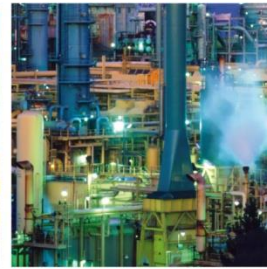




ECTA RESPONSIBLE CARE WORKSHOP 2019 – LNG TRUCKS - IMPRESSIONS / EXPERIENCES / DISCUSSION

12.09.2019 – Konstantin Kubenz



Agenda

- / Introducing Kube&Kubenz
- / What is LNG?
- / Which LNG vehicles exist in heavy load transport?
- / Challenge with LNG
 - / Refuelling
 - / Disposition
- / Driver-Feedback + Business Case
- / Discussion „Quo Vadis heavy load transport“
- / Sources



Owner-operated Logistics Company for chemical liquids & chemical fibre

- Foundation 1930 in Berlin
- Family business in the third generation
- Employees about 350
- Turnover in 2018: about EUR 80 Mio.

Standorte

- Hamburg (GER)
- Bergheim (GER)
- Worms (GER)
- Dordrecht (NL)
- Lyon (FR)
- Lainate (IT)
- Antwerpen (BE)



Liquefied Natural Gas (LNG) is not a naturally occurring energy source, instead it is produced from natural gas using technical processes.

Characteristics LNG

- LNG is approximately minus 160 degrees Celsius cold
- LNG is an odorless, colorless, non-corrosive, non-inflammable and non-toxic liquid
- Spilled LNG evaporates and vanishes
- LNG is only self-flammable at high temperatures
- Contact with air causes an extremely flammable and explosive gas

Hot facts about LNG

Emission reductions compared to the EUR-6 standards:

- 95 % less particles
- Up to 15 % less CO2 emissions

Fuel consumption:

- Up to 40 % lower fuel costs
- TCO savings of up to 10 %

Range:

- According to Iveco the range of a full tank is approx. 1500km - internally we calculate max 1200km

Contact with parts of the LNG refueling equipment or LNG may cause severe "cold-fire" or frostbite.



Caution

Try to extinguish a fire ONLY when you have received appropriate training and this is necessary to prevent personal injury or death.

Use only dry powder:
fire extinguishers of type B or C.

A LNG cloud displaces oxygen, causing a suffocation hazard in closed rooms or low areas, as the gas can accumulate there. Keep your distance.

Basically, there are two different engines for LNG vehicles - a gasoline engine and a diesel hybrid

Stoichiometric petrol engine (SI)

- Manufacturer IVECO/Scania
- Gasoline engine - Since natural gas has a high methane number, natural gas is a particularly suitable fuel for gasoline engines.
- However, in order to provide the same power, a larger SI motor must be selected.
- Current range 1500km

High-pressure direct injector (HPDI)

- Manufacturer Volvo
- Hybrid vehicles
- The idea behind the HPDI engine is to initiate auto-ignition with a small amount of diesel fuel
- More efficient than SI motors with higher degree of efficiency
- Current model only with 1000km range

Compared to a diesel engine, the SI gasoline engine consumes about 15 % more energy at high torque. The lower the torque demanded, the greater is the additional energy consumption.

Consumption (each 100km)		
Diesel	SI	HPDI
25KG	27KG	22KG

Range (in km)		
Diesel	SI	HPDI
2000	1500	1000

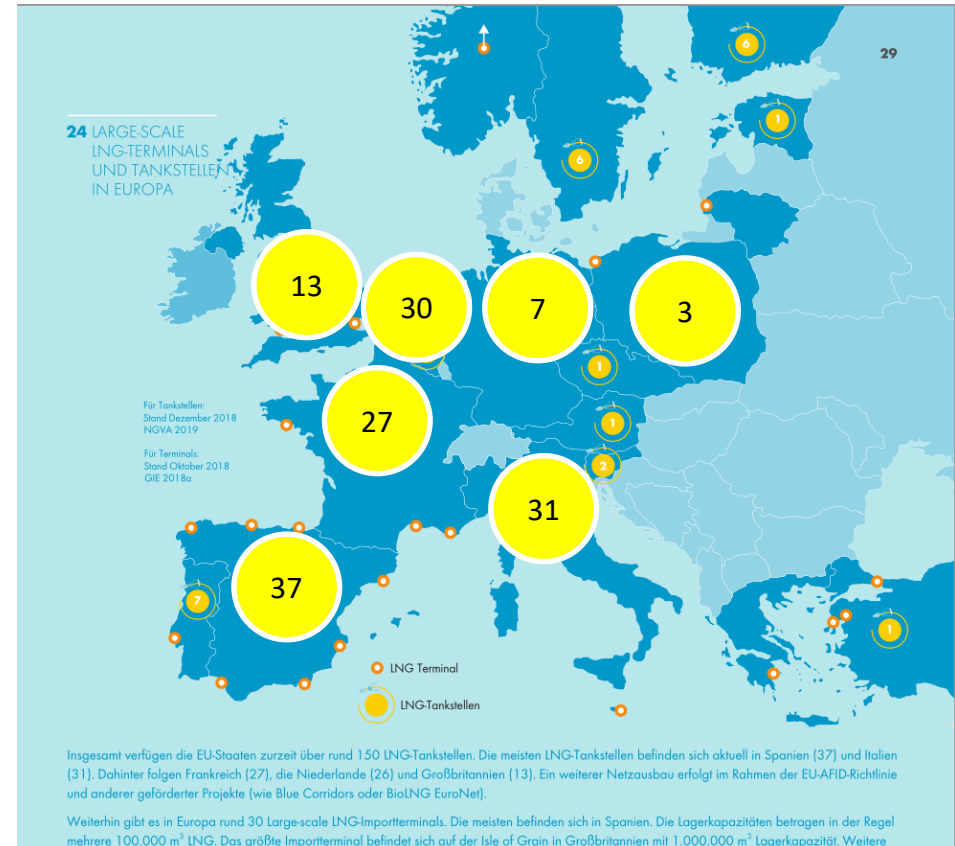
- All LNG trucks fulfil the Euro VI standard
- LNG trucks with SI engines emission reductions compared to Euro VI standard NO X 40%, PM 70%, CO 90%
- Up to 15% CO² savings possible with SI engines
- SI motors are considerably quieter

