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CEPAL
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Estimados lectores,

A través de ésta tenemos el agrado de poner en su conocimiento un resumen de los resultados del actual Estudio sobre "Consumo Energético en Terminales de Contenedores" de nuestra División.

Nos gustaría agradecer a todos los terminales e instituciones por su colaboración y apoyo en esta nueva línea de investigación y por su generosidad en poner esta información a disposición de la CEPAL y sus lectores.

Cordiales saludos,

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Dear readers,

please find the latest Maritime & Logistics Bulletin, containing information and key findings of ECLAC's most recent research on: "Energy Consumption in Container Terminals", below.

We would like to express our sincere gratitude to all the terminals and institutions that have been supporting us and have generously provided information during the course of this research activity.

Kind regards,

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Towards benchmarking energy consumption in container terminals

Key findings from UN-ECLAC's energy consumption survey 2015

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ABOUT THE DOCUMENT

ECLAC's energy consumption survey in ports and terminals is the most comprehensive and relevant analysis within and outside Latin America examining the evolution and detailed structure of energy consumption and efficiency measures in cooperation with the public and private sector. It provides the scientific fact base that will be used in the LAC region to formulate energy efficiency strategies and policies in the future.

This document synthesizes the most pertinent findings of a survey of over 41 container terminals around the world of which 30 are located in Latin America and the Caribbean and represent 1/3 of the regional annual container throughput in 2014.

The results are part of a global study on energy consumption in terminals and ports of all kinds. Follow - up publications including a larger set of countries as well as with specifications for bulk cargo, liquids and gas are under way. Furthermore, sub - regional and national seminars are envisaged over the course of the year to present the study's results, to discuss these with the maritime and port industry and to outline further steps to improve energy efficiency in ports and terminals.

RESUMEN

La medición de consumo energético en puertos y terminales realizada por CEPAL es el análisis más completo que se ha hecho tanto dentro como fuera de América Latina. Éste examina la evolución y detalla la estructura del consumo energético y las medidas de eficiencia tomadas en cooperación entre el sector público y privado. El estudio provee una base de hechos científicos para ser utilizada en la región con el fin de formular estrategias y políticas de eficiencia energética en el futuro.

Este documento sintetiza los hallazgos más pertinentes en la encuesta realizada a más de 41 terminales de contenedores alrededor del mundo, de los cuales, 30 de ellos se encuentran en América Latina y el Caribe, y representan a un 1/3 del movimiento anual de contenedores realizado el año 2014.

Los resultados son parte de un estudio global sobre consumo energético en terminales y puertos de todo tipo en América Latina. Las publicaciones que sigan luego de ésta incluyen un set más grande de países, agregando una futura clasificación entre carga seca, líquida y gas. En adición, se pretende realizar una serie de seminarios subregionales y nacionales en el transcurso del año para presentar los resultados del estudio y discutirlos con la industria marítima y portuaria, y así delinear los siguientes pasos para mejorar la eficiencia energética en puertos y terminales.

THE RELEVANCE OF ENERGY CONSUMPTION IN INFRASTRUCTURE THE CASE OF PORTS

The relevance of energy consumption as a base for identifying energy efficiency potential and calculating carbon footprints of ports and terminals in Latin America and the Caribbean (LAC) and beyond is of increasing importance as in addition to a growing share of refrigerated goods movements, cargo throughput and energy prices in the region have been increasing over the last years and more than 90 per cent of the Latin America's external trade (value) is moved through ports (BTI, 2013).

Thus, the performance of port infrastructure and services in terms of energy consumption and the resulting emissions is of significant relevance with regard to competitiveness of trade and infrastructure services, port performance and governance in the endeavour to develop towards more sustainable societies.

This document presents the worldwide first publication on energy consumption patterns with a global comparison of container terminals.

The growth of global container trade and port infrastructure development allows ports to develop into centres with significant energy consumption. Beyond size global container trade, and particular Latin America's container exports underwent a considerable increase in scale and change in structure with trade of reefer cargo, defined as refrigerated perishable goods, significantly increasing its share (e.g. Vagle 2013a, 2013b). This "young" trade does not only require different handling and logistics, but also consumes more energy during the whole transport process.

Despite increasing energy consumption, energy efficiency measures and strategies are rarely present in ports and terminals in a region, where energy security is at stake and high on the political agenda. Therefore there is an emerging awareness of consumption, efficiency and associated costs of energy in maritime trade.

