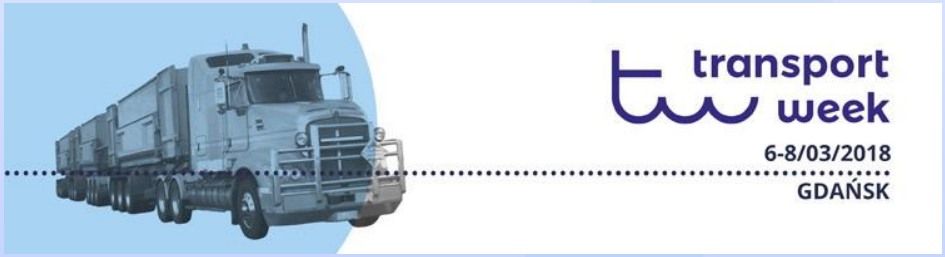
Opportunities & Synergies for LNG in the port and cargo handling industry - Sweden

Go LNG, 25-26 April 2018, Malmö



Asst. Prof. Lawrence Henesey

Blekinge Institute of Technology,

Karlshamn, Sweden

Learning Objectives for today:

- 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!!

Aim of the project

GoLNG project will focus on developing LNG competence and value chain (in Baltic Sea Region) by:

- ✓ Providing strategic approach towards the LNG infrastructure deployment in BSR shaping BSR Blue Corridor strategy
- ✓ Consolidating integrated LNG value chain adding users to existing LNG infrastructure.
- ✓ Providing technology, skills and knowledge for LNG value chain, establishing BSR LNG competence center.
- ✓ Providing business opportunities for regions LNG industry, establishing BSR LNG business cluster.
- ✓ Establishing a sustainability factor for LNG infrastructure, providing LBG value chain, technological concepts and business models

WWW.GOLNG.EU

Blue Corridor Strategy

The aim of the Strategy is to establish strategic approach of LNG infrastructure development and mobilize the critical mass of technology, business partnerships, and regulative authorities to implement LNG powered transport networks in BSR.

We will provide a model on how LNG infrastructure should be deployed in order to establish LNG powered transport corridors for Maritime; Road; Rail; Port equipment.

Cargo Handling : Container Terminal case

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Port 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
6. Shore Power Supply (LNG Bunkering..)

Market and Customer Trends

Market size for Port Equipment & Container Handling 9 Billion €


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SIEMENS
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Crane & Engineering Services
cascade
MICHELIN
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Schneider Electric
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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

Factors for developing Ecological Equipment

Environmental	Economical	Technological
reducing pollution (air and noise)	*reducing operating costs (oil prices) and maintenance costs*	*optimizing productivity & performances*

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

then

vision** is the **father of innovation!

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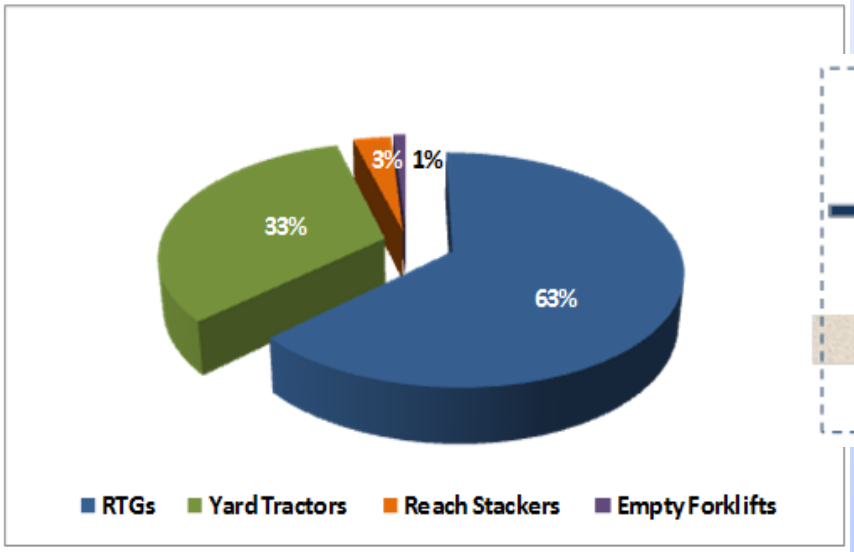
Lets Go GREEN!

