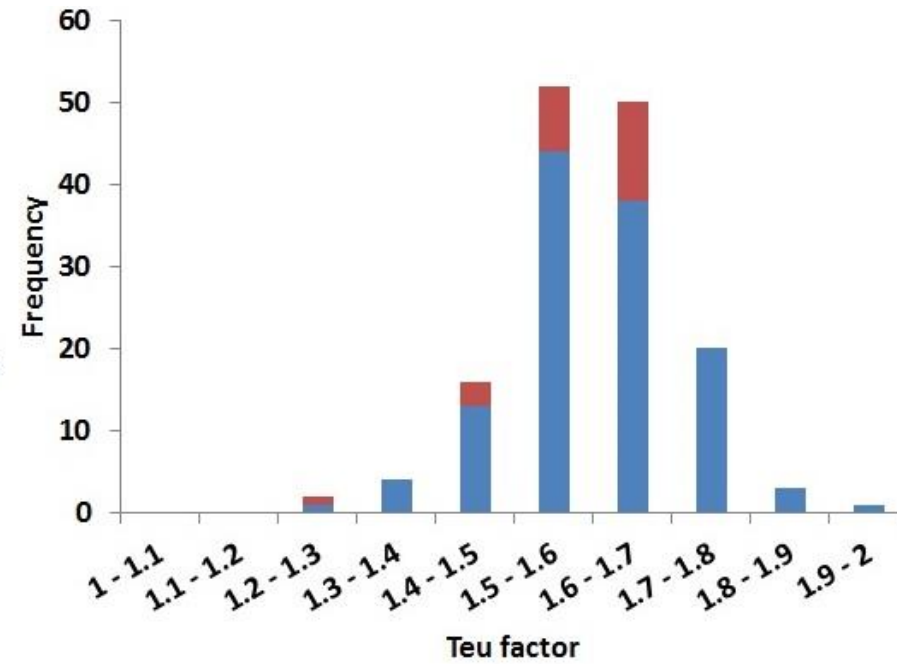


TEU factors

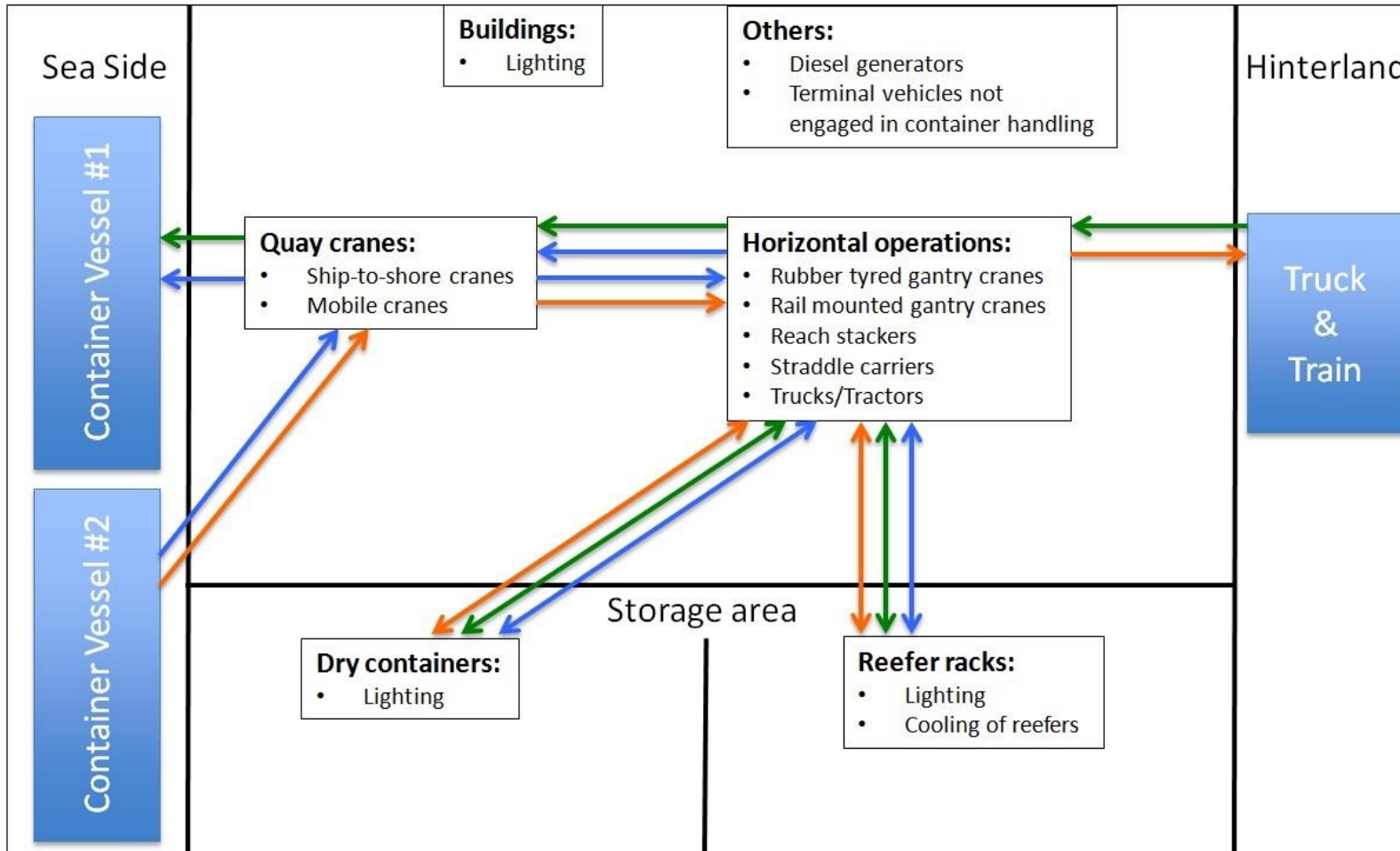
Terminal with less than 100.000 boxes



Terminal with more than 100.000 boxes



example: an activity based approach to allocate energy consumption



- ← Green arrow: Export container
- ← Orange arrow: Import container
- ← Blue arrow: Transhipment container

Source: Spengler 2015



The formula

$$TC = (QCC+HOC+CRC+BC+LC+OC+GEN) + UC$$

where: UC = Undefined consumption

TC = Total energy consumption from all sources

QCC = Energy consumption from all sources within the process cluster of quay cranes

HOC = Energy consumption from all sources within the process cluster of horizontal operations

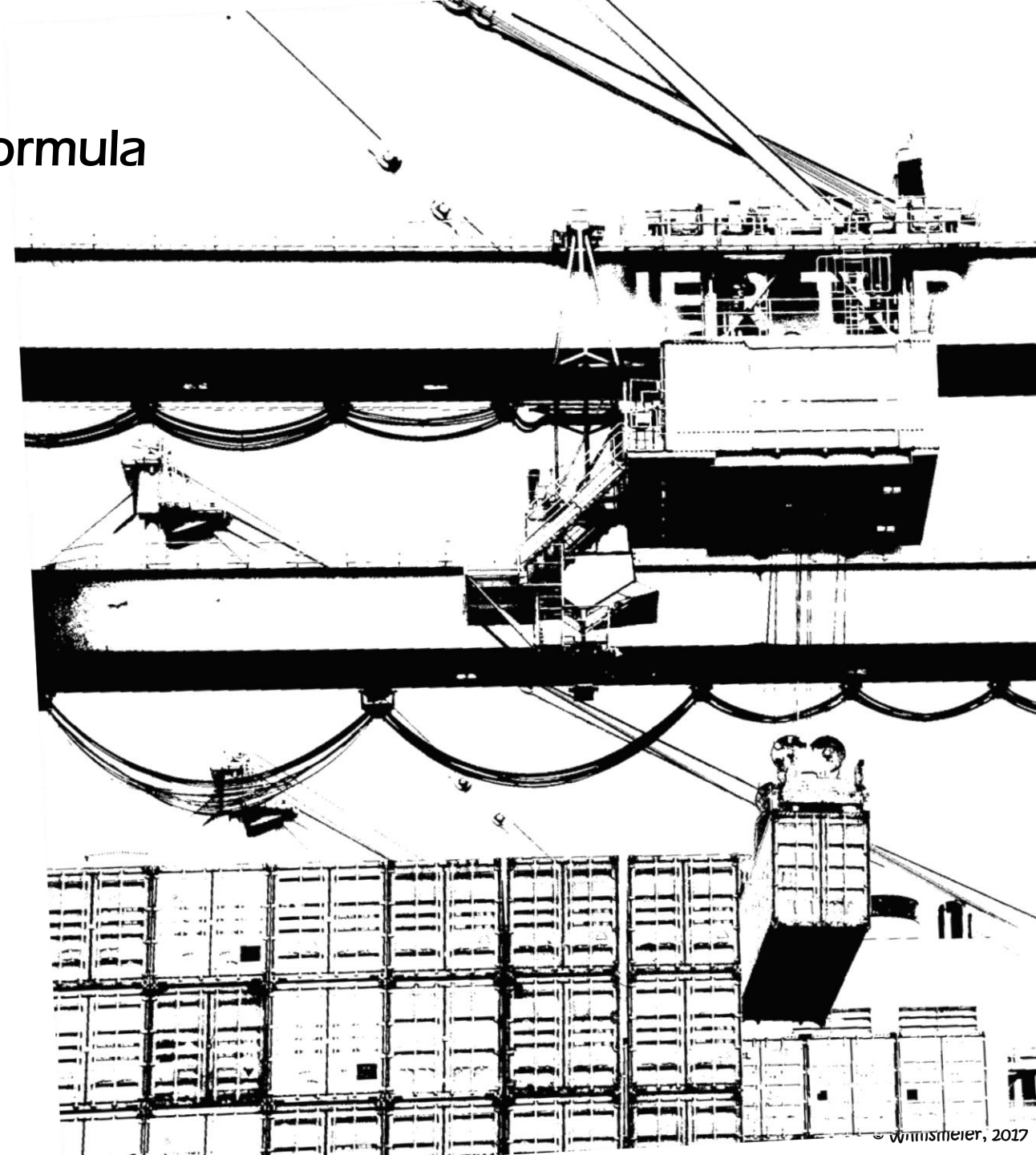
CRC = Energy consumption from all sources within the process cluster of reefer cooling

