From the Port Onward…

Opportunities & Synergies for LNG in the port and container handling industry

Value Chain and Maritime LNG Training

Świnoujście, Poland – December 6, 2017

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Blekinge Institute of Technology,

Karlshamn, Sweden

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Who is this guy?...

- ✓ Scientist on the application of techniques from Distributed Artificial Intelligence in Container Ports and Terminals, culminated into 50+ published articles and two books.
- ✓ Develop solutions for energy and data transmission in ports and container terminals globally. Employing automation and electrification technologies such as AGVs, ASCs, Automated cranes, RTGs and RMGs.
- ✓ Lecturer at several US and European Universities, member of the board of advisors at the Port Operations Research and Technology Centre at Imperial College London.
- ✓ Posseses 26 years of industrial work experience while living or employed in several countries such as: Evergreen, Sea Land, Bank of America, Deutsche Post GmbH, Sea Trade Reefer,TTS Port Equipment, Conductix-Wampfler AG and SIMPORT AB.
- ✓ Dr. Henesey is a member of the following organisations: Port Equipment Manufacturers Association (PEMA), Swedish Artificial Intelligence Society (SAIS), and Association of Computer Machinery (ACM).
- ✓ PhD in Computer Science from Blekinge Institute of Technology at Karlshamn, Sweden. MSc (Cum-Laude) in Transport and Maritime Management from the University of Antwerp, Belgium and degrees from Old Dominion University, Virginia, USA.

Learning Objectives for today:

- Brief History Lesson
- Opportunities for using LNG for other equipment and vehicles in a port
- Case for Terminal Tractors
- Case for yard cranes (Rubber Tired Gantry Cranes. RTGs)
- Case for other equipment, such as Automated Guided Vehicles and Straddle carriers
- Questions and Answers – don't be shy – ASK!!

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Developing LNG as a business opportunity

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Container Terminals & Container Handling

A Very Brief History Lesson

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Early days – For centuries, freight was handled manually

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Malcolm P. McLean

A truck driver who eventually built one of the largest trucking companies in America

He realized that there had to be a better way

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Malcolm P. McLean

Where would we be today if Malcolm P. McLean had believed the guy who said…

"Cargo can only be moved by hand."

"But, we've always done it this way"

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Thankfully he knew better…

In 1956 Malcom changed the shipping world forever!

The ship carried 58 35-feet containers, along with a regular load of 15,000 tons of bulk petroleum from Newark to Houston in April 26, 1956.

Port Newark, 1959

Just 5 Years later, a Global Standard was set that improved production, safety and cut costs while improving the way that we move goods around the world

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1961 – ISO set global standards for container sizes at 10’/20’/30’/40’

As reported on the a TV show
"Who Made America"
"As McLean's first container ship left Newark harbor, a man asked Freddy Fields, a top official of the ILA…
"What do you think of that new ship?"
Fields replied, "I'd like to sink that sonofabitch!"

Longshoreman strikes ensued,
but the cost of shipping
dropped by 90%

Modern containerization was born.

As a result of Standardization…

Production went from a rate of
1.3 Tons/Hour to > 30 Tons/Hour

$5.86/Ton to $0.16/Ton

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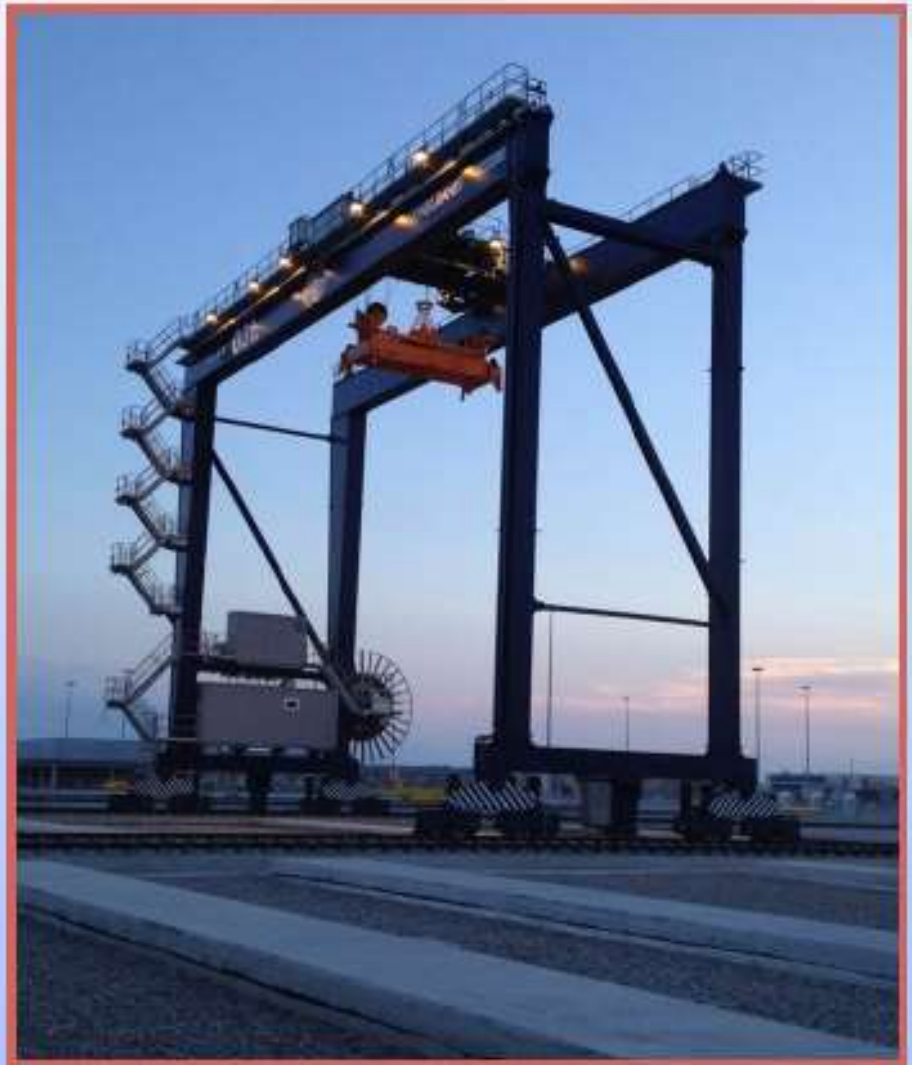
We find ourselves, once again, at the threshold of a new vision in terminal production, safety and cost savings



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Pick up any Trade/Industry magazine and we see that Automation is here to stay


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TMEIC
KONECRANES
APS Technology
SANY
ELME
navis
LIEBHERR
Franz Wöller Elektronikschmiedefabrik Osnabrück GmbH
PRYSMIAN
SIEMENS
ABB
BROMMA
ZPMC
AME
CONDUCTIX wampfler
TTS Liftec Oy
PHOENIX
TOC WORLDWIDE
WCS
EMERSON Industrial Automation
mattott & nichol
GRONNEVELD
PACECO CORP.
AVAHLE
kühz
EATON
GAUSSIN
GANTRAIL
GANTREX
HIRSCHMANN
Continental
TAYLOR
RHM 润邦重机
WAM
TRATOS
Portunus
KALMAR
Spahn + Burkhardt
APM TERMINALS
CASCADE
MICHELIN
Nexans
RFT
MAFI
Schneider Electric
SIBRE
smart-Tecs
TVH
HPC
Liftech
LASE
INTERCON
TSL
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CERTUS
CRANEPORTS
TERBERG
BROSA
SEOHO
VDL
LEHNERT
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HUBNER
BTG
DUTCH LANKA TRAILERS
TEREX
TIMARS
TBA
PORTEK
BANNER

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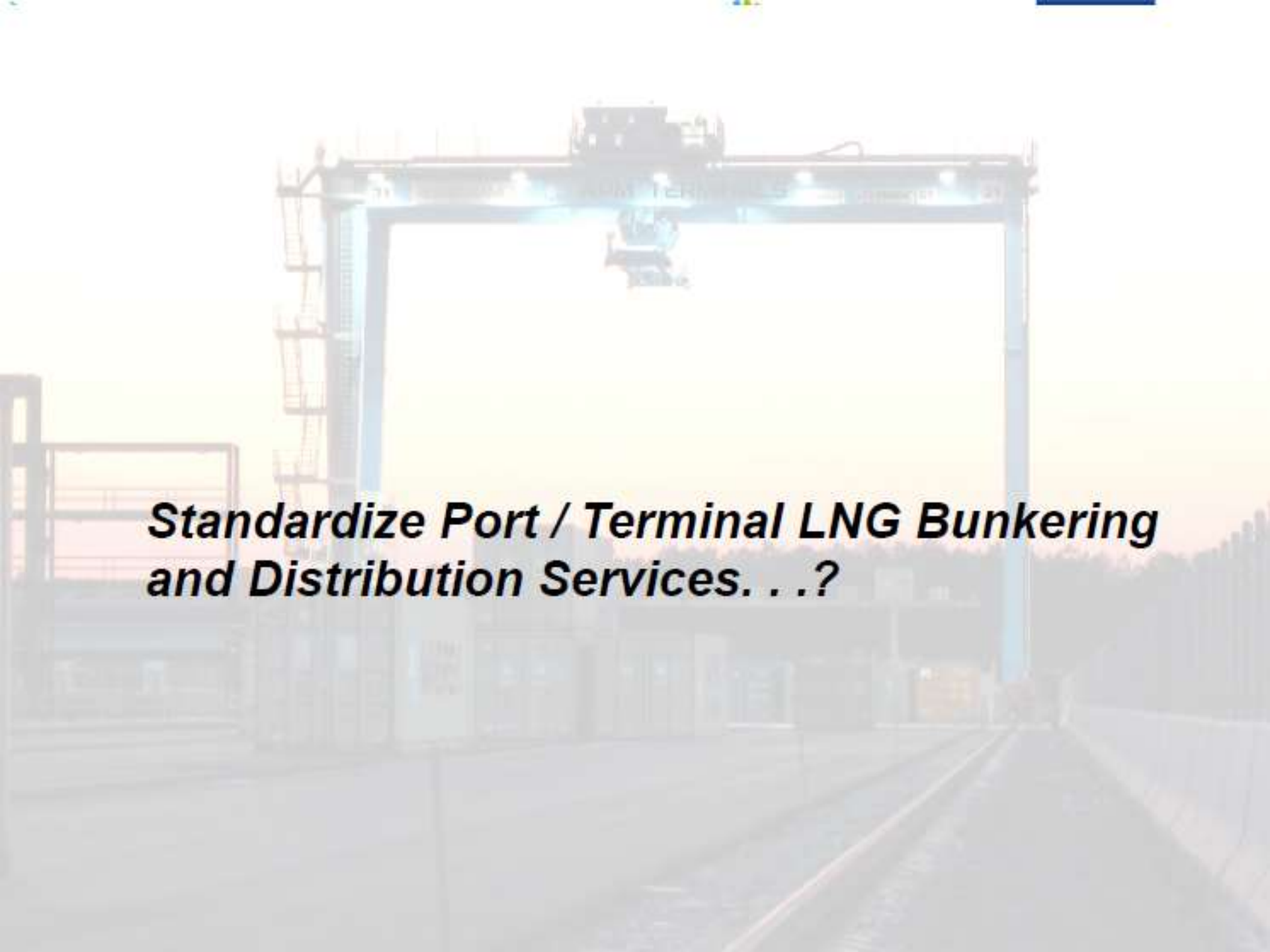
Since the earliest days of containerization…

There have been a lot of major changes in the way we do business. Standardization will allow us to work effectively and utilize the best that technology has to offer.