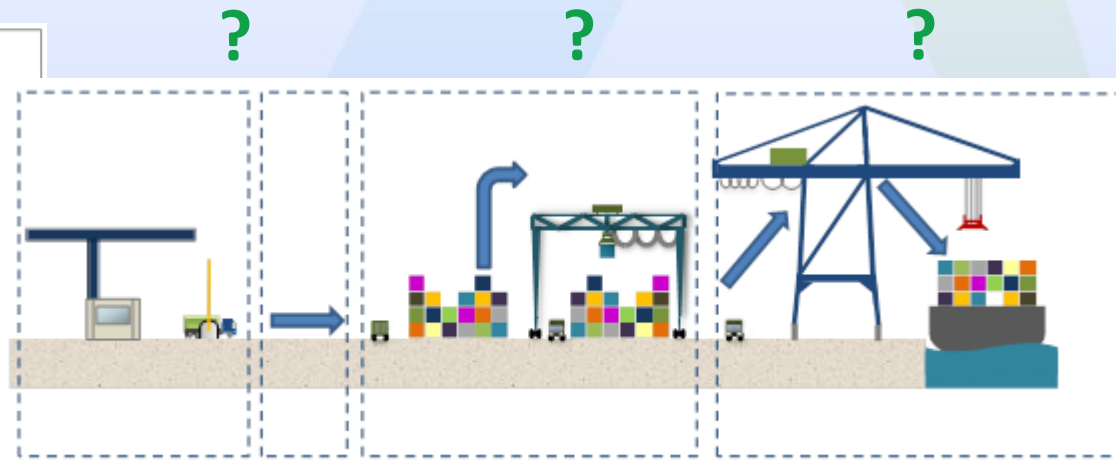
= *Ecological Equipment*

Where can we apply Ecological Equipment?

How much energy is consumed?



Where is the energy consumed?



Reference: GreenCranes Project

Which Machinery or Equipment to Consider?

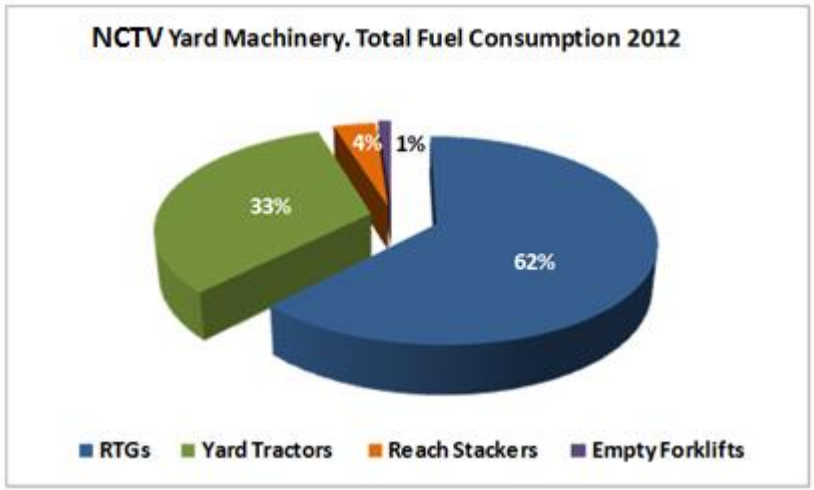
Rubber Tyred Gantry Crane (RTG)

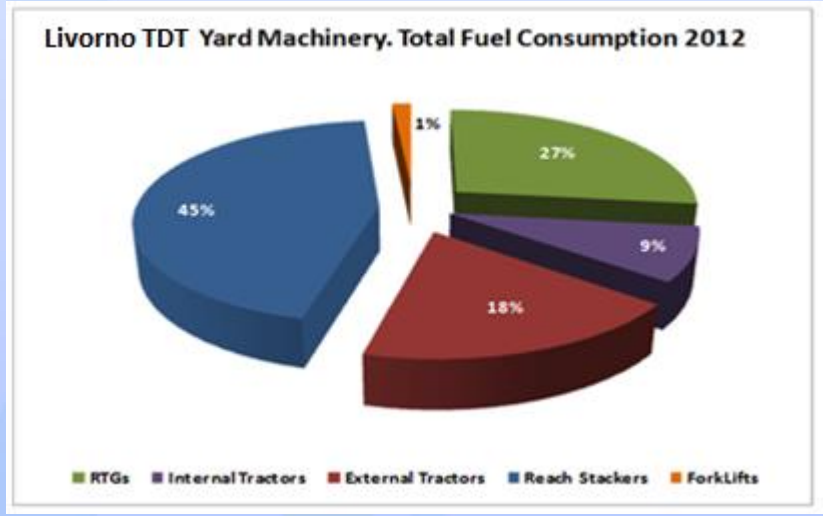
Terminal Tractor

Reach Stacker

Empty Forklift

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.

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Feasibility Evaluation: Terminal Tractors