BC = Energy consumption from all sources within the process cluster of buildings

LC = Energy consumption from all sources within the process cluster of lighting

OC = Energy consumption from all sources within the process cluster of others

GEN = Energy consumption from all sources within the process cluster of generators



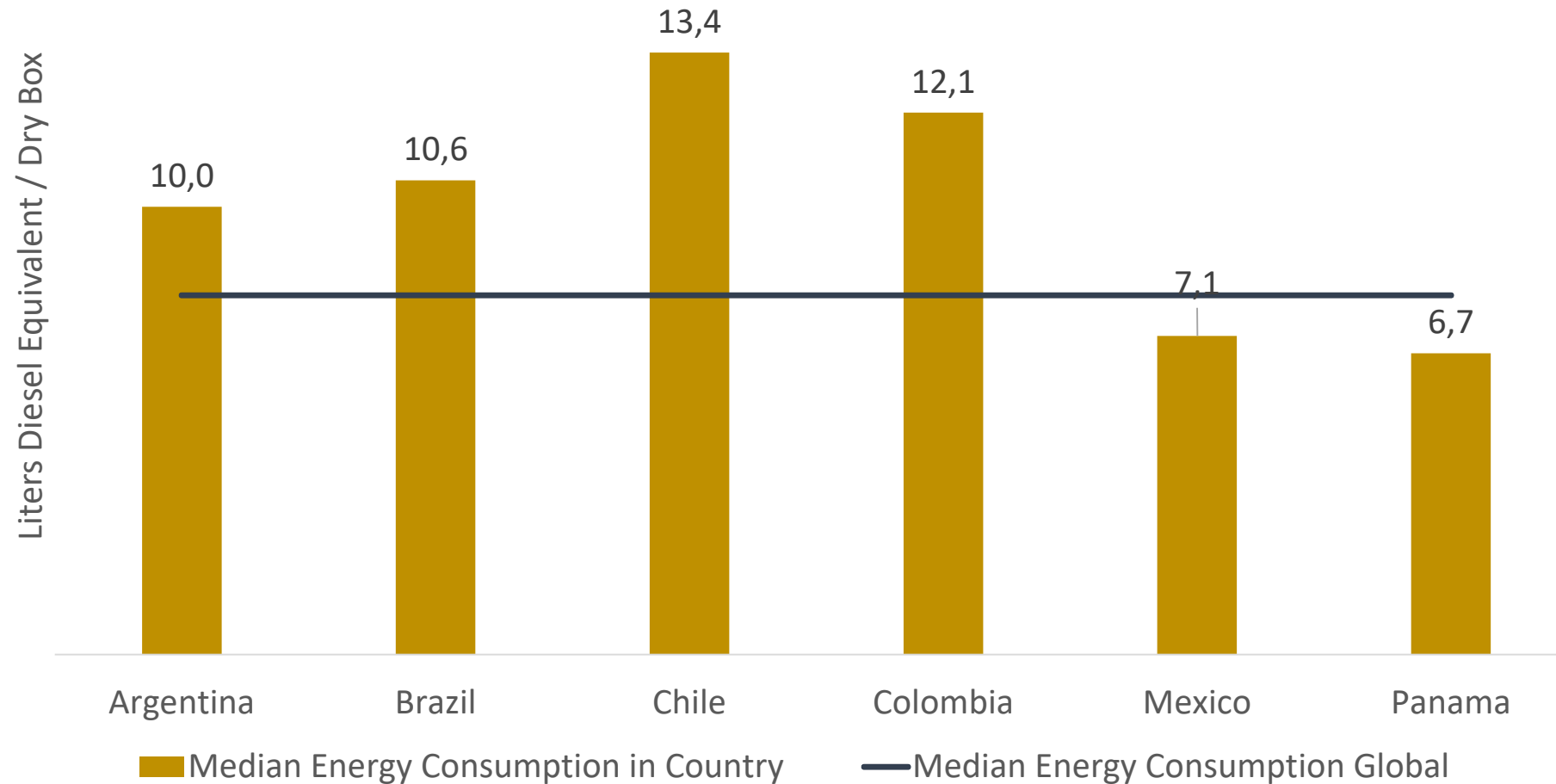
WEIXDNR

RESULTS

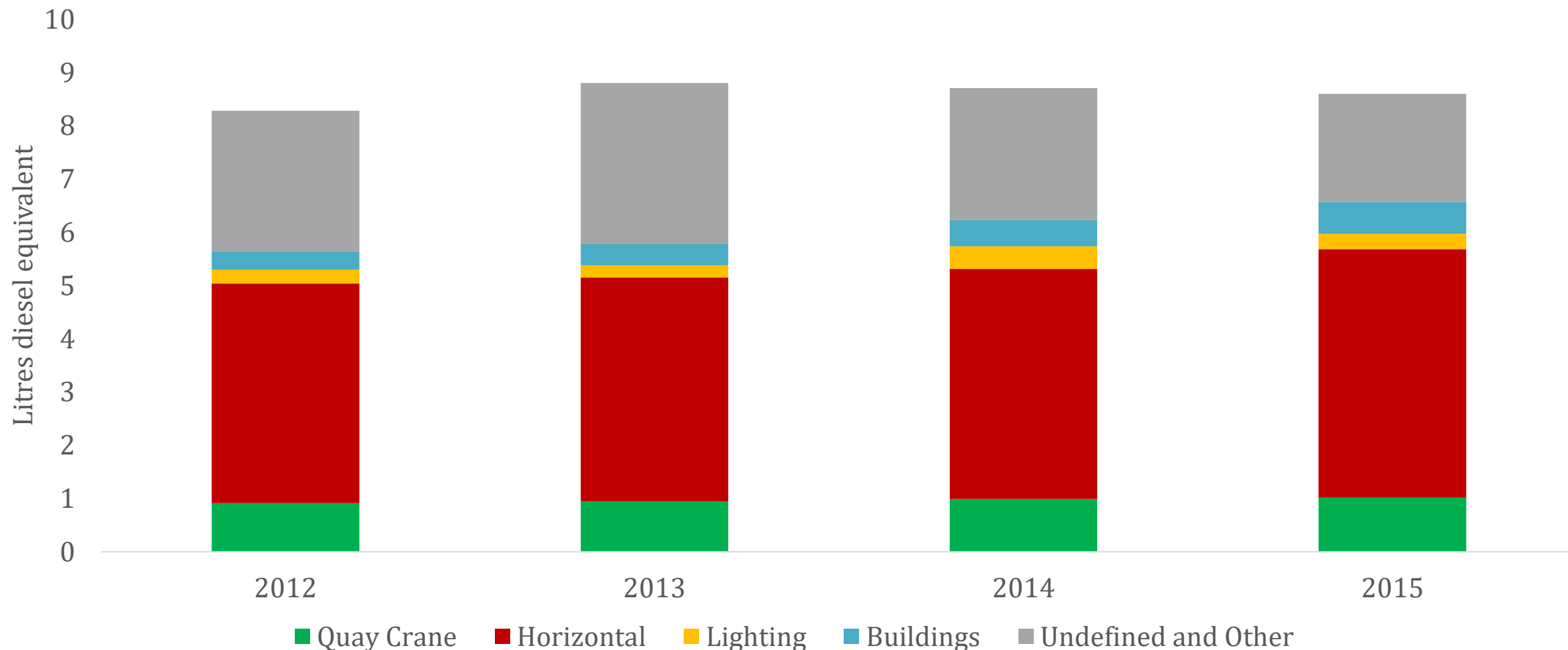
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Median litres of diesel equivalent consumed for handling one dry box (excluding reefer consumption), by country, 2012-2015