Within the shipping industry and in ports, energy management until recently was not recognised as a particularly urgent issue in the last decades of sustained growth of throughput and expansion. However, in the wake of the current economic challenges, a changing geography and structure of trade and greater awareness and demand for sustainable logistics, the topic of energy efficiency has come to the forefront of academic and industry discussion.

Port authorities and terminal operators have started to become aware of the challenge of energy efficiency, as many of them are increasingly concerned with their emission profiles, and regulation in port areas have become more stringent, mostly in relation to sulphur and nitrogen oxides (Acciaro, 2014). In the future, this will become even more relevant with respect to particulate matters (PM) and other short-lived climate change gasses as society is becoming more aware of the local impacts of port activity.

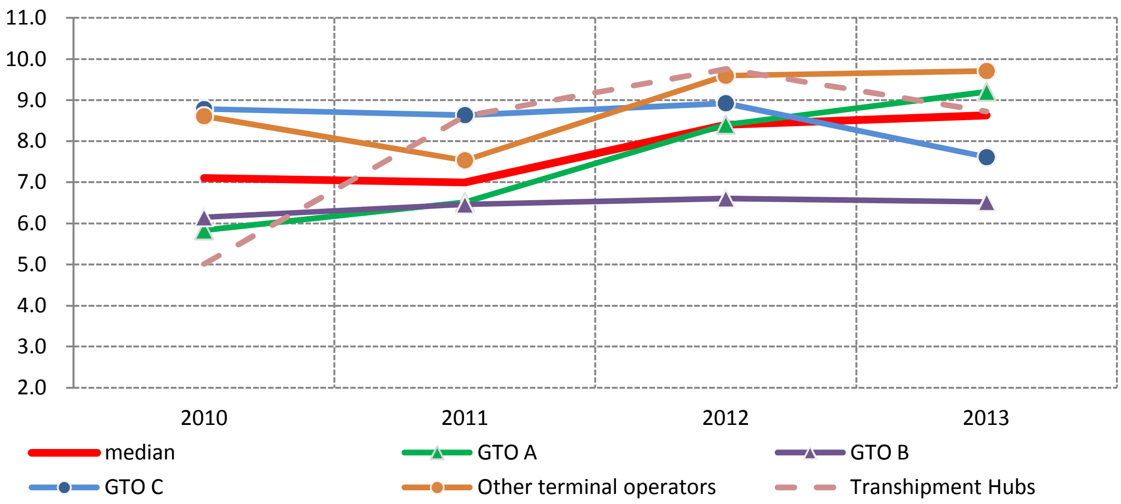
Energy consumption is important in port operation and port related activities, and with energy costs increasing also on land, port authorities and terminals are looking for ways to reduce their fuel bills. Thus, differentiated infrastructure charges based on incentives to promote energy efficiency and more environmental performance could be a future strategy (Wilmsmeier, 2012).

Terminals around the world are working to change their dependency on fossil fuel to electricity. These efforts are accompanied by the development of renewable energy sources within the port perimeter (Acciaro, Ghiara & Cusano, 2014). While some terminals have taken voluntary steps, such as making investments in energy efficiency technologies, many port authorities and terminal operators still lack awareness of the relevance of energy consumption and efficiency in their infrastructures. In many terminals sound strategies to measure energy consumption and to implement energy efficiency indicators are absent (Wilmsmeier et. al. 2014). Energy management places the port in the middle of a complex web of energy flows, and requires the terminal operator and port authority merely to be aware of how energy is used in the port and where it is coming from (Acciaro, 2013). It can be argued that a coordinated approach can result in energy cost savings, and even be a new source of business for the port.

6 KEY FINDINGS

1. **Median energy consumption per Box (dry, excluding reefer cooling) is equivalent to 8.6 liters of diesel in 2013.**