Green Cranes

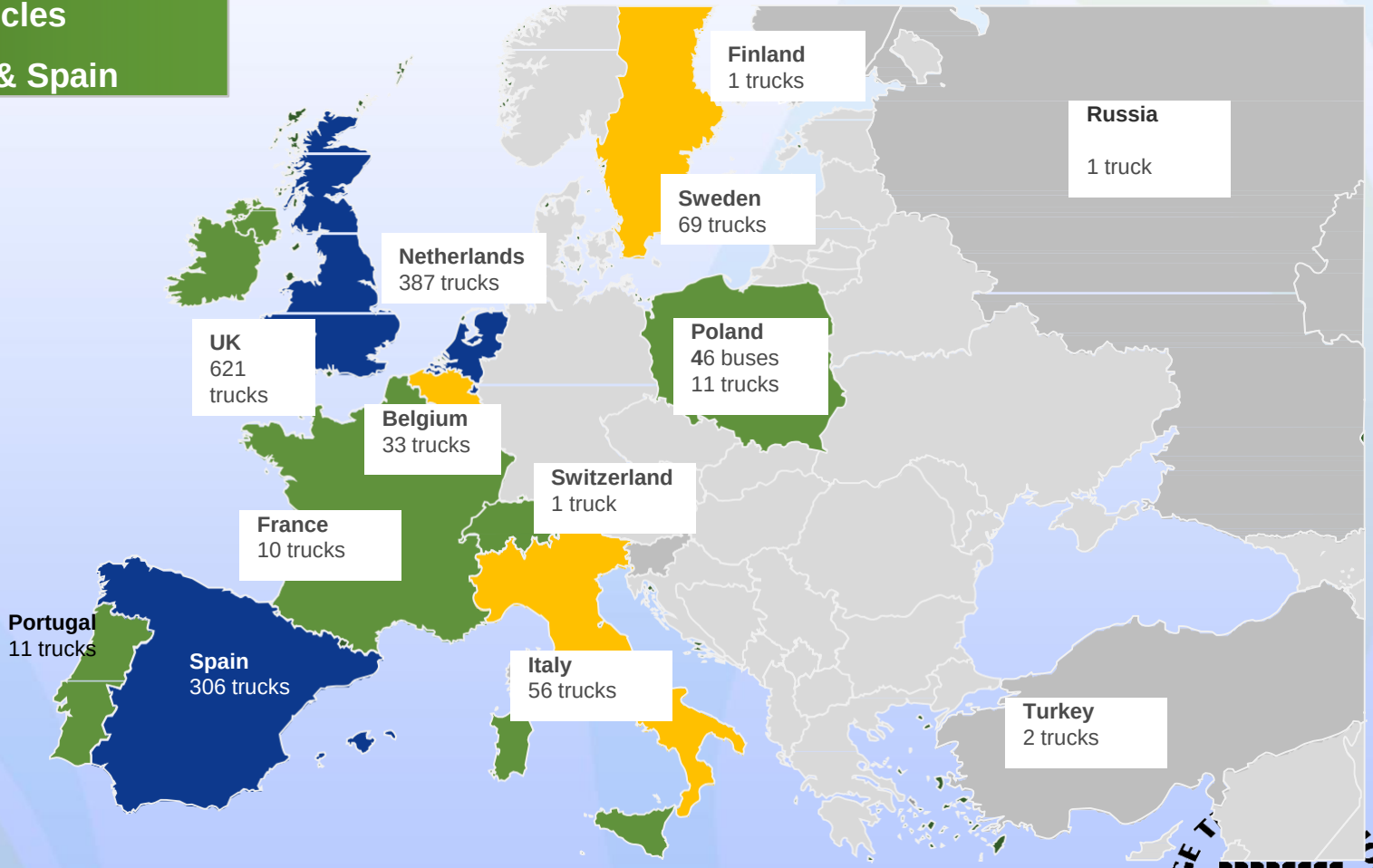
Terminal Tractors	RTGs	STS + Other
2,4 Million L 1,8 Million € GoB	4,6 Million L 3,4 Million € GoB	17,8 GWh 2,2 Million € kWh
Alternatives TT	**Alternatives RTG**	**Supply Alternatives**

• 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)

