ALTERNATIVE FUELS
– FACTS AND TRENDS FOR THE FUTURE

Status of bunker LNG in Europe and update on Danish LNG initiatives

19th. Of September 2016

IDA - 31 Kalvebod Brygge, København, 1560, Denmark

Presentation agenda

1. 16 years development of LNG fueled vessels – a look into the future

2. International key drivers “fueling” the LNG bunker business

3. Danish LNG developments

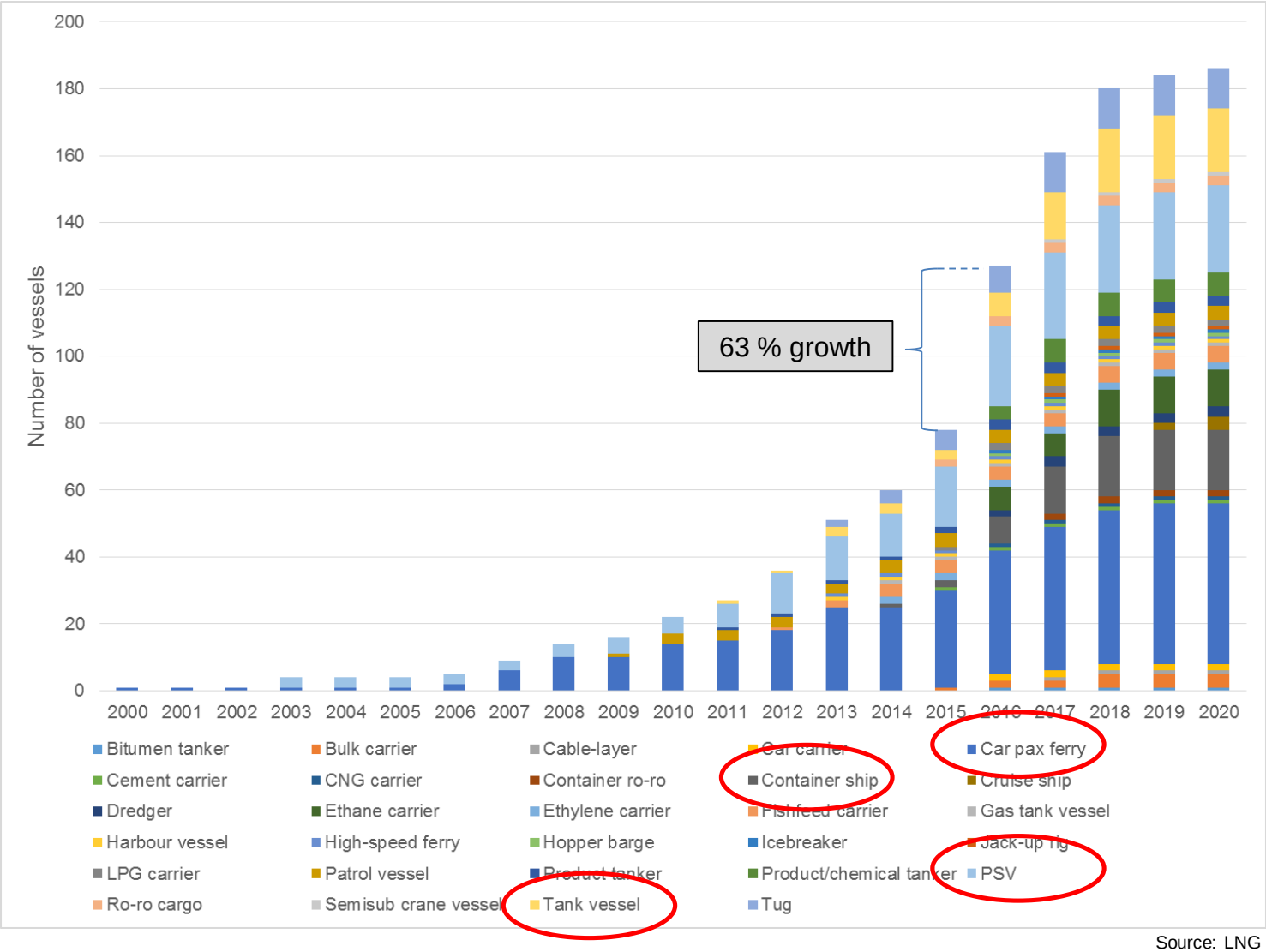
“Questions are welcome during the presentation”

16 YEARS DEVELOPMENT OF LNG FUELED VESSELS – A LOOK INTO THE FUTURE

GLUTRA
- the worlds first LNG fueled vessel

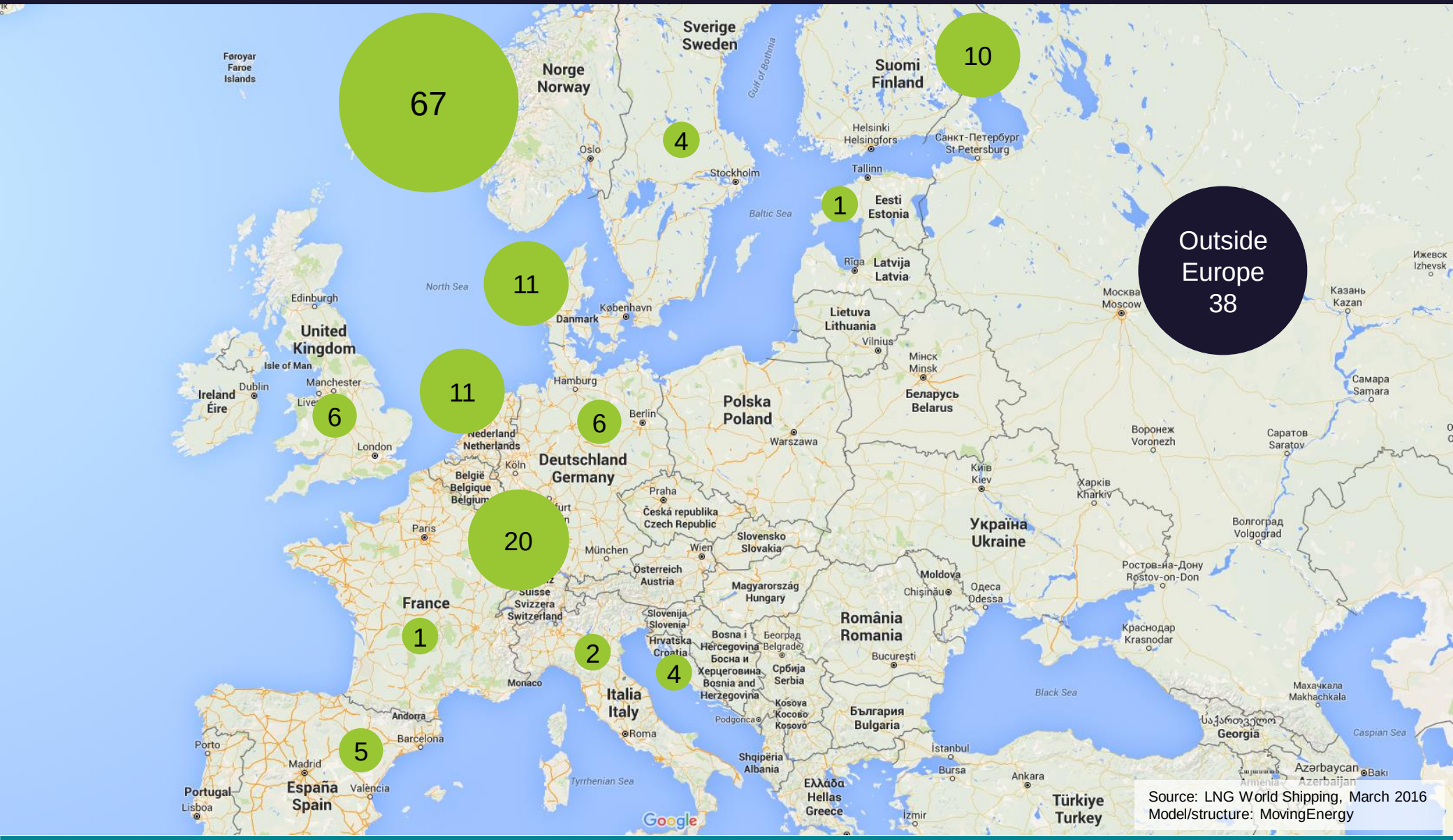
Build year:	2000
Gross Tons:	2268 tons
Summer DWT:	659 tons
LOA:	95 meter
LNG tanks:	2X32 m^3
Engine (Mitsubishi):	4 X 675 kW
Daily LNG consumption:	app 10 m^3