Median litres of diesel equivalent consumed per activity cluster (excluding reefer cooling), 2012-2015

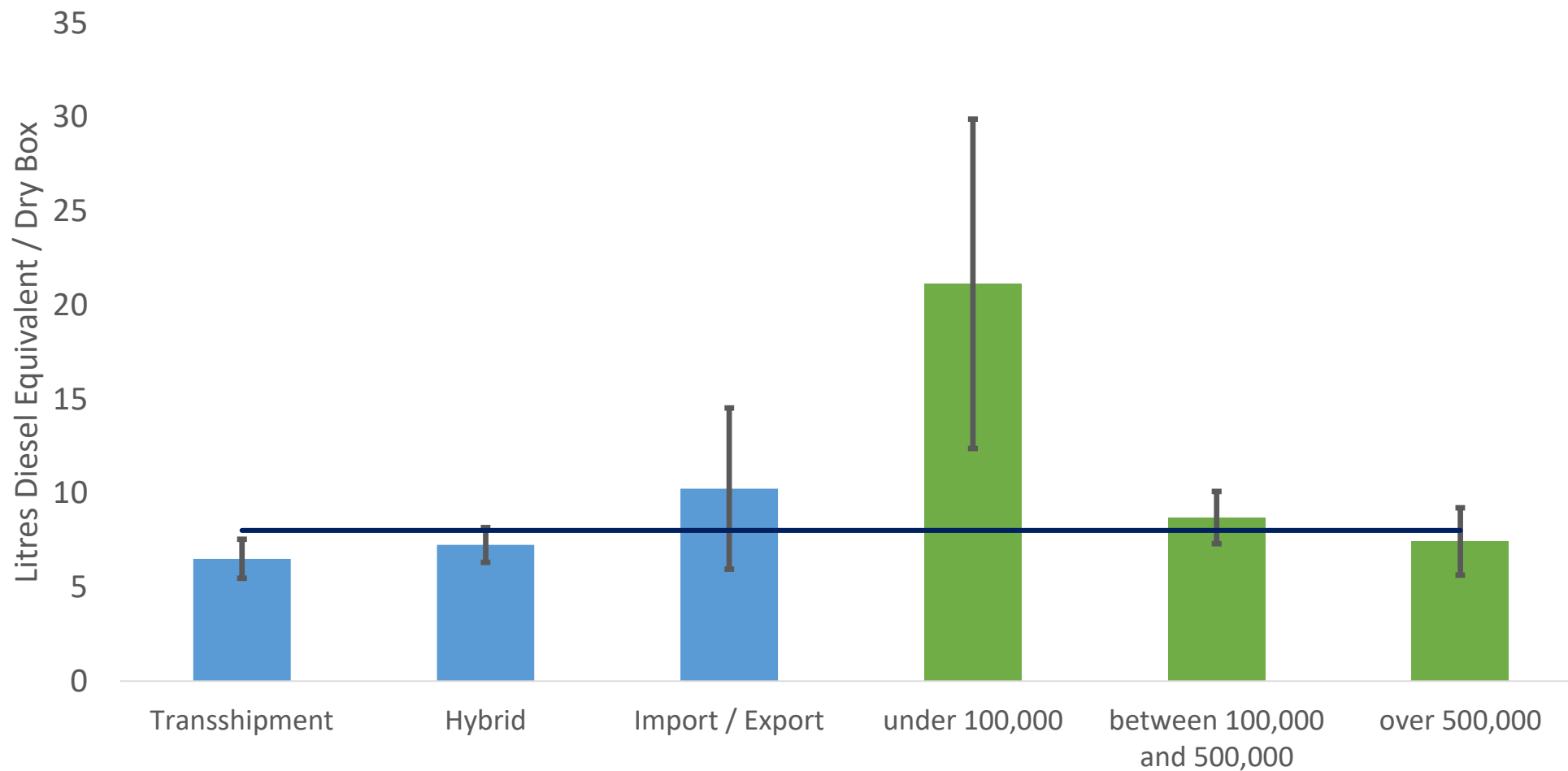


■ Quay Crane
 ■ Horizontal
 ■ Lighting
 ■ Buildings
 ■ Undefined and Other

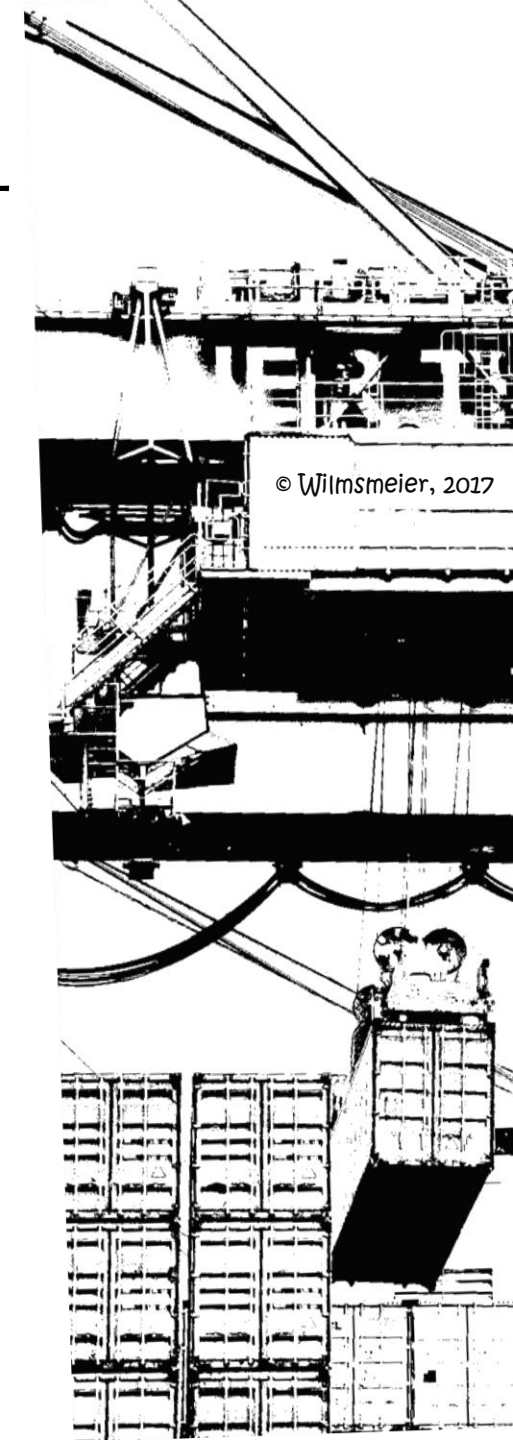
Source: Authors based on Wilmsmeier and Spengler (2016) and ECLAC Infrastructure Services Unit

Note: The calculations are based on data for 31 terminals in 16 countries

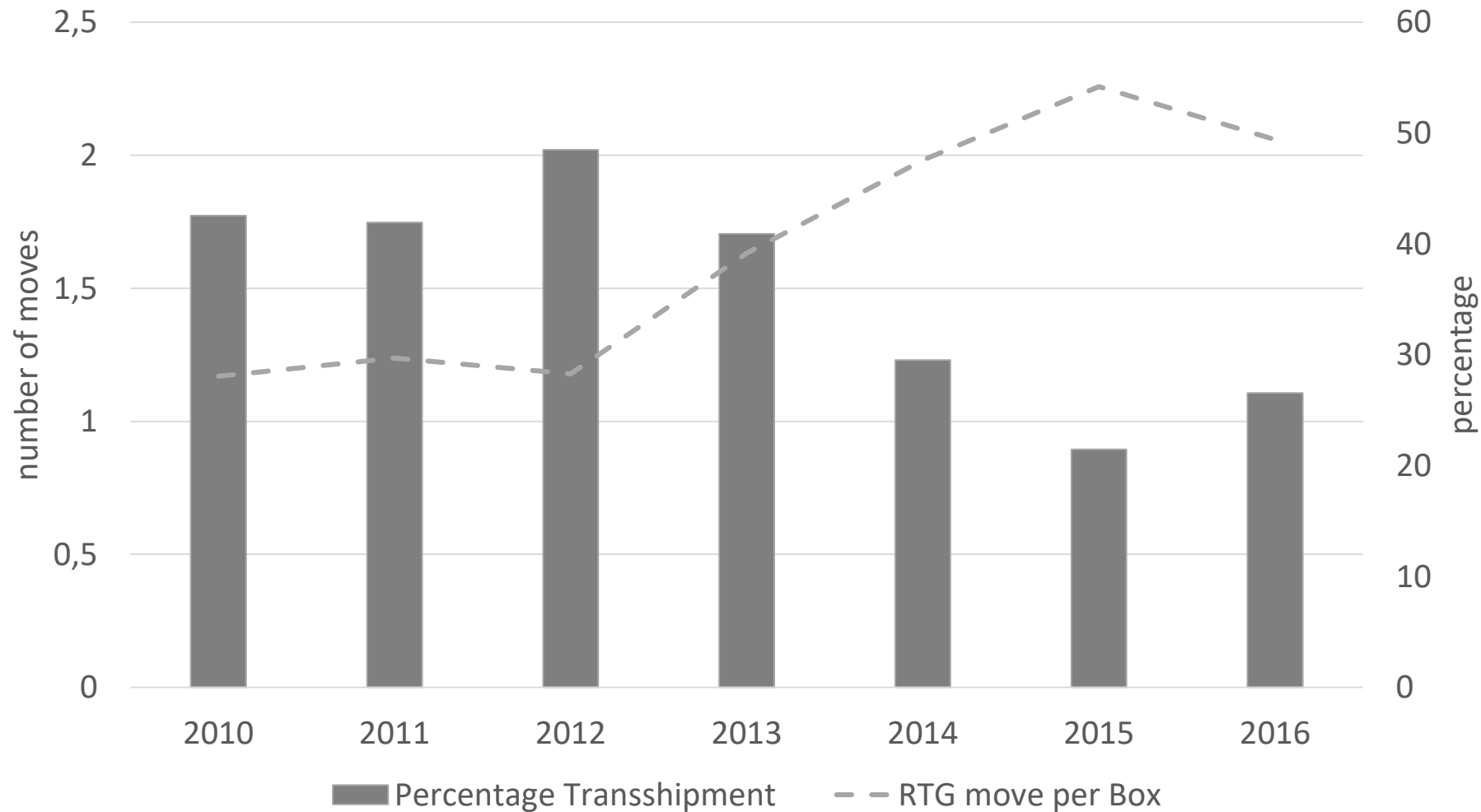
Median litres of diesel equivalent consumed for handling one dry box (excluding reefer consumption), by type and size of terminal, years 2012-2015