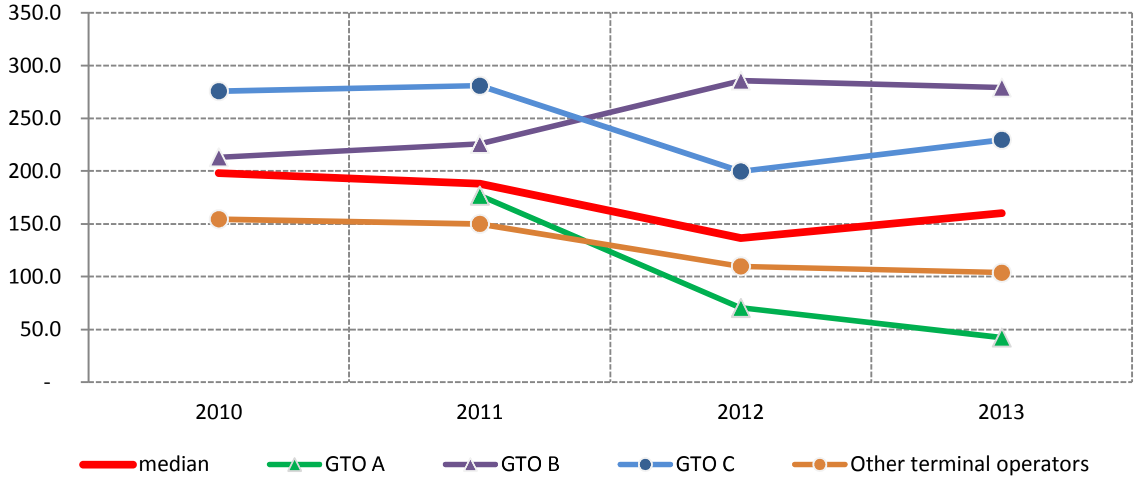
Figure 1 - Energy consumption per dry container in liters of diesel equivalent, 2010-2013



***Source**: ECLAC Infrastructure Services Unit*
***Note**: GTO = Global Terminal Operator*
Calculation based on 41 terminals in 17 countries with a total throughput of over 37 million TEU

2. **Median energy consumption for cooling a full Reefer Box is equivalent to 160 kWh in 2013.** Thus, median total energy consumption per Reefer box including handling is 24.7 liters of diesel equivalent.

Figure 2 - Energy consumption for cooling of reefer container in kWh, 2010-2013

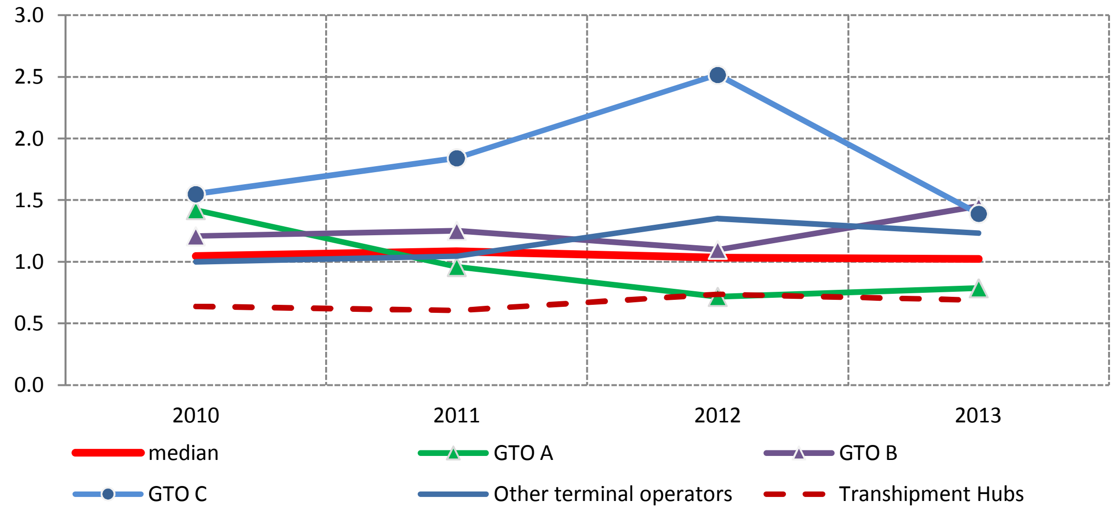


Source: *ECLAC Infrastructure Services Unit*
Note*: GTO = Global Terminal Operator*
Calculation based on 41 terminals in 17 countries with a total throughput of over 37 million TEU

Reefer cooling represents an average of 17.6 per cent of total energy consumption and varies depending on the importance of reefer cargo. By way of example, in the case of Chile reefer cooling represents almost 1/4 of total energy consumption in the terminals under study.

