

LNG KASUTAMINE TRANSPORDI KÜTUSENA

SISUKORD

1. Eesti Gaasi tutvustus
2. Mis on LNG?
3. LNG kasutamine meretranspordis
4. LNG kasutamine autotranspordis
5. LNG kasutamise teised perspektiivid
6. Kokkuvõte



EESTI GAAS IN BRIEF



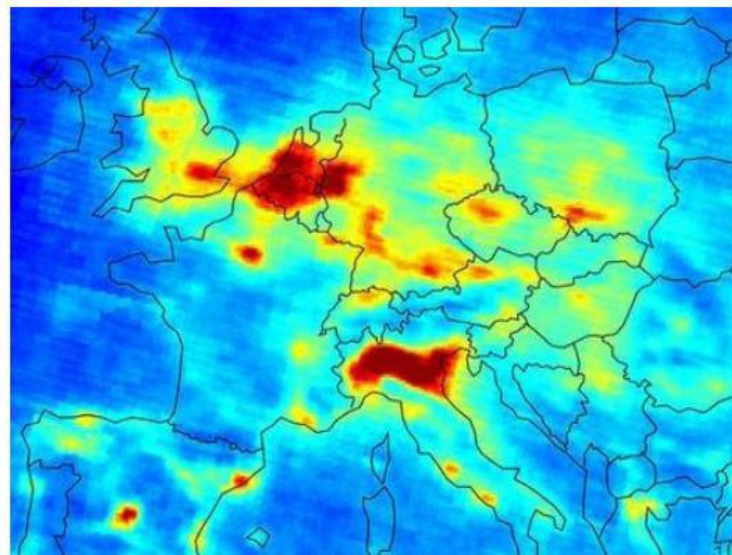
1. Asutatud 1993.
2. Maagaasi, elektri, CNG ja LNG müük.
3. Gaasijaotusvõrgu omanik (1 500 km).
4. Kaks tütarettevõtet:
 - Gaasivõrgud (gaasijaotusteenus),
 - EG Ehitus (ehitamine).
5. Tulud 2016. a 116 mil EUR.
6. Töötajate arv - 217 (november 2017).
7. Enamusomanik - INFORTAR AS (al. aprillist 2016).

MIS ON LNG?



- Veeldatud maagaas (liquified natural gas - LNG) on maagaas, mis on jahutatud kuni veeldumistemperatuurini -162°C . Veeldamisel väheneb maagaasi ruumala ligikaudu 600 korda.
- LNG tihedus on ligikaudu 450 kg/m^3 (lõhnatu, värvuseta vedelik).
- LNG ei ole mürgine, kuid metaani atmosfääris viibimine on inimesele eluohtlik lämbumissümptomite tekkimise kiiruse tõttu.
- Peamised riskid seotud gaasi tule- ja plahvatusohtlikkusega (plahvatusohtlik gaasi kontsentratsioon õhus on vahemikus ca 5...15%).

LNG KASUTAMISE KESKKONNAMÕJU



Envisat, ESA

NO₂ tropospheric column density [10^{15} molec./cm²]



Attack the invisible killer: premature deaths from air pollution estimated at 420,000 in 2010 (EC)



HEAVY FUEL OIL
3.5% Sulphur



MARINE GAS OIL
0.1% Sulphur



LNG

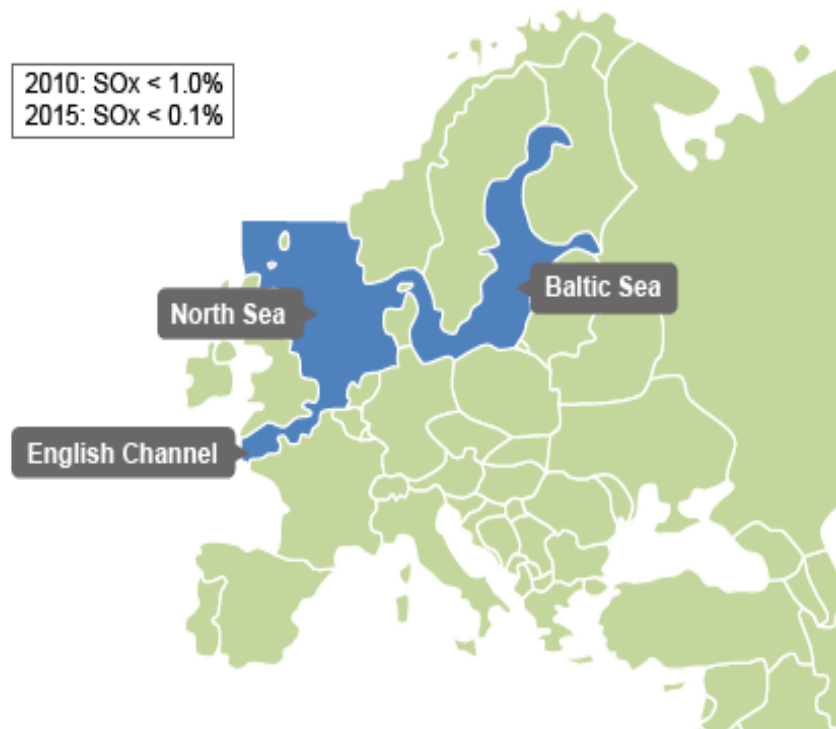
- 0% Sulphur
- Particulate matter: negligible
- Up to 90% less NO_x
- Up to 25% less CO₂

[European Commission SWD 2013 4]

IMO MARPOL NÕUDED

- Laevakütusele väävlisisaldus peab Läänemerel olema alla 0,1 % (IMO, 2015).
- ~14000 laeva – 12 mln tn/aastas
- Ülemaailmne laevakütuste väävlisisalduse piir 0,5 % jõustub alates 2020 (IMO, 2016).

