# Case Studies on Sustainable Practices in Australasian, European & Middle Eastern Ports


## AAPA - Facilities Engineering Seminar

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# Overview

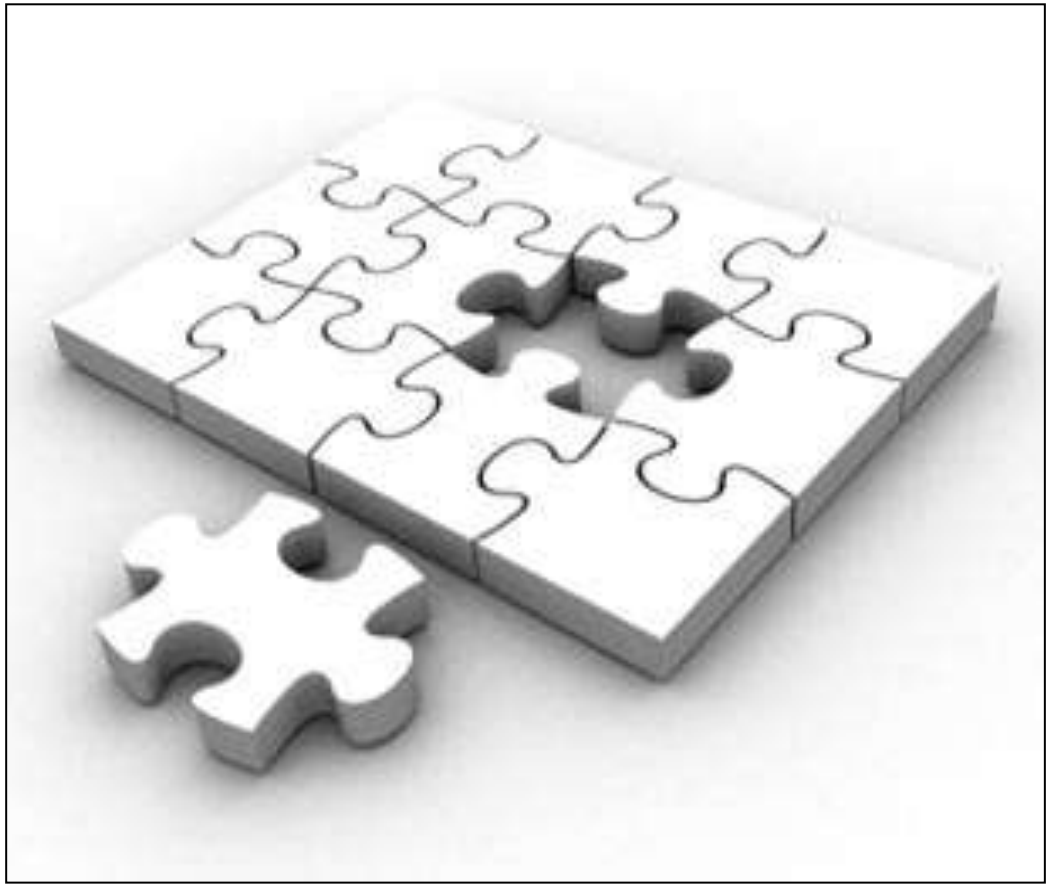
## Introduction

## Technologies

- Electrification
- Automation
- Alternative fuels

## Worldwide implementation

- Europe
- Asia
- Australia
- Middle East



**Learning from worldwide best practices to improve sustainability in the new port development: Australasia, Europe and Middle East**

The environmental impact of the world's ports has become the source of growing concern in the public and private sectors in recent years, with the maritime and port industry being forced to take steps to answer calls for improved air quality in ports and surrounding communities as a result.

In the case of **port equipment** or **ships** during the port stay, reducing diesel engine emissions is one of the keys to mitigating the hazardous effects of nitrous oxide (NOx), carbon dioxide (CO2) and particulate matter (PM) in and around terminals, as well as helping to meet national greenhouse gas (GHG) reduction goals as part of international climate change efforts.