Current European LNG market

1.500 LNG Vehicles

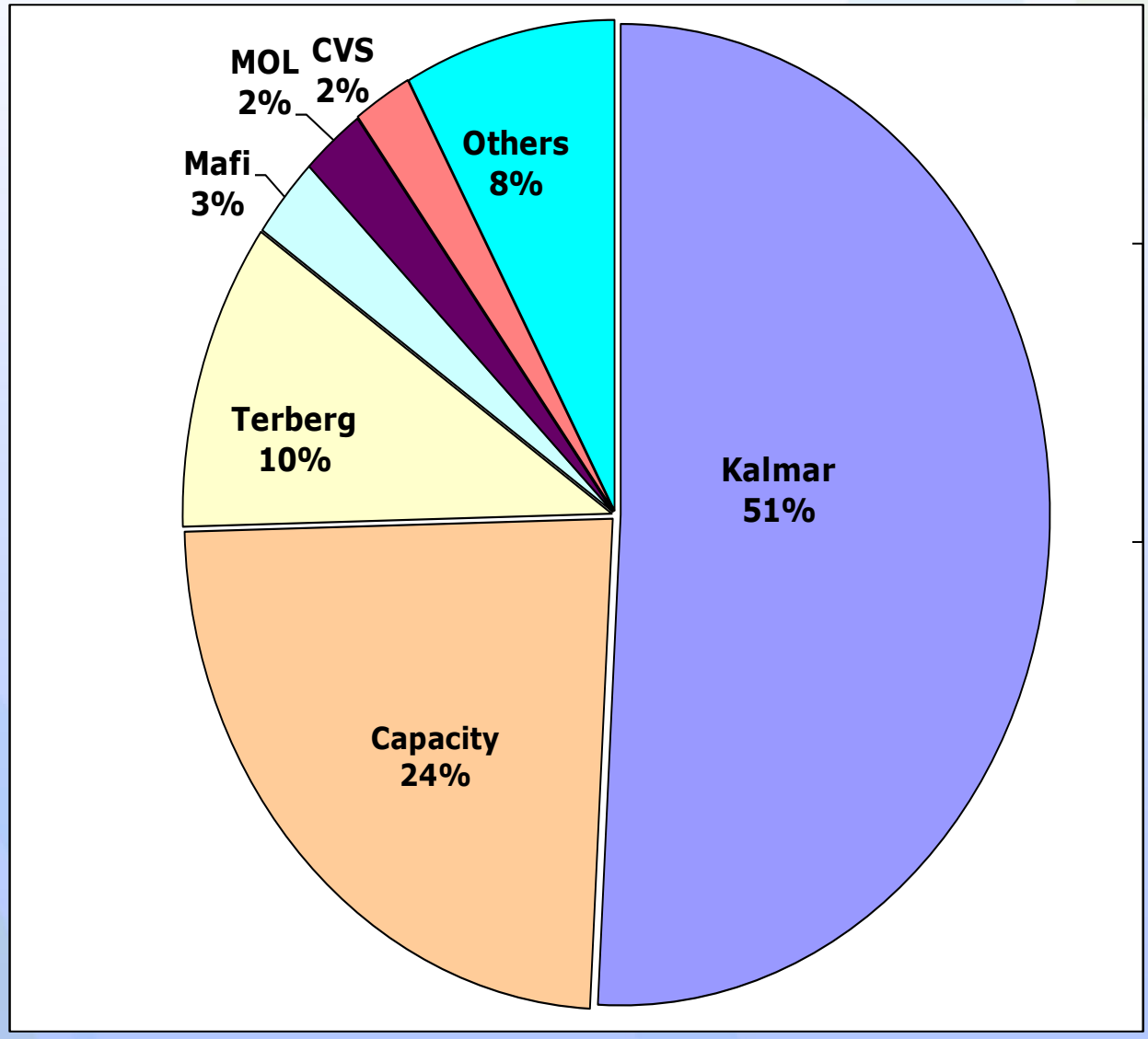
Mainly UK, NL & Spain



- > 200
- > 25
- < 10
- None

Source: NGVA Europe, 01.12.2014

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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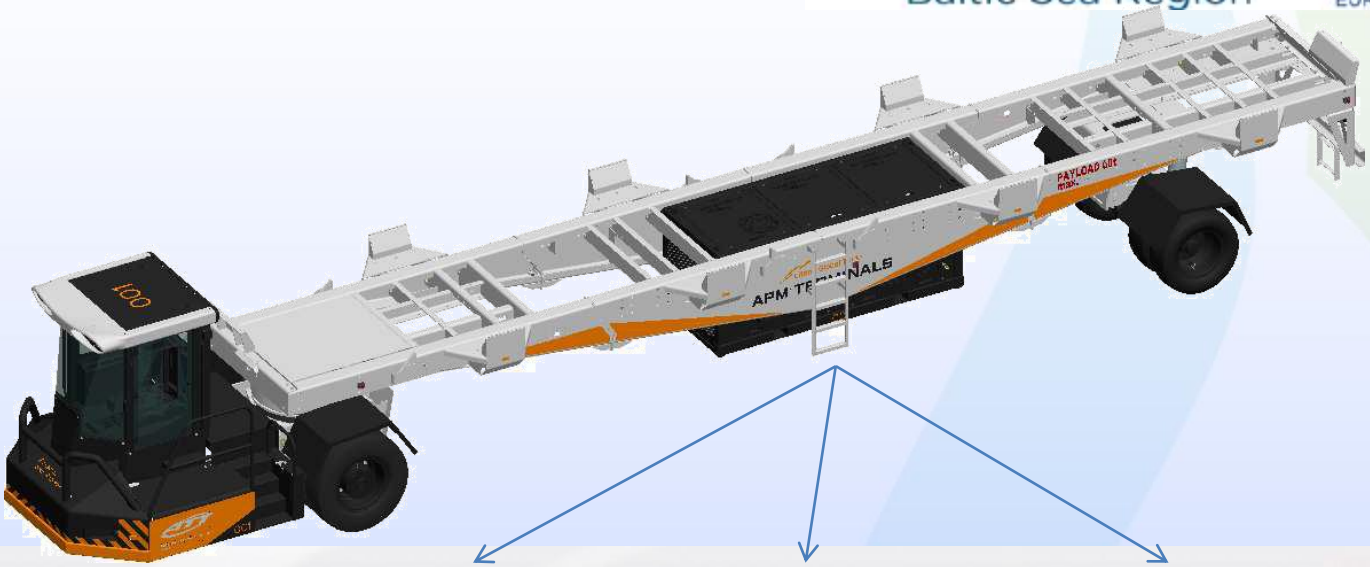

