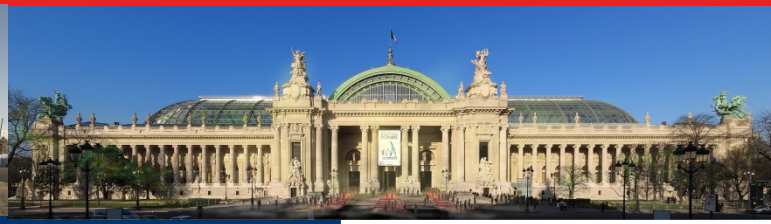
26th World Gas Conference

1 – 5 June 2015, Paris, France



GLOBAL POTENTIAL OF SMALL SCALE LNG DISTRIBUTION

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IGU
WGCPARIS2015
WORLD GAS CONFERENCE

Global potential of small scale LNG in 2025

Study for GOT, Gas and Oil Technology Implementation Agreement IEA

Objective: determine the potential global market volumes for small-scale LNG in the period 2015-2025.

Problem: fuel prices are quite dependent on other factors besides the potential volumes and availability.

Approach: technical and economical independent variables, replacement and fleet expansion rates (Quick scan, No price forecasting)

Scope: SSLNG retail volumes for heavy-duty vehicles, the maritime sector and a fuel- oil electric power generation segment.

Traditional fuel oil, gasoil and diesel consumption

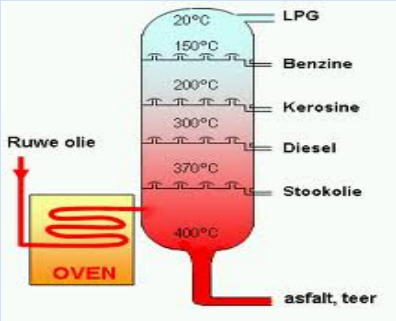
MTOE/year	Trucks		Maritime			Oil fuelled electric power	
			Total	Global	ECA		
	2010	2025	2010	2025	2025	2013	2025
Asia-Pacific	254	388	**112**	**140**	9	69	106
North America	**187**	**217**	37	23	7	22	26
Europe	157	179	**67**	**48**	**19**	16	18
Latin America	90	134	22	29	1	29	44
Middle East	105	142	22	28	2	**69**	**94**
Rest of the world	97	164	15	20	2	24	41
Total energy consumption	889	1225	276	289	40	229	327
The share of total consumption in 2025		62%		15%	2%		17%

MTOE = Million Tons of Oil Equivalent
Excluded: 4% rail since this is both diesel and electric traction
Source: TNO estimation based on ExxonMobil 2014

Maritime Fuel: How to meet Sulphur limits?

IMO regulations: Sulphur content shipping fuel limit
from 3,5% to 0,5% globally in 2020, *or 2025*

MGO, MDO, AGO



Available?
"Distillate capacity and pricing"

SCRUBBERS

Operable?
"Waste (absorbent) handling and regulation?"

LNG

Deliverable?
"Safe distribution at small scale?"

Maritime transport: potential LNG off-take by 2025

Cat. Transport	Ship size			% Energy consumption of total shipping	Potential for replacement by LNG		
	Category	% of Global fleet	Number of ships (2010)		% of new build	MTOE	MTPA
Inland ships				2.5%	25	1.2	1
ECA				12%	50	12	10
Deep sea	1	5%	2500	**39%**	**25**	**20**	**17**
	2	5%	2500	15.5%	50	16	13
	3	10%	5000	21%	10	4	3.7
	4	80%	40000	10%	10	2	1.8

Assumptions:

- Average replacement rate of ships is 3% per year, expansion of the fleet is 3.75% per year
- Building of new ships on LNG is assumed in to start in 2015 and remain constant until 2025
- Different shares (50%, 25% and 10%) of new build ships to be LNG fuelled, for each size segment

Conclusion:

- Cat. 1 ships (#2500) cover 39% off maritime fuel consumption

Road transport: Effect on Heavy Duty vehicles?