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# Technologies – Electrification

In ports part of the Cargo Handling Equipment, like the RTG cranes, and the ships, during the docking, are normally powered by Gen-Set / Auxiliary Engines

**RTGs**

Powered by a single Gen-Set
Power rage between 350 kW and 500 kW

**Ships**

One or more Auxiliary Engines Power up to 10 MW for AE

## RTGs Electrification

| (P) (kW) | (CO) (g/kWh) | ($HC+NO_x$) (g/kWh) | (PT) (g/kWh) |
|---|---|---|---|
| H: 130 kW ≤ P ≤ 560 kW | 3,5 | 4,0 | 0,2 |
| I: 75 kW ≤ P < 130 Kw | 5,0 | 4,0 | 0,3 |
| J: 37 kW ≤ P < 75 kW | 5,0 | 4,7 | 0,4 |
| K: 19 kW ≤ P < 37 kW | 5,5 | 7,5 | 0,6 |

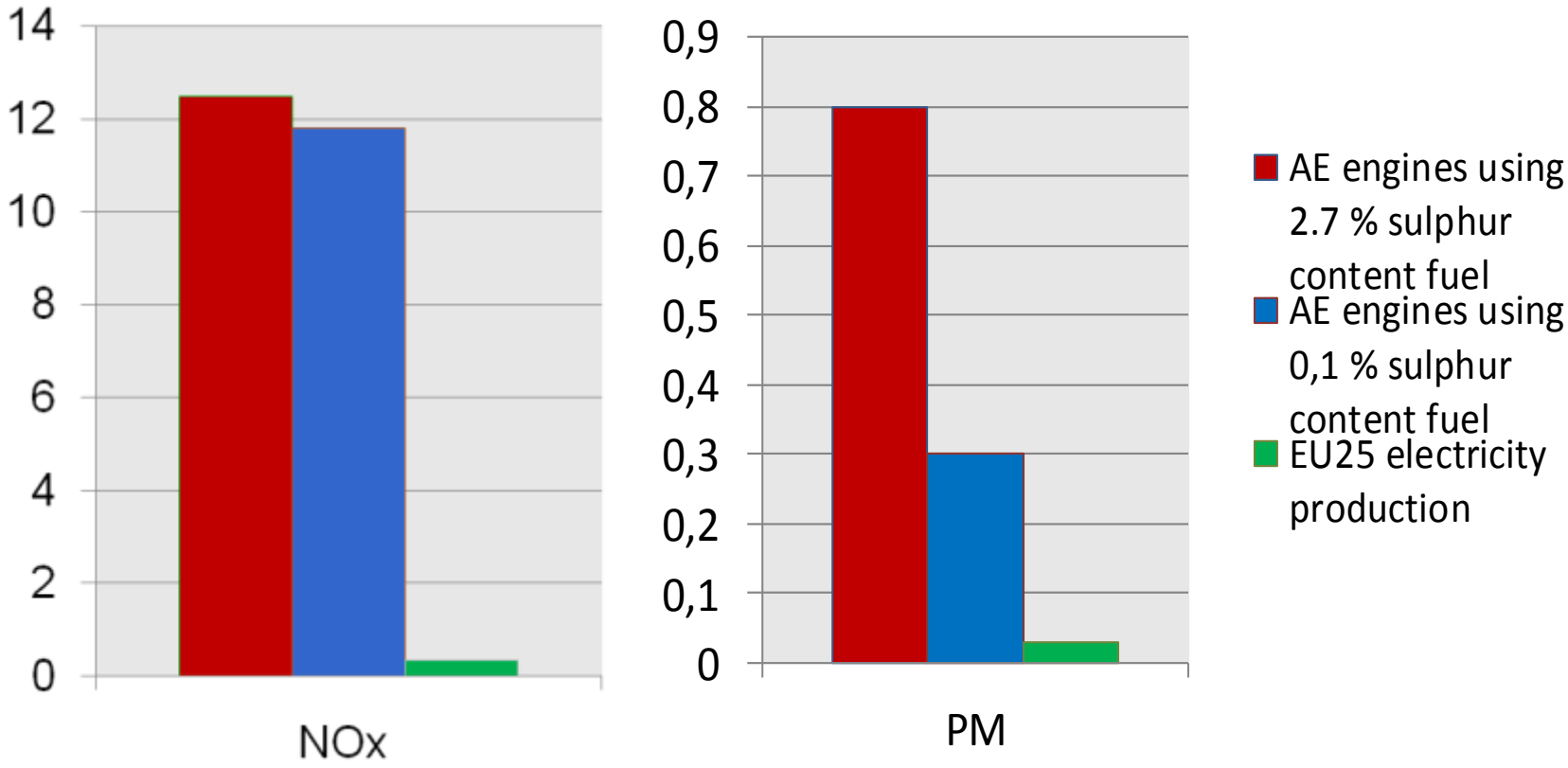
**EU Directive 97/68 dated December 19th 1997 Tier IIIA**