Standardize Port / Terminal LNG Bunkering and Distribution Services. . .?

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Market and Customer Trends

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Market size for Port Equipment & Container Handling

7 Billion €

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Equipment in Container Terminals

1. *STS* | Ship to Shore Cranes
2. *RTG* | Rubber Tyred Gantry Crane
3. *RMG* | Rail Mounted Gantry Crane
4. Intermodal Cranes
5. Horizontal Transport | AGVs, Trucks, Straddle Carriers

Market for Port Equipment - 2013

Part-financed by the European Union (European Regional Development Fund)

Description and Segmentation

- ✓ Ports and terminals industry projected growth rate of 6% - till 2017
- ✓ Total global container throughput will be 830 million TEU (Twenty-foot Equivalent Units) by 2017. Growth rate of 40% between 2011-2017.
- ✓ Conservative growth rate of 5% will double current global container volumes by 2025
- ✓ Containerisation with strong port development in various regions.
- ✓ More Large ships ordered, 445 new ships with capactiy of 3,27million TEU
- ✓ Larger ships means more time at port - leading to more costs.

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Main drivers of the Market

Trends	Container Ports	Consequence
Increasing competition of terminals	GTOs 	More efficient systems
Globalization	Carriers/Liners 	New investments in modern port facilities
Bigger Vessels		Bigger Cranes and faster logistics
Increase in energy costs	Port Authorities 	Energy Savings
Increasing environmental demands		Automation of Container Yards

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Factors for developing Ecological Equipment

Environmental

reducing pollution (air and noise)

Economical

reducing operating costs (oil prices) and maintenance costs

Technological

optimizing productivity & performances

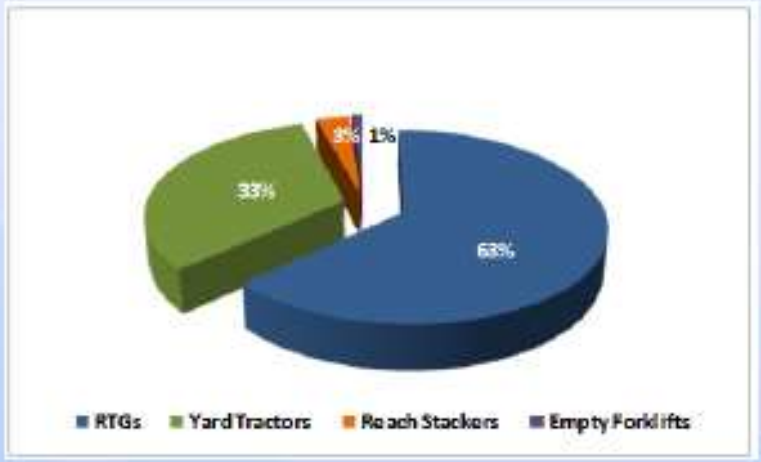
*If necessity is the **mother** **of invention***

then

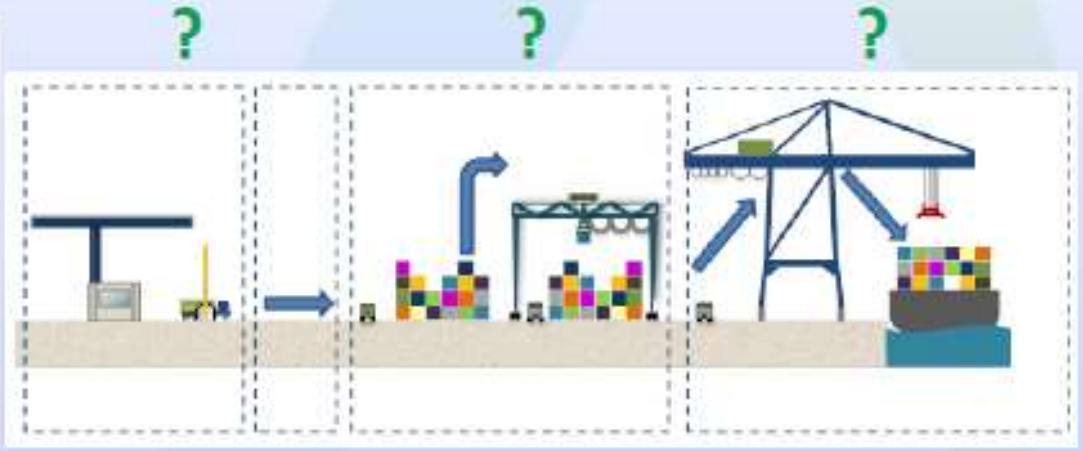
*vision is the **father** **of innovation!***

Where can we apply Ecological Equipment?

How much energy is consumed?



Where is the energy consumed?



Reference: GreenCranes Project

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Which Machinery or Equipment to Consider?

Rubber Tyred Gantry Crane (RTG)

Terminal Tractor

Reach Stacker

Empty Forklift

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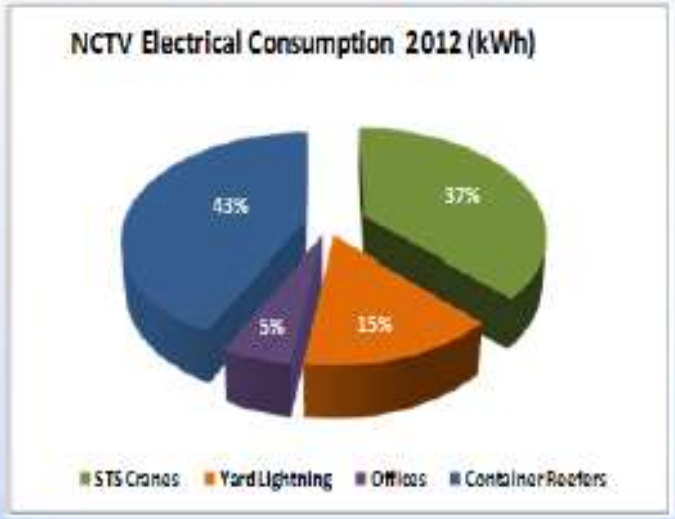
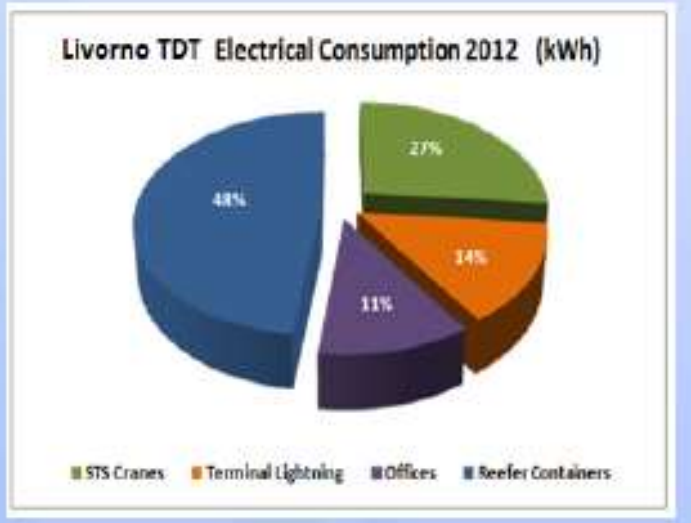
How much ELECTRIC consumption?