Oil based fuels: Global demand growth and environmental challenges

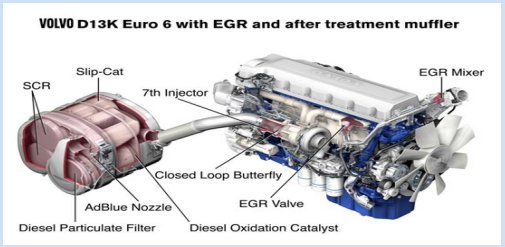
CLEAN ALTERNATIVES

Available & Feasible?

"Capacity & Technology fit"

DIESEL EURO 6

Mature Technology



Affordable?

"Extensive auxiliaries needed"

LNG FOR TRUCKING

Extended range vs CNG

Deliverable?

"Safe and cost effective distribution at small scale?"

Road transport: potential LNG off-take by 2025

Europe	Km/year	Energy share fleet	2025 MTOE	Potential for LNG	Potential MTOE	Potential MTPA
Total		**100%**	**179**	**26%**	**46**	**34**
Long haul	**135000**	**38%**	**68**	**50%**	**34.0**	**29.0**
Coaches	120000	5%	9	25%	2.3	1.9
Buses	60000	7%	12	25%	3.0	2.6
Regional delivery	60000	14%	25	25%	6.3	5.3
Construction	50000	13%	23	0%	0	0
Urban & service delivery	40000	17%	31	0%	0	0
Utility	25000	6%	10	0%	0	0

Assumptions:

- Average replacement rate of HD vehicles is 12% per year, expansion of the fleet is 5% per year.
- Different shares of new trucks to be LNG fuelled, for each region depending on its interest in LNG
- Started 2020 since it is not a legal requirement, availability

Conclusion:

- Long haul trucks cover 38% of total HDV road transport consumption

Small scale distribution: Effect on Fuel oil for power demand?

SMALL SCALE LNG DISTRIBUTION OPTIONS FOR MULTI-SEGMENT SUPPLY

Small LNGC

Enabling:
"Enable LNG distribution and bunkering"

Small terminal

Securing:
"Combine bunkering with local gas demand "

Break Bulk or FSRU

Flexible sourcing:
"int. sourcing for local gas demand, small distribution and bunkering"

Power production: potential LNG off-take by 2025

Oil fuelled Power in 2025	Electricity	Energy input	Potential share for LNG	
	TWh	MTOE	MTOE	MTPA
Europe	74	16	1.6	1.4
OECD Americas	102	22	2.2	1.9
Non OECD Asia	150	32	3.2	2.8
OECD Asia Oceania	173	37	3.7	3.2
Middle East	**320**	**69**	**17.2**	**14.7**
Africa	71	15	1.5	1.3
Latin America	137	29	2.9	2.5
Eastern Europe/ Eurasia	39	8	0.8	0.7
Total / world	1062	229	**33**	**28**

Assumptions:

- Only fuel-oil consumption for power production;
- Coal fired power not included (exceed small scale volume);
- Middle east 25% of fuel-oil power replaced by LNG, 10% for rest of world.

Conclusion:

- Middle East relevant for multi-segment supply due to high demand growth for power, water and oil-field operations (EOR);
- Residual fuels might become attractive for power production after 2020.

Total results: Potential for small scale LNG 2025

SSLNG Potential for 2025	Total consump-tion.	Potential for LNG		
	MTOE	MTOE	MTPA*	% per segment
HD vehicles	1225	192	164	16%
Maritime	337	55	47	16%
Electric power generation**	229	33	28	15%
Total	1791	280	239	16%

Assumptions:

- Quick scan: Market shares, replacement and fleet expansion rates.
- No price forecasting, excise taxation or other policy influences taken into account;

Conclusion:

- Real % are not likely to be higher, depending on government policies:

* = MTOE = Million Tons of Oil Equivalent. 1 MTOE/annum = 0.854 MTPA-LNG based on ratios of Lower Combustion Values
** = replacement of fuel Oil

Conclusion: Potential for small scale LNG 2025

Small scale LNG distribution:

- Strength: Provides flexibility (negotiable position)
- Weakness: no long term sourcing commitments
- Opportunity: multi-segment supply
- Threat: High spot prices

LNG for transport:

- Strength: Emissions (alternative?)
- Weakness: HDV technology development (Trucks)
- Opportunity: Availability of gas
- Threat: Costs of cryogenic infrastructure

Thank you for you attention!
Any questions?