**Table 3.2 Average emission factors for EU25 electricity production**

| | NOx (g/kWh) | $SO_2$ (g/kWh) | VOC (g/kWh) | PM (g/kWh) |
|---|---|---|---|---|
| Emission Factors | 0.35 | 0.46 | 0.02 | 0.03 |

**Source:** Task 2a – Shore-Side Electricity – Final Report
Entec UK Limited

## Shore connection



## $CO_2$ emission reduction

Generally AEs emit 690-722 grams $CO_2$ per kWh electricity (exact value depend from type of engine and type of fuel)

Compare to the $CO_2$ emission from electricity generation in different countries around the world

| Country | National grid power generation<br>g $CO_2$/kWhe |
|---|---|
| Japan | 461 |
| United States | 651 |
| United Kingdom | 543 |
| Italy | 523 |
| South Korea | 507 |
| Singapore | 598 |
| Spain | 447 |
| Netherlands | 612 |
| Norway | 3 |
| Indonesia | 917 |
| Germany | 612 |
| Russia | 811 |
| France | 108 |
| Malaysia | 603 |
| Taiwan | 690 |
| Turkey | 565 |
| Belgium | 310 |
| Brazil | 106 |

**Source:**
**Resources, Conservation and Recycling 54(2010) 462-467**
**Assessment of CO2 and priority pollutant reduction by installation of shoreside power**
**W.J. Hall**

# Technologies – Automation

Automation is the one of the most effective way to save energy. Simply using energy better is a cost-effective way of cutting Air emission.

It is often the cheapest and quickest route to reduce the environmental impact of Port operation

Automation can be applied to not only to the Cargo Handling Equipment but also to ship docking operation

## Automatic stacking cranes (ASCs)

Saving is in being able to operate several cranes simultaneously and in doing so, to even out their energy consumption. In other words, when energy is generated at one location, it can be used by another crane in the same supply grid. Studies show that even with just ten cranes operating at the same time, an optimum situation can be attained whereby energy is simultaneously generated and consumed, resulting in savings of about 30%.