SOx Emission Control Areas

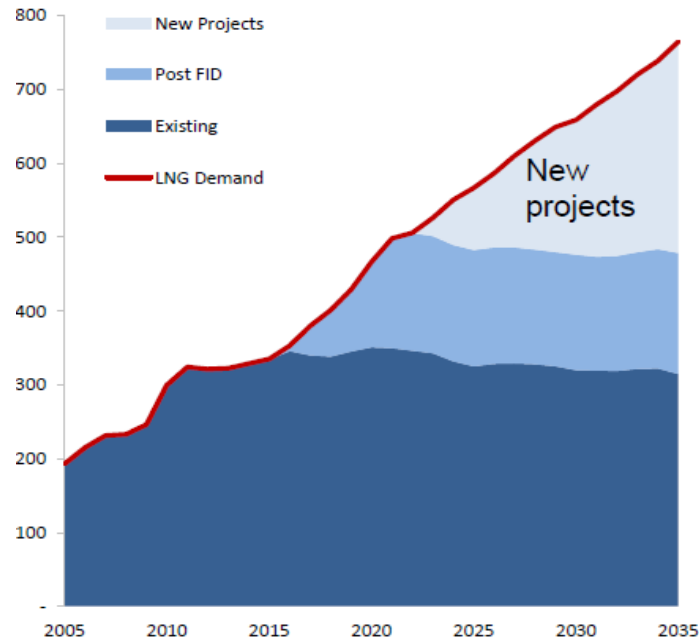


Source: International Maritime Organization

LNG TOOTMISE JA TARBIKUMISE PROGNOOS

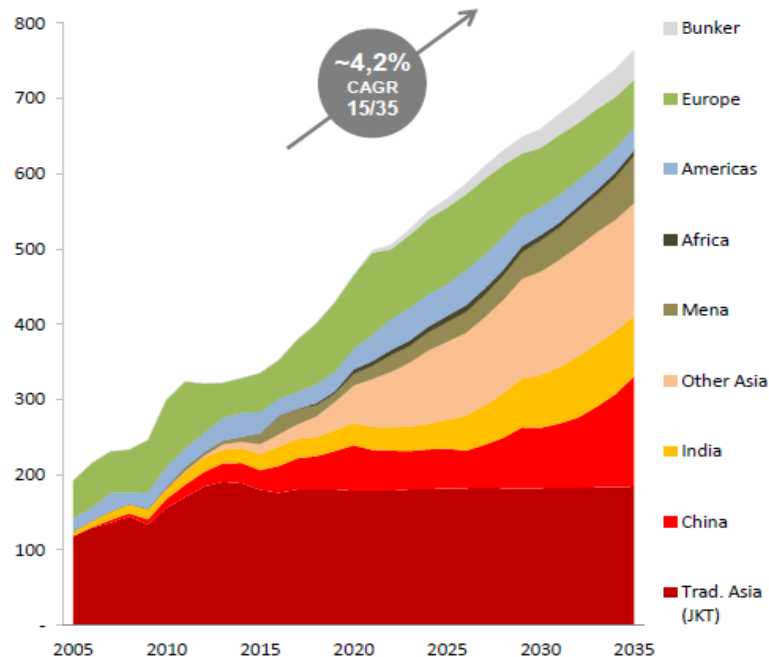
LNG Supply

Bcm

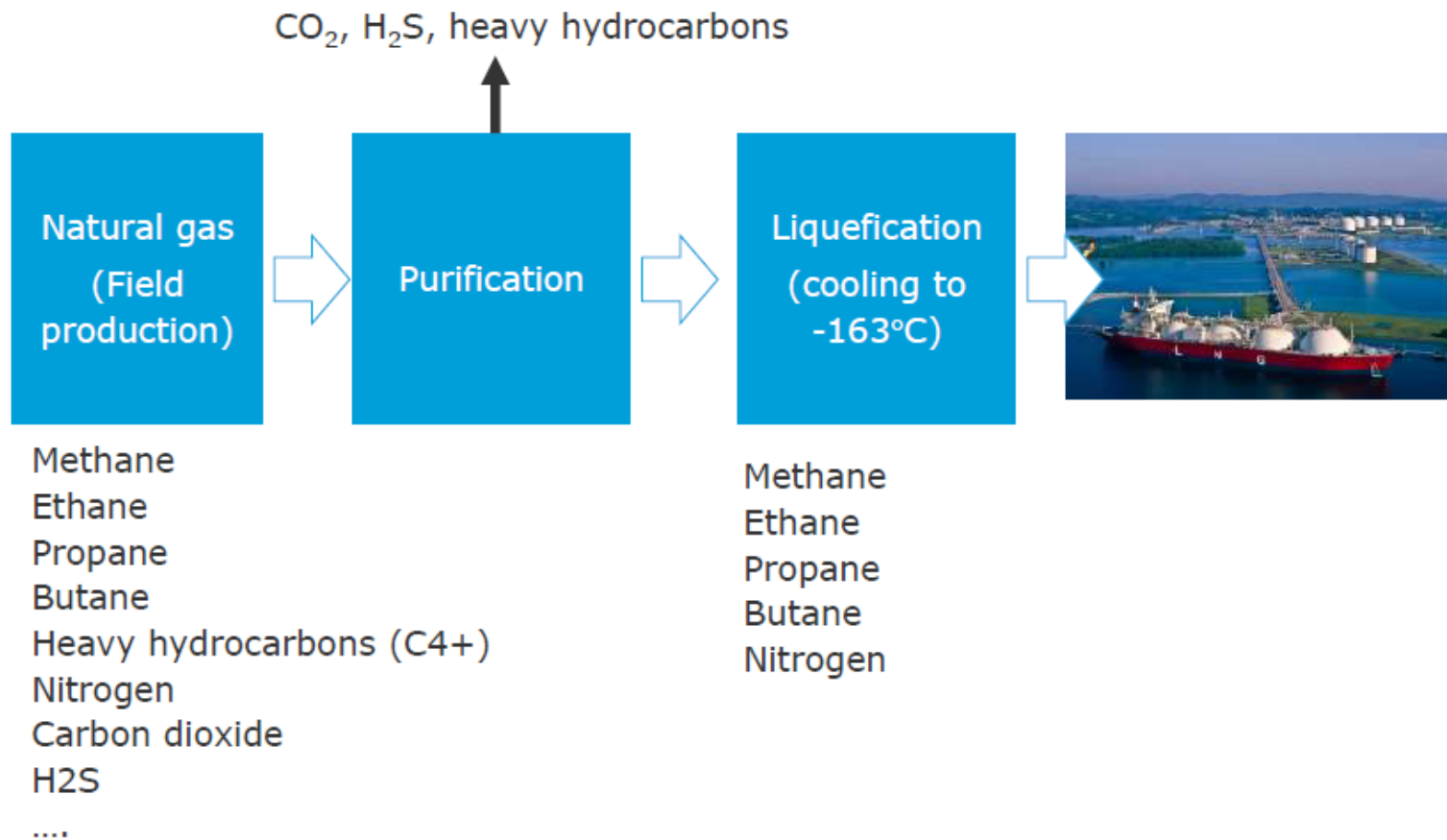


LNG Demand

Bcm



LNG TOOTMINE



LNG TOOTMISTEHAS



Norra, Hammerfest,
Statoil LNG tootmistehas Snøhvít (*Snow White*), 4,2 mln tn/a



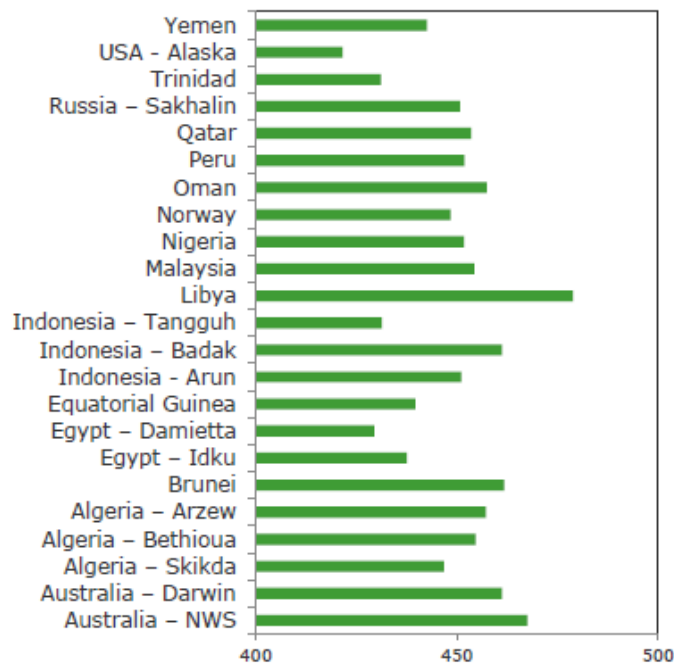
Venemaa, Pihkva,
Криогаз LNG tootmistehas, 0,02 mln tn/a

Summaarne LNG veeldamisvõimsus maailmas: 241 mmtpa (35 tehast).