Total numbers of LNG fuelled vessels is growing ☺



Source: LNG World Shipping, March 2016
Model/structure: MovingEnergy

Existing and ordered LNG fuelled vessels in Europe by 2020 - data from marts 2016



Source: LNG World Shipping, March 2016
Model/structure: MovingEnergy

Bunker capacity versus ship type/size - Ferrys

Bunker capacity versus ship type/size
Tugs/supply vessels

Engine: 8100 kW
LNG Tank: 290 m³

Engine: 8040 kW
LNG Tank: 209 m³

Engine: 8700 kW
LNG Tank: 200 m³

Engine: 3410 kW
LNG Tank: 80 m³

Bunker capacity versus ship type/size
Up-coming vessels – Tankers/Drycargo

Engine: 6300 kW
LNG Tank: 580 m³

Engine: 2610 kW
LNG Tank: 112 m³

Engine: 5850 kW
LNG Tank: 630 m³

4 vessels
To be delivered 2016/2017

Engine: 4500 kW
LNG Tank: 600 m³

4 vessels
To be delivered 2017/2018

"There begin to be a commend praxis of 10 days LNG bunker capacity"

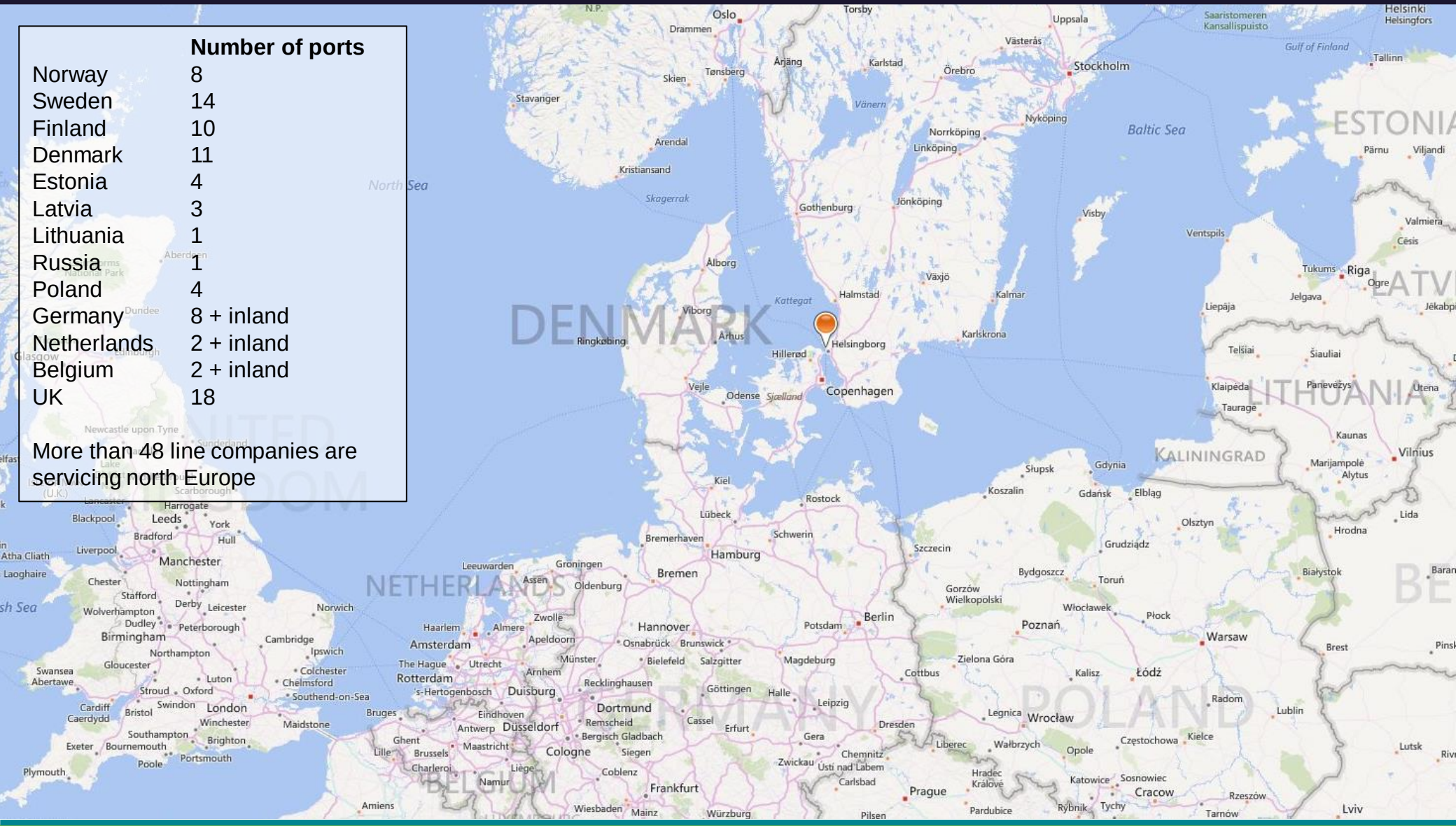
Carnival enters the world and orders 7 LNG fueled cruise vessels - from LNG “assisted” to fully LNG fueled

LNG will solely be supplied in port by trailers to secure clean fuel for power generation when a long side

LNG Future availability North Europe

	Number of ports
Norway	8
Sweden	14
Finland	10
Denmark	11
Estonia	4
Latvia	3
Lithuania	1
Russia	1
Poland	4
Germany	8 + inland
Netherlands	2 + inland
Belgium	2 + inland
UK	18

More than 48 line companies are servicing north Europe



Belgium – LNG bunker out of Zeebrügge
GAS4SEA, 5.000 m3

Belgium - Port of Antwerp

"French Engie has been granted 30 years concession by the Antwerp Port Authority to build and operate a LNG bunkering point for vessels and trucks"