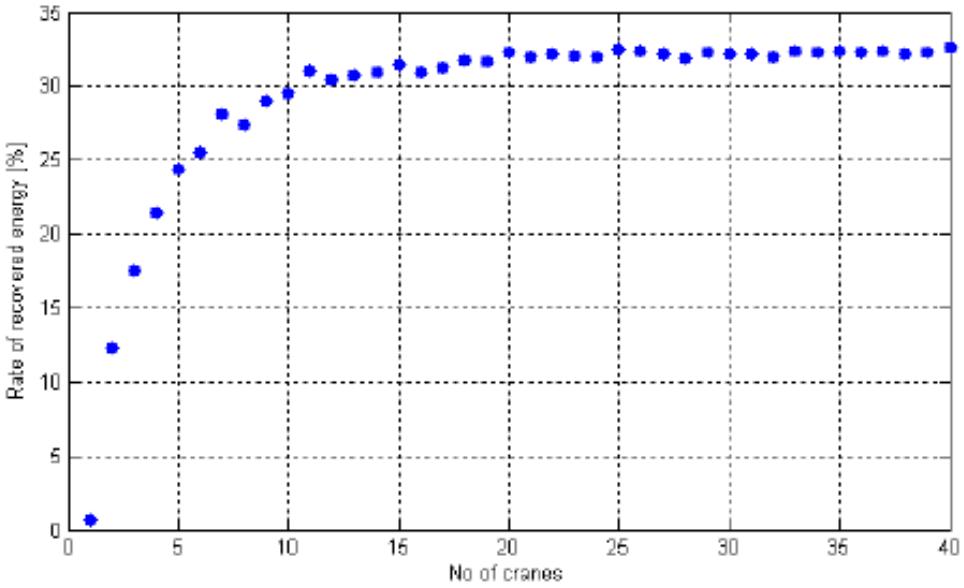



Figure 3.1 Rate of recovered energy depending on the number of independently connected cranes

**Source:**
**ENERGY AND ENVIRONMENTAL EFFICIENCY IN PORTS & TERMINALS**
**PEMA information paper**

## Automatic Mooring System

The use of the Automatic mooring System permit energy saving thanks to:

- Shortening  waiting time
- Shortening the time needed by the mooring
- Shortening the time of the port stay
- Shortening the use of the Tug
- Improved efficiency of the cargo operation





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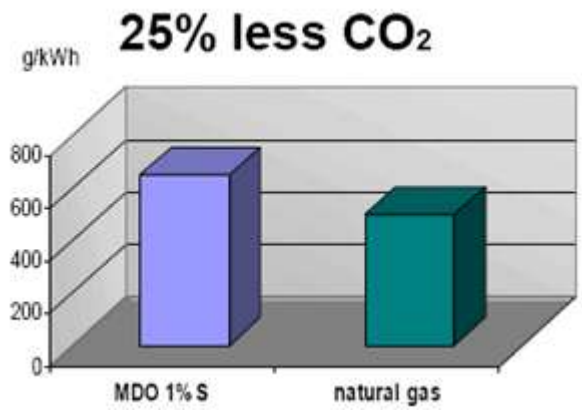
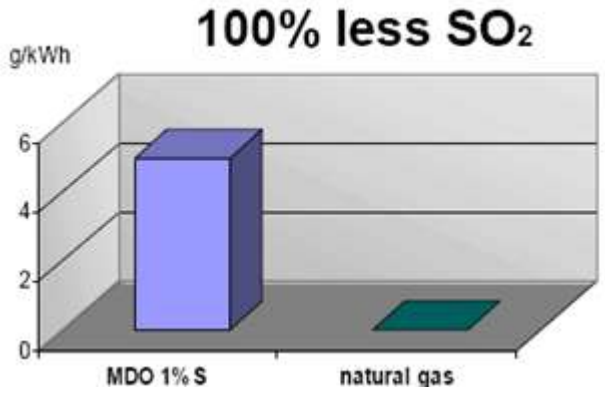
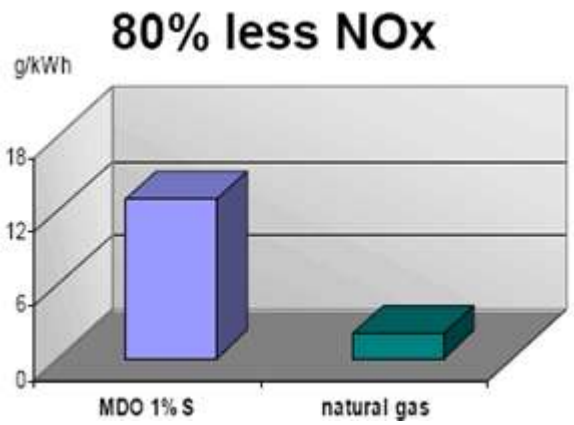
## Natural Gas

