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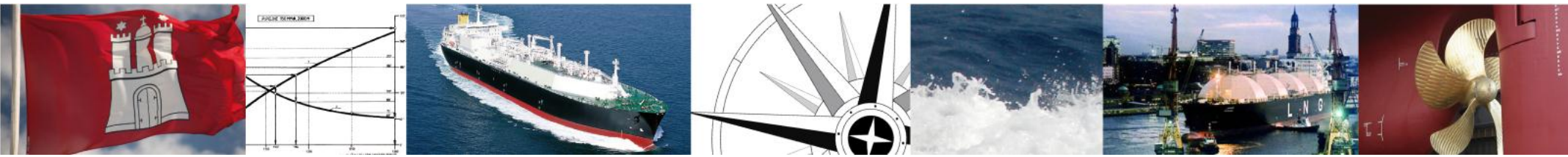
Small Scale LNG

Status and Trends in the Development of Small Scale LNG

Alexander Harsema-Mensonides

LNG High-Level Seminar

Constanta, 24 - 25 January 2013



Marine Service GmbH

MARINE SERVICE GMBH

- Marine Service GmbH at a glance:
  - Hamburg-based marine consultancy firm, founded in 1958, involved in LPG & LNG since the mid 1960's
  - Core business is commercial and technical consultancy services & turn-key project delivery for:
    - LNG shipbuilding / shipping
    - LNG terminals / LNG FSRUs / LNG FPSOs
    - Small scale LNG / LNG as marine fuel projects


CERTIFICATE

Marine Service GmbH

DIN EN ISO 9001:2000

Germanischer Lloyd

ISO 9001:2010 certified

  - 30 office staff in Hamburg, 12 – 25 project managers, supervisors & engineers in site offices worldwide

Liquefied Natural Gas

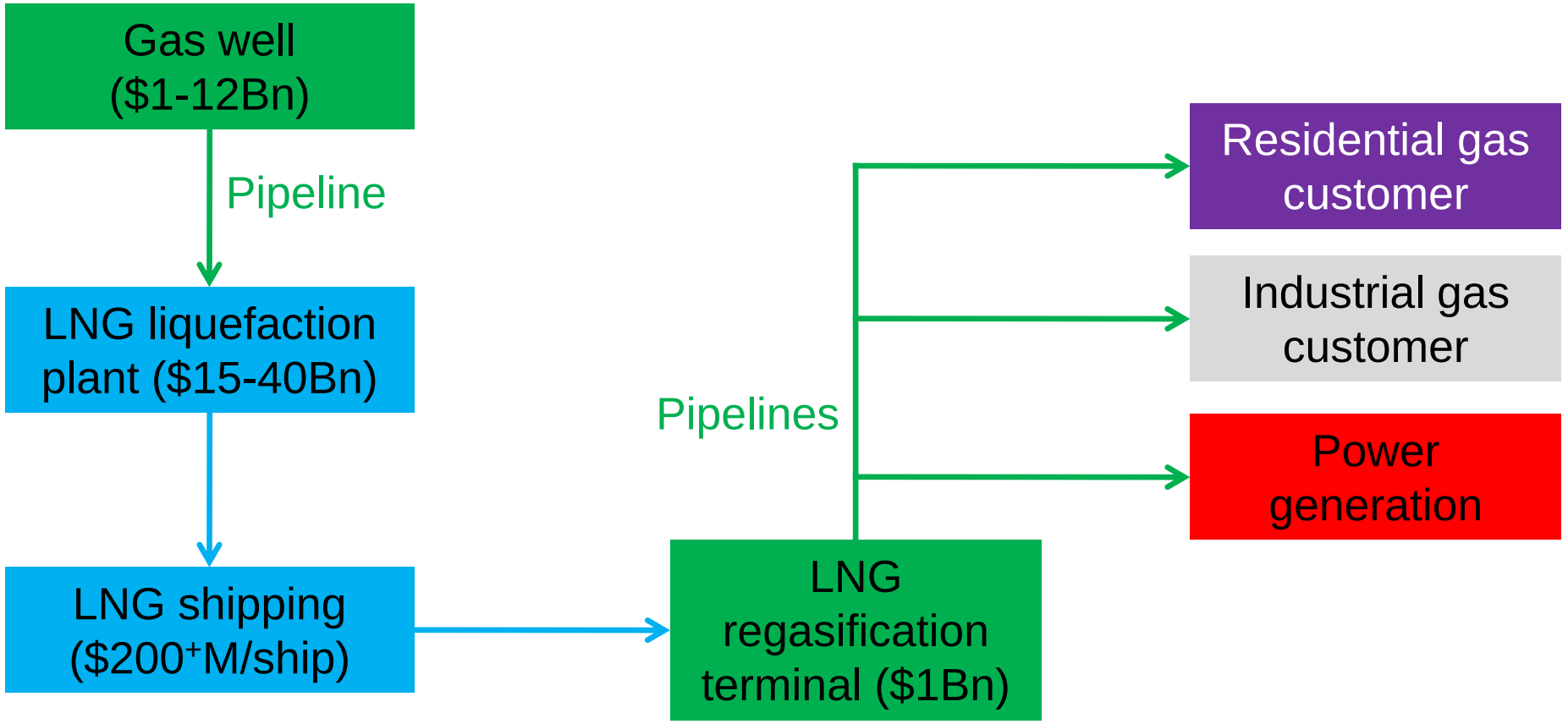
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- Liquefied Natural Gas (LNG):
  - Colorless, transparent, odorless, cryogenic liquid
  - Mixture of liquid CH_4 (>80%), C_2H_6, C_3H_8, C_4^+, N_2
  - Specific gravity around 423 - 485 kg/m^3
  - LHV about 49,500 kJ/kg
  - 1 m^3 LNG = 559 - 590 m^3 gas at atmospheric pressure
  - Boiling point is -161.5 ^{o}C at atmospheric pressure
  - Causes frost bite upon skin contact, cracks in mild steel
  - Below -100 ^{o}C LNG vapor is heavier than air
  - Flammable in 5 – 15% mixture with air