15 uut projekti erinevates astmetes. Kokku see moodustab umbes 10% tervest maailma gaasitootmisest.

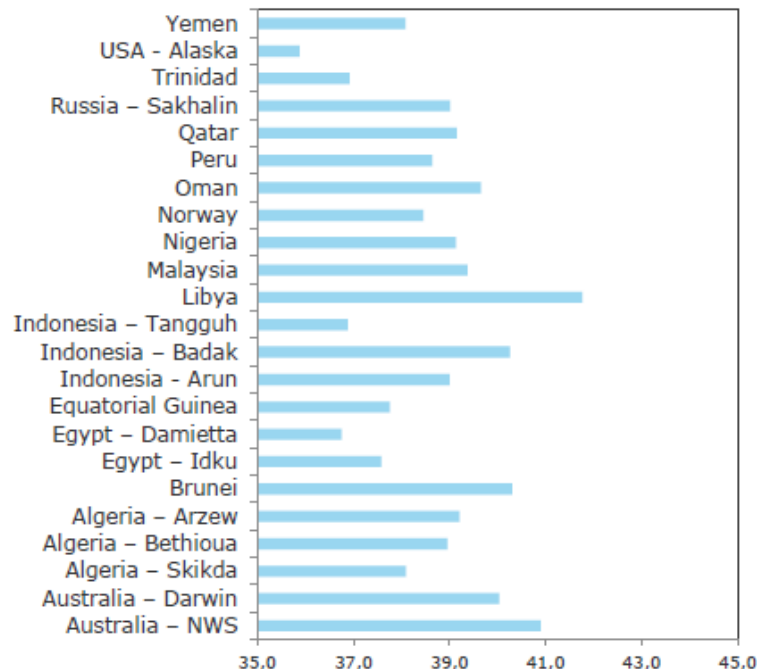
LNG moodustab samuti 30% rahvusvahelisest gaasi kaubandusest.

LNG KVALITEET



Density, kg/m³

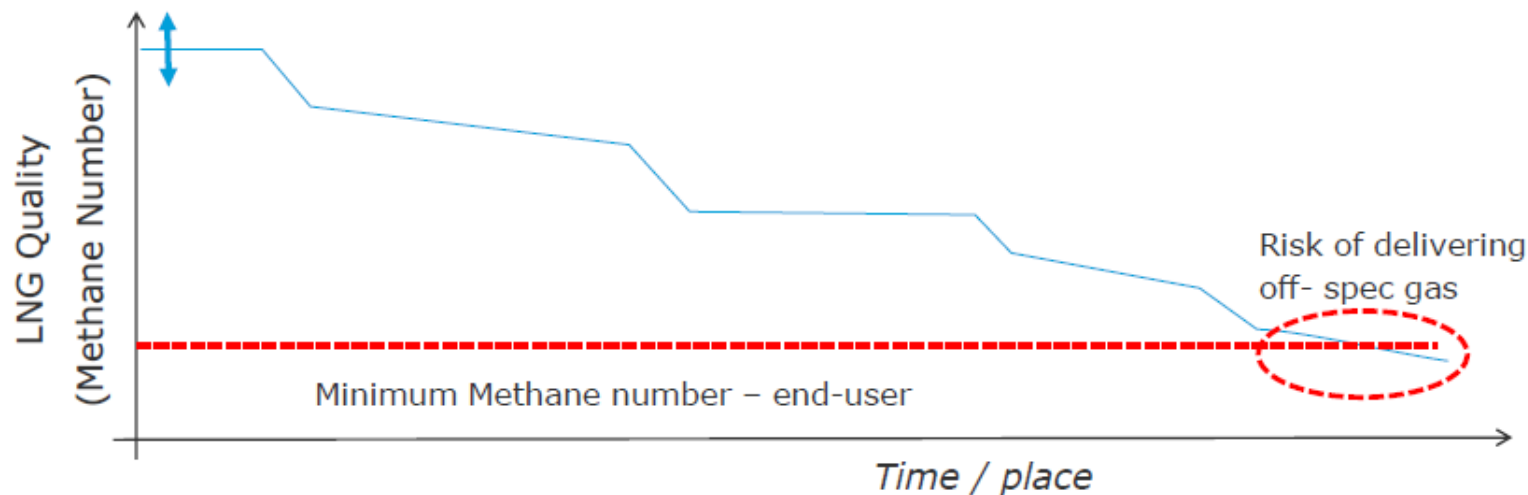
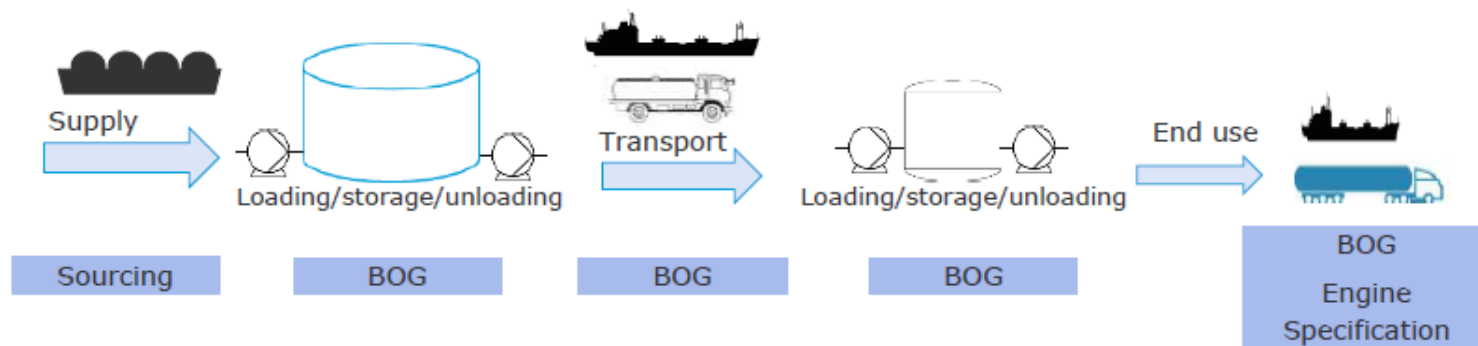
12% variation



Lower calorific value, MJ/m³(n)

17% variation

LNG KVALITEET – METHANE NUMBER



CNG/LNG - DIISLIKÜTUSE ALTERNATIIV



Cars, vans, light trucks, city buses, urban cleaning trucks and heavy trucks with short routes.