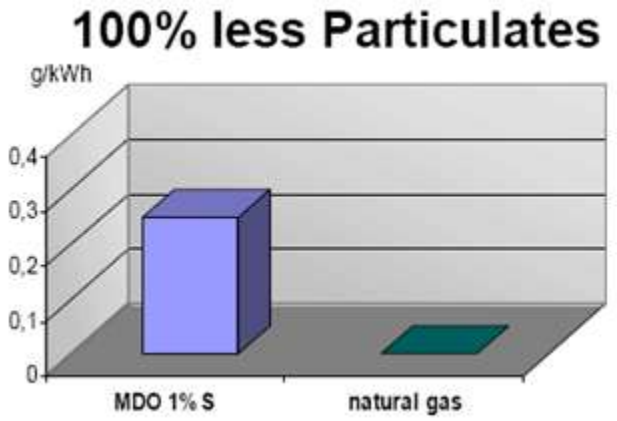
- The use of the natural gas instead of other fossil fuel permit to reduce consistently air emission.
- Natural gas does not contain sulfur or heavy metals. When burned, it also emits lower levels of $CO_2$ than naphtha, coal, oil or liquefied petroleum gas
- Thanks to its high energy density Liquefied natural gas (LNG) is use in some port as fuel for the terminal tractor, but also on board of ships for the main propulsion and auxiliary electricity production.
- Many study and pilot project are carried out for an extensive use of LNG in ports (CHE powering and energy production)

## Natural Gas emission comparison



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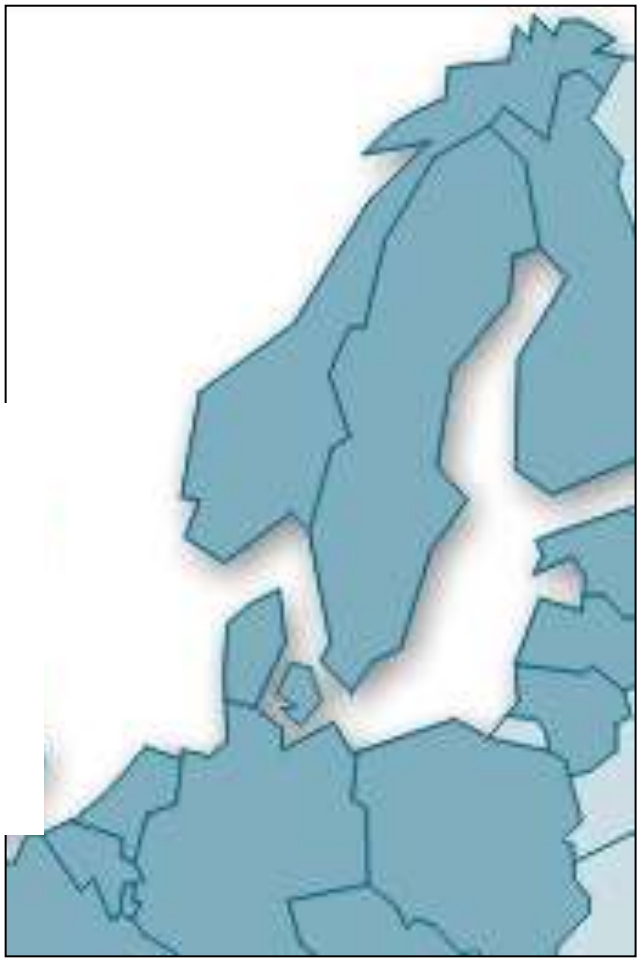
# Worldwide implementation – Europe

**Baltic Sea Ports**
**Ro-Ro vessel Terminals**
**Shore connection**



Following ports in Baltic Sea have installed shore connection:

- Gothenburg
- Luebeck
- Kemi
- Oulu
- Karlskrona
- Trelleborg
- Oslo

- Totally 10 berth are equipped with the shore connection and other 4 are under construction
- Power is supplied at 10 kV at 50Hz or 60 Hz (using a static frequency converter)
- The EU decided recently that Sweden will be permitted to make exceptions to the Energy Tax Directive. The Swedish Government was therefore able to cut the tax on power for vessels at the quayside by 98 per cent