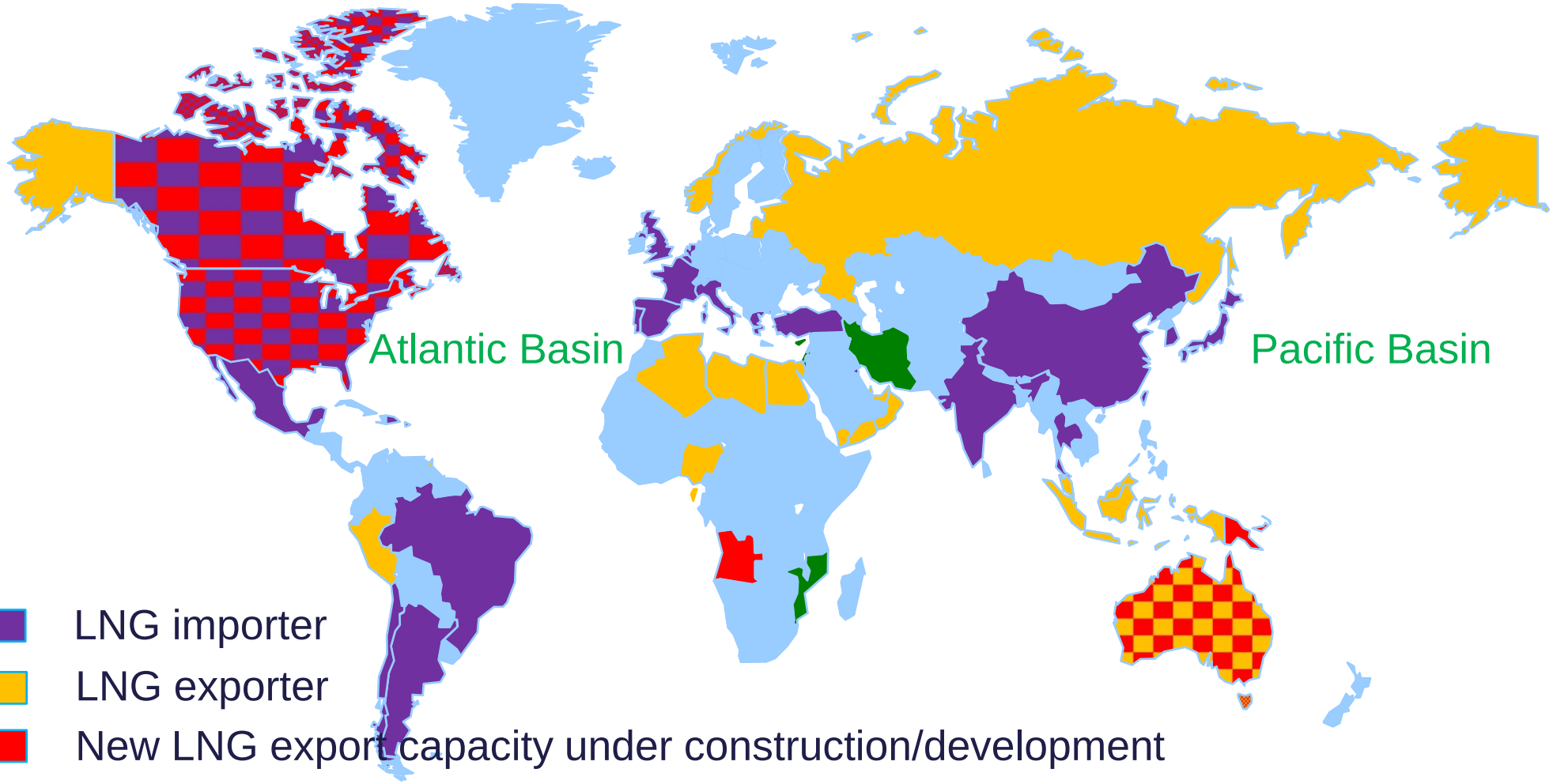
Traditional LNG Value Chain

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The World of LNG

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LNG Pricing

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- Approximate LNG spot prices (Jan 2013):
  - Japan/Korea/China: USD 17.50 / MMBTU
  - Europe (NBP / TTF): USD 10.50 / MMBTU
  - US (Henry Hub): USD 3.50 / MMBTU
- US & European price level interesting for non-base load applications: marine & road fuel
- Approximately USD 6 / MMBTU to be added for distribution, local storage and bunkering infrastructure
- More competition will lower distribution prices