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Port of Rotterdam

What is Small Scale LNG?

TRADITIONAL LNG:

SMALL SCALE LNG (SSLNG):

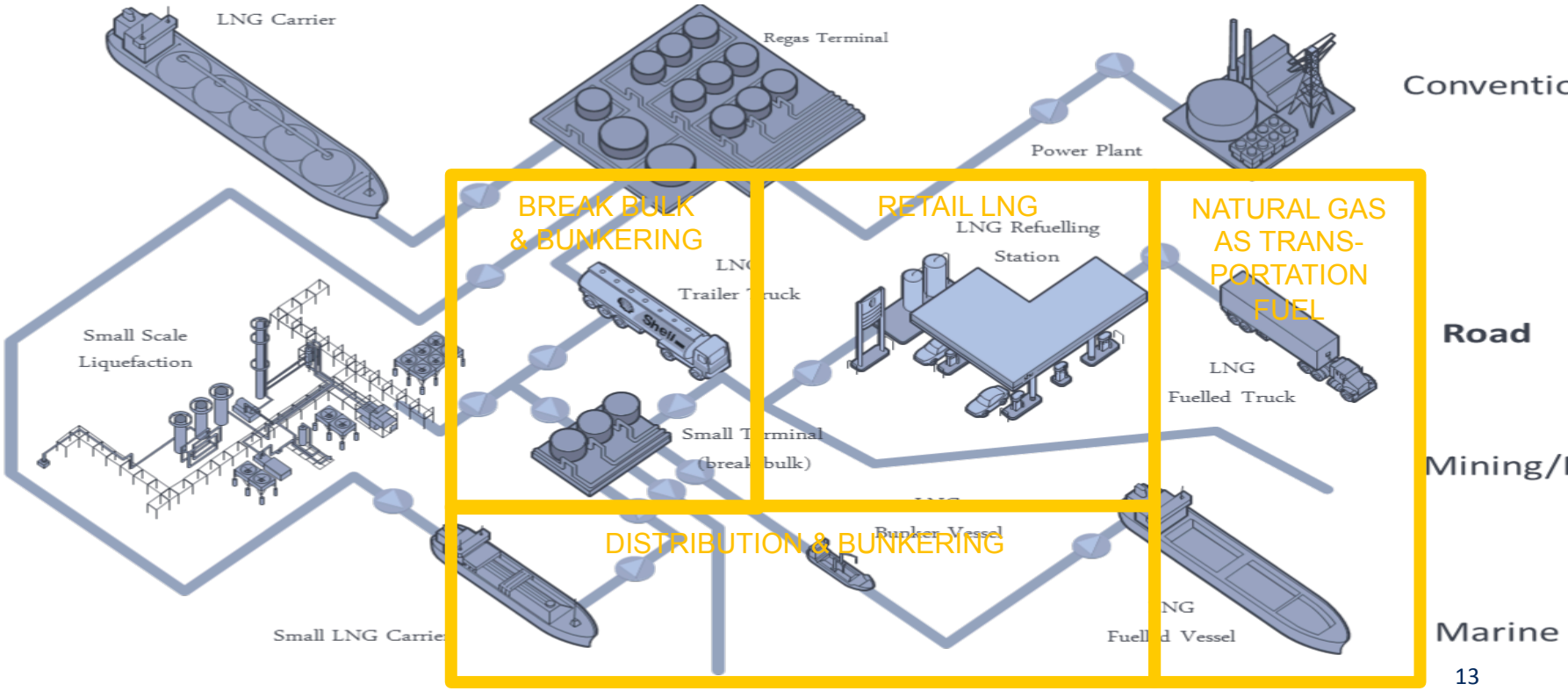
FOCUS AREA

Production

Distribution

And Application
Trucks/ships

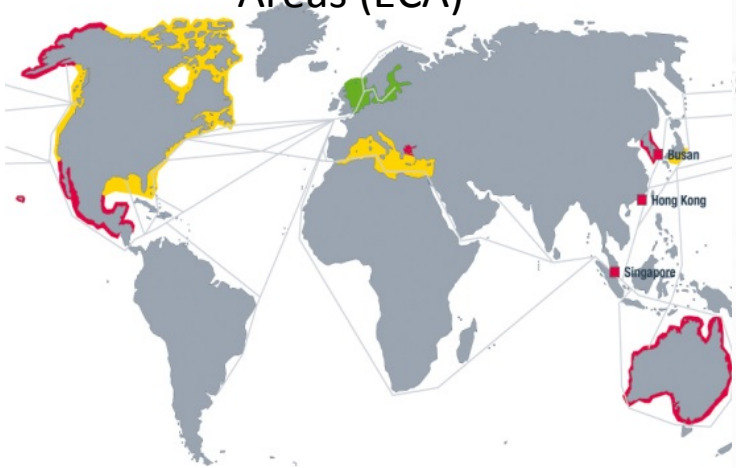
What is Small Scale LNG?