3. Median energy consumption per Box moved by quay cranes is equivalent to 1.0 liter of diesel equivalent in 2013.

Figure 3 - Energy consumption of quay cranes per dry container moved in liters of diesel equivalent, 2010-2013

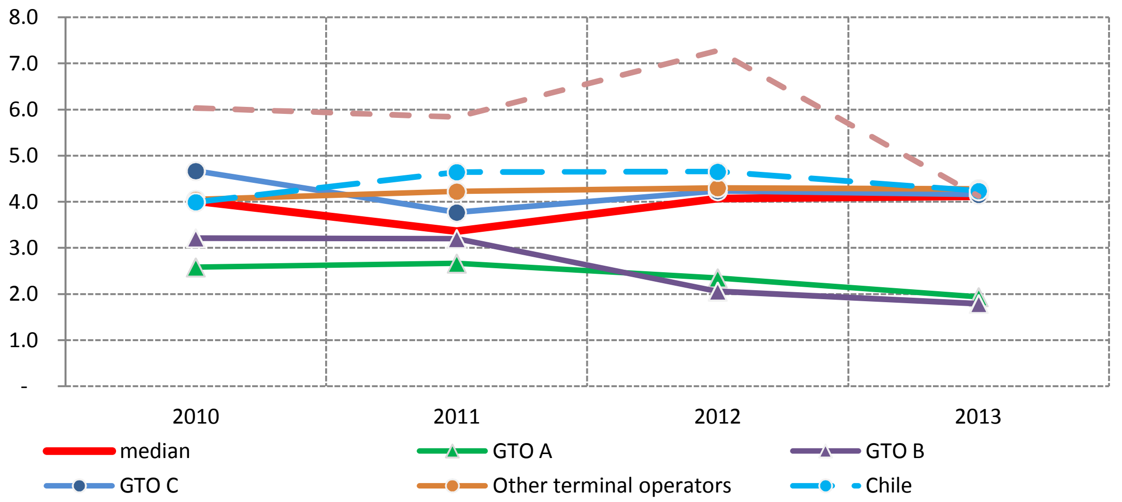


Source*: ECLAC Infrastructure Services Unit*
Note*: GTO = Global Terminal Operator*
Calculation based on 41 terminals in 17 countries with a total throughput of over 37 million TEU

Vertical activities (STS and mobile cranes) consumed an average of around 13 per cent of all energy in 2013. Depending on the type of crane deployed in the terminal this value can vary significantly and is highly influenced by the type of energy used.

4. **Median energy consumption per Box for horizontal activities is equivalent to 4.1 litres of diesel equivalent in 2013.**

Figure 4 - Energy consumption of horizontal activities per dry container moved in liters of diesel equivalent, 2010-2013



***Source**: ECLAC Infrastructure Services Unit*
***Note**: GTO = Global Terminal Operator*
Calculation based on 41 terminals in 17 countries with a total throughput of over 37 million TEU

Horizontal activities are all those activities realized by RTGs, Reach Stackers, RMGs etc. These activities consume the greatest share of energy in the terminal (ca. 45 per cent). These activities are principally based on diesel consumption.

5. **Buildings and lightings have an average share 3 per cent each in the energy consumption of the container terminals under study.**
6. **Terminals are highly dependent on diesel: in average only 35 per cent of the energy consumed in the terminals originates from electricity in 2013.**

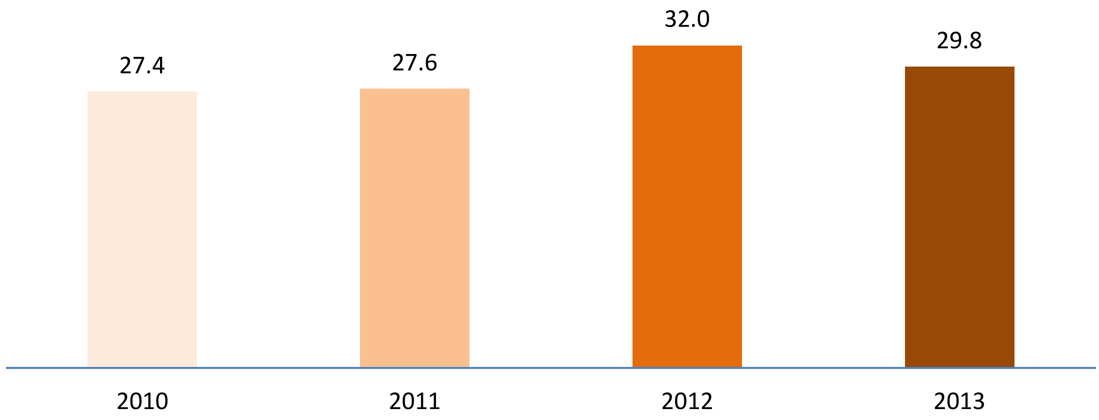
By way of example the share of diesel in the energy matrix of container terminals is 78 per cent in Chile, 88 per cent in Nigeria. In the case of Japan and Vietnam reference terminals have a share between 50 and 60 per cent in terms of diesel consumption.