LNG Trades in 2011

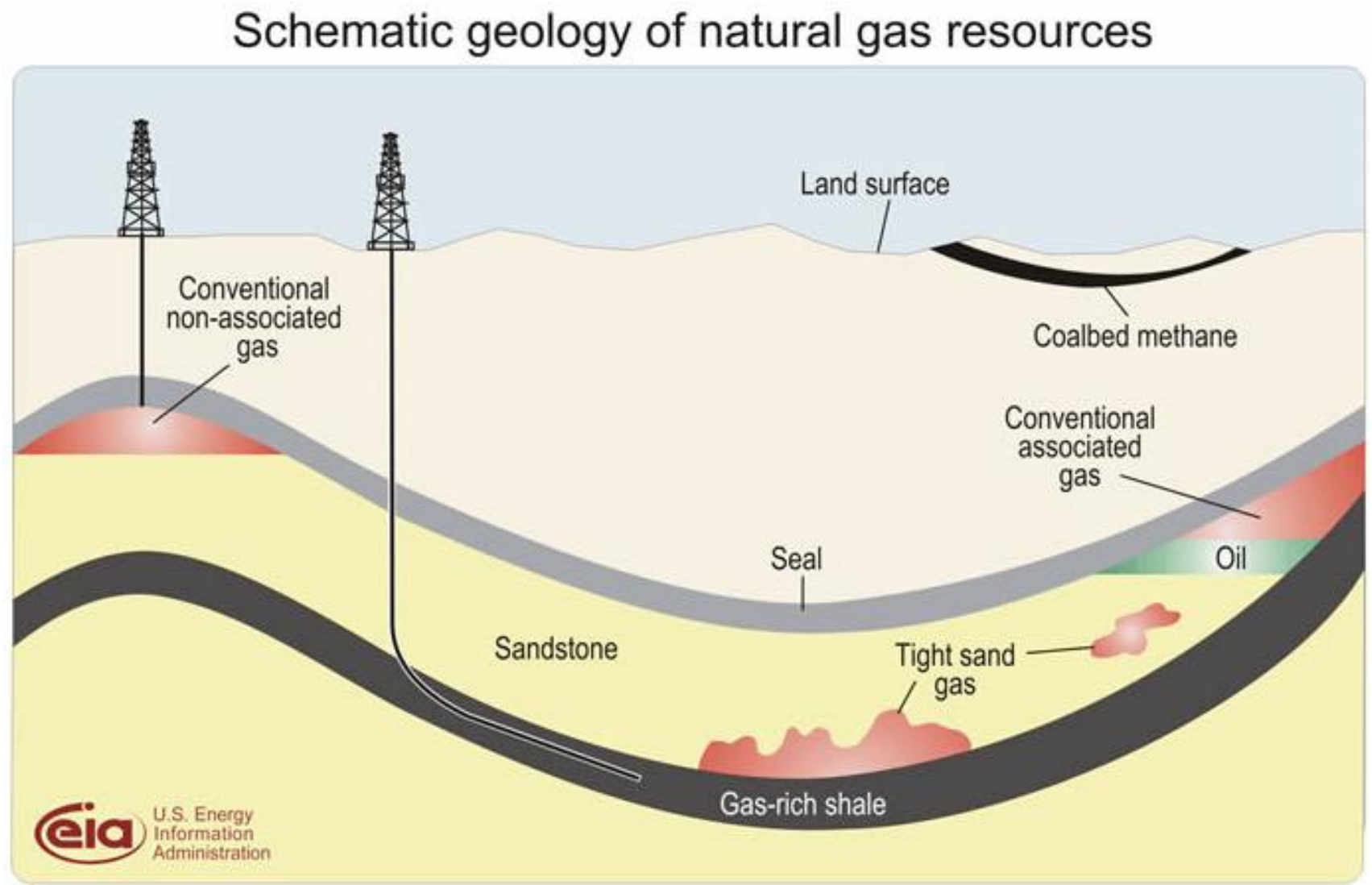
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Imports\Exports in 1,000,000 tons	Algeria	Libya	Egypt	Eq Guinea	Nigeria	Norway	Russia	Belgium	Spain	Peru	Trinidad & Tobago	USA	Abu Dhabi	Oman	Qatar	Yemen	Australia	Brunei	Indonesia	Malaysia	Totals
Belgium					0,1			-0,5			0,1				4,2	0,3					4,2
France	4,2		0,6		2,6	0,3					0,3				2,4	0,1					10,5
Greece	0,6		0,1		0,1						0,1				0,1						1,0
Italy	1,2		0,3			0,1			0,2		0,1				4,4						6,3
Netherlands	0,1		0,1		0,1	0,1		0,1			0,1				0,2						0,8
Portugal	0,1		0,1		1,9	0,1									0,1						2,3
Spain	2,9	0,1	1,7		4,9	0,9		0,2	-0,4	1,4	1,7	0,1		0,1	3,6						17,2
Turkey	3,0		0,3		1,0										0,4						4,7
U.K.	0,2		0,1		0,9	0,3					0,4	0,1			16,1	0,5					18,6
Europe	**12,3**	**0,1**	**3,3**	**0,0**	**11,6**	**1,8**	**0,0**	**-0,2**	**-0,2**	**1,4**	**2,8**	**0,2**	**0,0**	**0,1**	**31,5**	**0,9**	**0,0**	**0,0**	**0,0**	**0,0**	**65,6**
Argentina			0,1		0,3				0,1		2,1				0,3						2,9
Brazil					0,1						0,2	0,2			0,2						0,7
Chile			0,1	1,0							0,8	0,1			0,4	0,3			0,1		2,8
Dominican Rep						0,1					0,6										0,7
Mexico					0,8					0,5					1,3	0,1			0,1		2,8
Puerto Rico											0,7										0,7
Canada											0,8				1,6						2,4
USA			0,7		0,1	0,3				0,3	2,6	-1,0			1,9	1,2					6,1
Americas	**0,0**	**0,0**	**0,9**	**1,0**	**1,3**	**0,4**	**0,0**	**0,0**	**0,1**	**0,8**	**7,8**	**-0,7**	**0,0**	**0,0**	**5,7**	**1,6**	**0,0**	**0,0**	**0,2**	**0,0**	**19,1**
China			0,2	0,1	0,7		0,3			0,1	0,3	0,1			2,4	0,7	3,7		2,6	1,8	13,0
India	0,2		0,5		1,1	0,1					0,4	0,2	0,1	0,1	9,4	0,1	0,1			0,1	12,4
Japan	0,1		0,7	1,5	2,0	0,2	7,1	0,2		0,3	0,3	0,4	5,6	3,8	11,9	0,1	14,1	6,4	9,2	15,2	79,1
Korea			0,4	0,7	1,1		2,9	0,1		0,7	1,4	0,1		3,9	7,8	2,7	1,1	0,7	7,9	4,0	35,5
Taïwan			0,5	0,6	0,7	0,1	0,2		0,1	0,1	0,1		0,1	0,1	4,1	0,1	0,1		1,9	3,4	12,2
Thailand					0,1		0,1			0,2					0,3				0,1		0,8
Asia	**0,3**	**0,0**	**2,3**	**2,9**	**5,7**	**0,4**	**10,6**	**0,3**	**0,1**	**1,4**	**2,5**	**0,8**	**5,8**	**7,9**	**35,9**	**3,7**	**19,1**	**7,1**	**21,7**	**24,5**	**153,0**
Kuwait			0,1		0,6				0,1				0,1		1,3		0,2			0,3	2,7
Dubai					0,1						0,2				0,7		0,1			0,1	1,2
Middle East	**0,0**	**0,0**	**0,1**	**0,0**	**0,7**	**0,0**	**0,0**	**0,0**	**0,1**	**0,0**	**0,2**	**0,0**	**0,1**	**0,0**	**2,0**	**0,0**	**0,3**	**0,0**	**0,0**	**0,4**	**3,9**
Total	**12,6**	**0,1**	**6,6**	**3,9**	**19,3**	**2,6**	**10,6**	**0,1**	**0,1**	**3,6**	**13,3**	**0,3**	**5,9**	**8,0**	**75,1**	**6,2**	**19,4**	**7,1**	**21,9**	**24,9**	**241,6**

Source: GIIGNL / The LNG Industry in 2011

Shale Gas

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LNG Tsunami in 2020?