12,522,629 kWh (43%)

11,006,280 kWh (37%)

80%

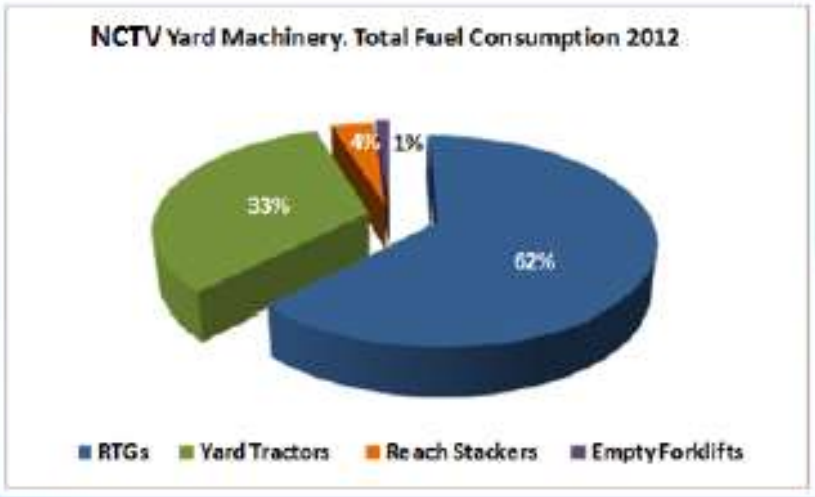
4,801,013 kWh (15%)

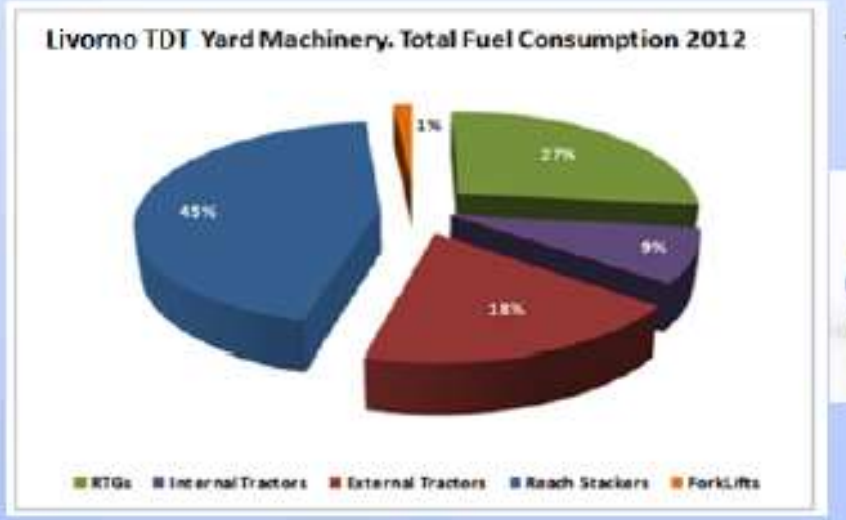
1,815,477 kWh (5%)

30,145,399 kWh (30.1 GWh)

X 3,000 (10,000 kWh / year)

How much DIESEL (FUEL) consumption?





4,049,138 L (58%)

2,245,147 L (32%)

90%

611,460 L (9%)

80,819 L (1%)

6,986,564 L

X 4,000 (1,300 L / year)

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- Terminal Tractors are the most used type of horizontal equipment found in Container Terminals worldwide
- Terminal Tractors represent significant part of the total fuel consumption in a port – often the 2nd most consuming of fuel after yard cranes.

Feasibility Evaluation: Terminal Tractors

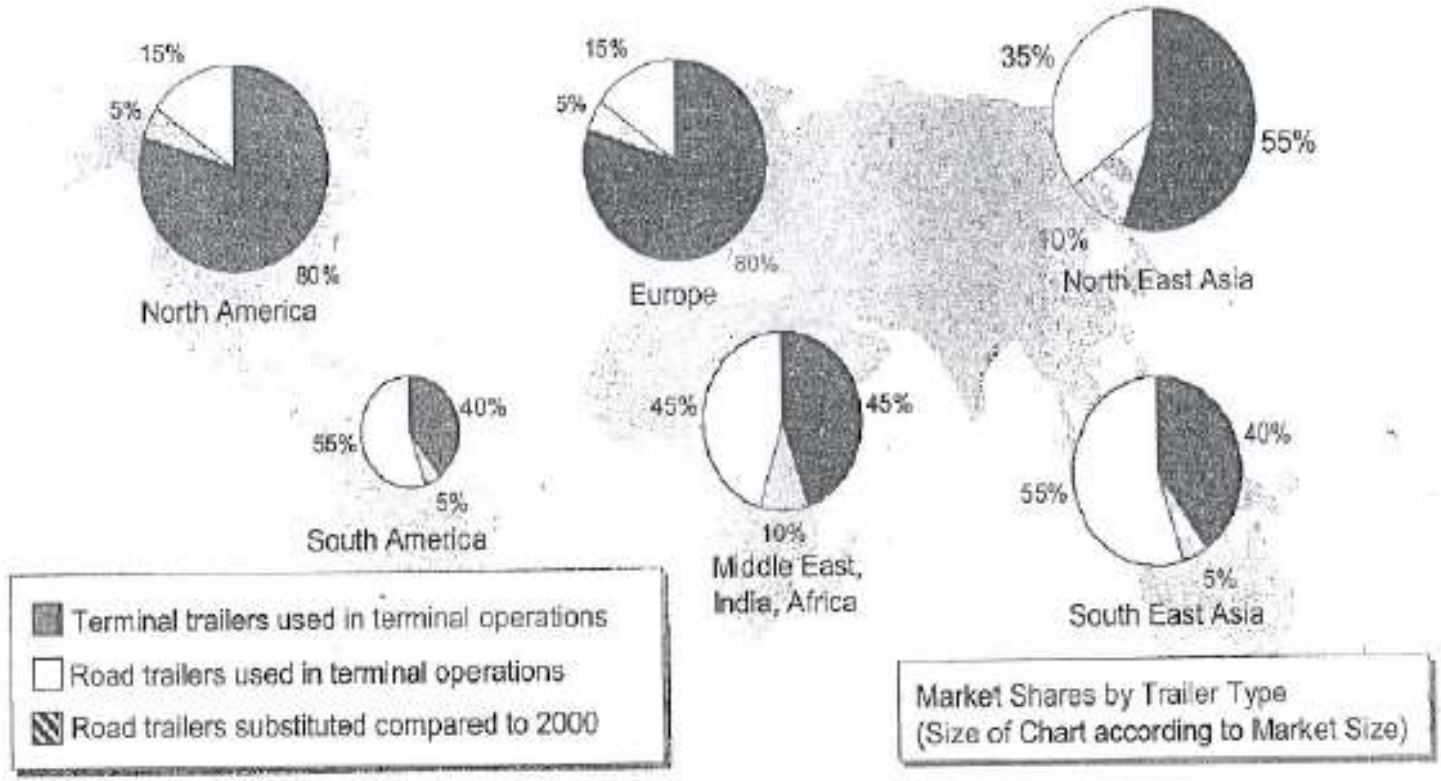
Green Cranes

Terminal Tractors	RTGs	STS + Other
2,4 Million L 1,8 Million € GoB	4,6 Million L 3,4 Million € GoB	17,8 GWh 2,2 Million € kWh
Alternatives TT	**Alternatives RTG**	**Supply Alternatives**

• Gasoil TIER 4 / Stage IV (2014)
• LNG
• Dual Fuel
	• RTG Engine Replacement TIER 4 (2014)
	• LNG / Dual Fuel
	• Electrification
	  • Conductor Bar
	  • Cable Reel
		• Current Electrical Tariff
		• Tariff 6.1 (Electrical Supplier)
		• Tariff 6.3 (Electrical Supplier)

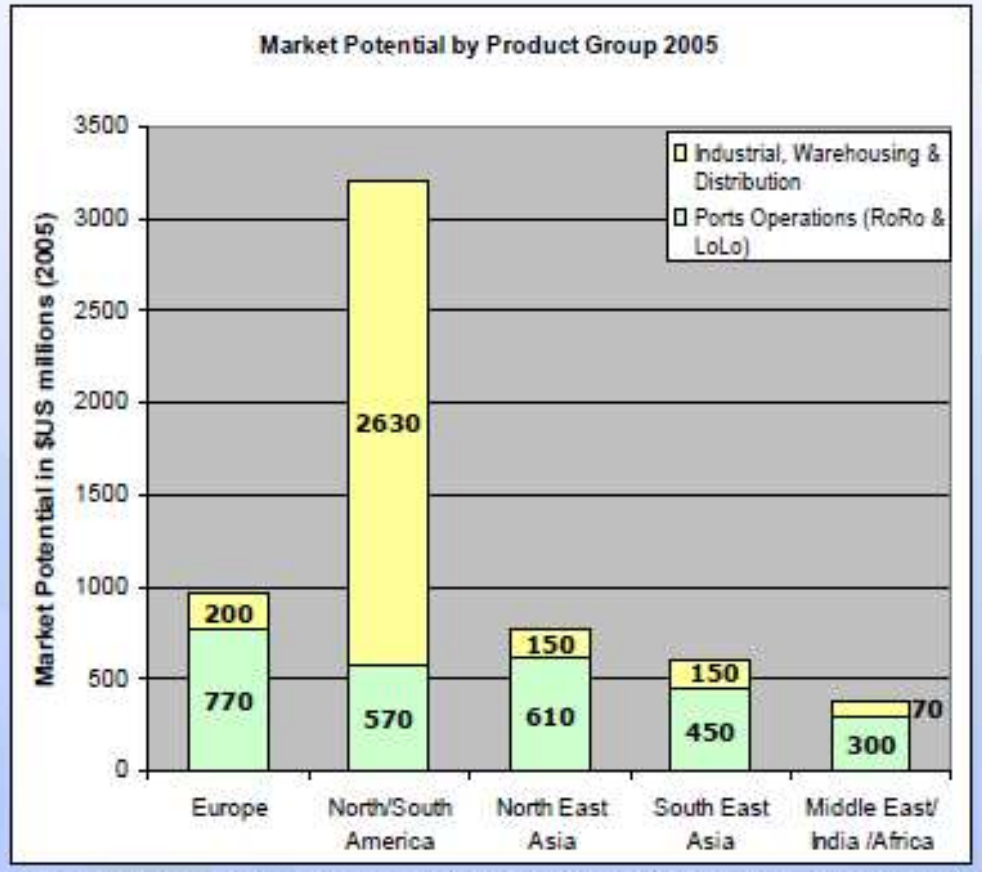
Terminal Tractor Market

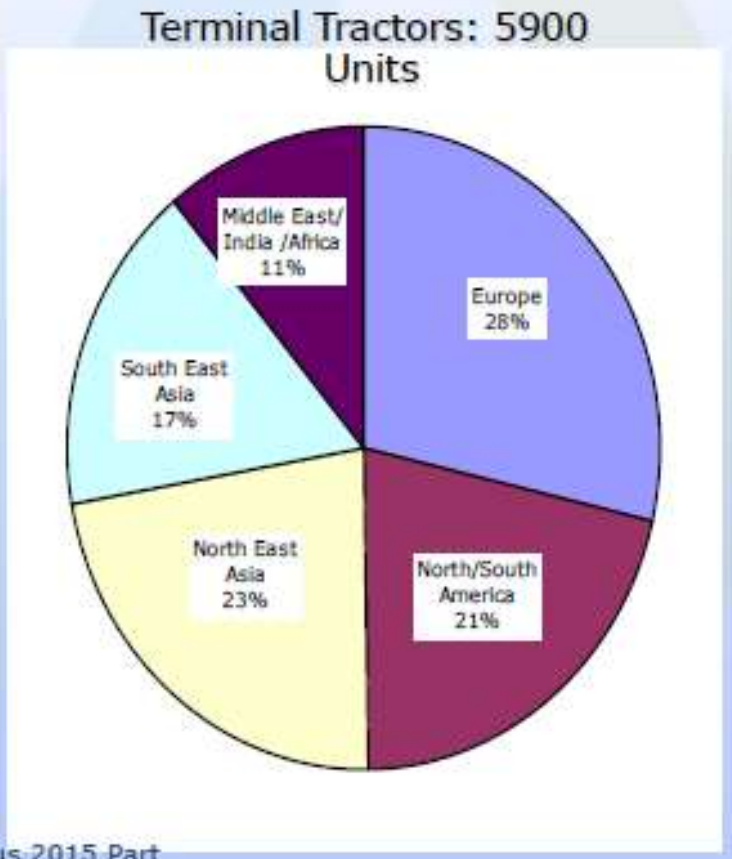
The use of specialised trailers differs from world area to world area. In highly developed Europe and North America 85% of the trailers used in terminals are specialised terminal trailers. In South America road trailers still dominate.