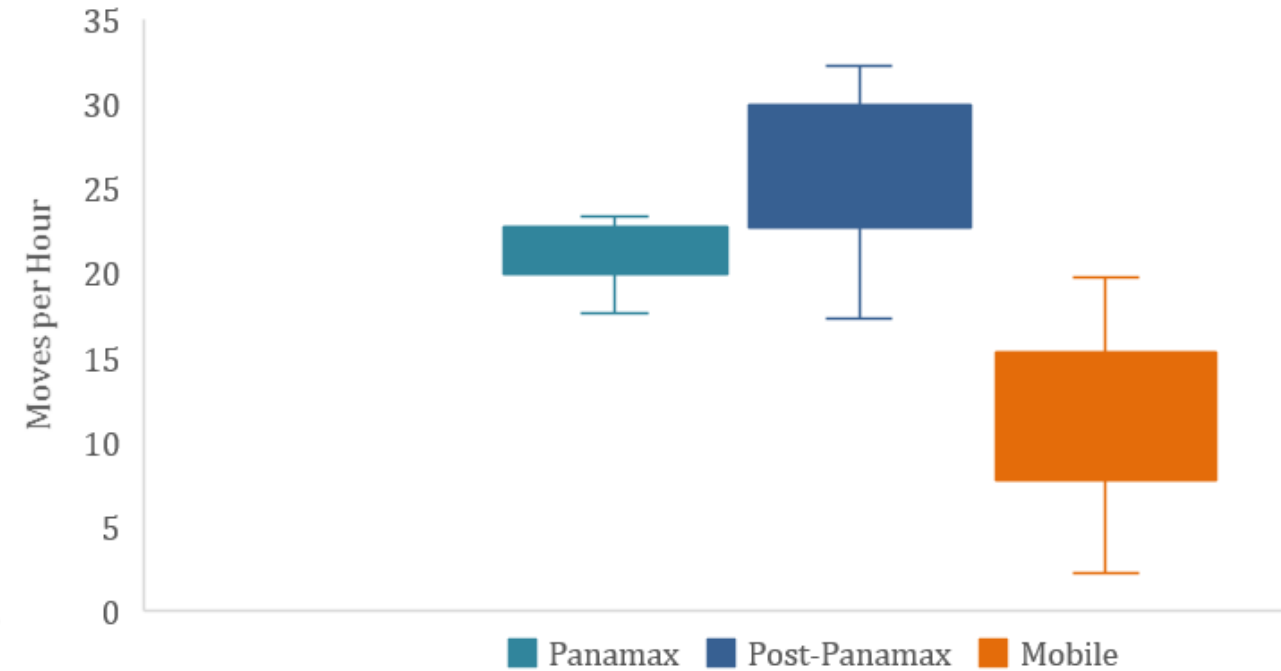
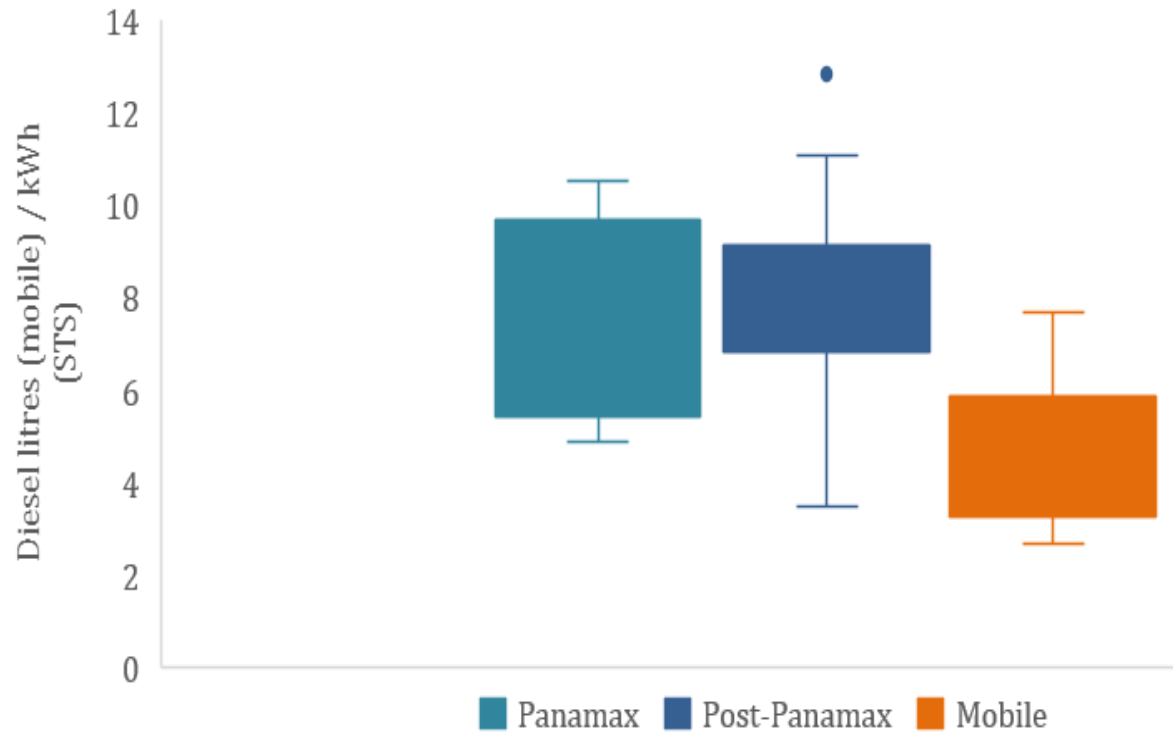
Source: Authors based on Wilmsmeier and Spengler (2016) and ECLAC Infrastructure Services Unit
Note: The calculations are based on data for 25 terminals in 8 countries



Example of the relationship between the share of transshipment cargo and RTG moves in Terminal B, 2010-2016