Diesel

Hybrid
Diesel/Electric

Full electric
Battery

Future energy
Full cell-hydrogen
Under development

LNG
Under development

GAUSSIN
MANUGISTIQUE

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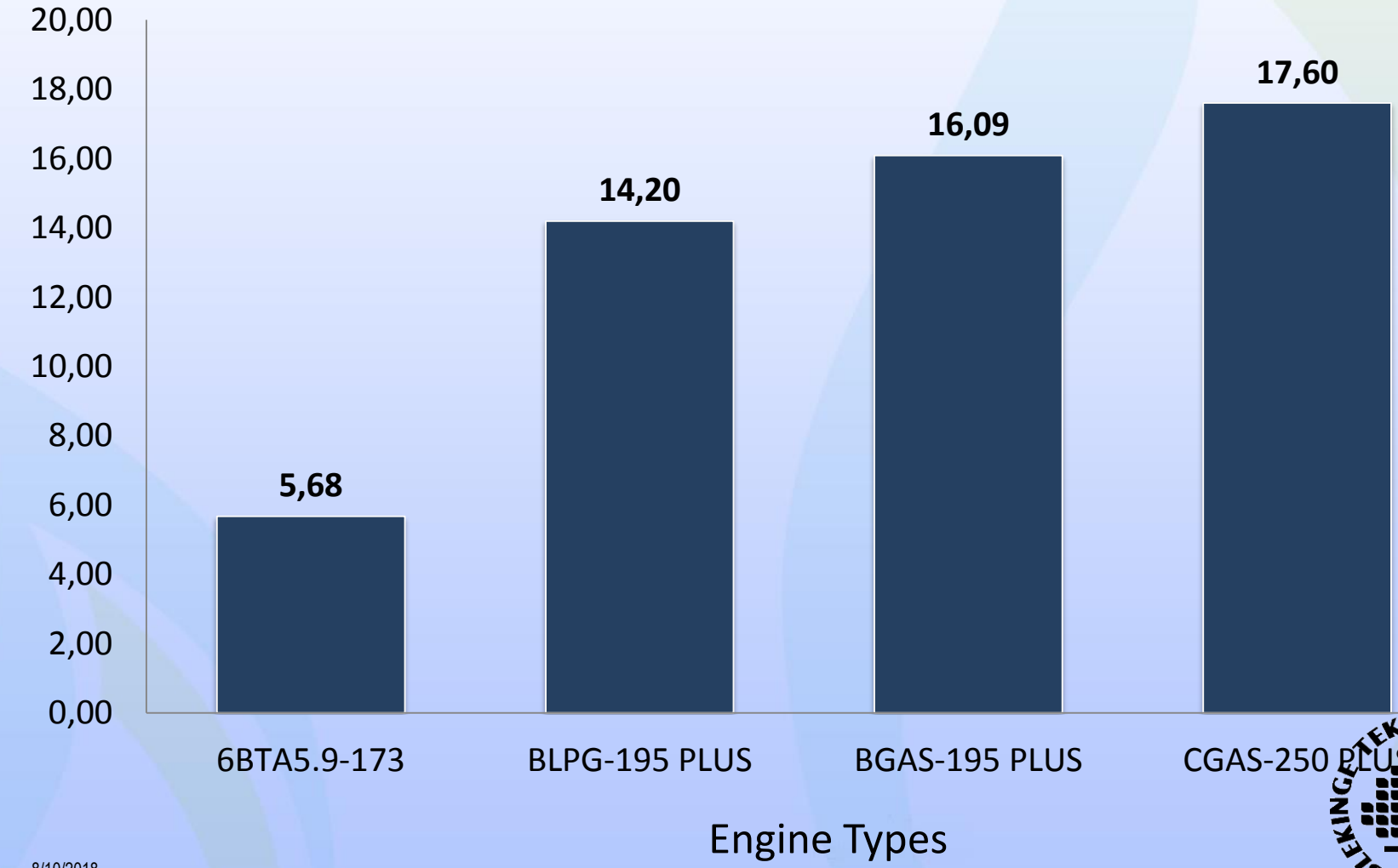
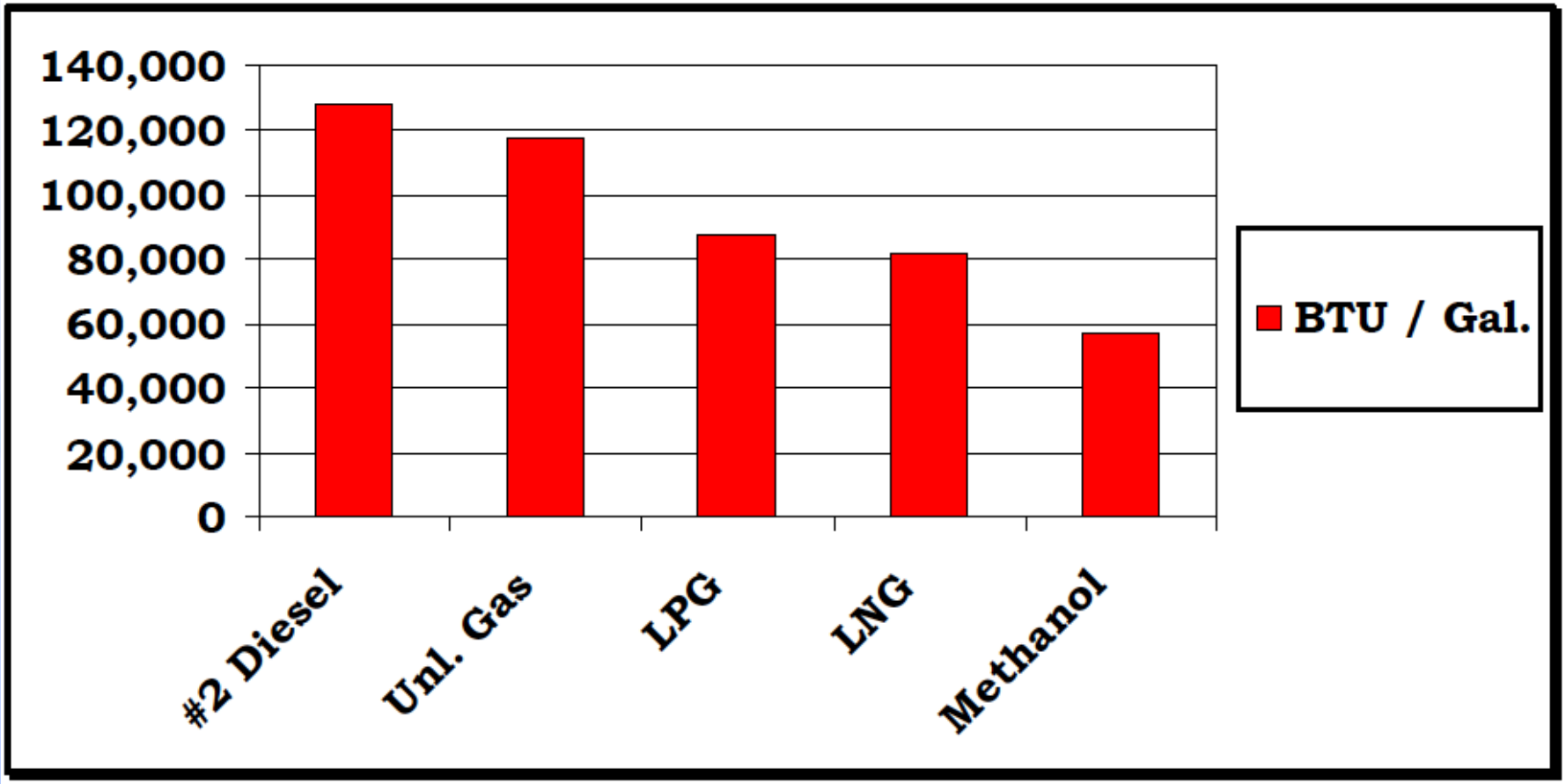
Fuel Consumption per Liter in comparing Engine Alternatives