## Baltic Sea Ports - Ro-Ro vessel Terminals -Shore connection


Cable Dispenser in rest position

Cable Dispenser in operation



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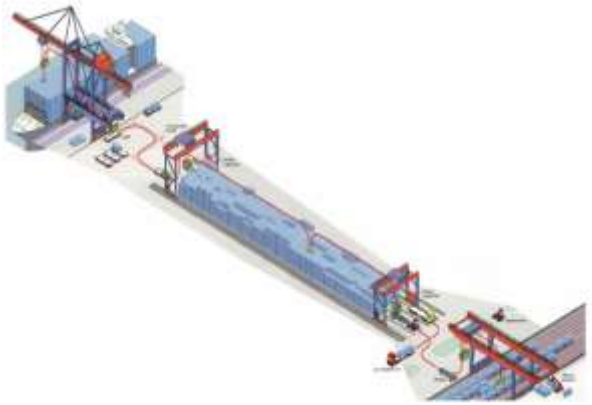
**Port of Hamburg (Germany) -Container Terminal Altenwerder (CTA)**
**Automatic Stacking Cranes**

- 52 unit installed
- In operation since 2002
- One inner and one outer crane on each block



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# Worldwide implementation – Europe

**Automatic Stacking Cranes**

- Over 260 ASCs installed in Europe installed
- Other over 100 unit to be installed in the next 3 years

**Euromax Terminal, Rotterdam**
**58 ASCs**

**ECT, Rotterdam: 137 ASCs**



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**Clean North Sea Shipping**
**Alternative Fuel: LNG**

A new project lead by Port Authorities together with other partners to develop storage facilities in the Baltic/North Sea in order to be able to supply LNG to ship for main propulsion and auxiliary electricity production

**Gasnor:**
"To create a Nordic network supplying LNG to shipping"

**Göteborg Energi:**
"To contribute towards the sustainable city"

**Port of Gothenburg:**
"To enable sustainable transport concepts by offering alternative fuels for shipping. Thereby increase the ports competitiveness."


Göteborg Energi GASNOR LNG GOT PURE PARTNERSHIP

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# Worldwide implementation – Asia

**Shenzhen Port (China)**
**Shekou Container Terminal**
**Shore connection**

- 2 berths of 9 nine electrified
- Power supplied 6.600 V at 60/50 Hz or alternatively 440 V at 60/50 Hz
- 5 MVA Static frequency converter installed (MV converter)
- Containerized solution for FC
- Flat rack equipped with
  - MV Switchboard
  - Step down transformer
  - Low Voltage cable reels


**Frequency converter container**



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# Worldwide implementation – Asia

**Shenzhen Port (China)**
**Shekou Container Terminal**
**Shore connection**

**Flat rack for LV power supply**

**Ship equipped for shore power**

**LV cable connection**



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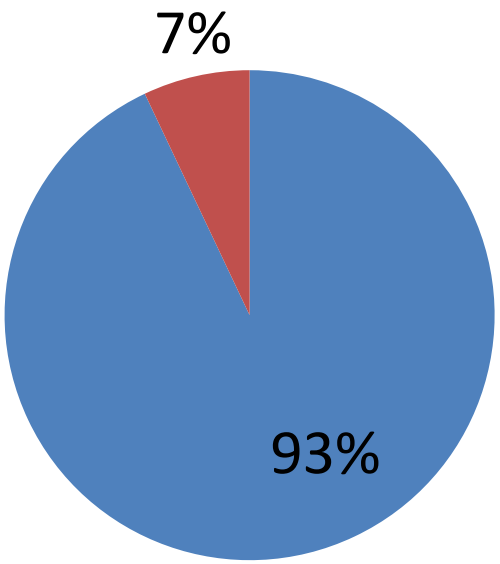
# Worldwide implementation – Asia