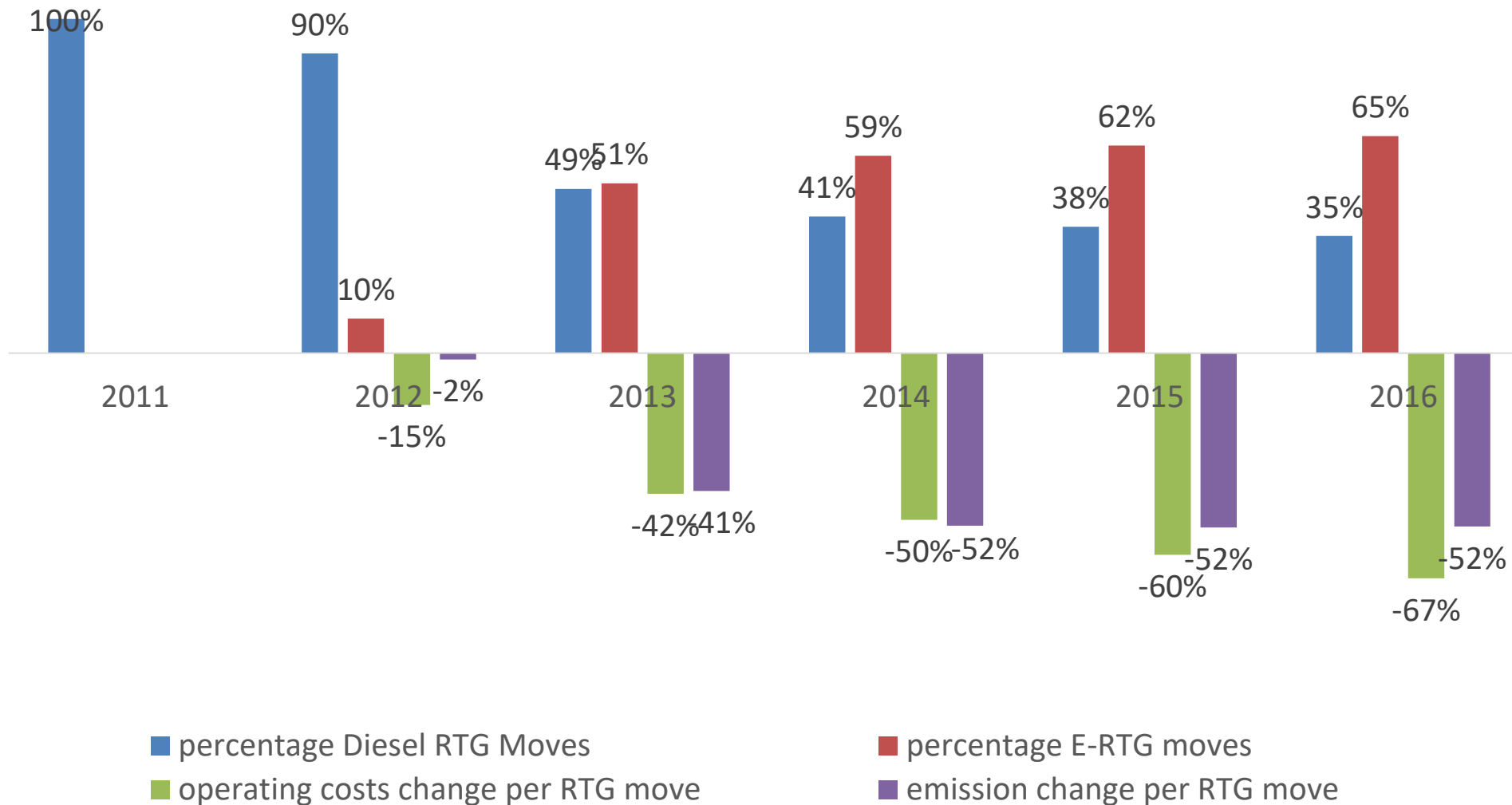


Productivity and energy consumption by crane type, 2012-2015

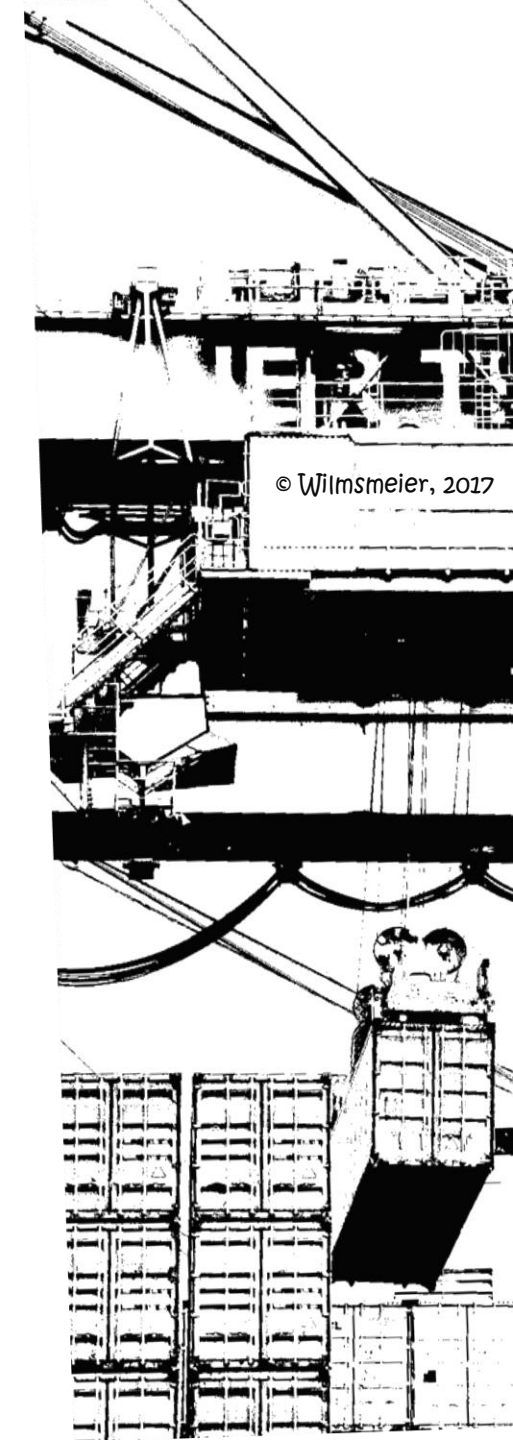


Source: Authors based on Wilmsmeier and Spengler (2016) and ECLAC Infrastructure Services Unit

Evolution of energy costs and emissions per RTG move in reference Terminal A



Source: Authors based on Wilmsmeier and Spengler (2016) and ECLAC Infrastructure Services Unit





WEXOR

COUNTRY SPECIFIC ANALYSIS

WEXOR

Example: new collaborations - Chile



Consumo y Eficiencia Energética

en los Principales Terminales Portuarios de Chile (1)

Principales Cifras (2)

Período enero - diciembre 2014



Boxes Transferidos
1,1 millones



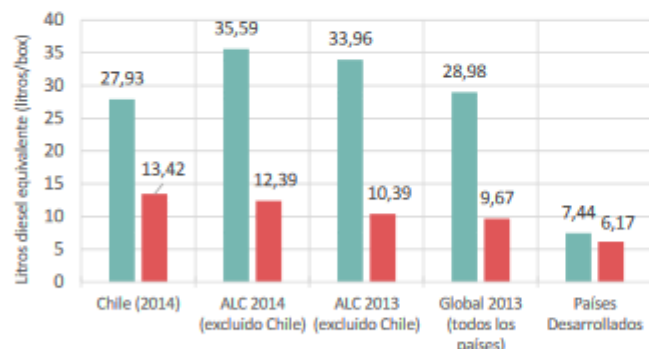
Consumo Diesel (litros)
9,9 millones



Consumo Electricidad
40,7 GWh

Análisis del Consumo Energético (**)

según tipo de contenedor

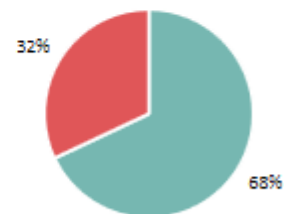


Tipo de contenedor

Contenedores Refrigerados (3)

Contenedores Secos

Distribución del Consumo Energético (Chile 2014)



(**) Consumo diesel equivalente por contenedor: Consumo de energía total por contenedor manejado en una terminal calculado en litros de diesel equivalente.

8%

mayor, es el consumo energético en operaciones asociadas a los contenedores secos en Chile, en relación a los países de América Latina y el Caribe para el año 2014.

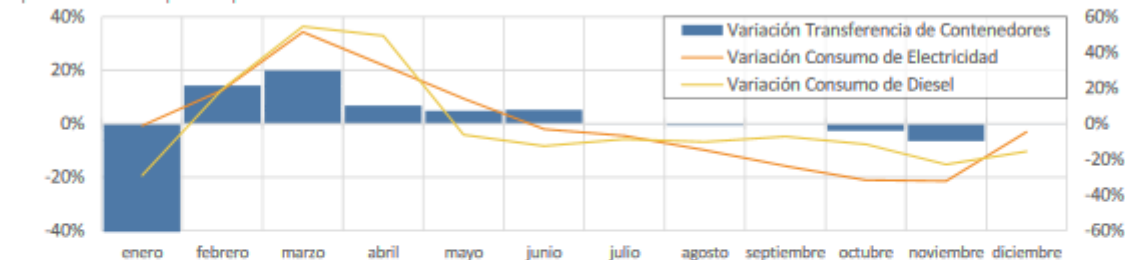
22%

menor, es el consumo energético en operaciones asociadas a los contenedores refrigerados en Chile, en relación a los países de América Latina y el Caribe para el año 2014.

Análisis del Consumo Energético

según mes del año

Evolución Mensual de Transferencias de Contenedores (eje izquierdo) y Consumo Energético de Diesel y Electricidad (eje derecho), evolución porcentual con respecto al promedio anual



20%

de aumento en el número de contenedores, con respecto al promedio anual, se produce en el mes de marzo.