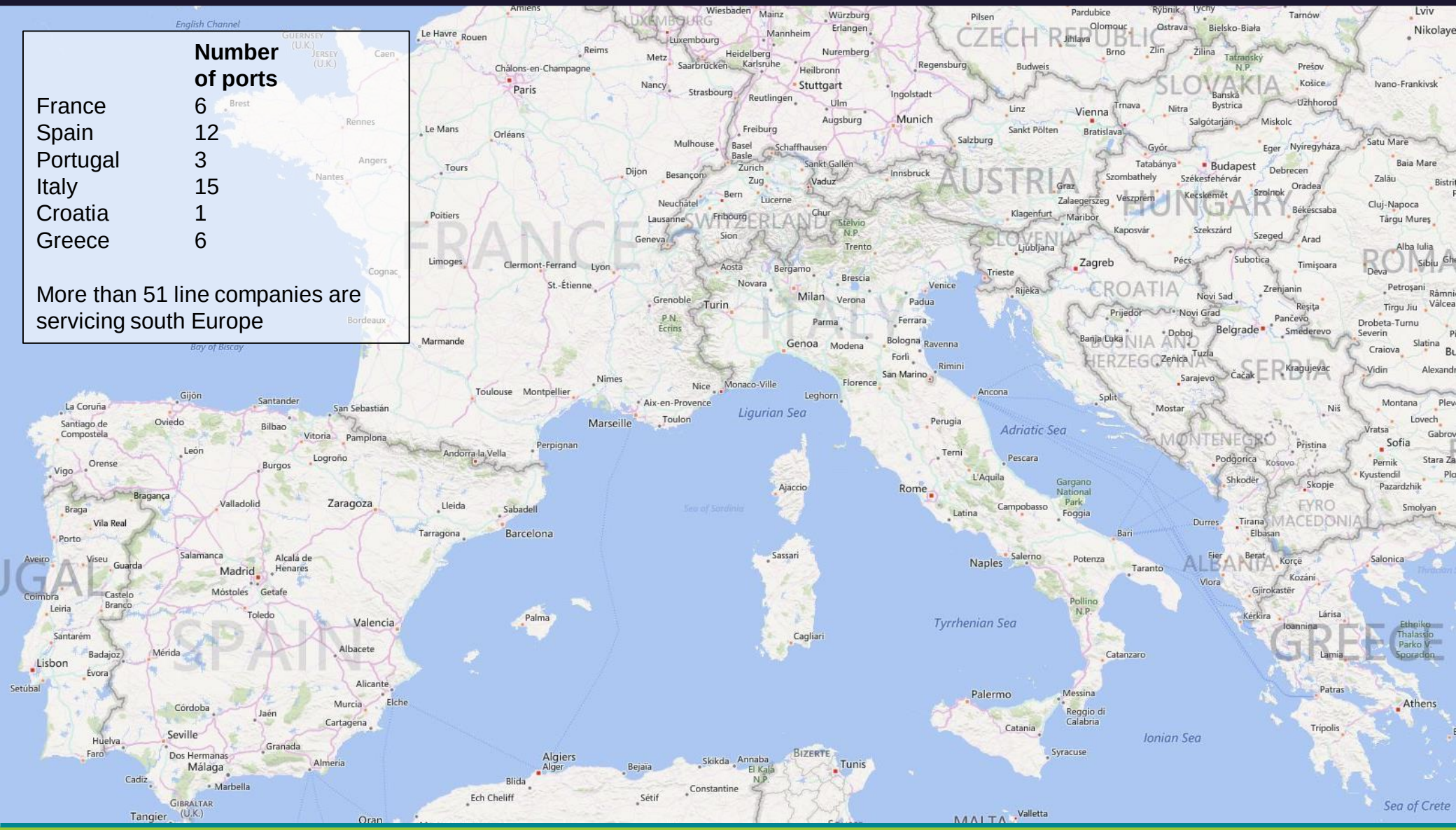
Pic source: http://www.madeinwest-vlaanderen.be