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?

ICC = (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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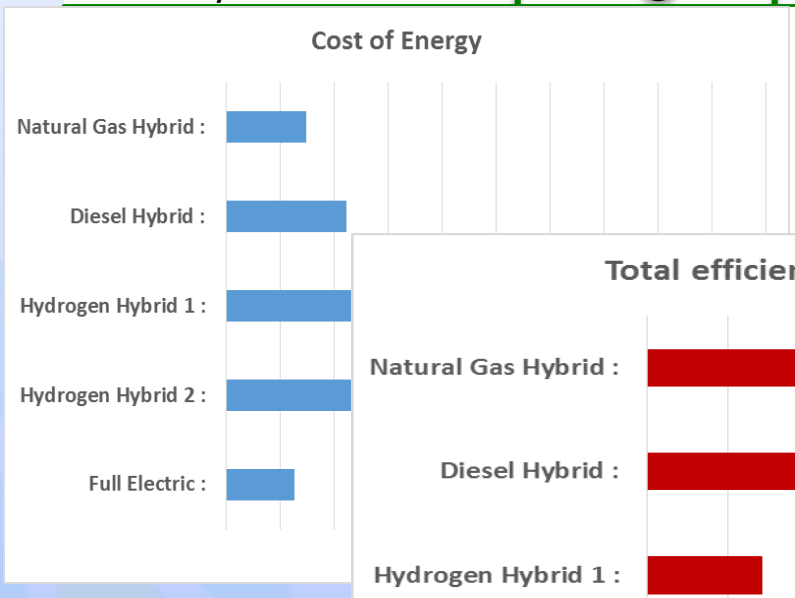
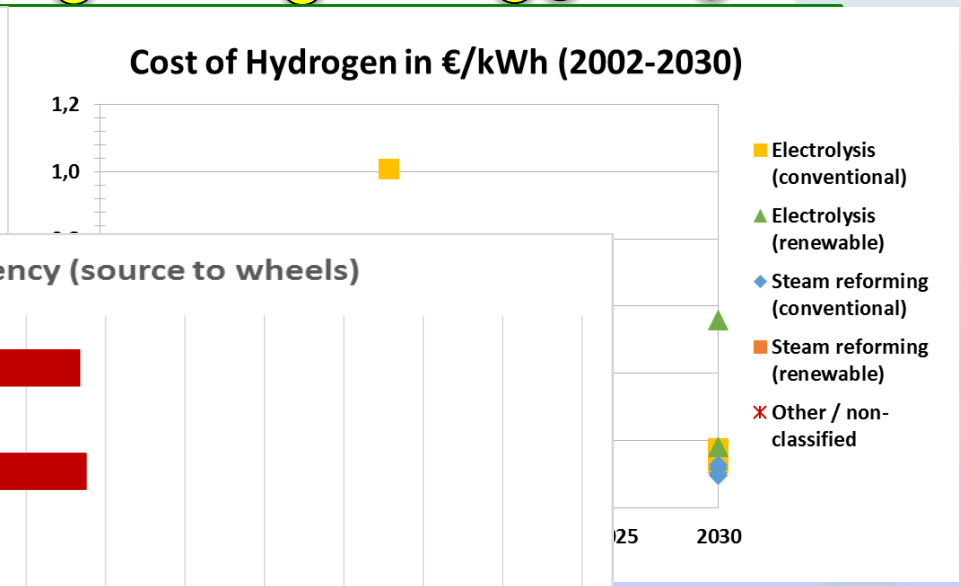
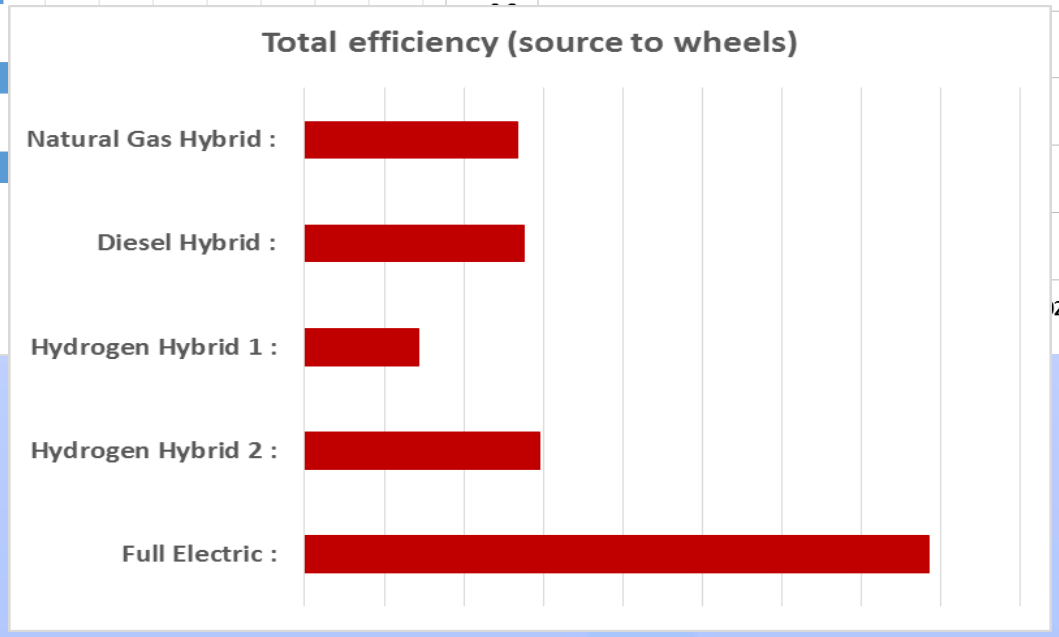
Factor	Diesel	LNG – No Incentives	LNG – LNG Incentives	LNG – SCAQMD (Max. 25 Vehicles)
Initial Cost of Vehicle	$80,000	$120,000	$120,000	$120,000
Purchase Incentives	$0	$0	$32,000	$40,000
Fuel Cost/Gallon After Tax Credits	$2.60	$0.50	$0.50	$0.50
Gallons/Operating Hour	1.7	3.8	3.8	3.8
Annual Operating 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
ICC	$153,837	$153,387	$121,387	**$113,387**

Comparison Hybrid, Electric, LNG

	LNG-Elec	CNG-Elec	Diesel-Elec	Full-Elec	H2
Power Pack™ Cost(Capex)	☺	☺	☺☺	☺	-
Cost of Energy	☺	☺	-	☺	-
Efficiency	☺	☺	☺	☺☺	☺







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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%)

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Feasibility Evaluation: RTG

Green Cranes

Terminal Tractors	RTGs	STS + Other
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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

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Full LNG powered Reach Stackers

Kalmar is engineering 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."

What have we learned in 20+ minutes. ?...

• 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.**

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.

More information found at: www.GoLNG.eu

LNG STAKEHOLDERS WILL MEET ONBOARD FJORD LINE'S LNG POWERED FERRY

The upcoming international conference "LNG – best fuel of the future!" will take place onboard Fjord Line's LNG powered ferry M/S Stavangerfjord. Bringing together buyers and sellers from all Baltic Sea Region, the event will give an ideal platform to get the latest news on LNG technologies, legislation and funding possibilities, explore new markets and become a part of the current and future LNG supply chain.

On 10-12 April 2018, the ferry will host participants, representing business organisations from Denmark, Lithuania, Sweden, Norway, Germany and Poland. Professionals will meet to exchange ideas and opinions about LNG development, to review LNG regulatory landscape, deepen technical and scientific knowledge.

International conference is to be held within the framework of the Go LNG project that has brought together 18 partners from 7 countries.