40%

de aumento en el consumo de diesel, con respecto al consumo promedio anual, se produce en el mes de marzo. Esto se debe a una mayor actividad de exportación de carga refrigerada (fruta) en la época de verano.



Notas: América Latina y el Caribe (ALC), 4 países; países desarrollados, 4 países; global, 17 países.

(1) Se consideran los 4 principales terminales portuarios a nivel país.

(2) Los valores exactos son: 1.103.439 boxes (considera contenedores secos y refrigerados), 9.893.355 litros de diesel, y 40.722.872 KWh.

(3) Se consideran sólo contenedores llenos.

(4) Se consideran 2 de los 4 principales terminales portuarios a nivel país.



Transferred TEU
3,8 million

Energy consumption in container terminals in Colombia 2015



Diesel consumption
17 million litres



Electricity consumption
106 GWh



Energy expenses
26,2 million USD

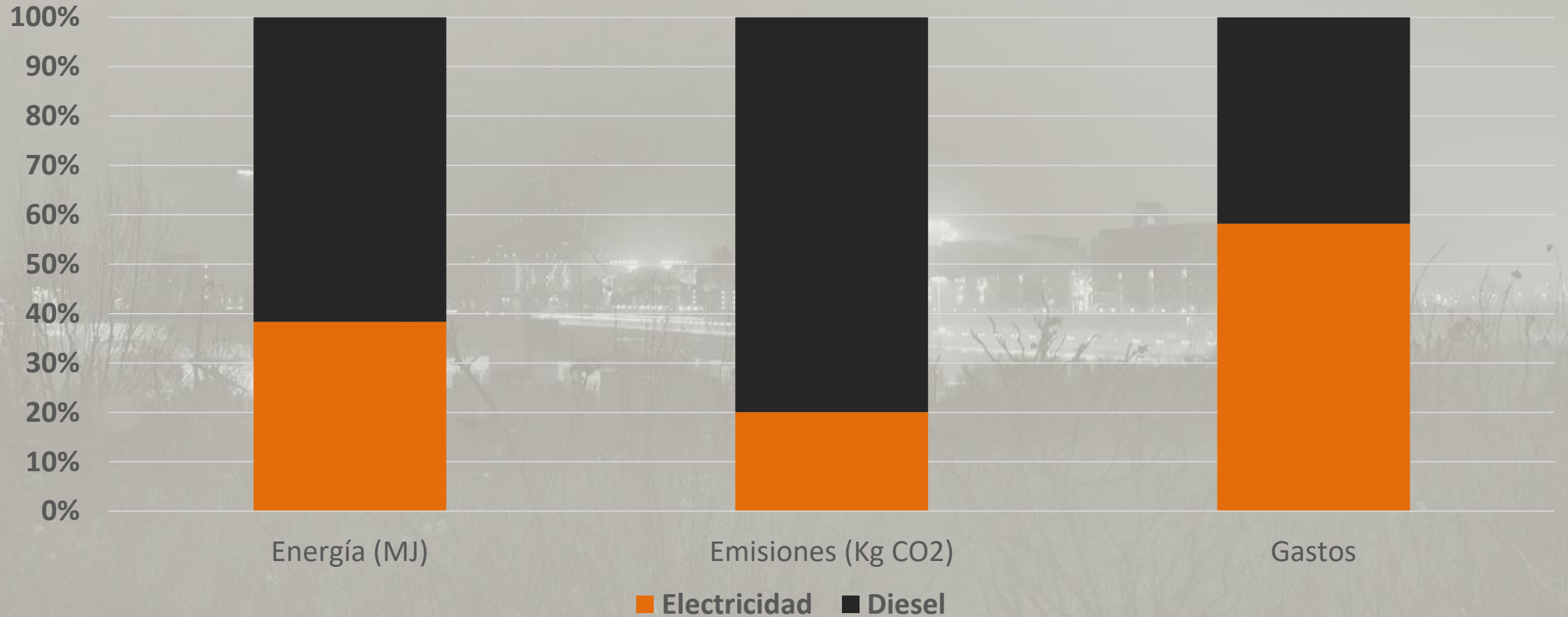


Emissions
56,4 million kg CO₂ or 24 kg CO₂ / box

liters diesel equivalent per dry box

2014	2015
11,53	10,37

Colombia, comparison: energy, emissions, expenses, 2015



new tools

Sustainable Performance Monitor

Introduction

There is a continued need to improve the performance of terminals to make them not only more competitive, but also more sustainable. The concept of sustainability has been recognized by industry to be an important contributor to the firm-specific competitive advantage.

This independent research initiative aims to identify best practice and performance examples in the port sector to establish a set of global bench-marking indicators.

To support terminals and create direct value added to the participants this online tool allows the terminals to benchmark themselves against the other terminals participating in the initiative in key strategic areas: e.g. productivity, emissions, energy efficiency, and water consumption.

The tool is being developed at the University of Applied Sciences Bremen, Germany in collaboration with the Universidad de los Andes, Colombia and supporting research at the Economic Commission for Latin America and the Caribbean, the Global Logistics Emissions Council and private sector entities (global and local terminal operators) among others. Currently, the initiative counts with the participation of over 140 terminals from four continents.

The initiative aims to:

- provide the participating terminals with an online tool that allows for managing and analysing energy efficiency and productivity in the terminal.
- monitor and improve the data regarding productivity, water and energy consumption, as well as and efficiency and other KPIs.

The applied methodology has been developed by United Nations Economic Commission for Latin America and the Caribbean (ECLAC) and the University of Applied Sciences in Bremen, Germany, as part of the efforts to reach the Sustainable Development Goals (SDGs) and to support countries and companies to improve and benchmark their performance under certain sustainability criteria.

All data are treated strictly confidential. All data at the individual terminal level obtained through the initiative, will be coded or de-identified. Under no circumstances will the identifiers be made available to individuals.

For further information please contact us at contact@spm-terminals.com

Findings

Trends in the Shares of Energy Sources

Percentages

Diesel is the main energy source in container terminals across the globe but might be as low as 50% in Japan or 60% in Vietnam for reference terminals in these countries. In Latin America and the Caribbean the shares of diesel and electric energy use have been almost constant over the last years. The current dependency on fossil fuels marks a significant potential towards electrification. However, the variation of consumption patterns across terminals depends significantly on the equipment configurations in each terminal.

Year	Diesel (%)	Electricity (%)
2010	~68	~32
2011	~67	~33
2012	~67	~33
2013	~66	~34
2014	~66	~34
2015	~67	~33

Source: *Wilmsmeier G. and Spengler T. (2016), "Energy consumption and container terminal efficiency"*

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Request Account

Country

Select country...