Terminal Tractor Market?

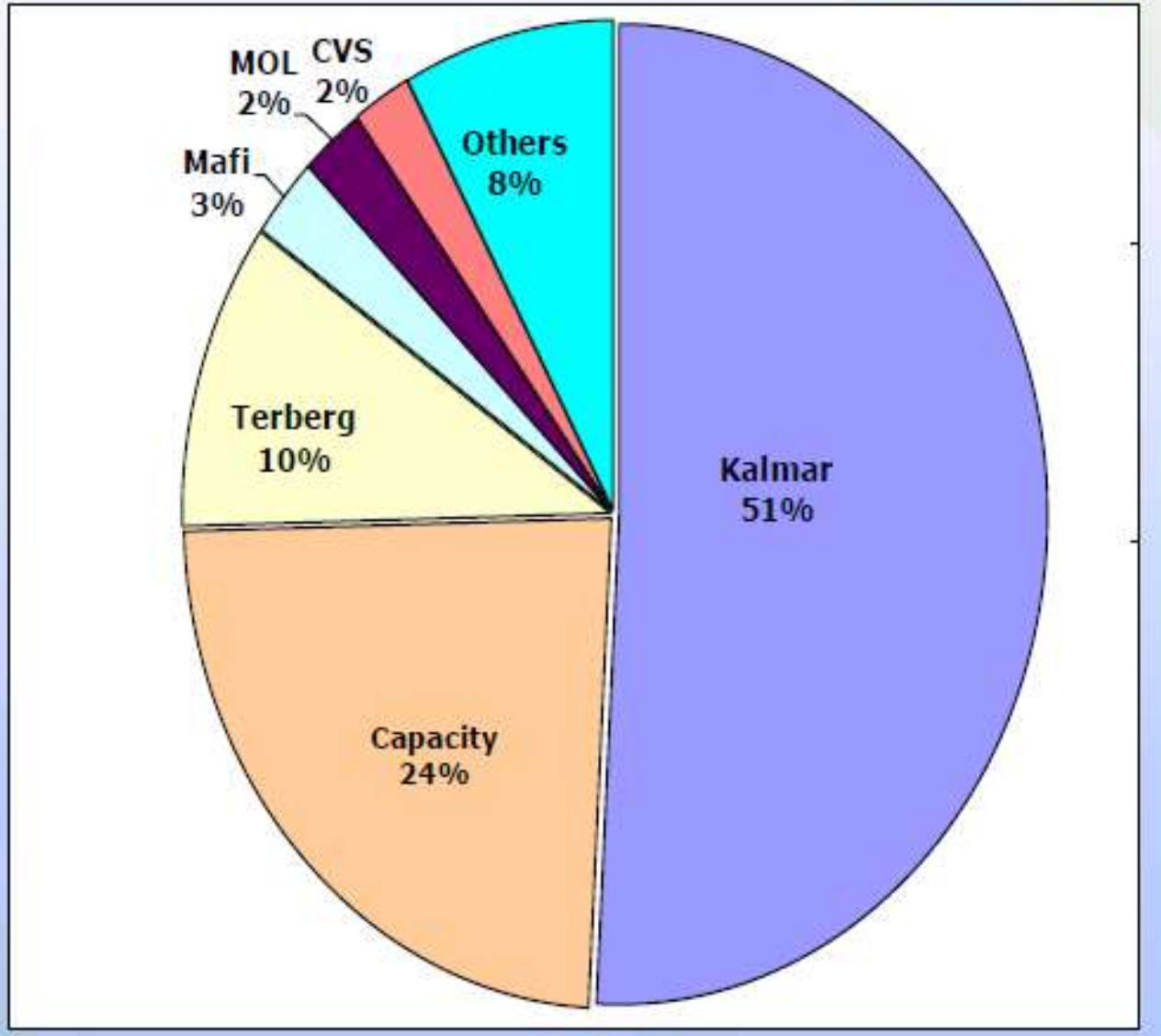
- Terminal Tractor market accounted for 5900 units (2700 delivered to ports and 3200 to other facilites for warehousing and distribution





Source: OneStone Intelligence GmbH (2006) "Container Terminal Focus 2015 Part 4A:Container Terminal Equipment – Current Equipment Market".

Terminal Tractor Market by supplier



LNG Facts for Terminal Tractors

- LNG in fuel tank is stored at less than 100 PSI but at temperatures of –259 F and lower. It has the ability to **contain more fuel in slightly less space** and much lower pressure than CNG.

- Fuel consumption in liters per hour is about **13.2 – 17 Liters per hour**.(Cummins C Gas + 250 HP/750lb/ft T).

- Based upon a 216 liter usable tank size this would **limit to about 12 –16 Hours** on LNG vs. **about 24 – 30 hours on a standard 190 liter** tank of diesel.

- Clear, odorless, and non-corrosive.

Reference : Kalmar Industries

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Diesel

Hybrid Diesel/ Electric

Full electric Battery

Future energy Full cell-hydrogen
Under development

LNG
Under development

GAUSSIN
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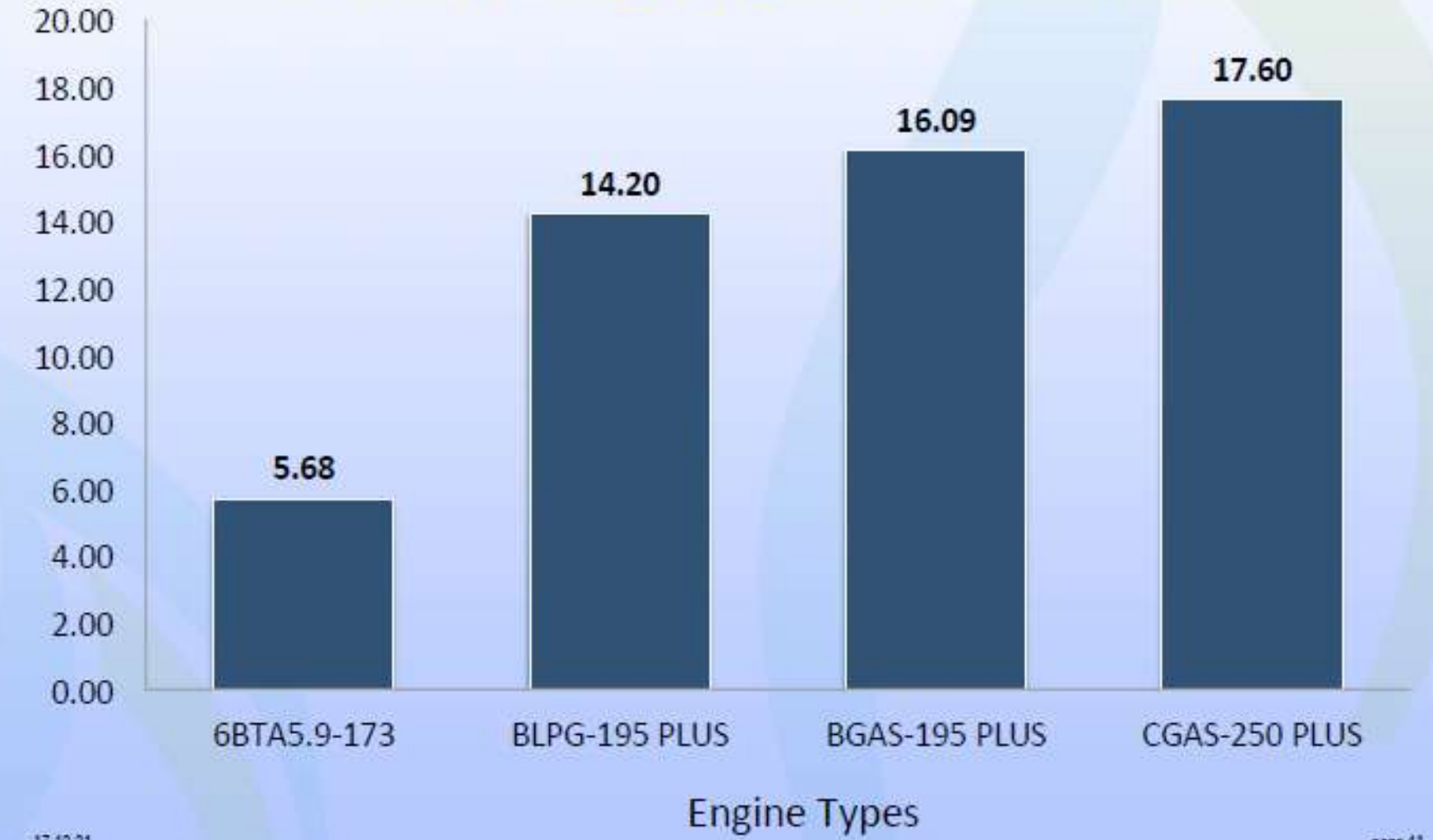
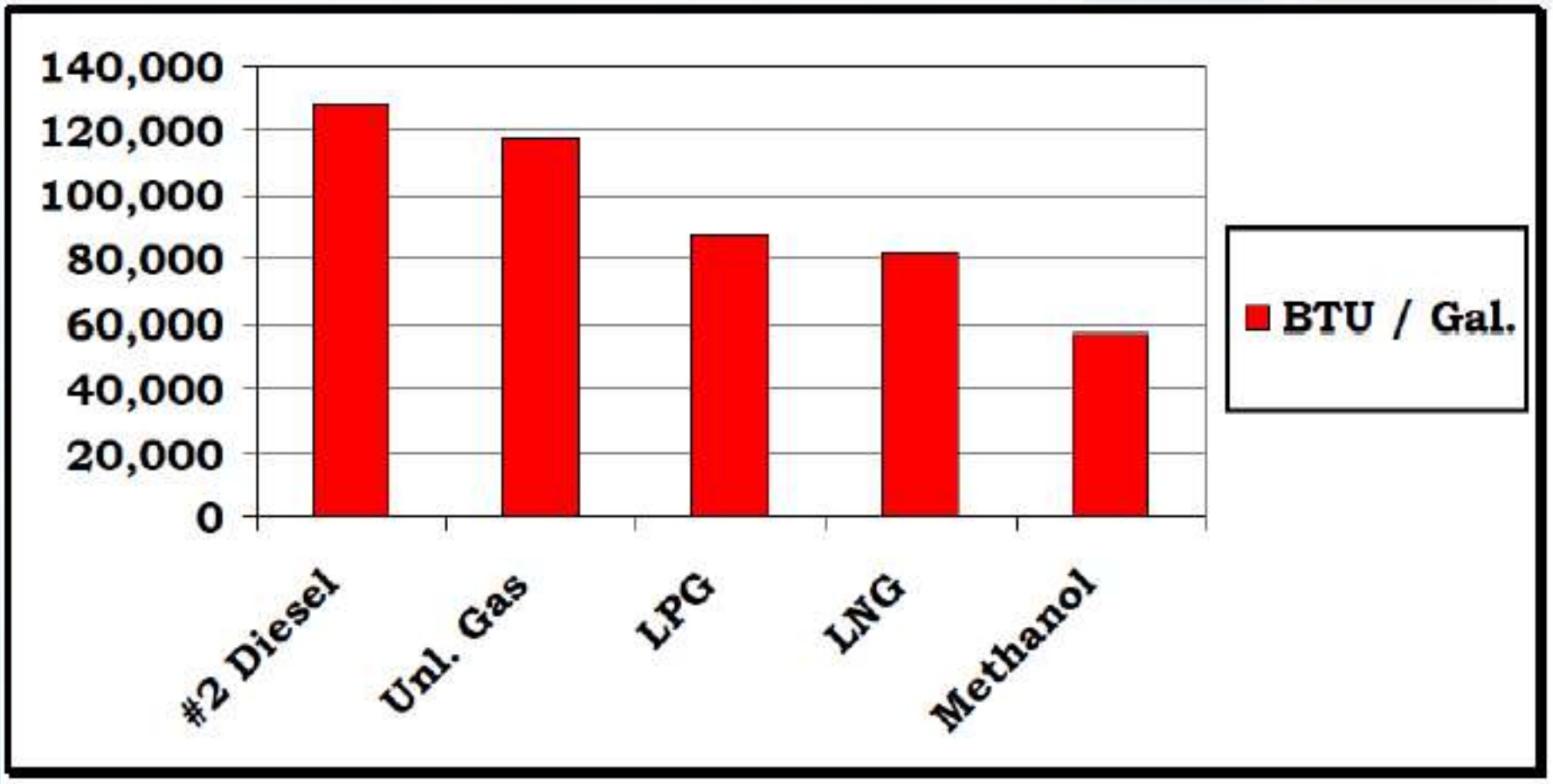
Fuel Consumption per Liter in comparing Engine Alternatives