THE PORT - ENERGY EFFICIENCY - EMISSIONS LINK

In the median each box moved in ports produced 29.8 kg CO_2 emissions in 2013.

For Latin America and the Caribbean these estimates indicate that the region's container activity emitted 865 Megatonnes of CO_2 in 2013. By way of example the CO_2 emissions from the region's port system are equivalent to the annual CO2 emissions of 185 000 Argentineans.

Figure 5 - Average CO_2 emissions per dry container handled in terminals in kg per box, 2010-2013



Source: *ECLAC Infrastructure Services Unit*
Note: *calculation based on 41 terminals in 17 countries with a total throughput of over 37 million TEU*

THE STRUCTURE OF ENERGY CONSUMPTION

One important part in analysing energy consumption is a detailed understanding of the role of different container types in a terminals energy bill (FAL Bulletin 329).In order to be able to identify the energy consumption of different container types an activity-based cost approach is recommended. This approach allows: a) identifying in which area of operation what amount of energy is consumed and b) setting of detailed indicators.

The following activity clusters are considered: vertical operations (quay cranes), horizontal operations (e.g. RS, RTG, RMG etc.), lighting, buildings, and cooling (reefers). Time is a further important factor when it comes to measuring energy consumption and setting indicators for energy efficiency, because of a) the seasonality certain traffics (e.g. reefer), b) variations in dwell time of different container types (e.g. import and export container), and c) ship calling patterns, all of which can cause significant variations and peaks in energy consumption.

Even though literature on energy consumption in container terminals is scarce, some literature is available regarding the energy consumption of specific cargo handling equipments from an operational perspective, which claim that bus bar-powered RTGs equipped with online braking can reduce energy consumption by up to 60 per cent (Yang, Chang & Wei-Min, 2013). In general though these publications do not have a systemic view on energy consumption beyond the effect of technical advancement. One example is the introduction of electric rubber-tired gantries and their operation on green port performance.

CONCLUSIONS

The findings in relation to the current energy consumption of container terminals show the need for action, and are highly relevant for industry and policymakers given the urgent need to address competiveness, energy security and climate change.

Therefore the following six action points have been developed in order to help discover energy efficiency solutions for ports:

1. **You can only improve what you measure.** Ports and terminals should install an energy monitoring system to assess current energy consumption and its costs.
2. **Identify energy consumption sources -** Ports and terminals should identify their energy-consumption sources to discover energy reduction potentials**.**
3. **Formulate an energy efficiency and reduction plan at the process level -** Ports and terminals should formulate an energy efficiency and reduction plan at the process level to coordinate energy efficiency actions.
4. **Implement energy efficiency measures and strategies -** Ports and terminals should implement energy efficiency measures and strategies as a coordinated action, especially focusing on processes with high energy reduction potential.
5. **Obtain energy efficiency certificates -** to demonstrate your success Ports and terminals should apply for energy efficiency certificates to demonstrate their success and to gain competitive advantage.
6. **Formulate a long-term sustainability strategy to meet future energy needs -** Ports and terminals should formulate a long-term strategy to meet future energy needs, especially if an expansion or electrification of the port or terminal is planned.

Thus, significant potential exists to reap the benefits for technological change, electrification, policy incentives and proactive port sustainable and integrated port governance

This work addresses the relevance of energy consumption as a basis for identifying energy efficiency potential and carbon footprint calculations in container ports. The research was only possible due to the strong interest and support from public and private sector stakeholders, who are becoming aware of the unused potential of measures for improvement.

These findings also stress the importance of a detailed understanding of energy consumption patterns and sources, and show how much more research is required to gain a full understanding of these issues. Aside from identifying consumption, this first research on energy consumption and efficiency from a global perspective illustrates not only the environmental, but also the economic dimension of the energy discussion and how this can help turn container terminals into more sustainable infrastructures.

The presented results are not only relevant for the terminal operators, but also to policymakers, port authorities and transport and logistics operators, since these figures provide details to benchmark different terminals and countries.

By way of example, policymakers and port authorities should support the ports and terminals in reducing energy consumption and emissions in various ways. These include helping terminals and other operators to establish green technologies; developing differentiated port and terminal charges related to energy consumption, implementing energy management for ports as a whole to enable load shedding and smart grid (macro grid) applications, energy brokerage to allow for environmentally friendly and economical contracts with providers, and developing an energy mix including own energy production using wind farms, solar panel installations, tidal energy, and others.

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