Terminal Name

Terminal Name

Port Name

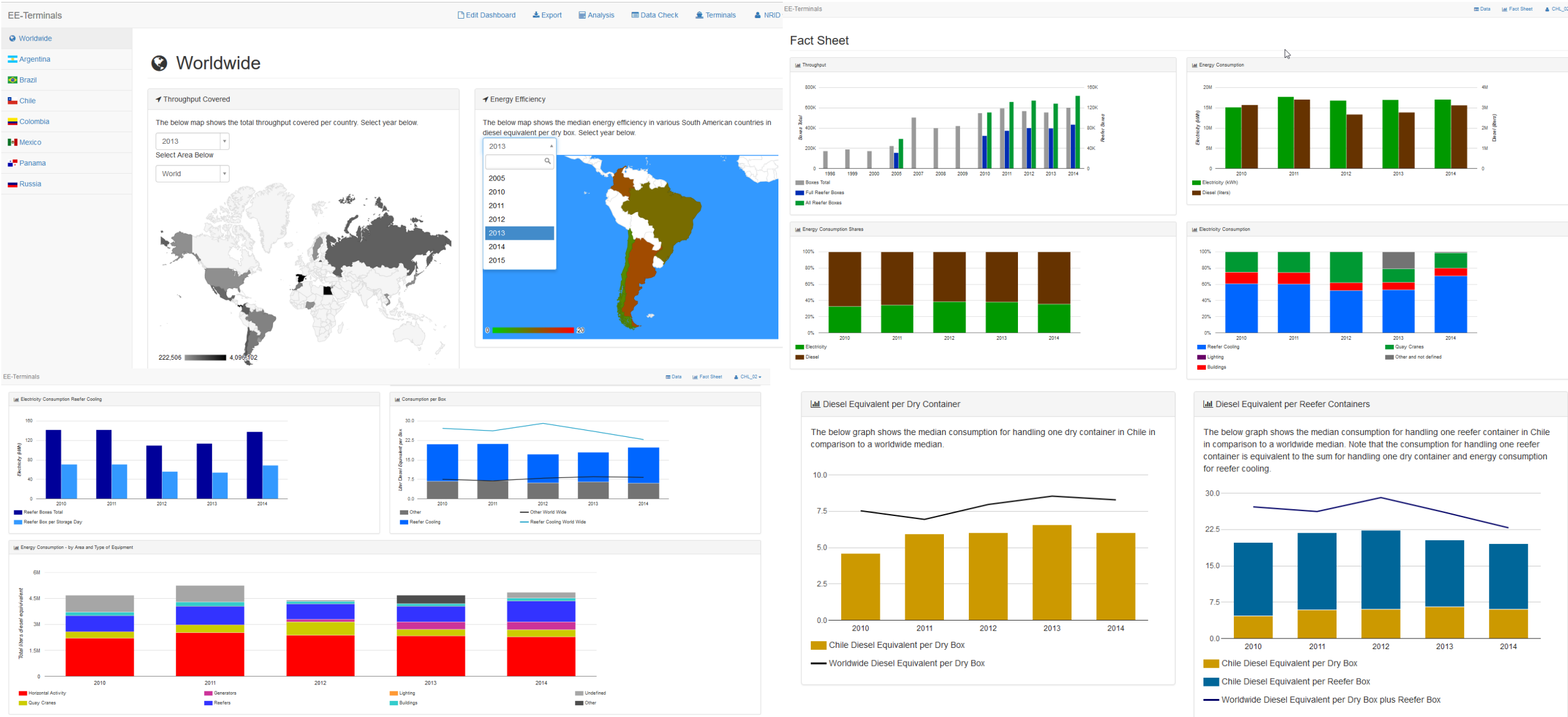
Port Name

Operator

Operator

Visit: <https://spm-terminals.com>

New tools



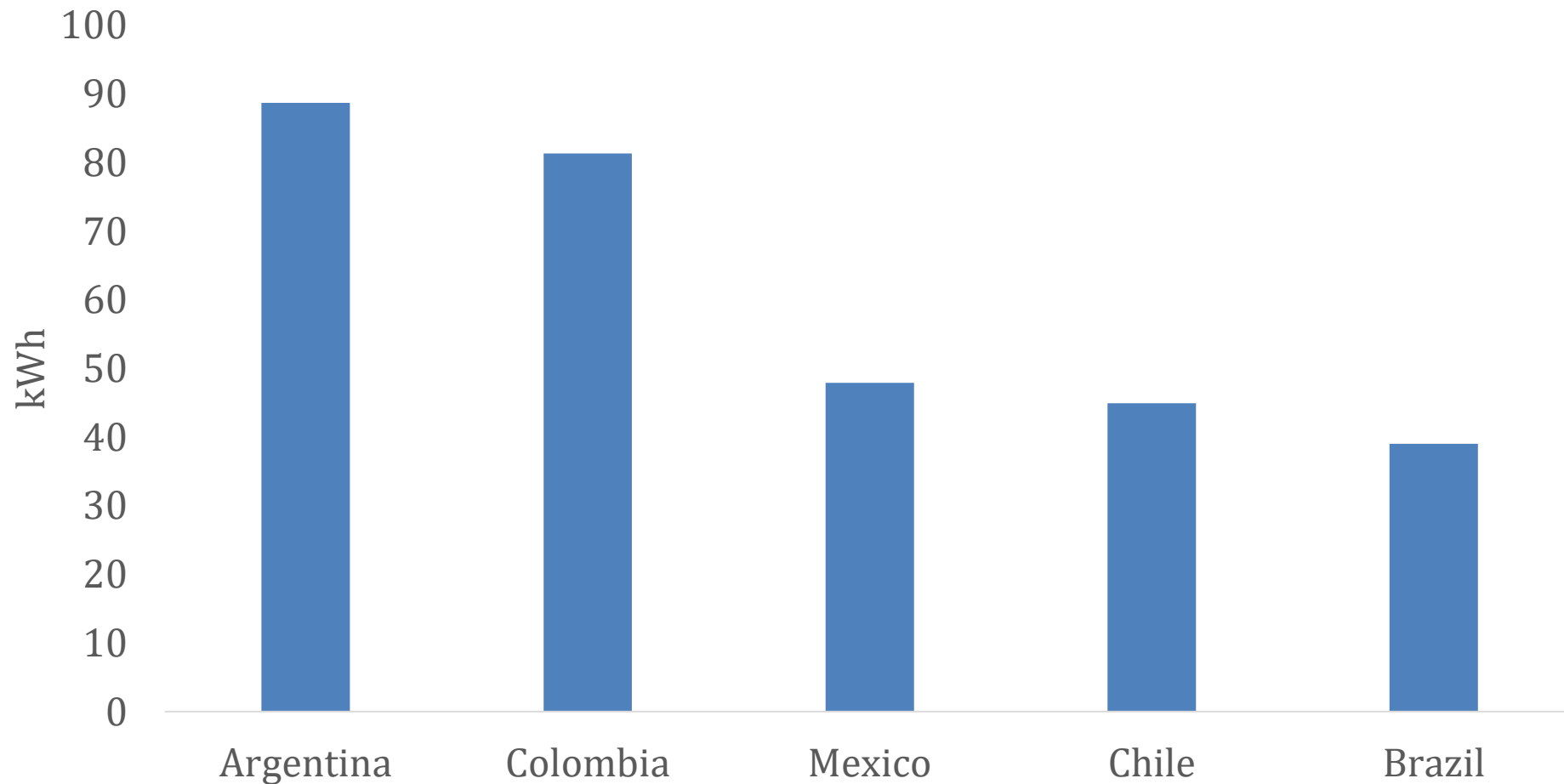
WEXDNR

THE REEFER CASE

WEXDNR



Average energy consumption per storage day per full reefer container by country

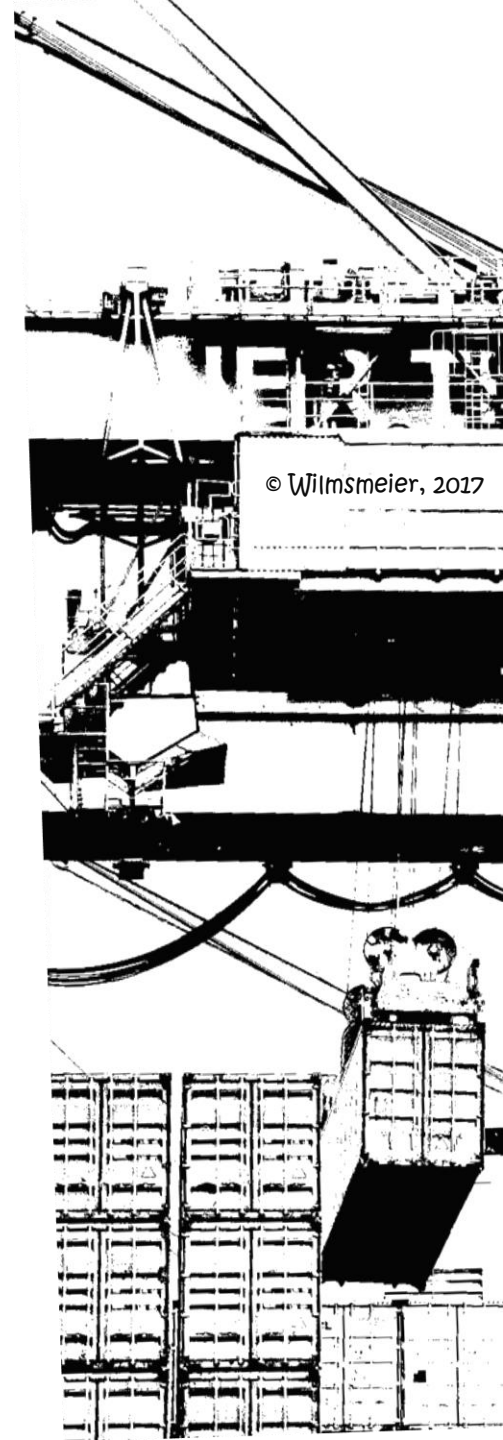


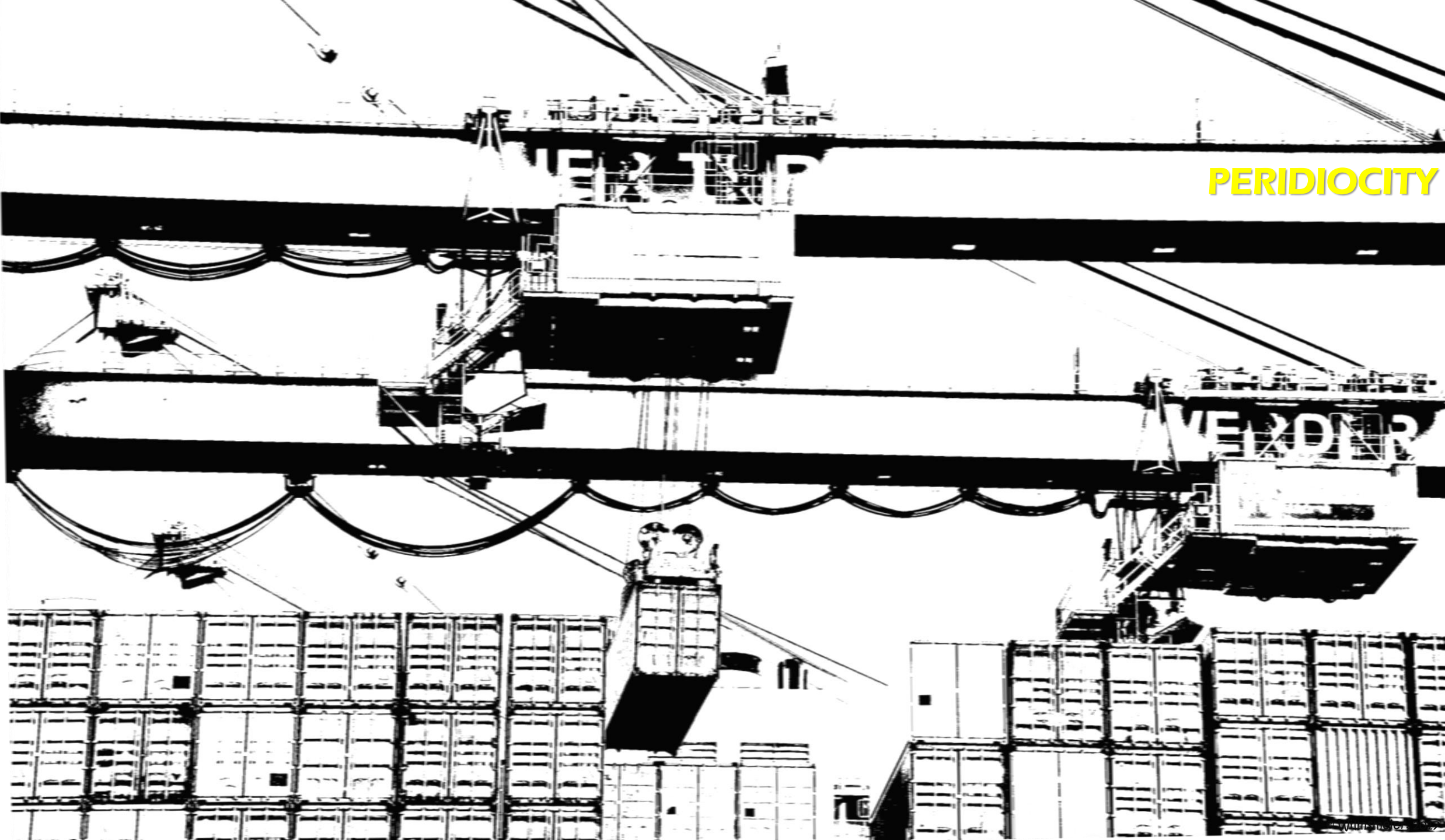
Source: The Authors based Wilmsmeier and Spengler (2016)



differentiating products effects on emissions

- reefer containers account for 10 to 20% of total box movements in Chile
- reefer cooling represents 60% of the electricity consumption in the terminals.
- dwell times are crucial factor in energy consumption
- the effect on emissions estimation
- Example:
 - Terminal A, in Chile, calculated emissions (without scope 3) to be 27.57 kg CO₂e per box (TPS, 2013) in 2013.
 - Applying the differentiation of container types based on the activity based approach:
 - CO₂ emissions:
 - per standard container are 19.32 kg
 - reefer container 66.18 kg CO₂





NEXT STEP

PERIODICITY

NEXT STEP

Periodicity of energy demand

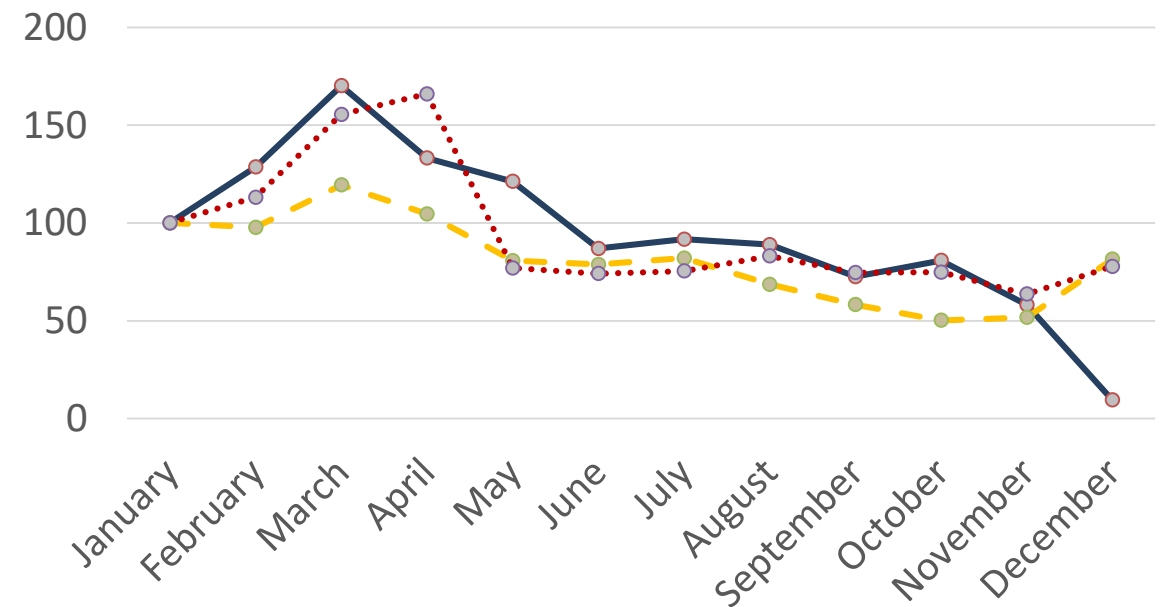