Rotterdam – LNG bunker out of Rotterdam
Shell, 6.500 m3 – operational mid 2017

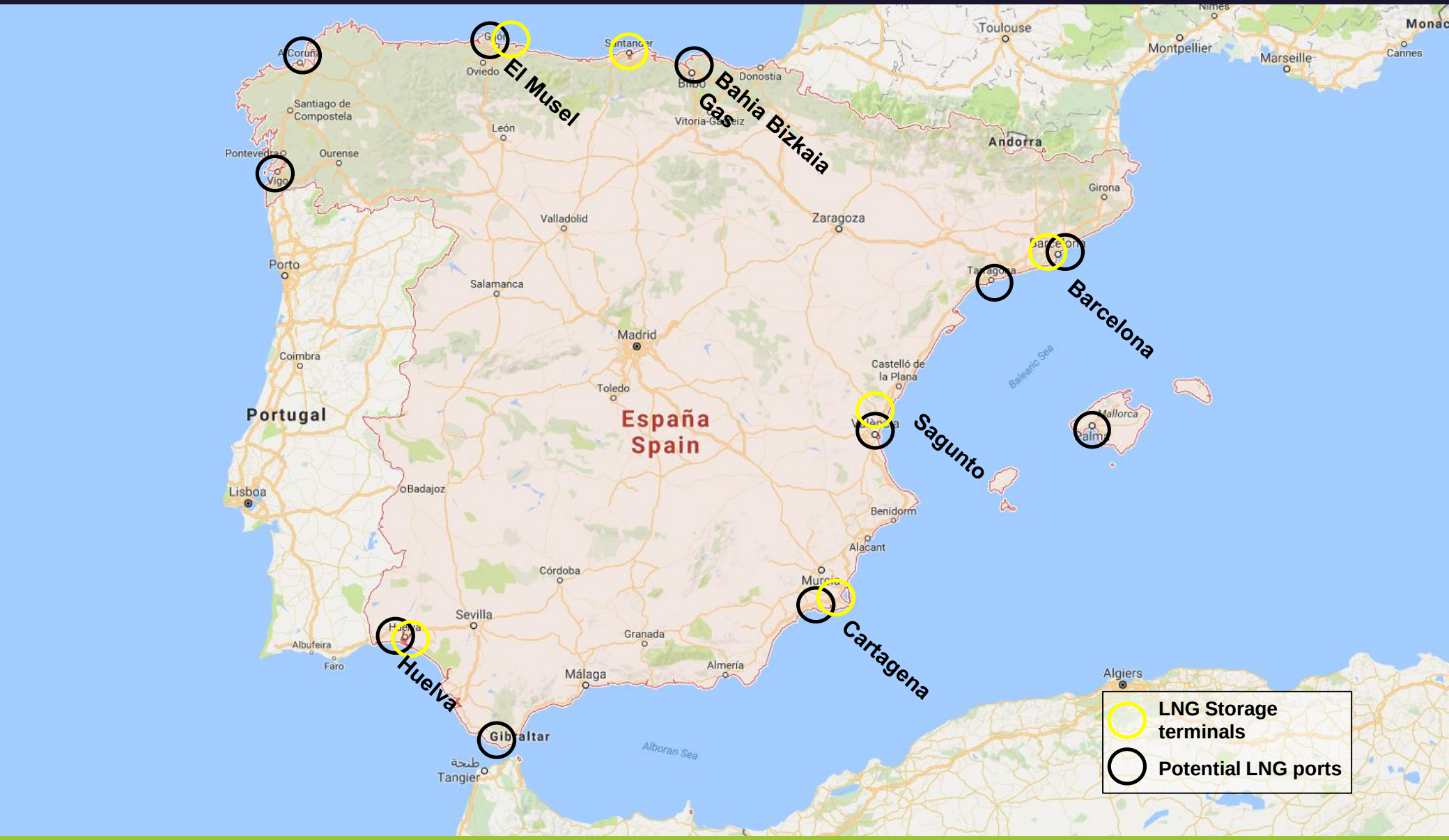
LNG Future availability South Europe

	Number of ports
France	6
Spain	12
Portugal	3
Italy	15
Croatia	1
Greece	6

More than 51 line companies are servicing south Europe

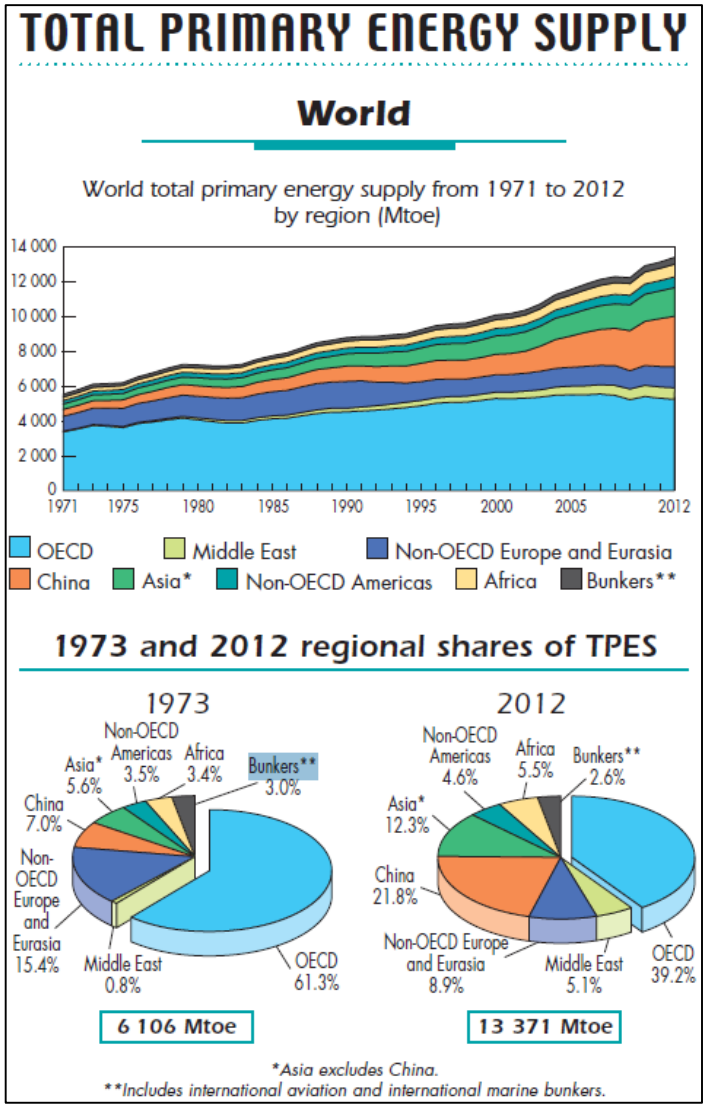


LNG Availability and bunkering opportunities SPAIN



INTERNATIONAL KEY DRIVERS “FUELING” THE LNG BUNKER BUSINESS

Top-down understanding of marine bunker conversion potential

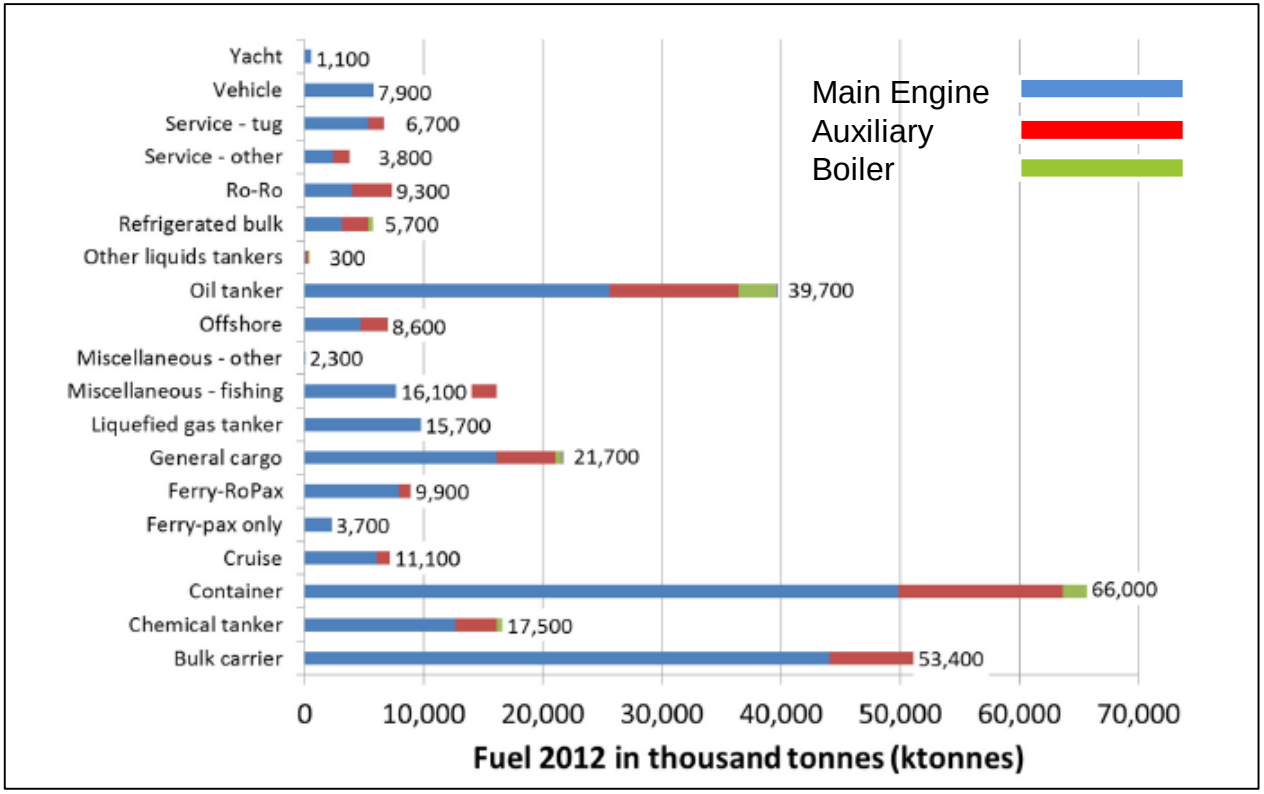


App 250 mill tons marine bunker pr. year

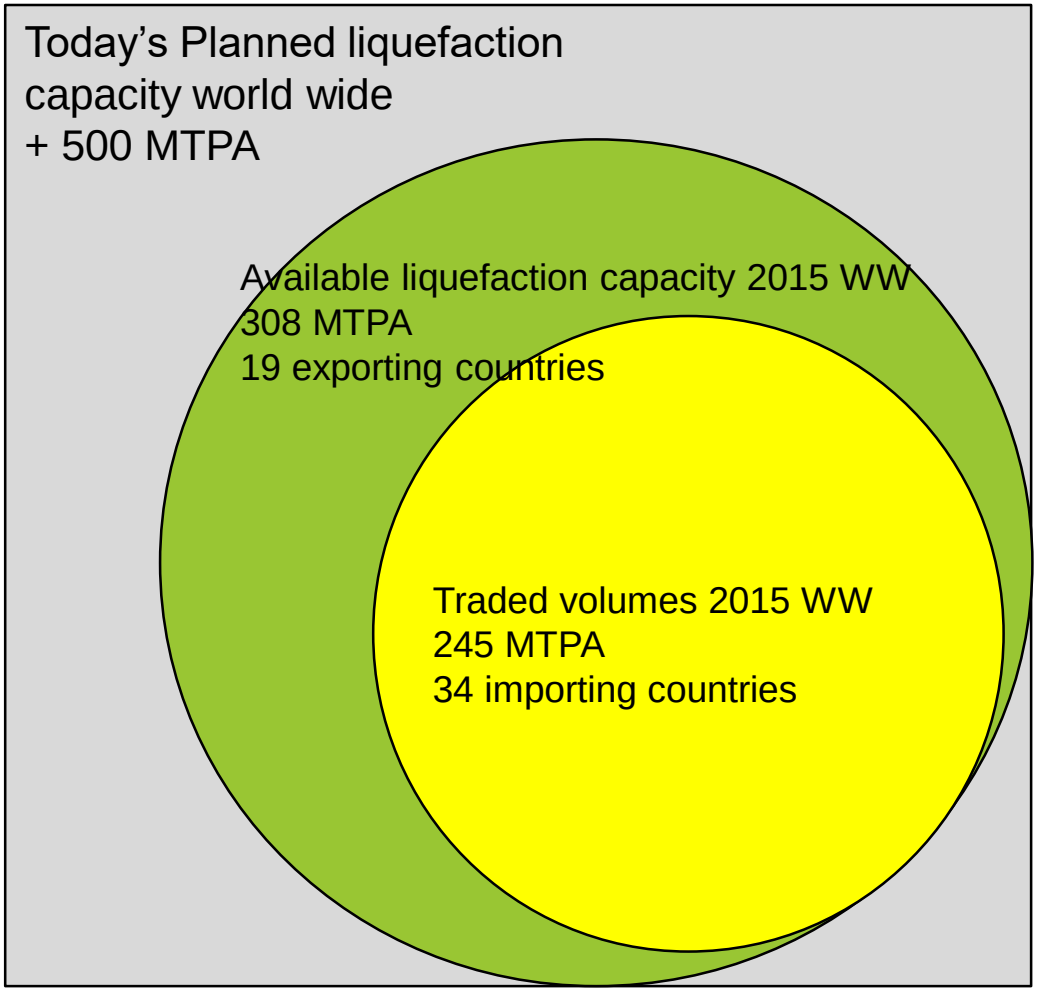
82 % is international
- 85 % is HFO
- 15 % is MDO/MGO