Long haul trucks, coaches, rail and vessels ships and marine applications

CNG



LNG



LNG MERETRANSPOORDIS

199 LNG fuelled ships globally

- 112 ships in operation
- 87 being built

North America (31)

- ✓ 13 in operation
- ✓ 18 being built

South America (21)

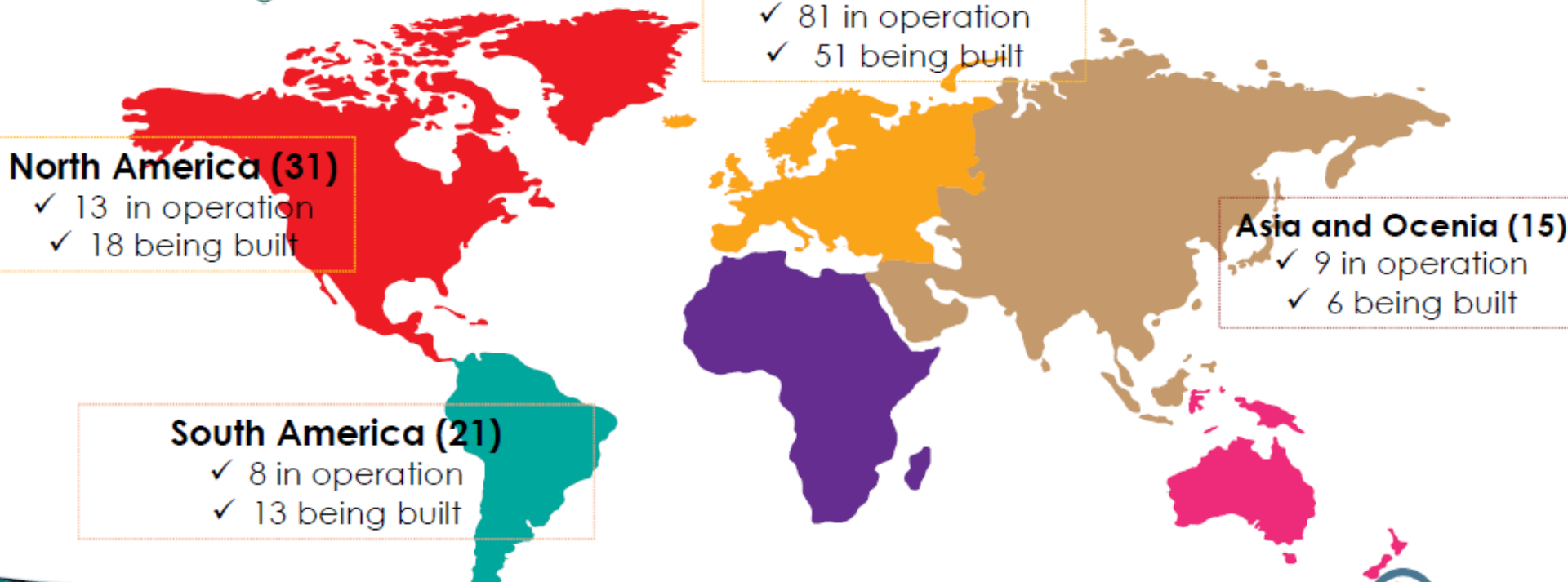
- ✓ 8 in operation
- ✓ 13 being built

Europa (132)

- ✓ 81 in operation
- ✓ 51 being built

Asia and Ocenia (15)

- ✓ 9 in operation
- ✓ 6 being built



LNG KUI LAEVAKÜTUSE EELISED

Kahjulikud atmosfääriemissioonid:

- SO_x praktiliselt puudub
- PM praktiliselt puudub
- NO_x väheneb 90...95%
- 25% väiksem CO_2 kogus
- HFO-ga ja MGO-ga võrreldes 20% madalam kütusekulu
- MGO-ga võrreldes madalam hind
- Puhas põlemisprotsess – puhas põlemiskamber – väiksemad remondi- ja hoolduskulud

ERINEVATE KÜTUSTE ENERGILINE VÄÄRTUS

Fuel	Energy density, GJ/m ³
HFO	41.20
MGO	35.68
Biodiesel (E20)	32.61
Gasoline	30.38
LPG	23.41
Ethanol (E85)	22.30
LNG	20.49
Methanol (M85)	15.61
CNG	9.20
Liquefied hydrogen	8.50

LNG HOIDMINE LAEVAS

- Tihedus 2x väiksem, kui vedelkütustel, seega teoreetiliselt võtab samaväärne LNG kogus naftakütustega võrreldes 2x rohkem ruumi.
- Temperatuur -162°C . Aurumise vältimiseks tuleb hoida kahekordse seinaga ja vaakum-perliit-isolatsiooniga mahutites, enimlevinud on C- tüüpi silindrilised mahutid rõhu all kuni 8 bar.
- Mahutite paigutamisel laeva sisse peavad need asuma eraldi ventileeritavas ruumis, parrastest eemal vähemalt $1/5$ laeva laiusest. Kokkuvõttes nõuab vajaliku koguse LNG paigutamine laeva keres olevaisse mahutitesse **3...4 korda suuremat ruumi võrreldes vedelkütustega.**

35000 m³ oil tanker newbuilding



Option 1: Conventional propulsion

- Capex=0 M€
- Opex=3,3 M€/año

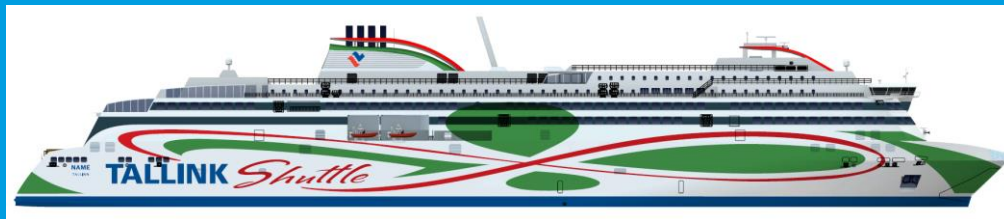
Option 2:Scrubber

- Capex=2,3 M€
- Opex= 2,95 M€

Option 3:LNG

- Capex=5,1 M€
- Opex = 1,63 M€

MEGASTAR – UUS LNG LAEV



MEGASTAR

Built in: Meyer Turku Shipyard

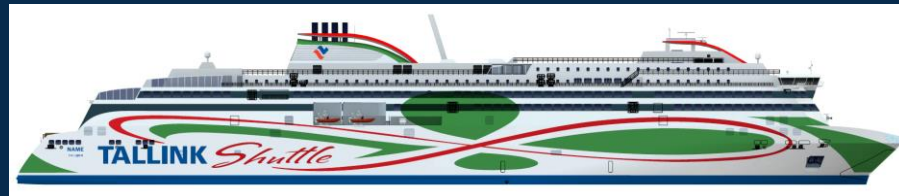
Gross tonnage: 49 000

Length: 212 meters

Capacity: 2800 passengers, 800 cars

Engine: Dual fuel (LNG/MGO)

Service speed: 27 knots



LNG powered fast ferry for the Tallinn - Helsinki shuttle service



The vessel cost is app. EUR 230 million

Production of the vessel started on 4th of August 2015.