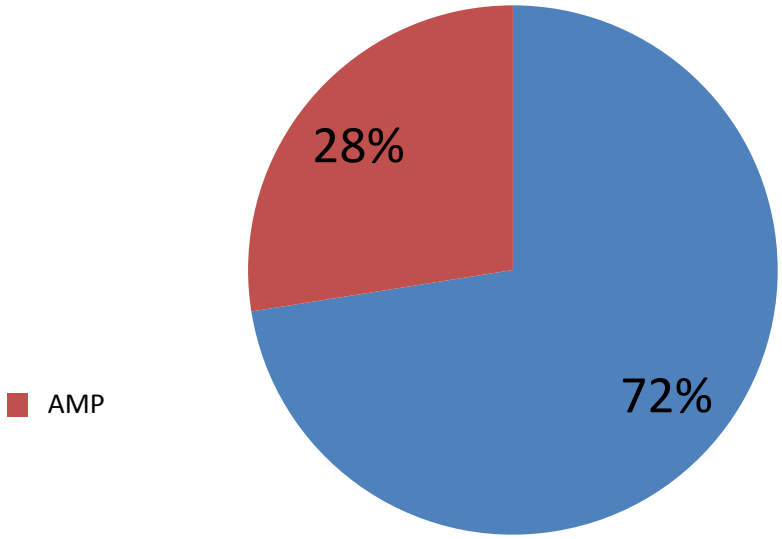
## Percentage of vessels in service with AMP equipment




**4,000 to 15,000 TEU containerships updated 1 Dec 2010**

Source: Boxfile 1 Dec 2010, container vessel 4000-ULCS TEU

## Percentage of post-panamax vessels with AMP order by scheduled delivery date 2011 - 2015




**New-builds update 01-Janauary-2011**

Source: boxfile 1 Janauary 2011, container vessel 4000-ULCS TEU



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## Hong Kong Port (HK) -Modern Terminals Ltd. - E-RTG

- Retrofitting of 78 RTG cranes
- Bus bar system
- Power supply at 460 V at 50 Hz
- Automatic connection and disconnection to busbar
- RTG auto steering implemented

## Hong Kong Port (HK) -Modern Terminals Ltd. - E-Rtg

Bus bar connection point

Bus bar detail

Automatic arm



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**Port Headland (Western Australia) - Utah Point Multi-User Bulk Export Facility - Automatic Mooring System**

- Moor Master type MM200B
- 14 unit installed for a total holding capacity of 2,800 KN
- Tide range 6,5 m.
- Passing vessel during operation
- Service 1 daily mooring of dry bulk carriers up to 135kdwt, 295m LOA

## Port Headland (Western Australia) - Utah Point Multi-User Bulk Export Facility - Automatic Mooring System

Vacuum pad installed on vertical rails

Vacuum pad detail

Huang Shan Hai, 2nd ship moored at PHPA

## Port Headland (Western Australia) - Utah Point Multi-User Bulk Export Facility - Automatic Mooring System

## 2011 WA Engineering Excellence Award

**Key Benefits**

Through simplicity of operation and design concepts, the MoorMaster system delivers the following significant benefits to PHPA and facility proponents:

- Improved safety of mooring operations.
- Greater port export efficiency through elimination of vessel creep, lost time due to passing vessel interactions and reduction in the time required to capture, moor and release individual vessels which combined provide an estimated time saving per vessel of 2.5 hours.
- Eradication of the need to construct large and expensive Mooring Dolphins.
- Improved Utah Point Berth throughput capacity and berth efficiency with maximum vessel size increased to a length overall (LOA) of 270 metres compared to 225 metres using traditional rope mooring methods.
- Reduced port operating costs for tug boats and personnel involved with stevedoring and corresponding reduction in fuel emissions.

*Refer Port Strategy May 2007 article in*



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**Port of Salalah (Oman)**
**Berth 6 and 1**
**Automatic Mooring System**

- Cavotec MoorMaster type MM200 & MM600
- 4 unit installed on berth 6 for a total holding capacity of 2,400 kN
- 12 unit installed on berth 1 for a total holding capacity of 2,400 kN
- Long waves effecting port operation during Monsoon Season
- Service 2 daily mooring of container ship up to 362m LOA


# Worldwide implementation – Middle East

**Port of Khalifa (UAE)**
**ADPC**
**Automatic Stacking Cranes**

- In operation from mid 2012
- 6 unit already fully erected on site
- Totally 24 ASCs




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# Thank you for your attention