In addition to the refuelling process, the infrastructure and the fuel pose challenges for scheduling

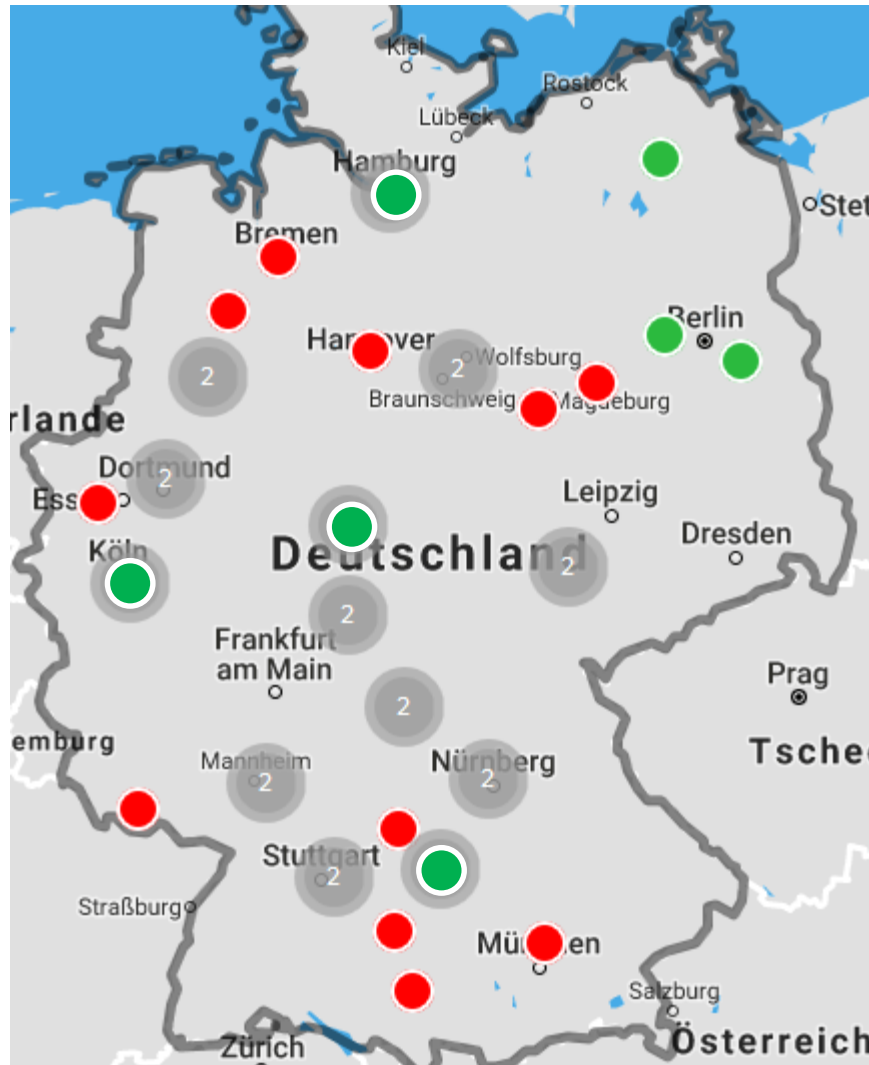
Challenges in the disposition

In the disposition there are challenges which still have to be considered at the moment

- The density of the filling station network in GER requires either a dedicated operation in the pendulum HH/Benelux or a spot 500km around HH/Benelux
- The tank process takes longer (partly also long queues)
- The vehicles should not stand still for too long (pressure build-up in the tank)
- Since from 10 bar pressure in the tank the gas must be led back before refueling - the vehicles should be driven 100km before refueling
- Spare parts only conditionally available - long downtimes for repairs



But the build up of the infrastructure is ongoing and in Germany soon a reliable network will be established



Infrastructure development

- Currently 7 LNG fueling stations live
- Further 38 under construction or within the planning phase
- Still delays in the ramp-up due to long administrative approval processes

Hamburg	Hamburg	(Shell)
Stavenhagen	MV	(Liquind)
Wustermark	Brandenburg	(Liquind)
Grünheide	Brandenburg	(Liquis)
Kassel	Hessen	(Liquis)
Köln	NRW	(GasCom)
Nördlingen	Bayern	(Liquind)

To be accepted as an alternative, both the business case and the driver's perception have to be appropriate

Driver-Feedback

For the three vehicles used, we initially trained 10 drivers in the refueling process.