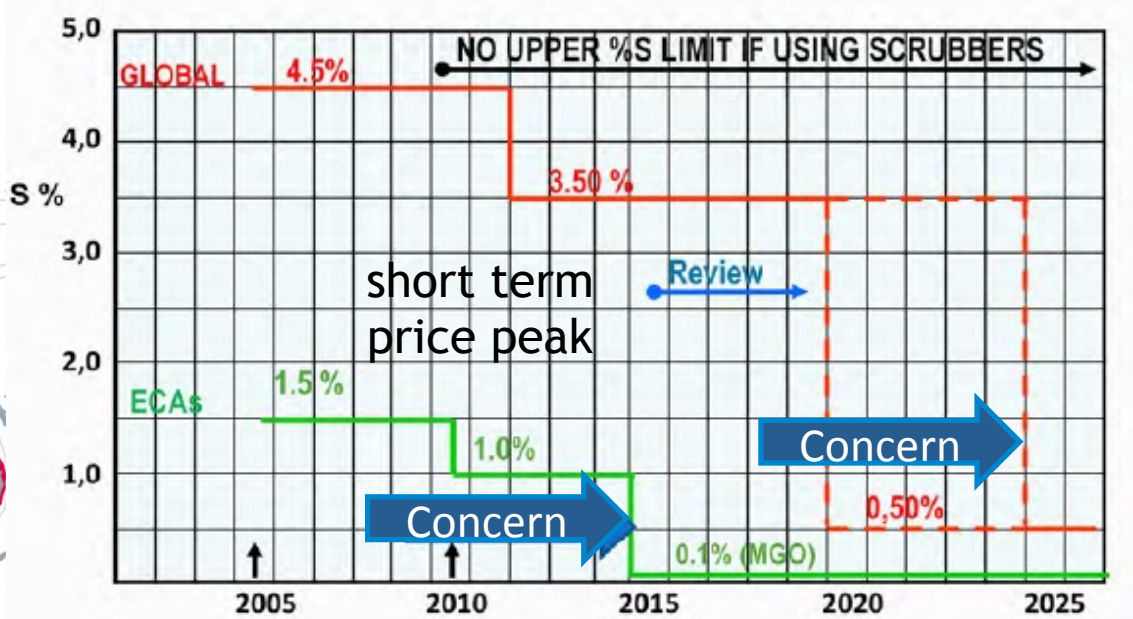


Why LNG as a fuel for transport?

Effect of marine fuel sulphur content regulation by IMO

Emission Controlled Areas (ECA)





Challenge to meet demand for distillates after 2020-2025

What will be the effect on distillates pricing, and *road fuel diesel*?