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- Global LNG production 2011: approx. 240 MTPA

Global LNG production capacity expansion in MTPA			
Country	Under construction	Optimistic forecast	More realistic forecast
Australia	65.2	139.3	81.2
Angola	5.2	5.2	5.2
PNG	6.6	8.6	6.6
Malaysia		3.6	3.6
Nigeria		38.4	
Equatorial Guinea		4	4
Mozambique		50	20
USA & Canada		137.8 & 30.7	25 & 10
Russia		43.5	10
Cyprus / Israel		15	
Iran		78	20
Total	**77**	**554.2**	**185.6**

Small Scale LNG

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- Small Scale LNG = LNG in smaller quantities:
  - LNG for non-gas grid connected heat & power users
  - LNG for trucks and busses
  - LNG as marine fuel
    - Short sea shipping
    - Inland shipping
  - LNG for energy users that want independence from the established pipeline gas suppliers
  - LNG for energy users that can use the cold from LNG, as well as the combustion energy

New LNG Value Chain

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Well head

Pipeline

LNG liquefaction plant

LNG carrier

LNG regasification terminal

Multi-modal transport

LNG satellite terminal

Pipeline

Mini LNG plant

Multi-modal transport

Pipeline

Residential gas customer

Industrial gas customer

Power generation

LNG Import Terminal

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Q-flex LNGC “Mesaimeer” at St. Johns LNG terminal in Newfoundland



Source: Canaport LNG

Mid Scale LNG Plant

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Pocket LNG Carrier

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- Dimensions: 130 – 150 x 25.7 – 28 x 6.5 – 7.1m (LxBxD)
- Capacity: 18k – 23k m^3
- Built: 6
- Price: $80M – 101M
- Delivery: 1993 – 2007
- Employment:
  - Long term LNG charters to from SE Asia to Japan (Sendai, Hiroshima, Fukuoka etc)





LNG Distribution Vessels

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LNG distribution vessels in operation:

1 x 1,100 m³
4 x 2,500 m³
1 x 3,500 m³
1 x 7,500 m³
4 x 10,000 m³
2 x 12,000 m³
1 x 15,600 m³

LNG Satellite Terminal

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LNG Local Storage

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- Large cylindrical pressure vessels
- Refueled by LNG distribution carrier or LNG truck
- Simple, scalable and effective solution



Source: Marintek / Sintef

Halhjem ferry terminal


Source: Marintek / Sintef

LNG Logistics Solution

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LNG ship-to-ship transfer from LNGC ”Höegh Galleon” to MT ”Pioneer Knutsen”

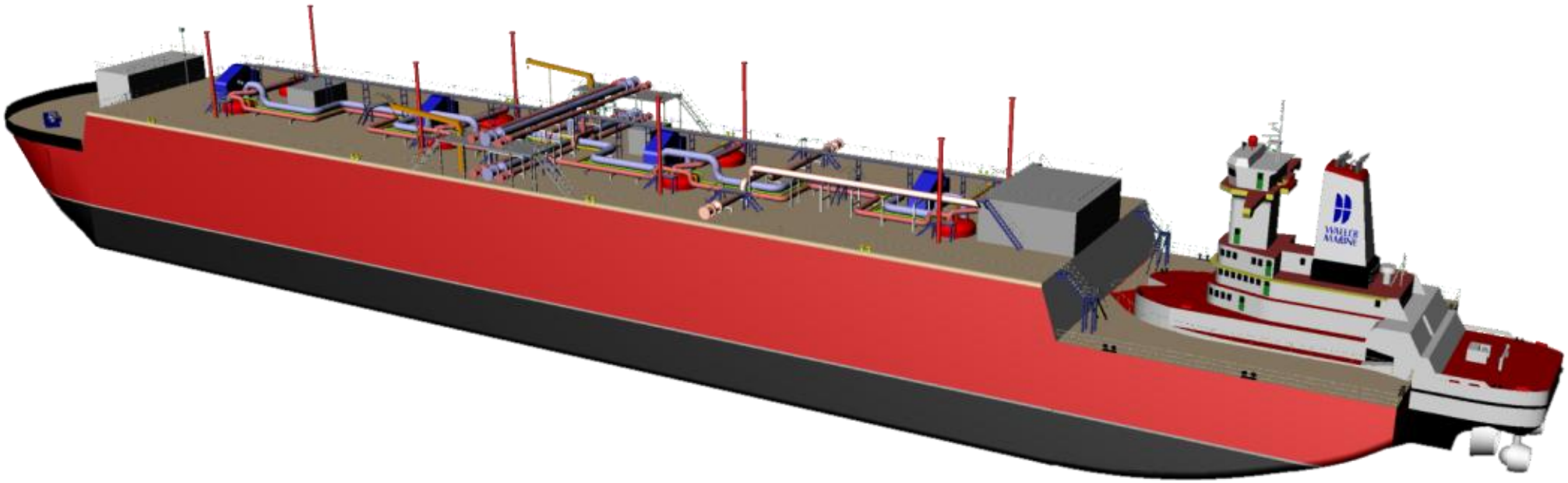


Source: grady

LNG Tank Barge

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Articulated tug and LNG tank barge