18 % is domestic
- 31 % is HFO
- 69 % is MDO/MGO

Source: IEA and IMO



Todays LNG capacity -2015



Unutilized liquefaction capacity
+50 MTPA

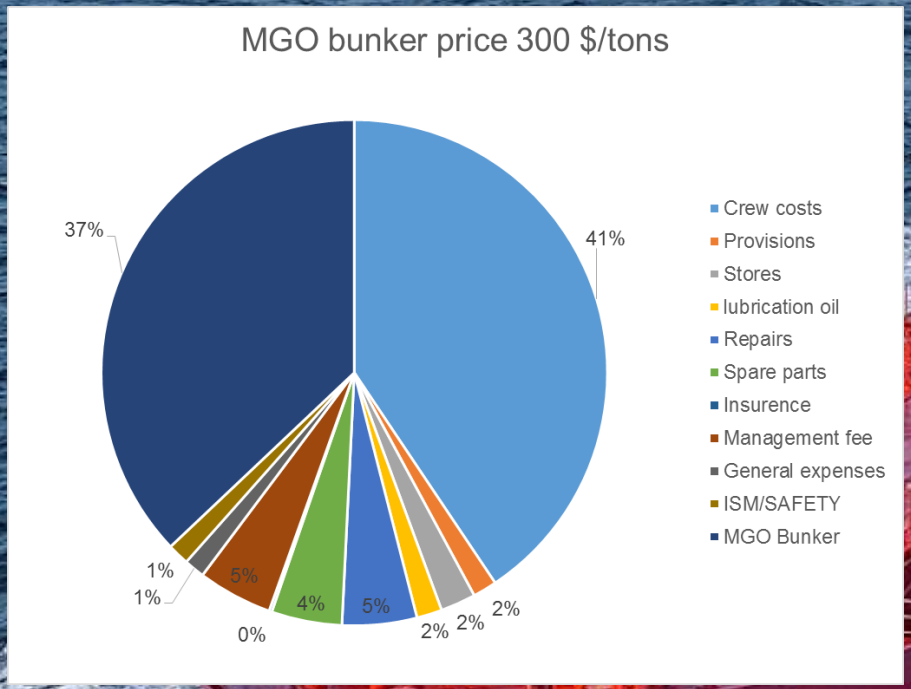
LNG available in 53 Countries'

449 LNG Vessels
64 Million Cubic Meters

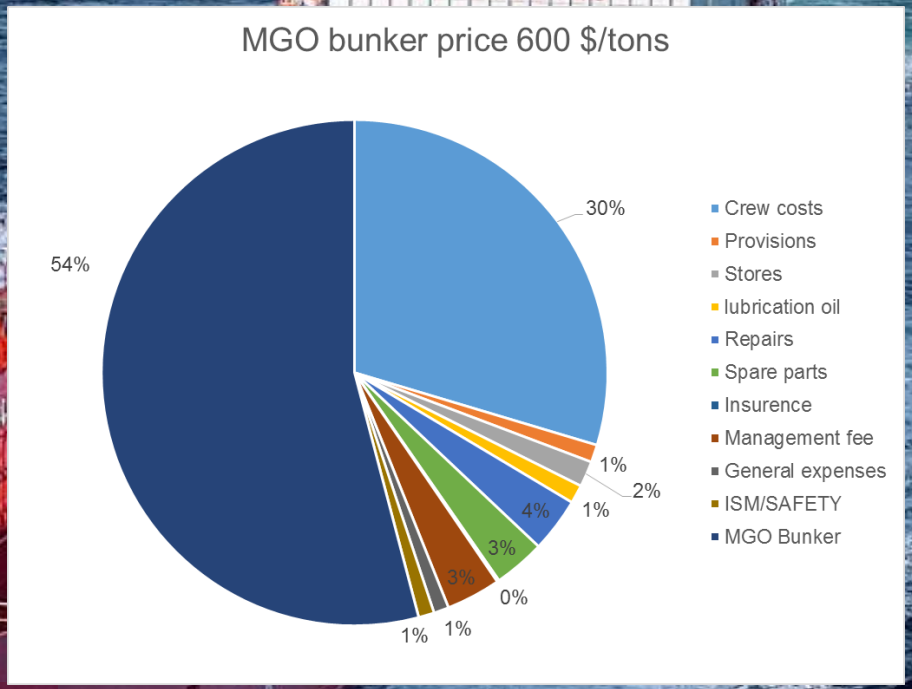
Are energy costs important for vessel owners and charterers ?

Business case:

Tank vessel:	15.000 m^3 capacity	Crew of 18 seamen
Main Engine MCR:	4.000 kW	
Engine efficiency:	45 %	
Days at sea:	260 days	
Yearly fuel consumption	4.600 tons MGO/year >> 55.000 MWh/year	



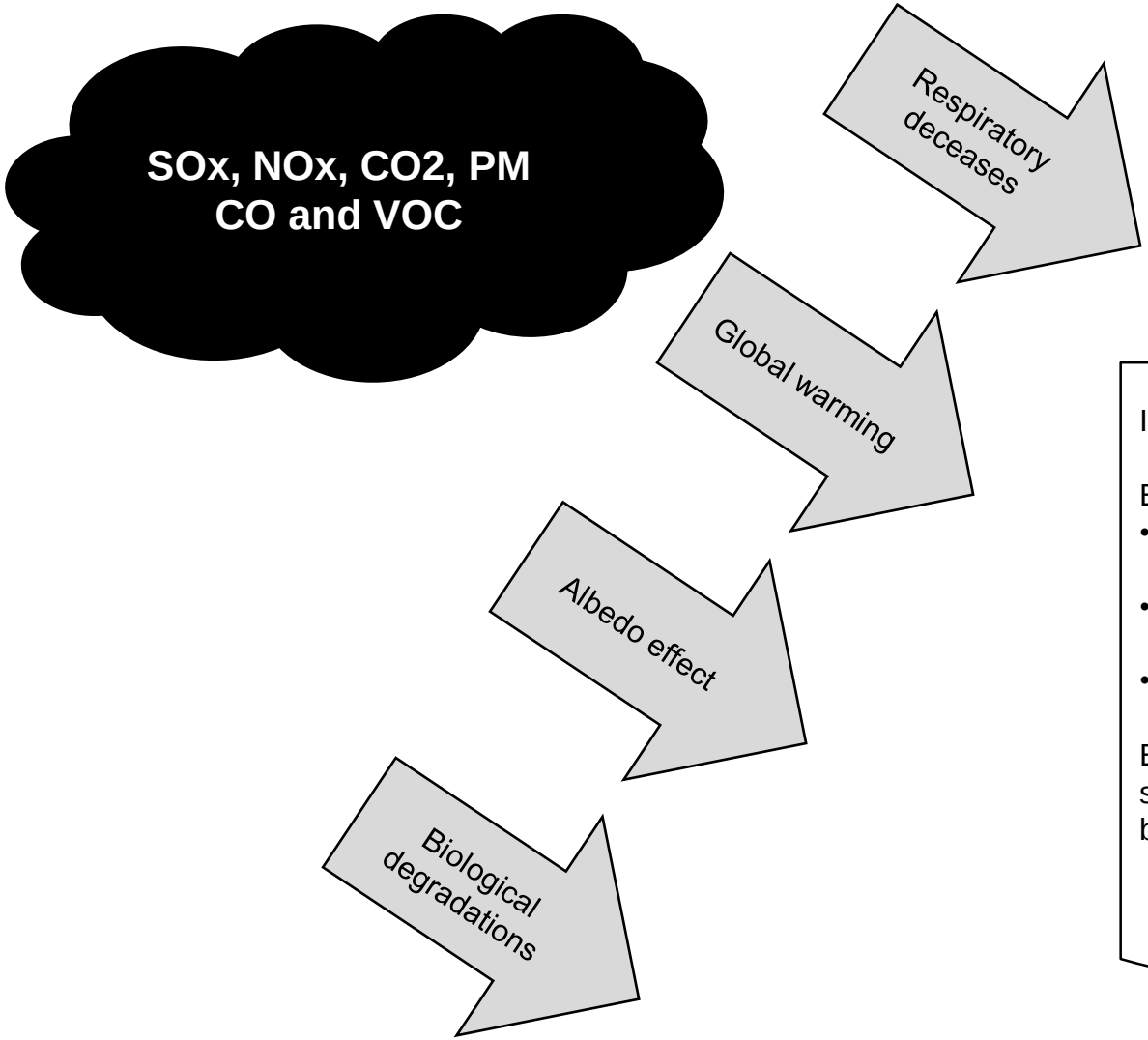
3.772.819 $/year



5.171.139 $/year

Data source: Thome Ship Mgmt. Singapore
Energy calculations MovingEnergy

Maritime emissions raises relatively – as a result more attention from governments and the public