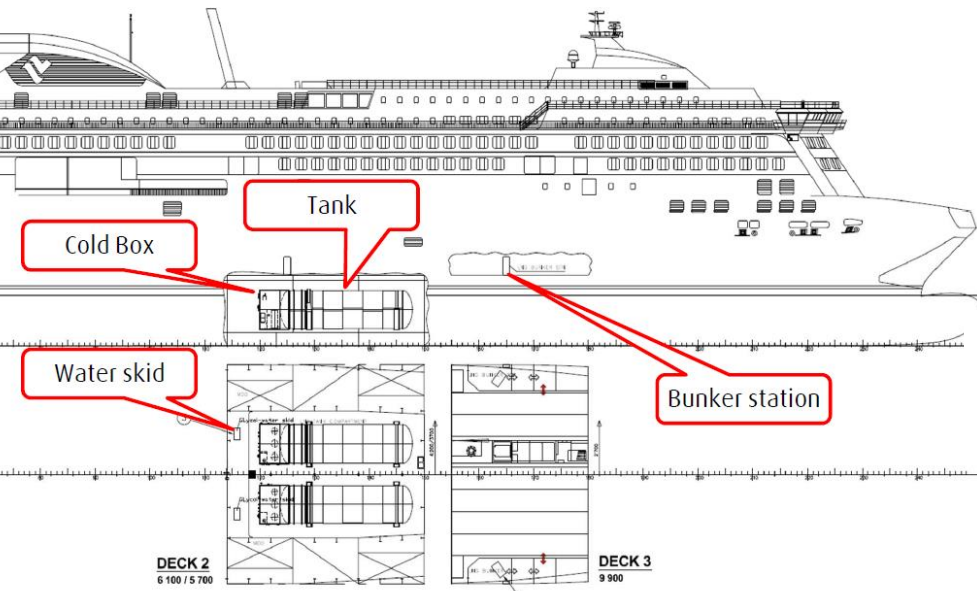
In operation since 30th of January 2017



Co-financed by the European Union

Connecting Europe Facility

LNG punkerdamise tehn. andmed

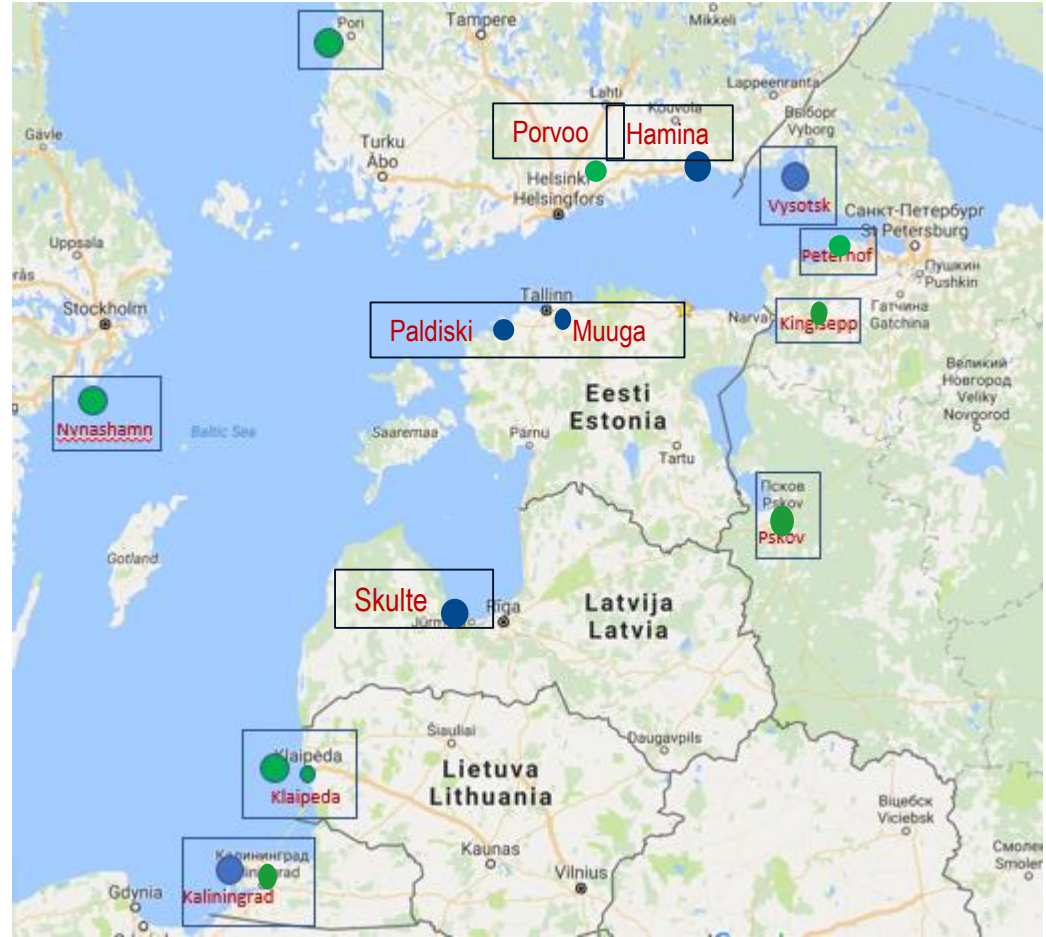


- Gross volume, warm: 301 m³ per tank
- Net cold volume 285 m³ per tank
- Max filling ratio: 90 %/95 %
- MAWP 9 barg
- Normal working pressure 4-6.5 barg
- Vaporizer capacity (max withdrawal) 2000 kg/h per tank system
- Bunkering flow, max 300 m³/h
- Bunkering pressure, max 8 bar

LNG TARNEALLIKAD

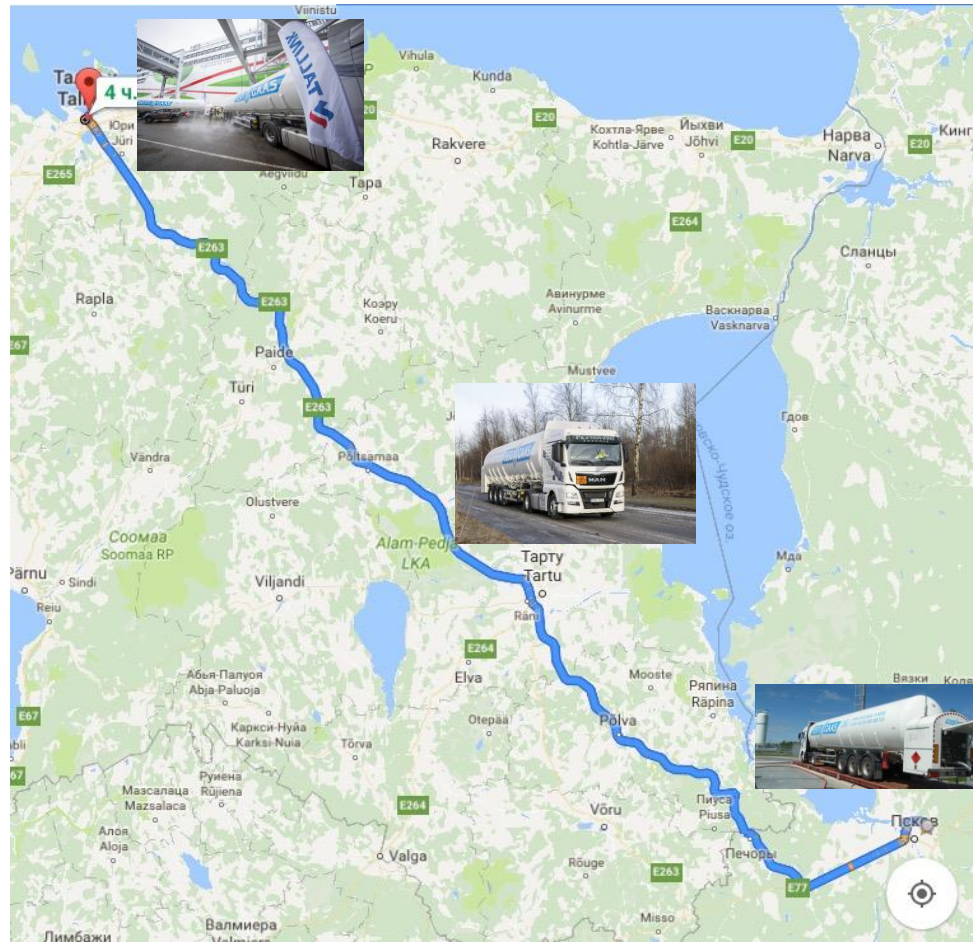
- Mitmed LNG tootmistehased ja terminalid Läänemere regioonis.