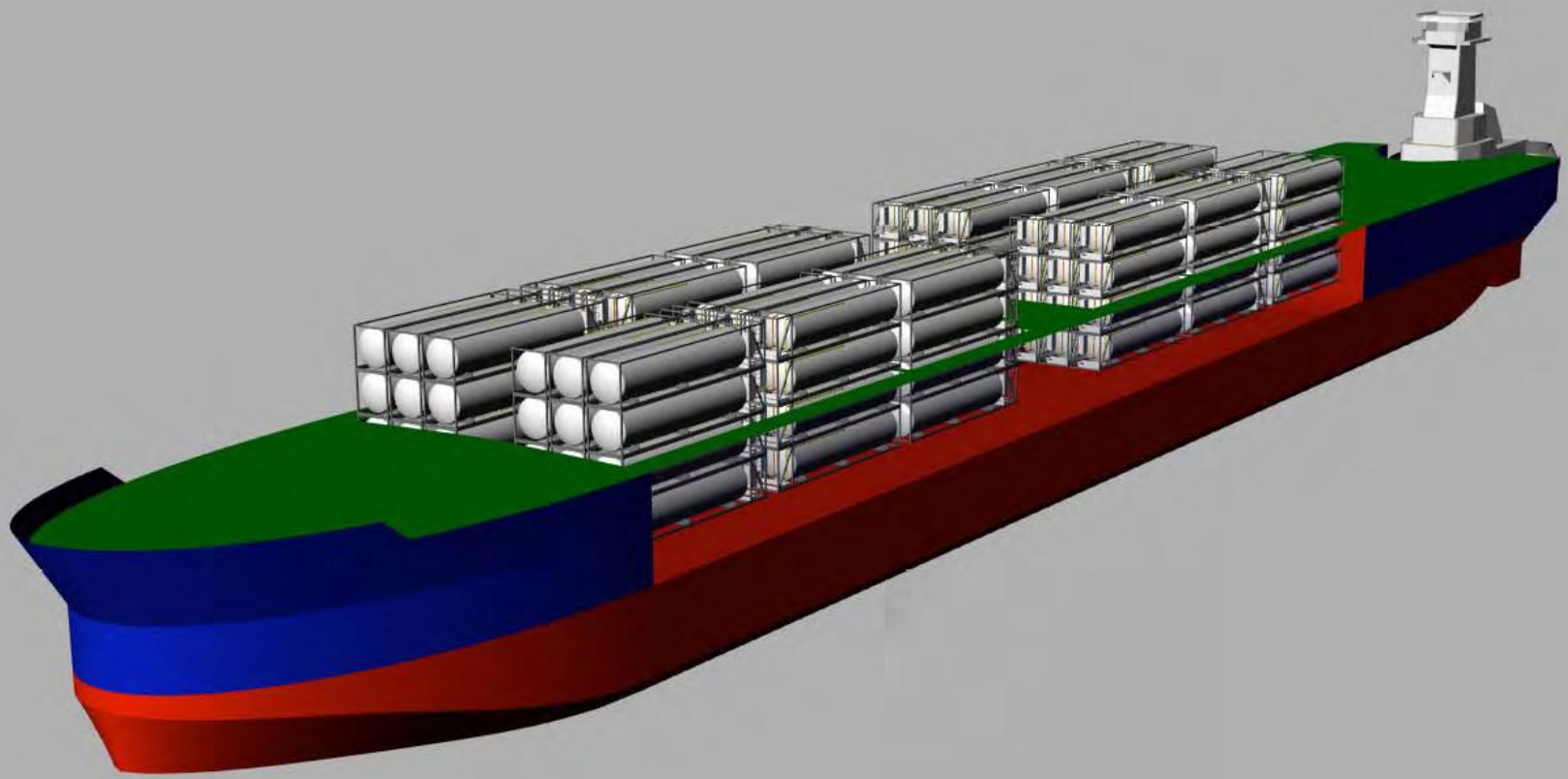


(source: Waller Marine)

LNG Intermodal Barge

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Articulated tug and intermodal LNG barge

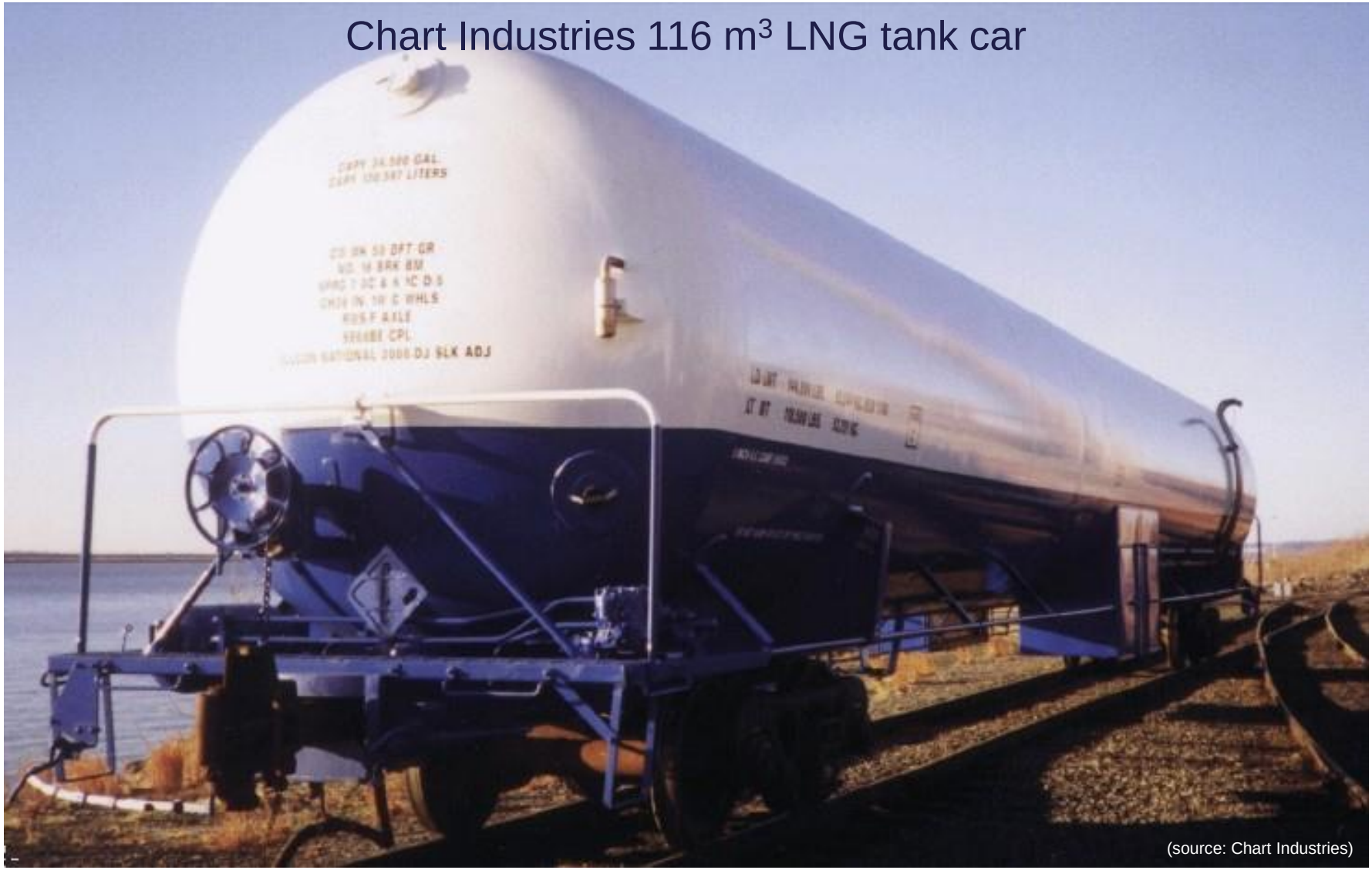


(source: Argent Marine Management / Maersk Line)

LNG Tank Cars

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Chart Industries 116 m^3 LNG tank car



(source: Chart Industries)

LNG Tank Trailers

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LNG road train in Australia with 3 trailers of approximately 50 m^3 LNG each