IMO - MARPOL Annex VI

EU strategy:

- Monitoring, reporting and verification of CO2 emissions from large ships calling EU ports
- Greenhouse gas reduction targets for the maritime transport sector
- Further measures

EU's CO2 emissions from maritime transport should be cut by at least 40% from 2005 levels by 2050

Drivers in the LNG Bunker supply chain

1. Terminal loading feeds
2. Distance to LNG Loading point
3. Bunker scheduling flexibility
4. Bunker volume
5. Bunker connection speed
6. Bunker speed
7. Bunker frequency
8. LNG temperature
9. Methane release during bunker
10. System Interaction between vessel and shore (IGF/ESD)

CAPEX and OPEX
all depends on type of supply chain and specific vessel LNG bunker needs

Various supply chains

Trailer **T**o **S**hip
Ship **T**o **S**hip
Port **T**o **S**hip
Trailer + **P**ort **T**o **S**hip

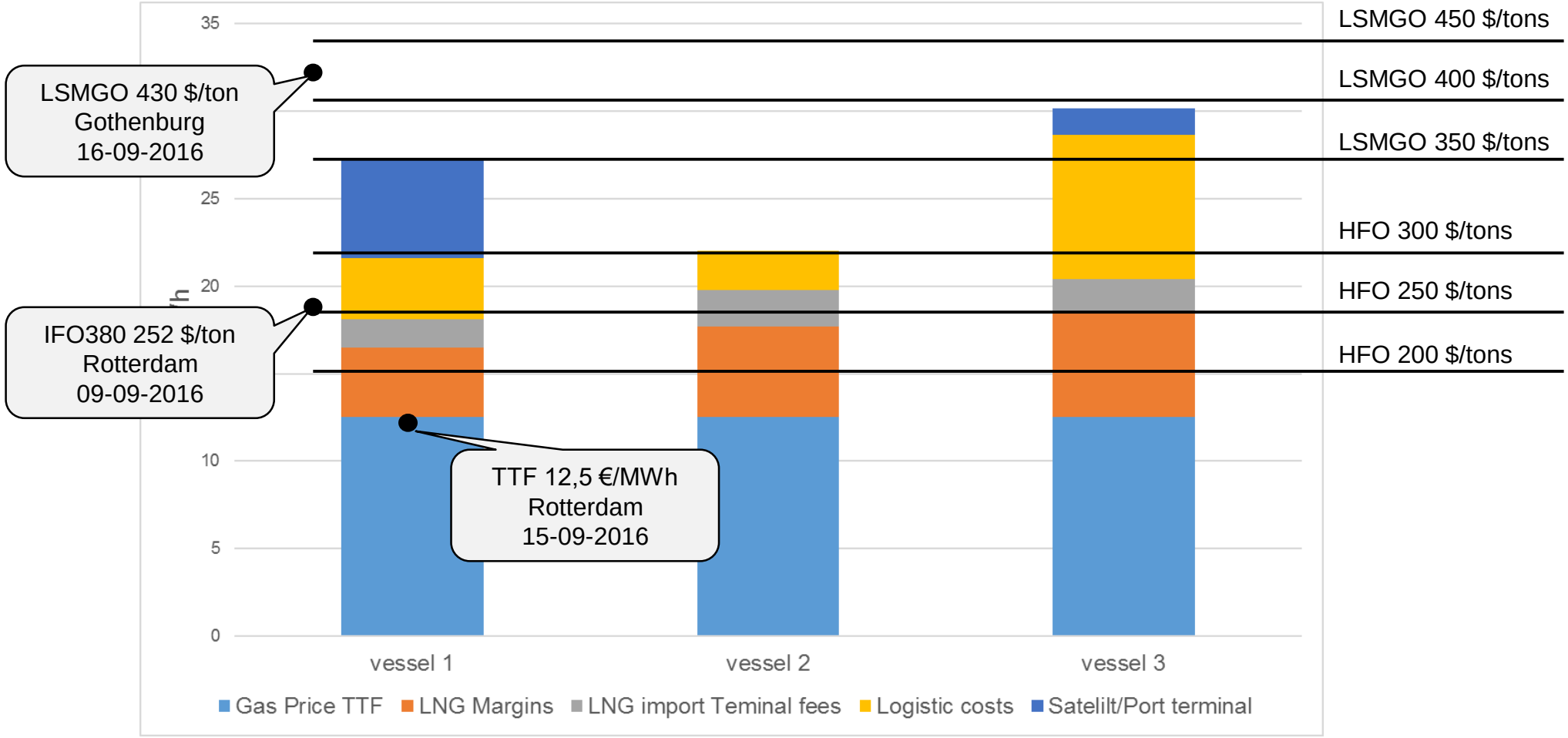
VS.

Vessels LNG bunker needs

To be analyze when vessels are built or converted

Bunker prices
- LNG bunker supply chain analysis Q2 2016

CAPEX and OPEX translated
into LNG pricing elements

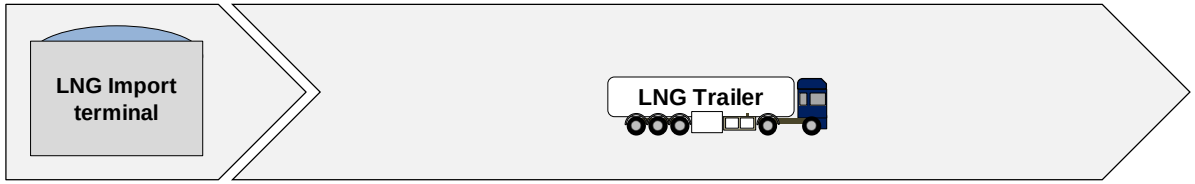


DANISH LNG DEVELOPMENTS

LNG Supply chain
- 3 scenarios distributing LNG to maritime industry

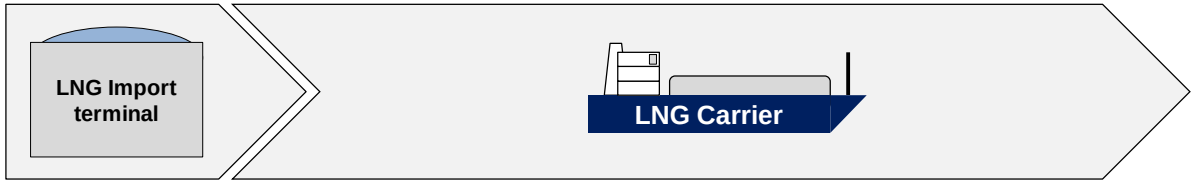
Scenario 1: 100 % LNG Trailer/container distribution

1. Zeebrügge
2. Rotterdam
3. *Swinousje*
4. *Klaipedia*



Scenario 2: LNG Ship distribution

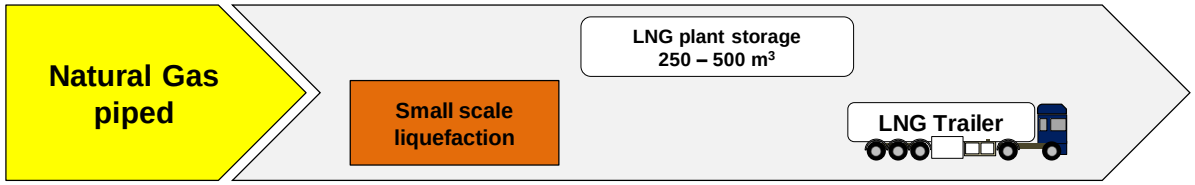
1. Zeebrügge
2. Rotterdam
3. Klaipedia
4. *Swinousje*