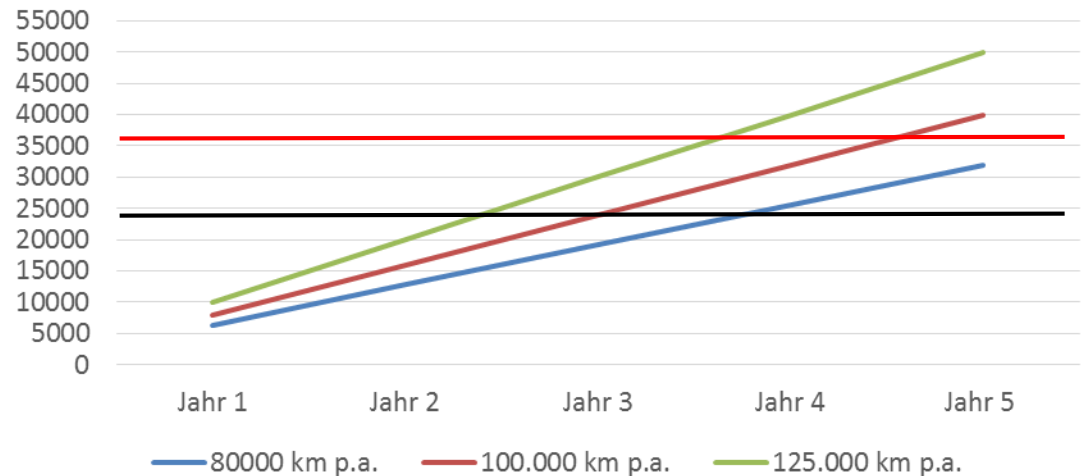
Driver-Feedback

- ✓ After initial uncertainties, there is a certain routine for the fueling process, so that it is no longer a concern
- ✓ In principle, it is criticized that the vehicles do not have the normal power, especially in mountains/hills and a lack of power in the lower rotation range
- ✓ Driving is subject to a certain adjustment, as the vehicles have to be driven with significantly more use of the accelerator pedal
- ✓ For the auxiliary heating there are so far only diesel models - so diesel has to be refueled as well
- ✓ No differences while driving

Business Case + TCO

The acquisition costs for LNG vehicles without subsidies are around € 36,000 higher than for diesel vehicles

- ✓ However, LNG is 2019+2020 exempted from toll in GER
- ✓ LNG 8 cent advantage (without tolls) the KM through LNG costs
- ✓ Car tax is equal



Significant differences in LNG prices in Europe

0,80€ netto BE

1,00€ netto GER

1,15€ netto NL

A view into the future - Quo vadis heavy load transport? A suggestion for discussion

Legislative framework

EU CO² Limits

- ✓ New vehicles should emit 15% less CO² from 2025 and 30% less from 2030

It is expected that the LNG vehicles will reach the 2025 limits but will not be able to meet the 2030 ones

- ✓ The 2030 limits can only be met if LNG is partly mixed with BIO-LNG and this is also taken into account.

Further aspects of LNG vehicles

- ✓ Significantly higher acquisition costs
- ✓ It is unclear how the LNG price (taxation + market price) will develop in the future.
- ✓ Toll advantage in NL completely cancelled - planned in GER 0.01€ per KM
- ✓ Service station infrastructure under construction - sufficiently developed in GER by 2020
- ✓ Diesel driving prohibitions in cities? e.g. HH through traffic
- ✓ Noise restrictions?
- ✓ Temporary technology?

Alternatives?

- ✓ Overhead line truck with dangerous goods? Infrastructure?
- ✓ Electric heavy load trucks? Pay-Load?
- ✓ Fuel cells truck?
- ✓ Regenerative fuels?
- ✓ Inland navigation in times of climate change
- ✓ Rail freight transport with quality problems
- ✓ Digitalization as a panacea? 0

Sources

Shell – Shell LNG Studie

Cf. <https://www.shell.de/medien/shell-publikationen/shell-lng-studie.html>

Nationale Plattform Zukunft der Mobilität - Wege zur Erreichung der Klimaziele 2030 im Verkehrssektor

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Logistik Initiative Hamburg – LNG Liquefied Natural Gas in der Logistik available under: <https://www.hamburg-logistik.net/services-und-publikationen/publikationen/leitfaeden/lng-liquefied-natural-gas-in-der-logistik/>

Dena – LNG task-force available under: <https://www.dena.de/themen-projekte/projekte/mobilitaet/lng-taskforce-und-initiative-erdgasmobilitaet/>

Own experiences