Source: Gary Richards



56 m^3 LNG road trailer in Norway

Source: Marintek /Sintef

LNG Tank Container

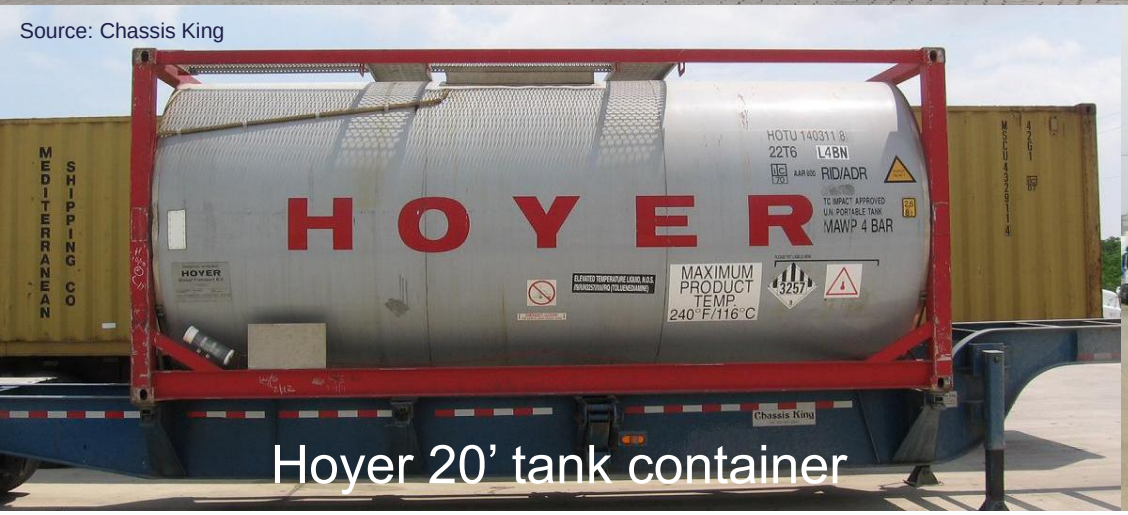
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Marine Service 40’ LNG fuel tank container