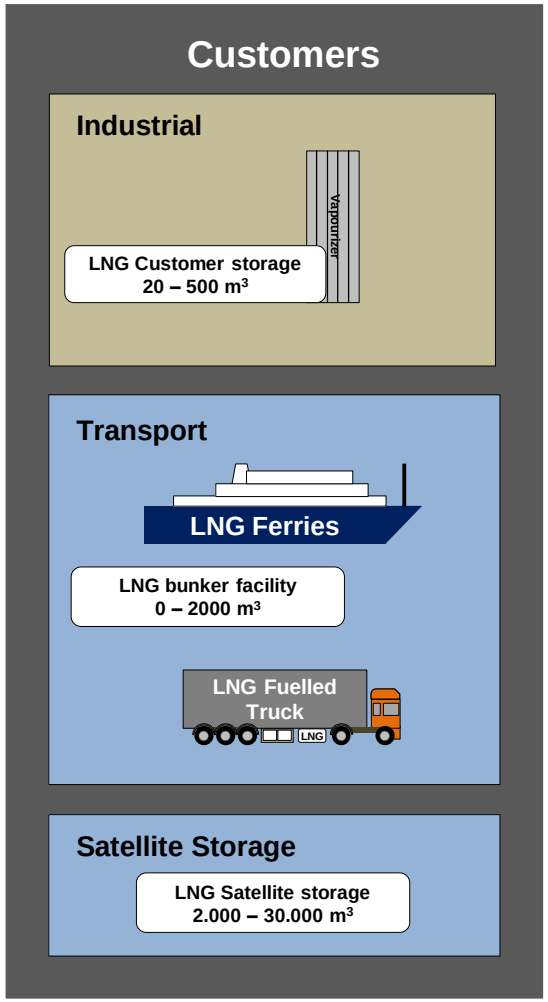


Scenario 3: Local LNG production + LNG Trailer distribution

Transmission grid
1. TSO

Distribution grid
1. Locale



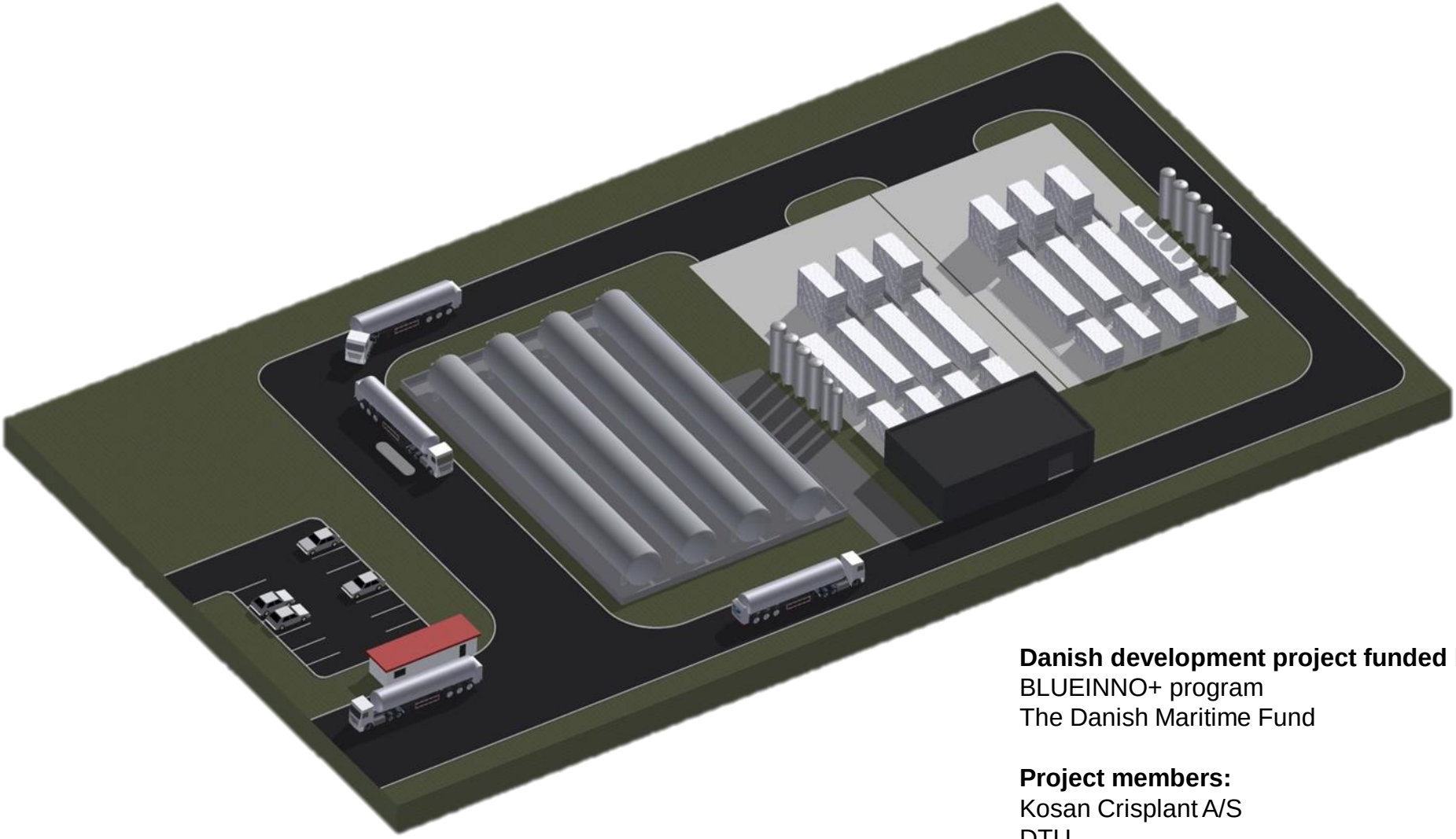


Largest possible LNG port project (PTS)
…….before Seveso II and full Environmental impact assessment

- LNG Storage in Denmark 500 m3 >> 200 tons (below SEVESO 2)
- To bunker Fjordlines 2 LNG ferries Bergenfjord and Stavangerfjord
- Yearly consumption each ferry app. 12.500 tons of LNG

LNG self-service at the “forecourt”
- The ferry to Samsoe “Princesse Isabella”

Local LNG production – PTS/TTS/STS
- for countries having exploration and surplus of NG or BG



Danish development project funded by:
BLUEINNO+ program
The Danish Maritime Fund

Project members:
Kosan Crisplant A/S
DTU
MovingEnergy

Denmark - Port of Frederikshavn
- local LNG production directly at the harbor

> Operational by end of 2017 > Ready to supply LNG/LBG to the maritime industry in Scandinavia

> Modular design allowing you to grow-as-you-go

> Fully automatic facility

> The plant can be started or stopped in less than one hour and set to run with variable output to accomodate short-term demands

> Limited footprint > Approx. 10,000 m²

> Low OPEX combined with high efficiency (0.6 kWh/kg of LNG)

> Versatile solution > Excess heat can be used in the district heating network

STS - module design in combination focus on LNG 3.900 – 7.500 m3

Modular design:
Version B: 3.900 m^3 LNG in 2 bilobed tanks + 500 m^3 MGO in 2 center tanks

3 section design:
1 aftship design including accommodation and engine room
1 centership design including “cargo hull”
1 forship design including bow thruster and winches