Energy Comparison



Machinery or Equipment Deliveries 2008-2013

Equipment type	2008	2009	2010	2011	2012	2013
Reach Stackers	1408	796	1227	1452	1504	1324
FLTs Laden	198	110	113	146	178	146
FLTs empty	613	318	467	549	709	671
Terminal Tractors 4x2	2843	1778	1343	1727	1625	1596
Terminal Tractors 4x4	692	404	320	375	414	404

Terminal Tractor 4x2

Terminal Tractor 4x4

Reach Stacker

What is the Pay Back?

LCC = (Initial Cost of Vehicle) – Purchase Incentives + PVFuel – PVResale

Where:

- Purchase Incentives = Value of Grants, Tax Credits, etc. Applied to Vehicle Purchase
- PVFuel = Present Value of Fuel Expenses During Vehicle Service Life
- PVResale = Present Value of Resale Value of Vehicle at End of Service Life
- $PV = Ft /(1 + d)t$
- Ft = Future Cash Flow in Year t
- d = Discount Rate

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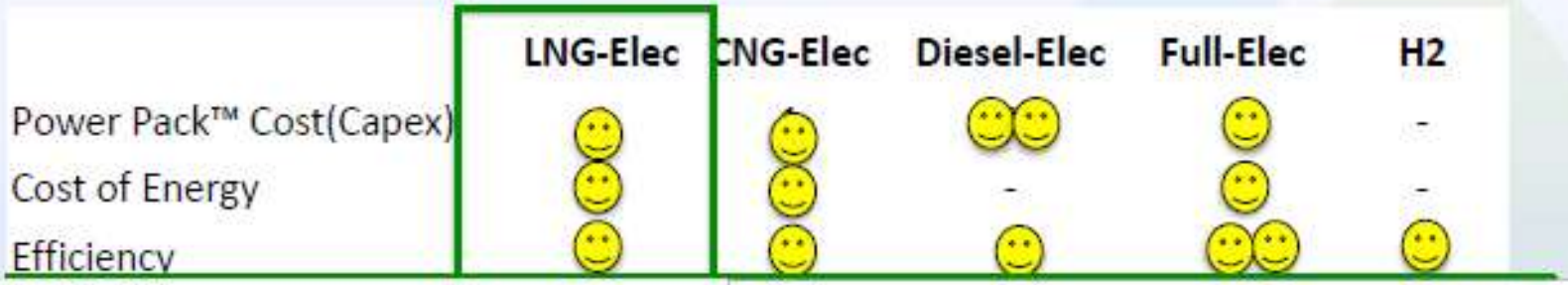
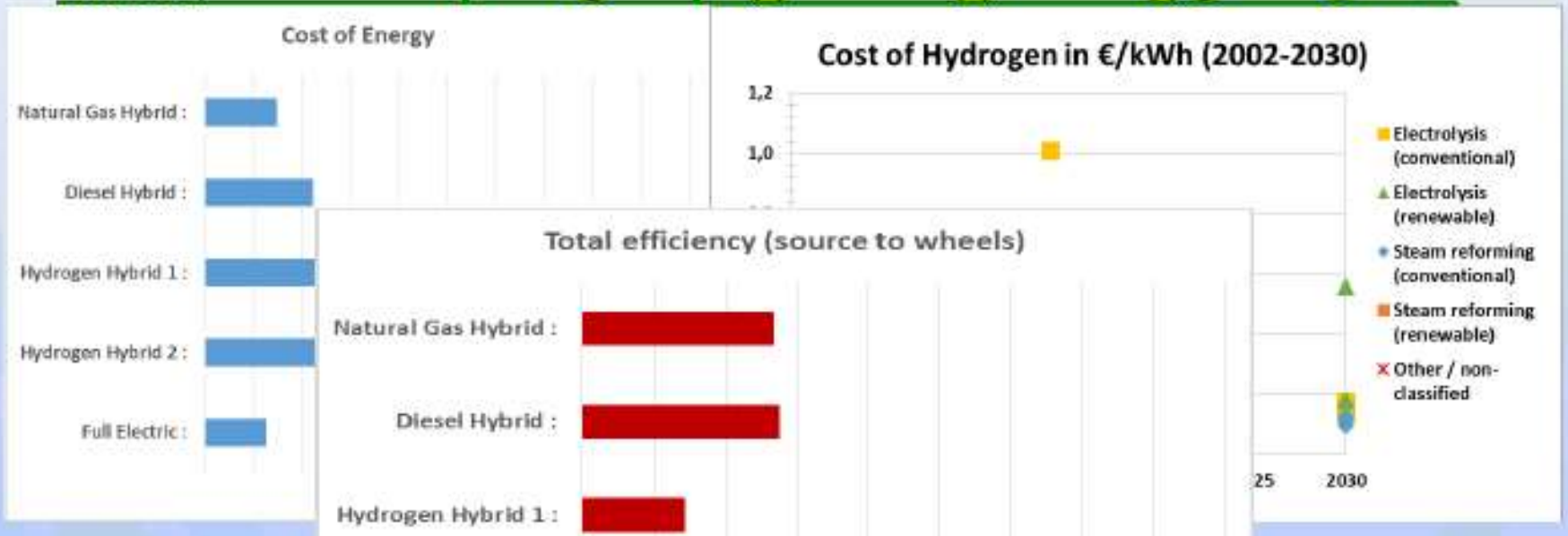
Factor	Diesel	LNG – No Incentives	LNG – LNG Incentives	LNG – SCAQMD (Max. 25 Vehicles)
Initial Cost of Vehicle	$80,000	$120,000	$120,000	$120,000
Purchase Incentives	$0	$0	$32,000	$40,000
Fuel Cost/Gallon After Tax Credits	$2.60	$0.50	$0.50	$0.50
Gallons/Operating Hour	1.7	3.8	3.8	3.8
Annual Operating Hours	2	2	2	2
Annual Fuel Costs	$8,840	$3,800	$3,800	$3,800
Service Life	10 Years	10 Years	10 Years	10 Years
Discount Rate	3%	3%	3%	3%
Present Value Fuel	$77,669	$33,387	$33,387	$33,387
Resale Value	$5,000	$0	$0	$0
Present Value Resale	$3,832	$0	$0	$0
LCC	$153,837	$153,387	$121,387	**$113,387**

Comparison Hybrid, Electric, LNG





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- RTG are the main solution for moving containers in terminal yards worldwide
- RTG represent significant part of the total fuel consumption in a port (more than 50%)