Source: Marine Service GmbH

Source: Chassis King



Hoyer 20’ tank container

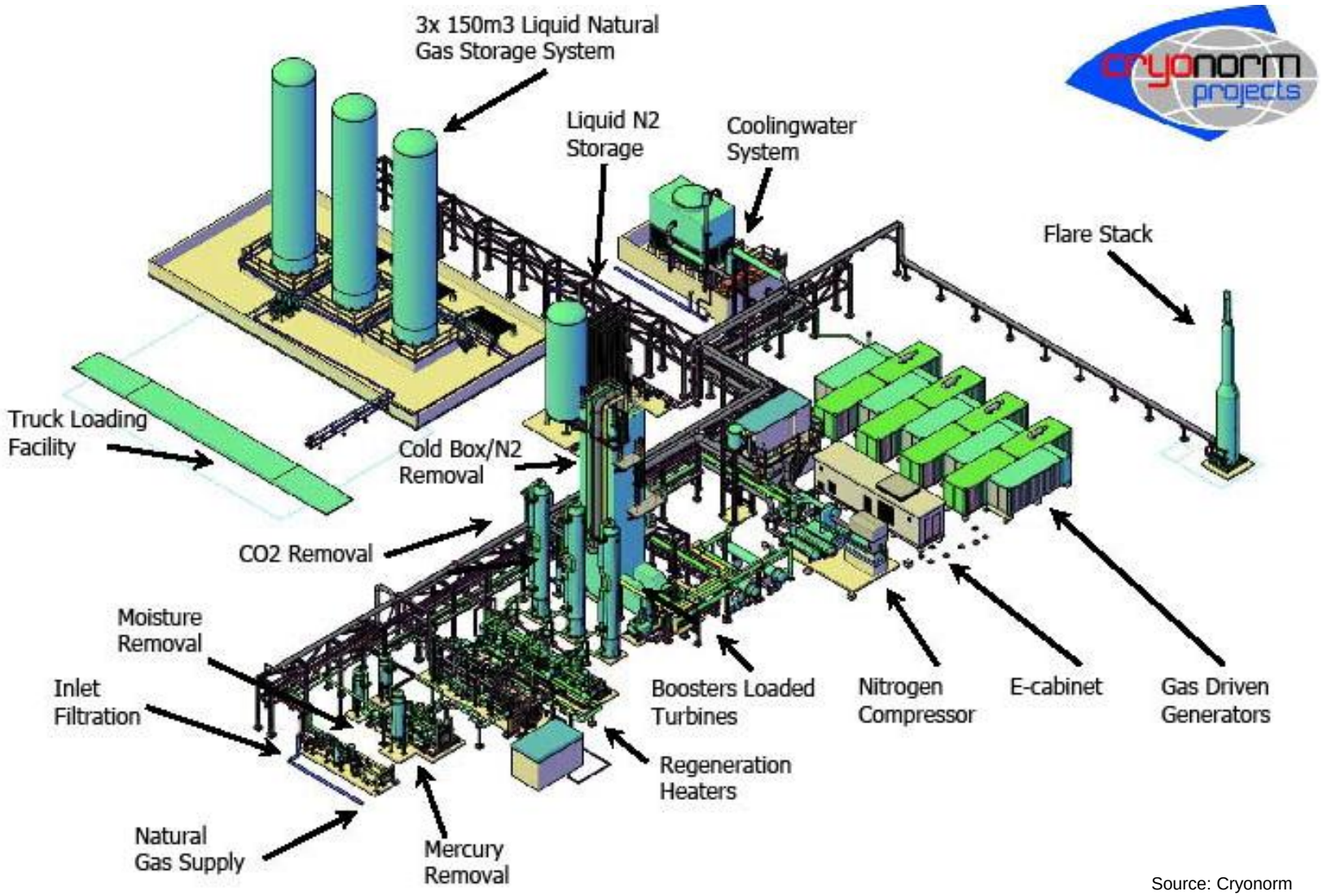
Source: CIMC-ENRIC



CIMC 40’ LNG tank container

Small Scale LNG Plant

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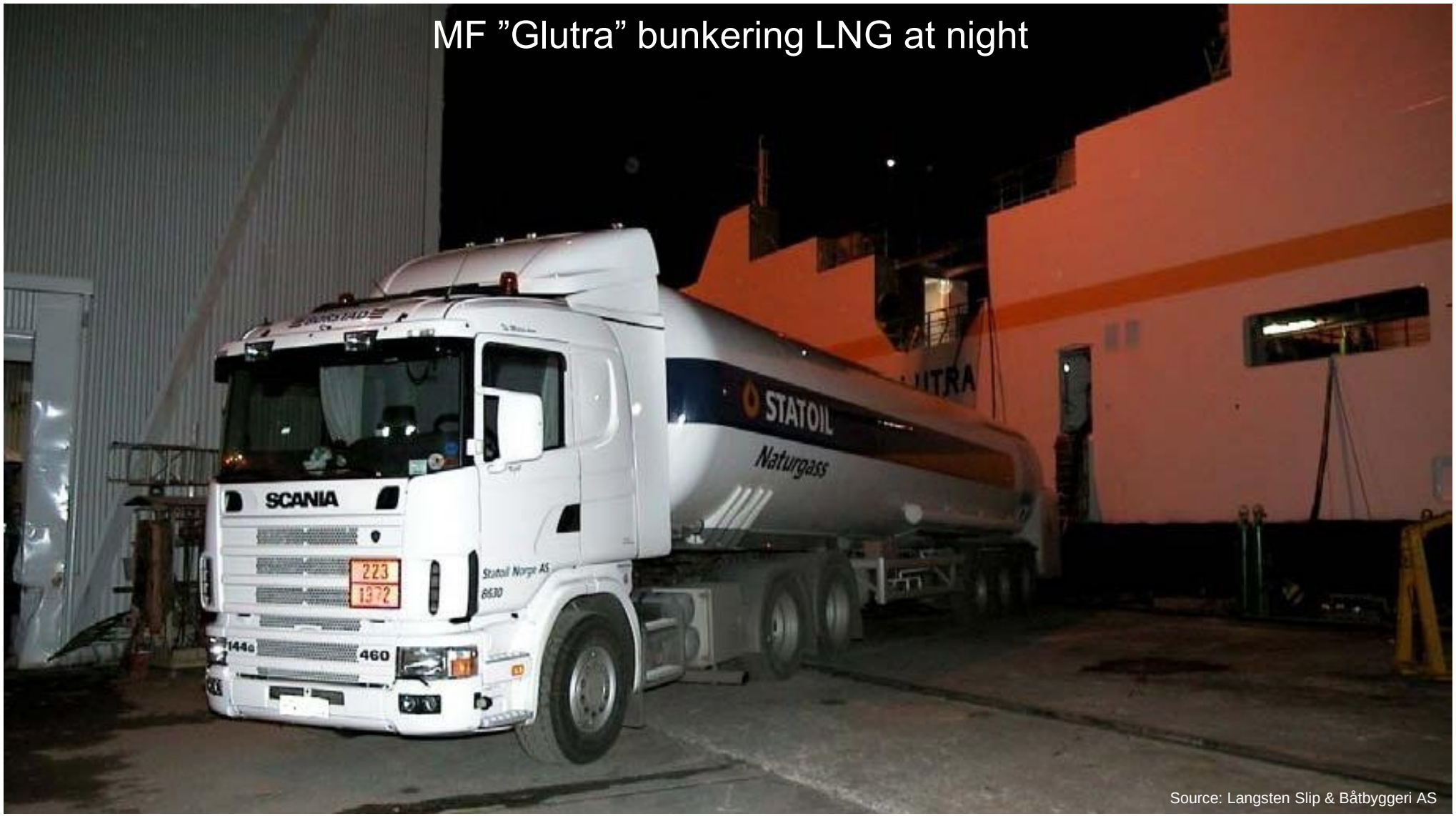


Source: Cryonorm

Traditional LNG Bunkering

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MF ”Glutra” bunkering LNG at night



Source: Langsten Slip & Båtbyggeri AS

LNG Bunkering Today

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MT “Argonon” in Antwerp

Source: Deen Shipping

- LNG bunkering with trucks:
  - High flexibility location-wise
  - Limited fuel quantity



Source: Gasnor

Eidesvik OSV in Norway



MS “Viking Grace” in Finland

Source: Åbo Underrättelser

LNG Terminal Bunkering

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MT ”Bit Viking” bunkering LNG at Risavika LNG terminal



Source: Tarbit Shipping



Source: Skangass

LNG Bunker Vessel

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- LNG bunkering by dedicated LNG bunker vessel:
  - Flexible in terms of location
  - Larger quantities
  - Quite similar to current marine fuels bunkering practices
  - Regulations for LNG binkering still unclear

MS “Viking Grace”