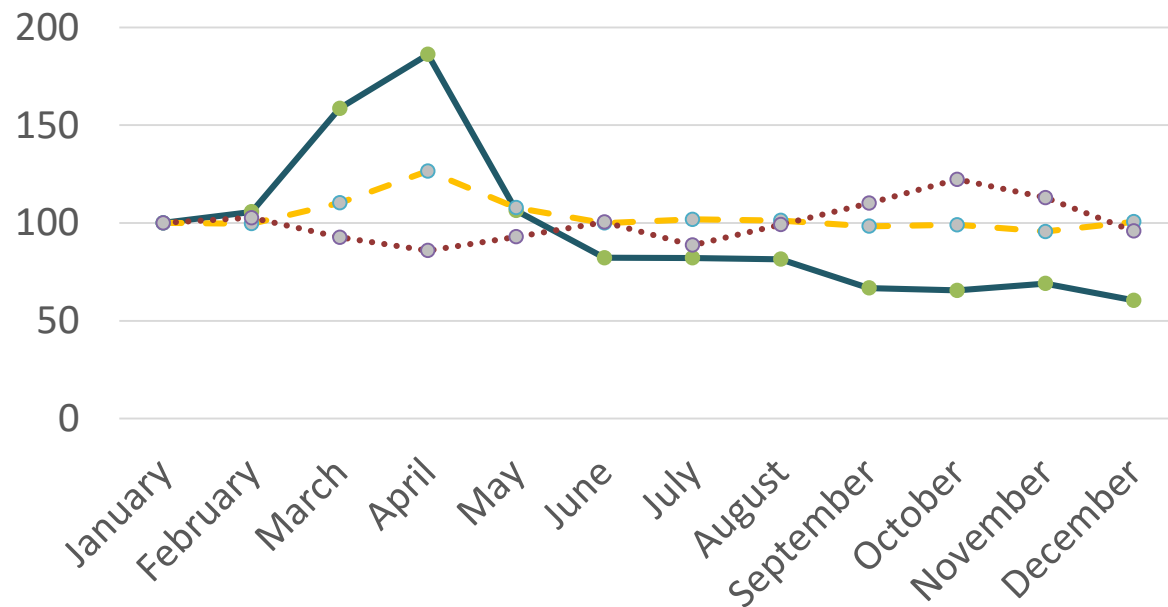
TIME	EXAMPLE/DRIVER
ANNUAL SEASONALITY	Harvesting season of fruit (e.g. apples in Chile)
MONTH	Vessel calling pattern
WEEK	Berth occupancy
DAY	Work shifts, delivery of reefer cargo



correlation between reefer activity and electricity consumption, percentage change (base month January = 100), year 2014

Terminal C

Terminal D



● reefer container
—●— electricity consumption (kWh)
...●... diesel (litres)

—●— reefer container
—●— electricity consumption (kwh)
...●... diesel (litres)



Next steps for moving ahead

- strengthen concerted effort of public and private sector
- further develop and use tools to gather new data
 - Water
 - Energy
 - Emissions, and
 - Social indicators
- Further evaluation of the effects of:
 - Technological change
 - Operational differences
 - Energy generation and security issues
- Tool development for
 - Bulk,
 - Roro
 - Passenger terminals
- collaborate towards a new standard of information
- can we walk the talk of a sustainable future?



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questions?

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