Feasibility Evaluation: RTG

Green Cranes

Terminal Tractors	RTGs	STS + Other
2,4 Million L 1,8 Million € GoB	4,6 Million L 3,4 Million € GoB	17,8 GWh 2,2 Million € kWh
Alternatives TT	**Alternatives RTG**	**Supply Alternatives**

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Facts + Figures

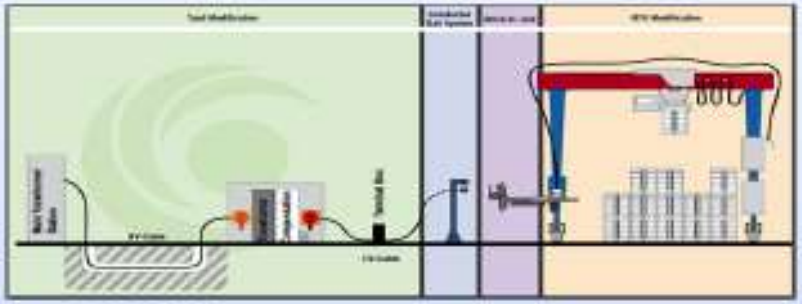
- Diesel engines are the main source of RTGs
- Container handling increases
- At the same time diesel prices increased rapidly
- In some cases RTGs account for 50 % of a container terminals' diesel consumption

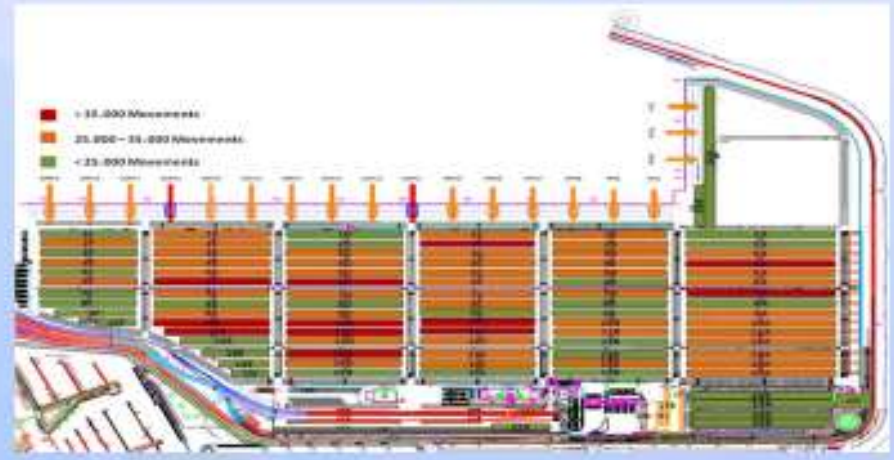
Effects

- High fuel consumption & costs
- High dependecy on fossil fuels that have unpredictable prices
- High cost in larger size Genset service (- USD 20k / year)
- Environmental; carbon emissions, air and noise pollution

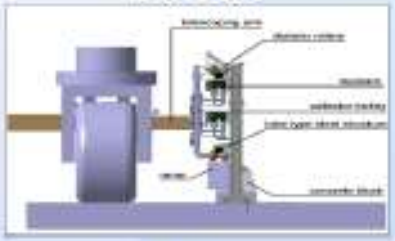
RTG Electrification technologies

RTG Electrification



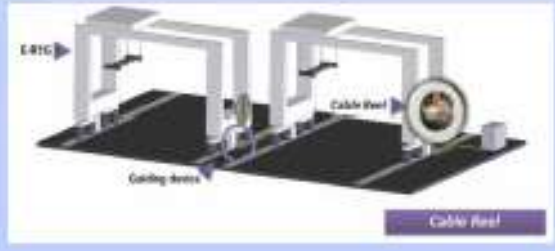


Bus Bar

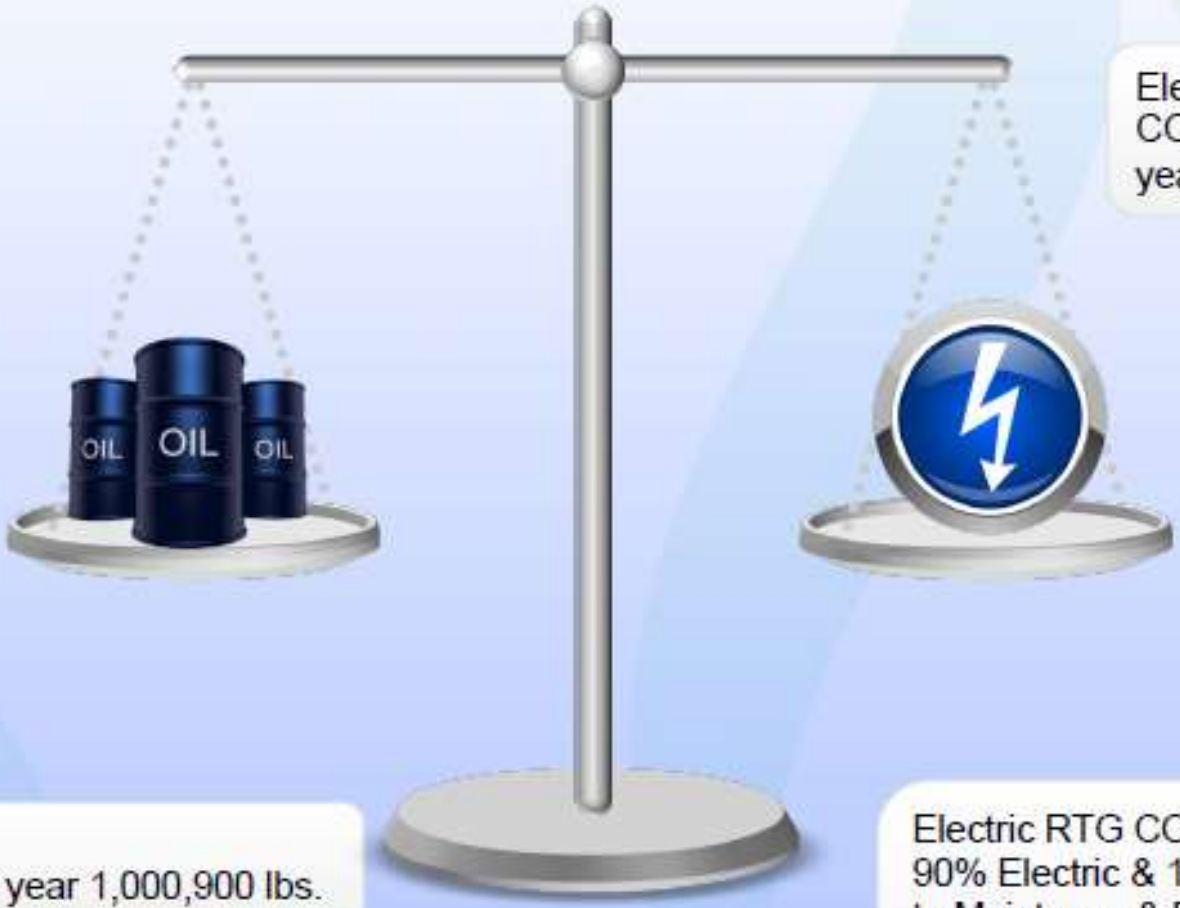


Cable Reel

Sourc ix



EcoLogical facts from an eRTG solution – GPA, US



Electric RTG
CO_2 emission per year 414,470 lbs.

Diesel RTG
CO_2 emission per year 1,000,900 lbs.

Electric RTG CO_2
90% Electric & 10% Diesel (due to Maintance & Block Changing) emission per year 447,000 lbs.