- töös
- planeeritud



LNG TARNED MEGASTARILE

- Eesti Gaas tarnib LNG peamiselt Pihvast (2x350 km, 24h).
- Osa tarneid on tehtud ka Soomest (Pori terminal) ja Poolast (Swinoujście terminal).

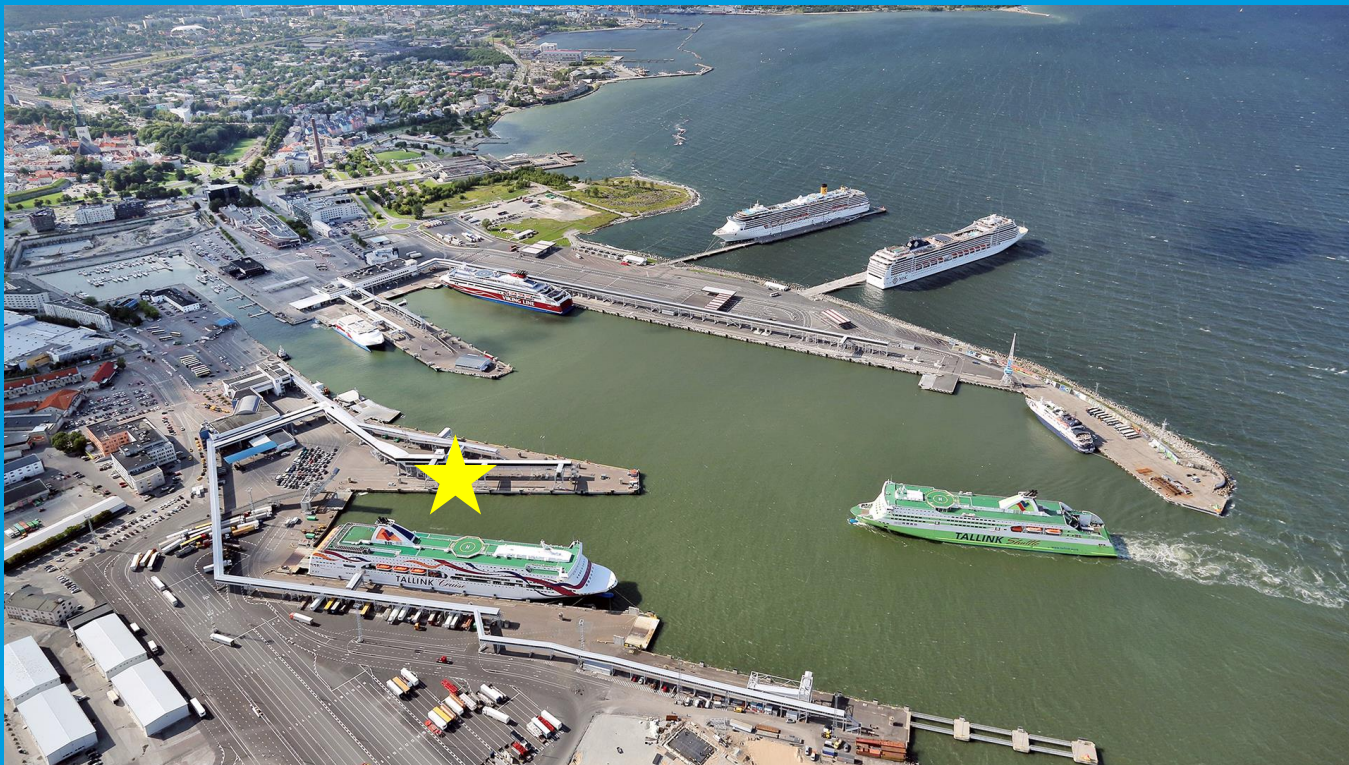


LNG POOLHAAGISED



- Eesti Gaas omab 8 GOFA poolhaagist LNG transportimiseks ja punkerdamiseks
- Iga poolhaagis on varustatud Cryostar 1000 l/min krüo-pumpaga

PUNKERDAMISE ASUKOHT



Vanasadam
Tallinn,
Kai Nr 5

TRUCK-TO-SHIP (TTS) PUNKERDAMINE



Punkerdamine toimub 4 korda nädalas (öösi 2:00-6:00)
2-4 poolhaagist korraga (kuni 176 m³).

PUNKERDAMISE LÄBIVIIMISE OHUTUSREEGLID



- Operaatorid varustatud spets. tööriietega ja gaasianalüsaatoriga.





LNG AUTOTRANSPOORDIS

LNG TRANSPORDIVAHENDID

Veokid



Spets. tehnika



Bussid



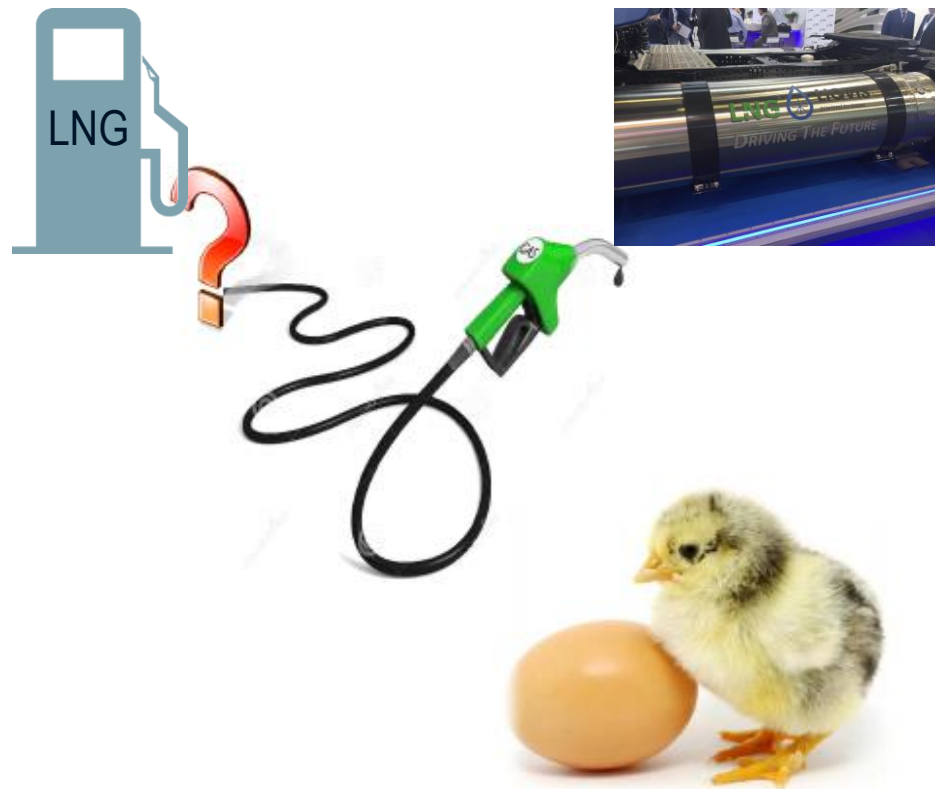
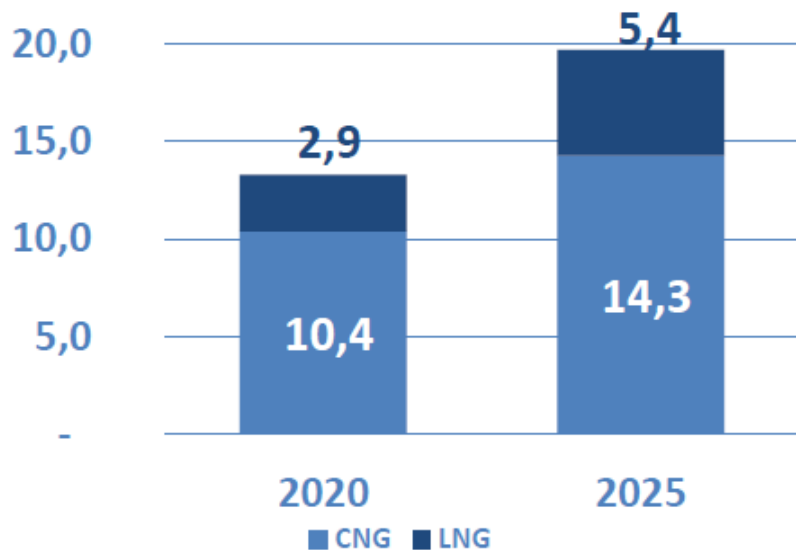
Prügiveokid