Source: STX Europe

AGA LNG bunker vessel

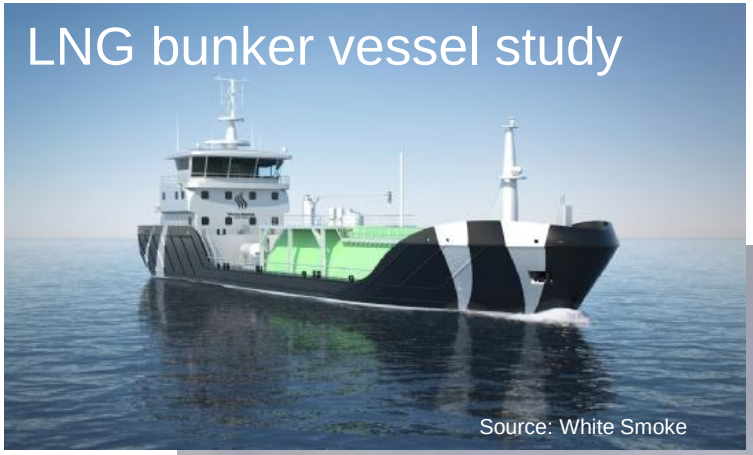


Source: AGA

LNG Bunker Vessel

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LNG bunker vessel study



Source: White Smoke

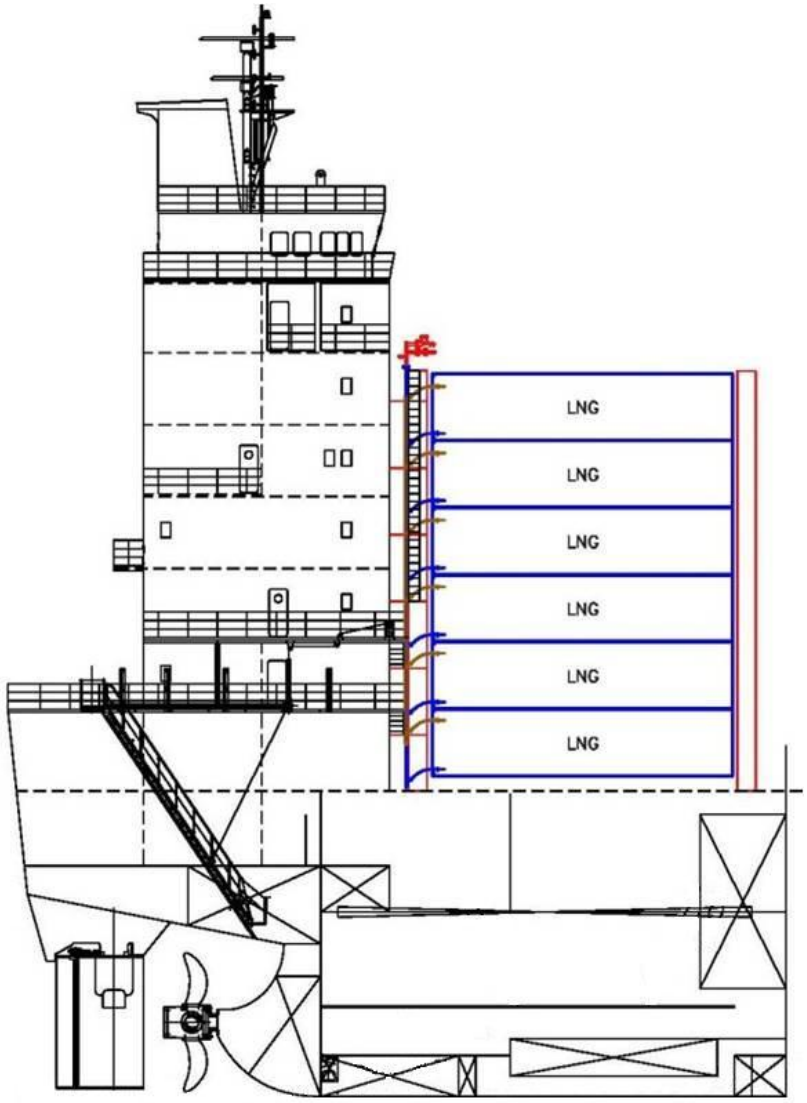
LNG ship-to-ship transfer from “Pioneer Knutsen” to “Coral Methane”



Source: DNV

LNG Fuel Tank Container

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Source: Marine Service GmbH



Marine Service LNG fuel tank container

LNG Fuelled Inland Shipping

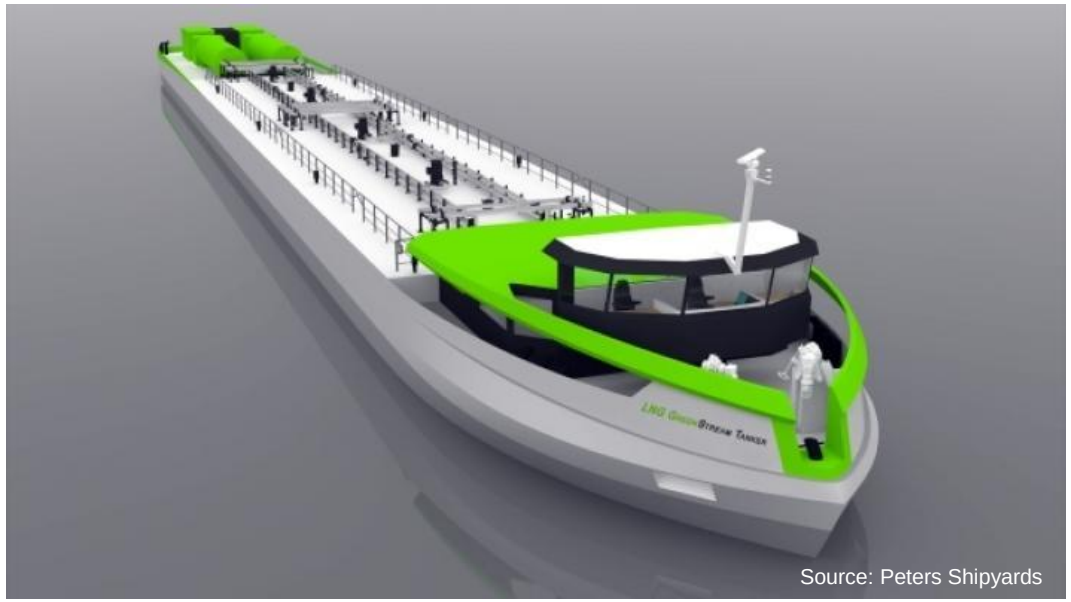
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Source: Deen Shipping

MT ”Argonon” (2011)

LNG Greenstream Tanker (2013)


Source: Peters Shipyards

LNG Fuelled Locomotives

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MK1200G LNG switcher (1998)



Source: Jody Moore



Source: CN Railway

Dual fuel retrofit EMD SD-40-2 (2012)

Source: RMZ



Gas turbine electric locomotive (2011)

Dual fuel retrofit EMD SD-40-2 (1999)



Source: BN

LNG Passenger Vessels

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2800 Passenger ferry ”Viking Grace” with dual fuel diesel propulsion



Source: STX Europe

Source: Karyn Hannah / Incat



1000 Passenger fast ferry ”Lopez Mena” with gas turbine propulsion

What Is Still Missing?

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- Currently under development:
  - LNG transport by inland waterway vessels
  - LNG for airplanes
  - LNG for agricultural purposes (green houses)
  - LNG for industrial vehicles and machinery
  - LNG for passenger vehicles
  - LNG for offices and residential buildings
- Any other application you can think of?
- Remember, LNG was intended as a coolant for the Chicago meat industry in the early 1900's

Well, It's Not All Good News

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- Additional space losses:
  - Cylindrical LNG storage tank shape
  - Tank insulation
  - Additional bulkheads, void spaces, access trunks, vents, etc.
- LNG could require up to 3 - 4 times as much space as MDO for the same amount of energy

Comparison LNG to MDO			
Fuel	**LHV [MJ/kg]**	**Density [kg/m³]**	**Energy density [MJ/m³]**
MDO	42.7	900	38,430
LNG	49.5	445	22,028
MDO/LNG energy density ratio: 1.75			

And What's More….

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- LNG requires higher CAPEX for storage and distribution than traditional residual and distillate fuels
- LNG has BOG issues that require attention
- Most of LNG related accidents happened during LNG handling
- Release of uncombusted Methane contributes to the Green House Effect 23 – 72 times more strongly than CO_2

Is LNG Safe?



Source: Hardstaff Group / Steve Storrar

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Thank you very much for your kind attention

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