CO_2 reduction of ~ 52%

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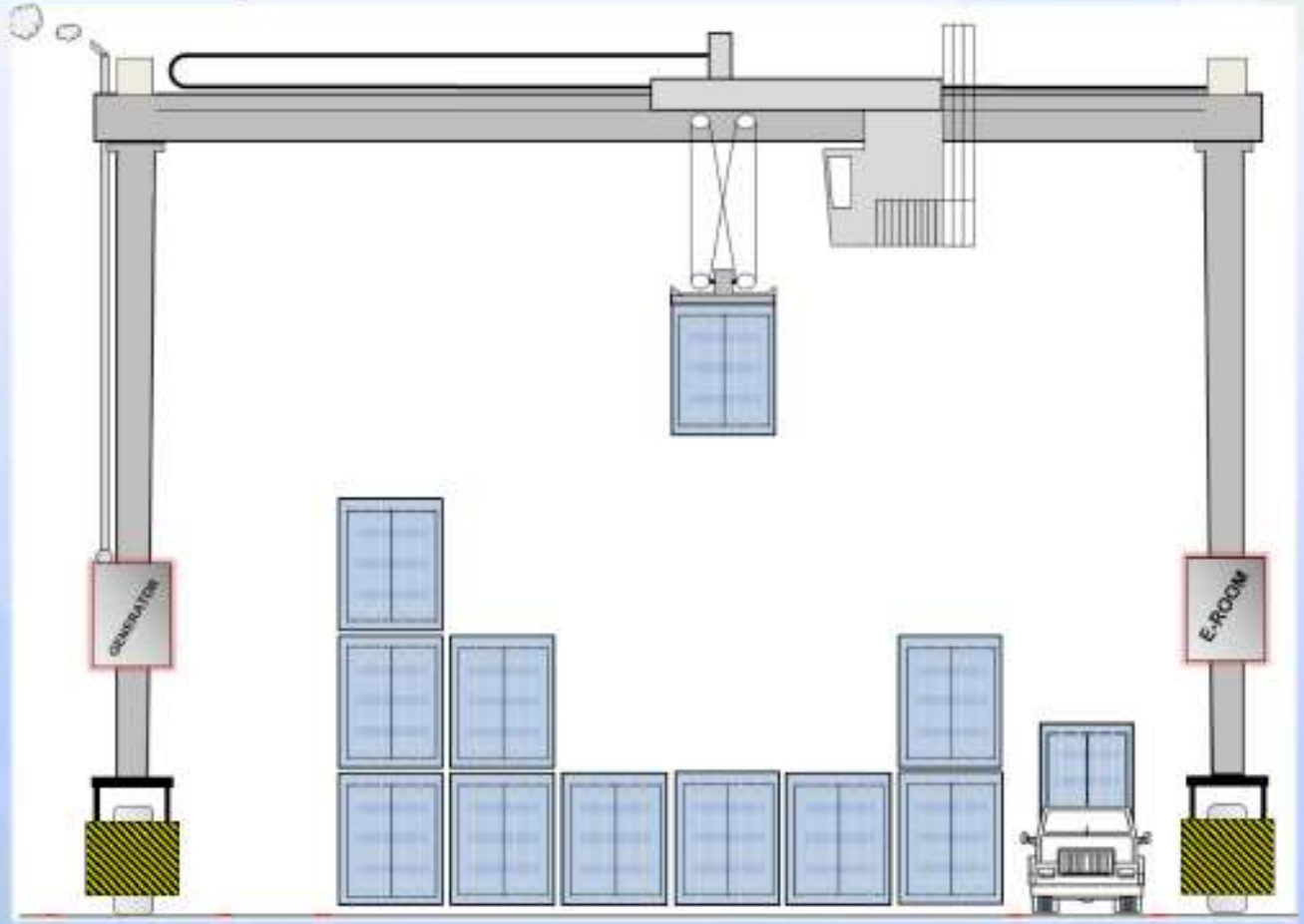
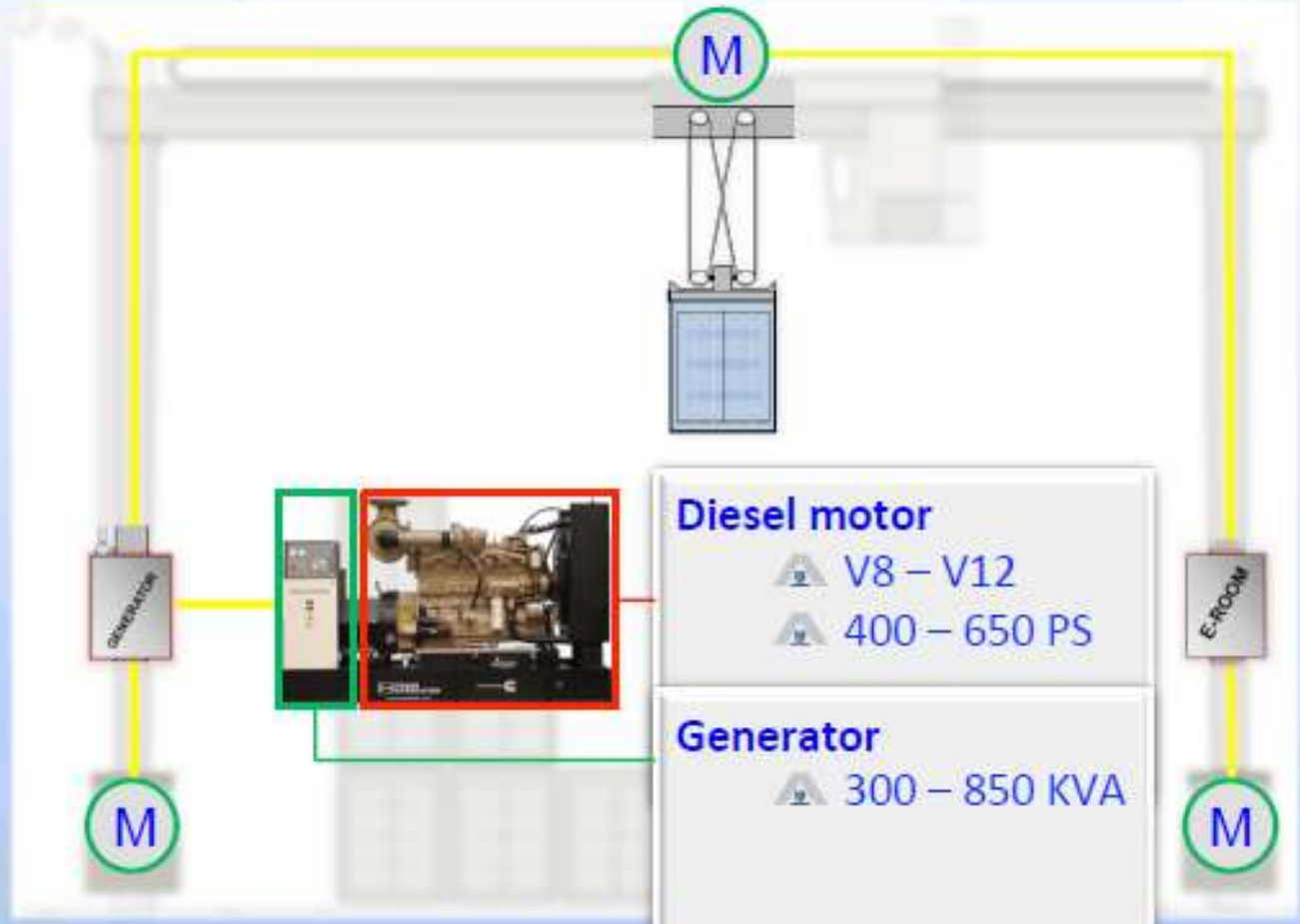
Fully Electric RTGs: eRTG

Principle Function:



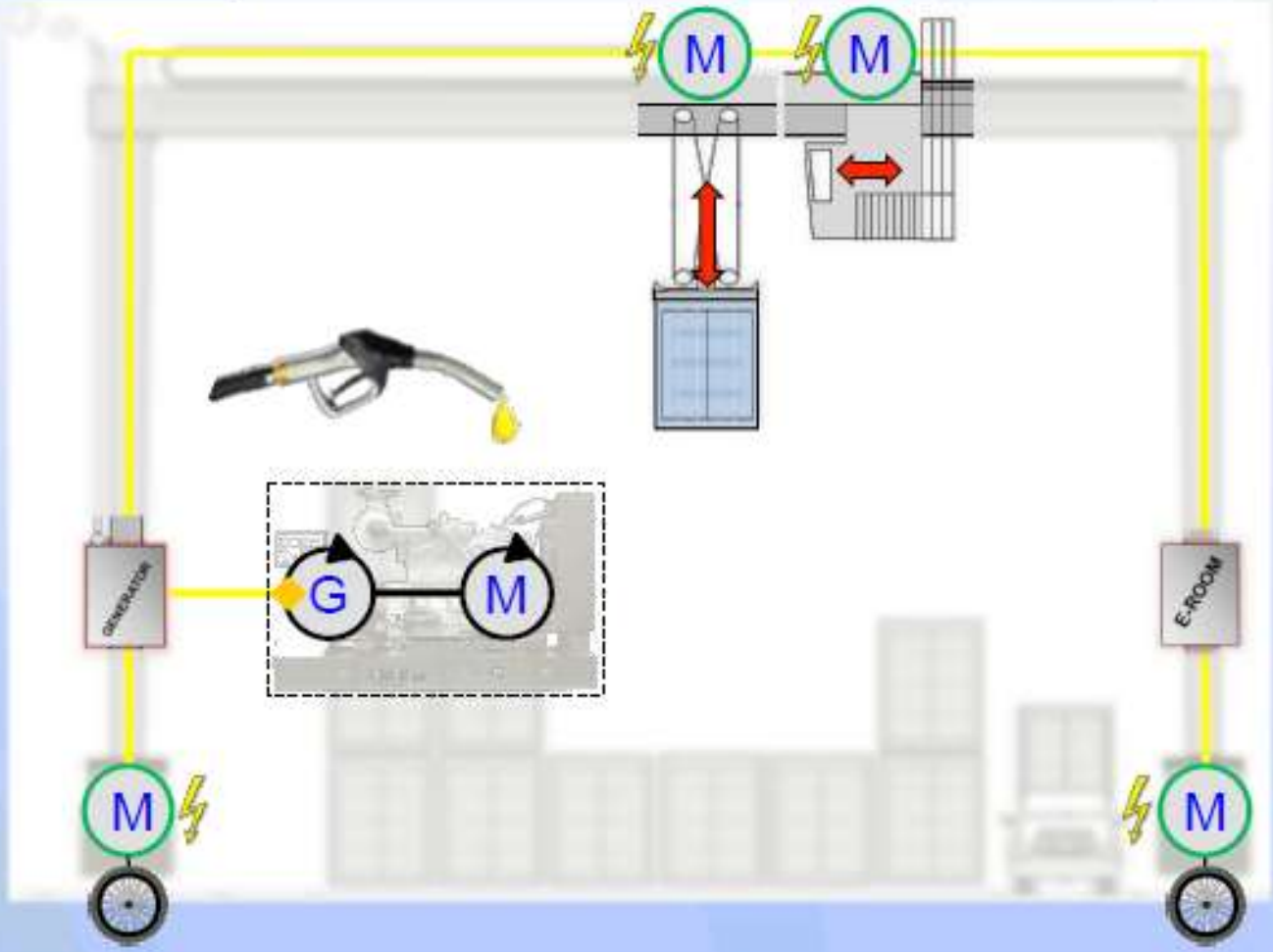
Fully Electric RTGs: eRTG

Principle Function:



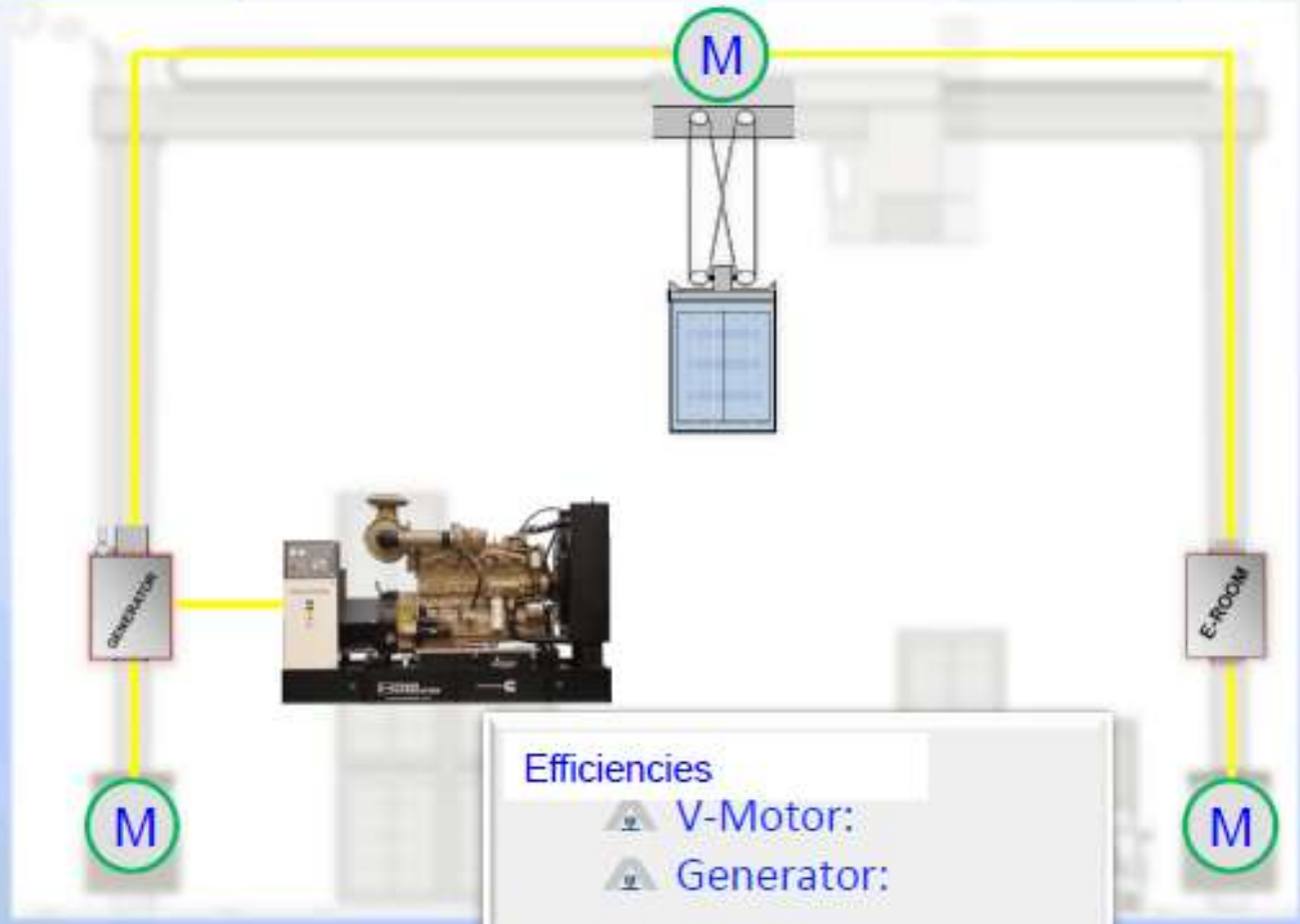
Fully Electric RTGs: eRTG

Principle Function:



Fully Electric RTGs: eRTG

Principle Function:



Efficiencies

- V-Motor:
- Generator:

Case for e-RTG: E3Economy, Efficiency & Environment

RTG Type	Conventional RTG	EcoRTG	EcoRTG w/ supercapacitors	eRTGs
Fuel / Energy consumption (15 moves / hour)	20,9 lit/hour	13,1 lit/hour	6,8 lit/hour	35kWh
Energy costs: Diesel € 2.31 / kWh: € 0.06	€ 12,79	€ 7,99	€ 4,17	€ 2,33
Operating hours 3600, cost / year	€ 46 033,92	€ 28 771,20	€ 14 998,32	€ 8 391,60

Additional savings for reducing maintenance costs associated with diesel generators:

- Maintenance costs per operating hours (€1,90 / hour) : € 6 840 per yr.
- Tier 4 Diesel replacement @ 25000 hours (€ 4,45 / hour) : € 110 250

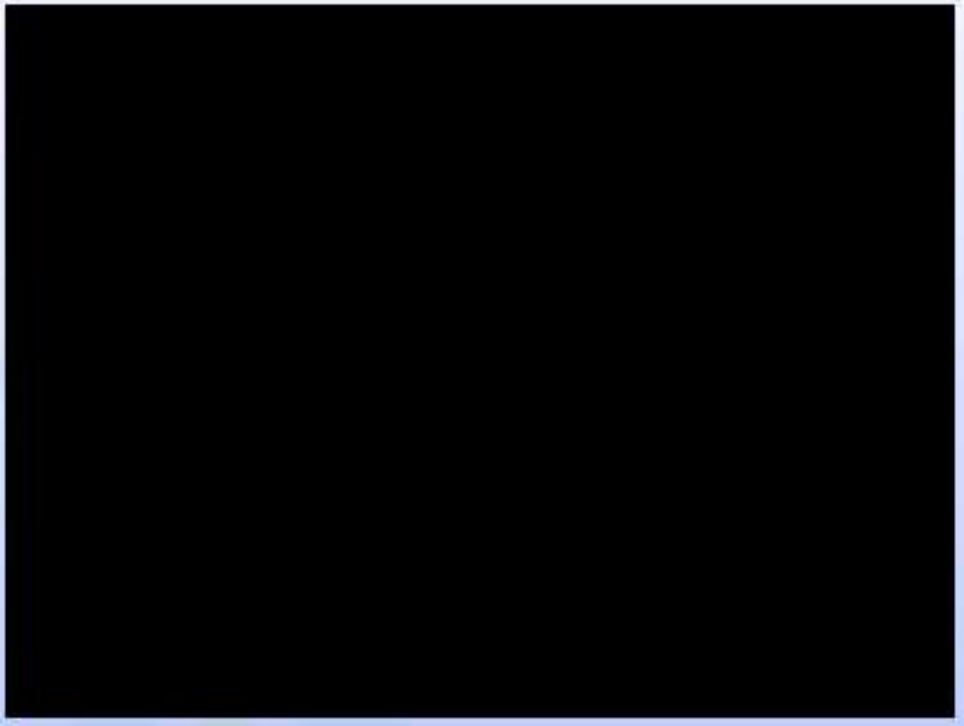
*Reference: Innovation for future generations conference, "GPA's eRTG demonstration project", Aug. 5-7, 2012.

Solutions: Electrification to reduce fuel and maintenance for achieving savings of up to 85%

Financial Benefits:

Cash flow and ROI statement				
BENEFIT DRIVERS	YEAR			
	0	1	2	3
Improved operational time (less down time)		25 000	25 000	25 000
Reduced energy cost due to less running time		50 859	50 859	50 859
Reduced Maintance cost			9 180	9 180
Fewer accidents, resulting in less workers' compensation		10 000	10 000	10 000
Diesel replacement avoided 150,000 / 7 years		21 429	21 429	21 429
other…				
Total annual benefits		$107 288	$116 468	$116 468
Implementation filter		90%	95%	100%
Total benefits realized		$96 559	$110 645	$116 468
Costs	**Year 0**	**Year 1**	**Year 2**	**Year 3**
Total	$250 000	$0	$0	$0
Benefits	**Year 0**	**Year 1**	**Year 2**	**Year 3**
Annual benefit flow	-$250 000	$96 559	$110 645	$116 468
Cumulative benefit flow	-$250 000	-$153 441	-$42 796	$73 672
Discounted benefit flow	**Year 0**	**Year 1**	**Year 2**	**Year 3**
Discounted costs	$250 000	$0	$0	$0
Discounted benefits	$0	$96 559	$110 645	$116 468
Total discounted benefit flow	-$250 000	$96 559	$110 645	$116 468
Total cumulative discounted benefit flow	-$250 000	-$153 441	-$42 796	$73 672
Initial investment	**Year 0**	**Year 1**	**Year 2**	**Year 3**
Initial investment	**$250 000**	**$0**	**$0**	**$0**
Implementation costs		**$0**	**$0**	**$0**
Ongoing support costs	**$0**	**$0**	**$0**	**$0**
Training costs	**$0**	**$0**	**$0**	**$0**
Other costs	**$0**	**$0**	**$0**	**$0**
Total costs	$250 000	$0	$0	$0
ROI measures				
Cost of capital	6%			
Net present value	$37 355			
Return on investment		39%	83%	129%
Payback (in years)	2,37			

Other equipment to be « LNG-nized »



AGV –Automated Guided Vehicles

Straddle Carriers

Full LNG powered Reach Stackers

Kalmar is to engineer and produce a diesel-LNG powered reachstacker prototype as part of the GREENCRANES project.

"The LNG power is a very interesting future fuel alternative both for port equipment business as well as for the whole shipping industry. Natural gas extractions are increasing and this can clearly be seen as one of the future trends."

GoLNG

Interreg Baltic Sea Region

EUROPEAN UNION

EUROPEAN REGIONAL DEVELOPMENT FUND

What have we learned on *Opportunities & Synergies for LNG in the port and container handling industry?*

- Port **Container Terminals are huge energy consumers,** especially on those energy sources based on fossil fuels.

- From the **economic point of view**, increase of **energy prices** means more cost which **reduces Port competitiveness.**

- In terms of **environmental impact**, with the current motivation in having LNG bunkering and ships being built with LNG engines, the additional effort to **"bunker port equipment is a low barrier to entry (Cherry Picking).**

- Concerning **social impact**, ports are usually located near populated cities **affect nearby population as direct GHG emissions (derived from diesel oil) are locally deployed, not only CO_2, but also other pollutant and toxic gases like N_2O, Sulphur compounds and suspension particles.**

- Efforts to reduce fuel consumption and GHG emissions produced **by RTGs, yard tractors and reach stackers are strongly recommended. More studies on equipment needed!!**

More information found at:

WWW.GOLNG.EU

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Interreg
Baltic Sea Region

EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND

THANK YOU

Total to Supply LNG for CMA CGM's New 22,000 TEU Ships

News:
05 Dec 2017
09.32am

Questions …

Is your Port Ready?

Will you be able to Compete or risk be left behind….?

Total and CMA CGM have signed an agreement covering the supply of around 300,000 tons of liquefied natural gas (LNG) a year for 10 years starting in 2020.

Thank You for your attention!

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