CNG/LNG TARBIMISE PROGNOOS AUTOTRANSPOORDIS

On-road transport

Gas demand in the road transport
(Europe in 2015-2025, bcm)



DISEL VS CNG VS LNG

DIESEL

1 Liter



=

CNG

~ 5 Liters (0.77kg)
CNG compressed @ 220bar



=

LNG

~ 1.5÷1.8 Liters
Liquid @ -162°C (0.41÷0.5 Kg/l)



LNG VÕRDLUS DIISLIKÜTUSEGA

CNG-LNG vs DIESEL Euro VI	
NOx Emissions	-54%
NO2 Emissions	-96%
CO2 Emissions	-10% (15 ton / truck / year)
Externalities (2009/33 EU)	-4 885 € (-14%)
Fuel consumption	-15% (kg vs litres)
ON BOARD EMISSION MEASUREMENTS (PEMS)	

BIO CNG-LNG vs DIESEL Euro VI	
NOx Emissions	-54%
NO2 Emissions	-96%
CO2 Emissions	-80% (-120 ton / truck / year)
Externalities (2009/33 EU)	-28 400 € (-80%)
Fuel consumption	-15% (kg vs litres)
ON BOARD EMISSION MEASUREMENTS (PEMS)	

■ Evolution of fuel system and tank capacity

FROM REGIONAL TO INTERNATIONAL TRANSPORTATION

2012

REGIONAL DISTRIBUTION
CNG 40T



AT CAB
RANGE: 450 KM
POWER: 330 HP
MANUAL TRANSMISSION

2013

INTER-REGIONAL ROUTES
C-LNG 44T



AT CAB
RANGE: 900 KM
POWER: 330 HP
MANUAL TRANSMISSION

2016

LONG-HAUL
DOUBLE LNG 44T



AS CAB
RANGE: 1,500 KM
POWER: 400 HP
EUROTRONIC AMT

2017

INTERNATIONAL
DOUBLE LNG 44-50 T



AS CAB
RANGE: 1,600 KM
POWER: 460 HP
HI-TRONIX-HI-CRUISE

IVECO

LNG TANKLAD JA VEOKID EUROOPAS

- > 1500 truck
- > 120 LNG fuelling stations



Country	CNG	LNG
 Austria	172	0
 Belgium	78	2
 Bulgaria	125	0
 Croatia	2	0
 Cyprus	0	0
 Czech Republic	143	0
 Denmark	15	0
 Estonia	6	0
 Finland	27	2
 France	51	8
 Germany	883	2
 Greece	10	0
 Hungary	10	0
 Ireland	1	0
 Italy	1178	10

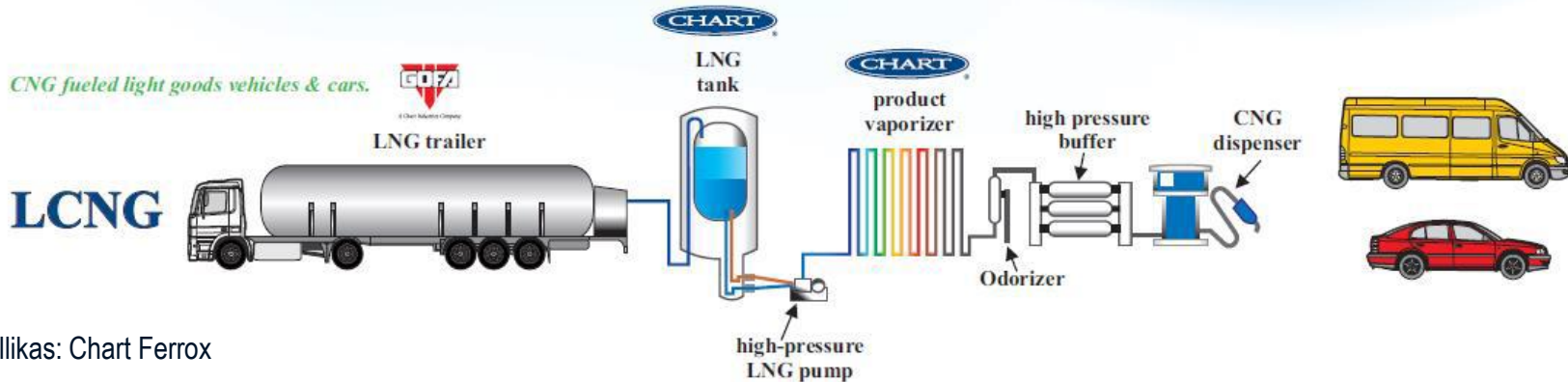
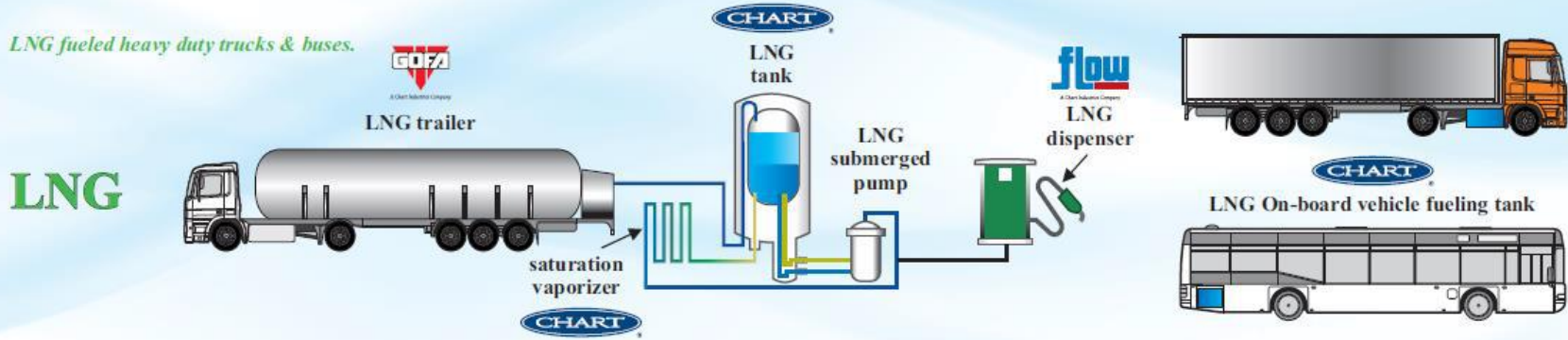
Allikas: www.ngva.eu