The speakers list includes the delegates of the international companies *Bureau Veritas Marine & Offshore, Kosan Crisplant, Nauticor GmbH&Co KG, DNV GL, Fjord Line A/S, SkanGas* etc. Academic institutions, such as World Maritime University, established by the International Maritime Organisation (IMO), and Maritime University of Szczecin will also send their delegates to share their presentations.

Formal sessions and discussions will be coupled with matchmaking meetings, possibility to experience the bunkering of M/S Stavangerfjord and guided tour "LNG from the Engine room to the Bridge" – the programme will ensure that attendees were given meaningful time and outstanding networking opportunities.

Organisers of the upcoming conference highlight that new investments are required worldwide to meet the growing LNG demand: "It is time for the Baltic Sea Region LNG Cluster companies and businesses to demonstrate their vast knowledge, cutting edge technologies and newest innovations to the world".

The global demand for LNG is expected to increase 4-5% pr. year between 2015 and 2030. Most of the future LNG growth is anticipated to be created by further floating storage regasification units (FSRUs), the declining domestic gas production, small scale LNG and the transport sector.

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Thank You for your attention!

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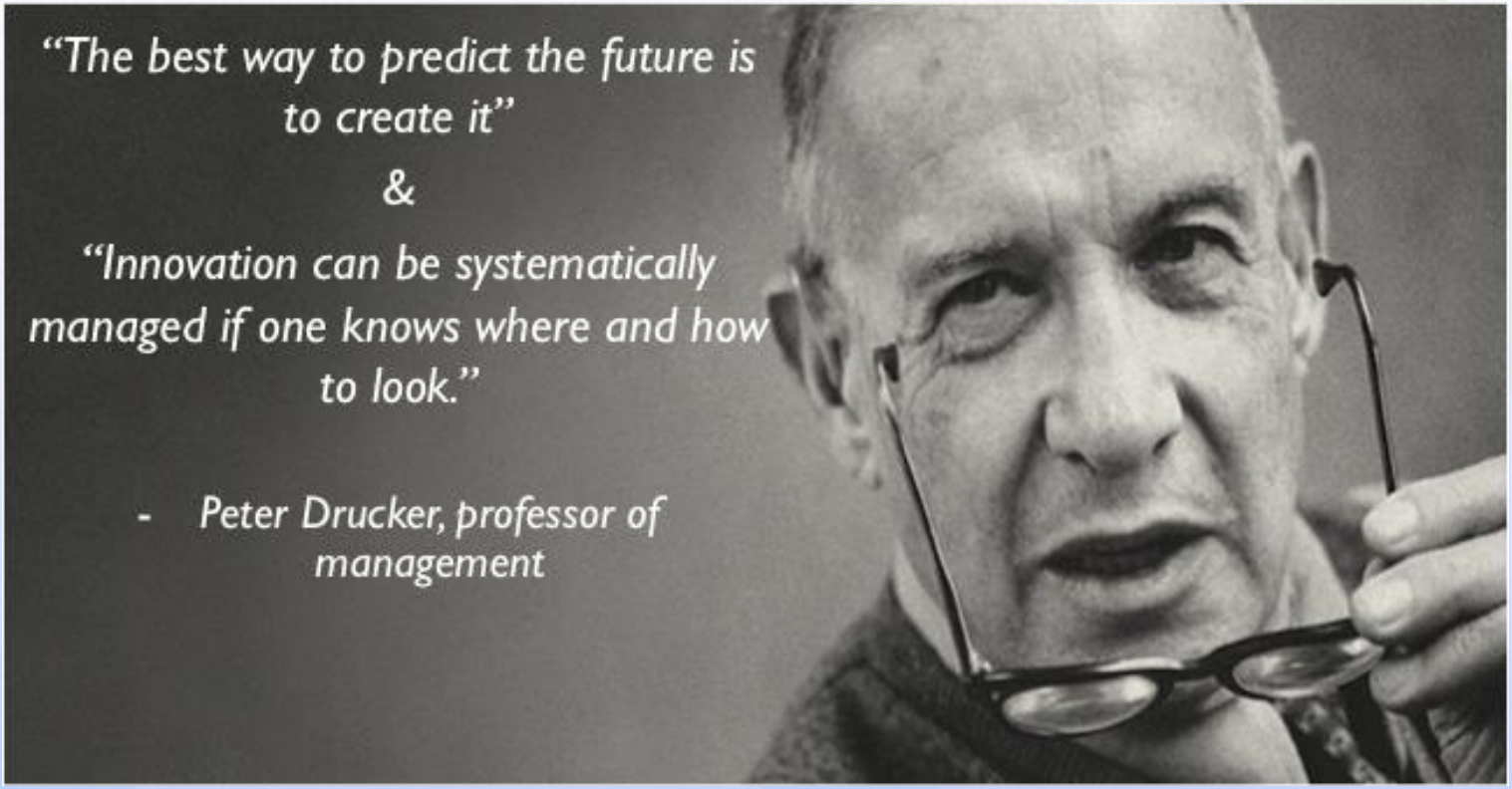
"The best way to predict the future is to create it"
&
"Innovation can be systematically managed if one knows where and how to look."
- Peter Drucker, professor of management

QUESTIONS?....