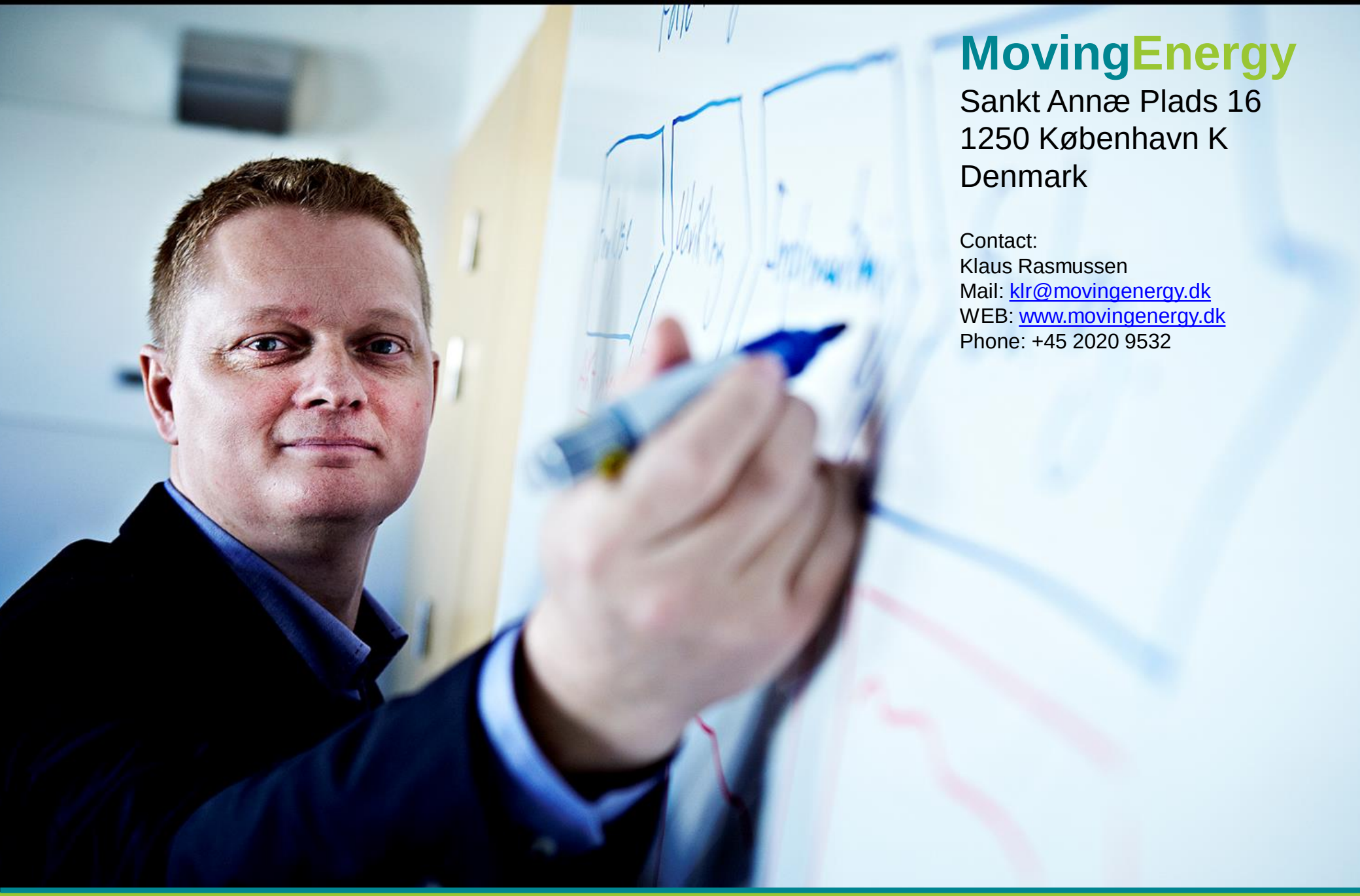
Main particulars:

Length overall:	95,3 m
Breadth mid.	18 m
Design draught:	3,5 m

Propulsion:
2XWärtsila 6L20DF
2 steerable thrusters + 1 bow thruster

Accommodations:
9 crew

Source: Odense Maritime Technology A/S



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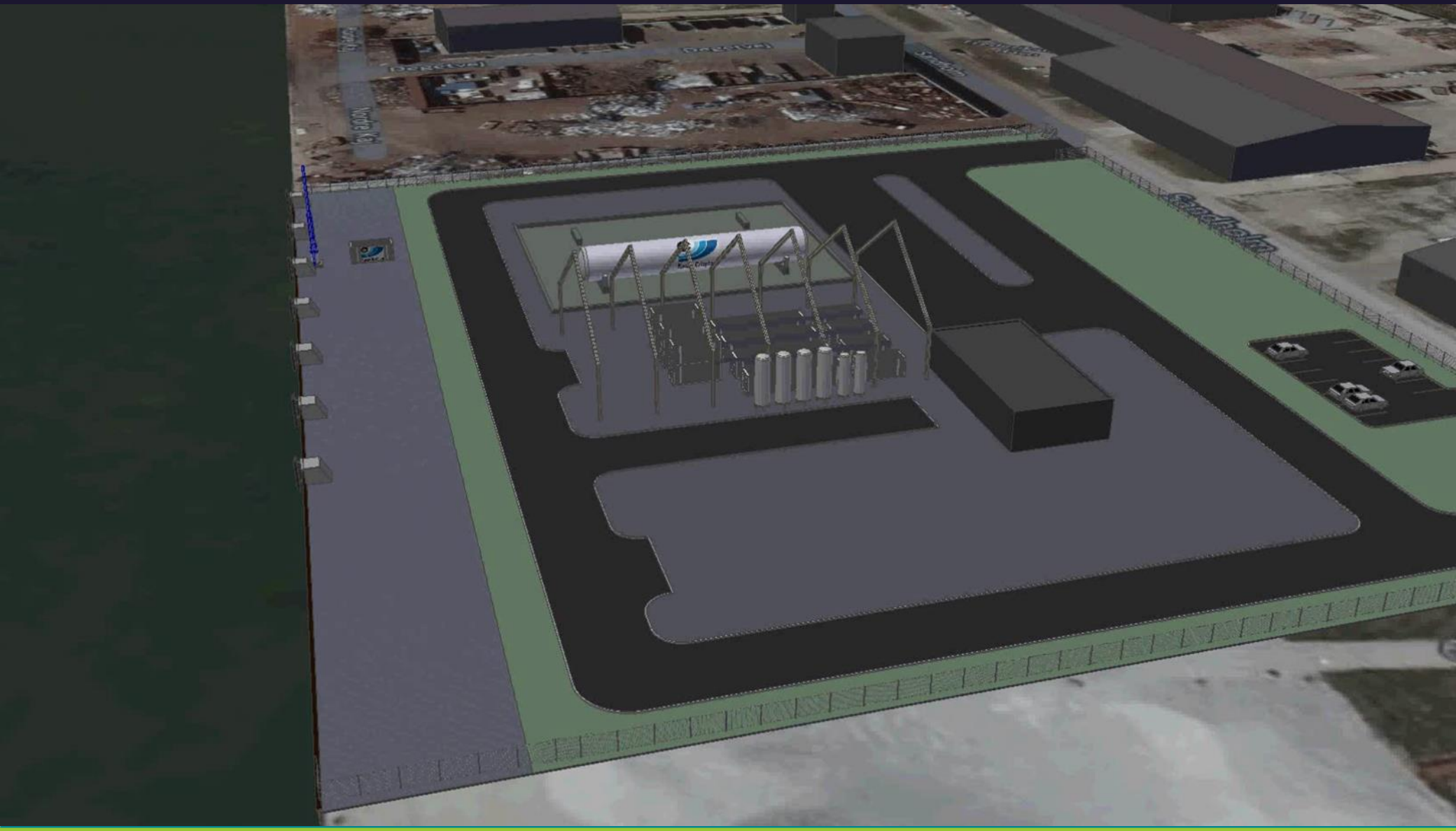
APPENDIXES

Port of Frederikshavn
- Latest update on stage 2 – 150 tons/day



Every LNG salesman's dream

MAERSK MC KINNEY MOLLER >> 18.000 TEU

- Propulsion engines: 2X32 MW
- Daily fuel consumption: App. 3 GWh LHV

Equivalent to……. app. 500 m^3 LNG/day