EESTI GAAS		
 Latvia	0	0
 Lithuania	3	0
 Luxembourg	7	0
 Malta	0	0
 Netherlands	162	21
 Poland	27	1
 Portugal	12	7
 Romania	1	0
 Slovakia	11	0
 Slovenia	4	0
 Spain	44	22
 Sweden	167	6
 UK	20	18
 EFTA Iceland	5	0
 EFTA Norway	7	0
EFTA Switzerland	140	1
Total EU + EFTA	3.307	101

Source: NGVA Europe Statistical Report 2017

LNG/ LCNG TANKLATE SKEEM

ISO/DIS 16924 Natural gas fuelling stations – LNG stations for fuelling vehicles



LNG TANKLATE TÜÜBID

Mobile refueling unit



Skidded fueling station – 100% automated



Mobile tank station

- Maximum 30 m³
- Maximum 12,000 kg
- 5 – 30 fillings a day

Fixed LNG or LCNG fueling station



Fixed LNG & LCNG fueling station



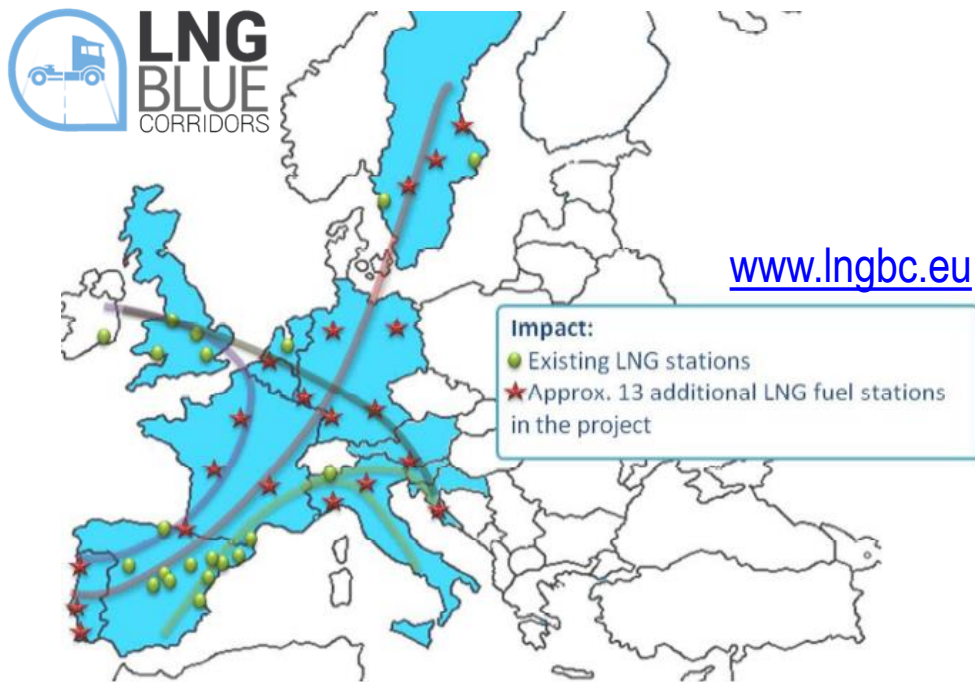
Portable tank station

- 30 – 60 m³
- 12,000 – 24,000 kg
- 30 – 70 fillings a day

Fixed tank station

- Minimum 60 m³
- Minimum 24,000 kg
- 70 – 150 fillings a day

EU PROGRAMM - LNG BLUE CORRIDOR

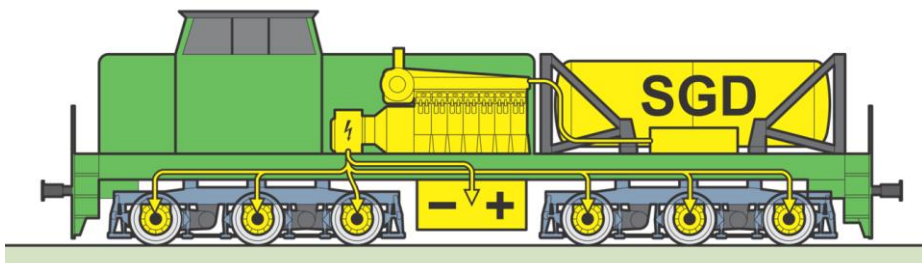


Country	City, Locations
France	Paris, Lyon, Metz, La Crèche
Germany	Karlsruhe, Hannover, Munich, Berlin
Italy	Piacenza, Roma, Verona, Parma, Livorno
Sweden	Malmö, Jönköping, Stockholm, Örebro, Lidköping
Spain	Cadiz, Pamplona
Portugal	Lisbon, Faro
UK/Ireland	M25 London Orbital, M4 South Wales, South of Dublin, M6 Manchester
NL/Belgium	Rotterdam, Venlo, Antwerp
Croatia	Split
Slovenia	Postojna

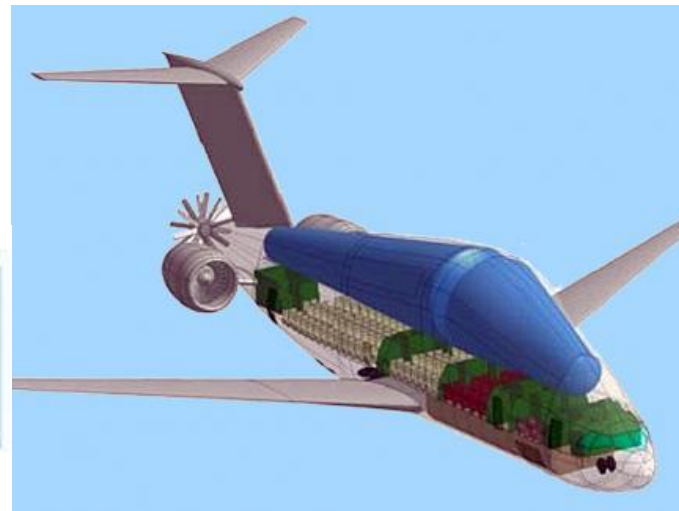
This European project is financed by the Seventh Framework Programme (FP7), with the amount of 7.96 M€ (total investments amounting to 14.33 M€), involving 27 partners from 11 countries.

TEISED LNG KASUTAMISE VÕIMALUSED TRANSPORDIS

1. LNG kasutamine raudteel (Hispaania, USA, Venemaa, Leedu, Läti, Kazakstan).
2. LNG kasutamine lennunduses (Boeing -777, TU-206).



LNG-Tanks
Lower Deck



1. LNG on parim alternatiiv HFO, MGO ja diislikütustele.
2. LNG kasutamine oluliselt vähendab keskkonnakahju.
3. Tulenevalt oma omadustest LNG hoiustamine ja kasutamine oluliselt erineb traditsioonilistest kütustest ja nõuab eriteadmisi.
4. Järgmiste 10 -15. a jooksul on oodata oluline LNG tarbimiskasv kõikides transpordi sektorites.

A circular graphic of a gas burner with 24 blue flames arranged in a ring. In the center of the burner, the text "TÄNAN TÄHELEPANU EEST!" is written in white capital letters.

**TÄNAN
TÄHELEPANU
EEST!**

Sergei Jefimov

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AS Eesti Gaas