GasShow LPG | LNG | CNG 2012
EXHIBITION & CONFERENCE

Liquefied-to-Compressed Natural Gas Opportunities & Strategies

LCNG & LNG Station
Fordonsgas, Sweden

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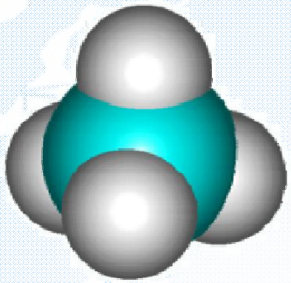
What is LNG?

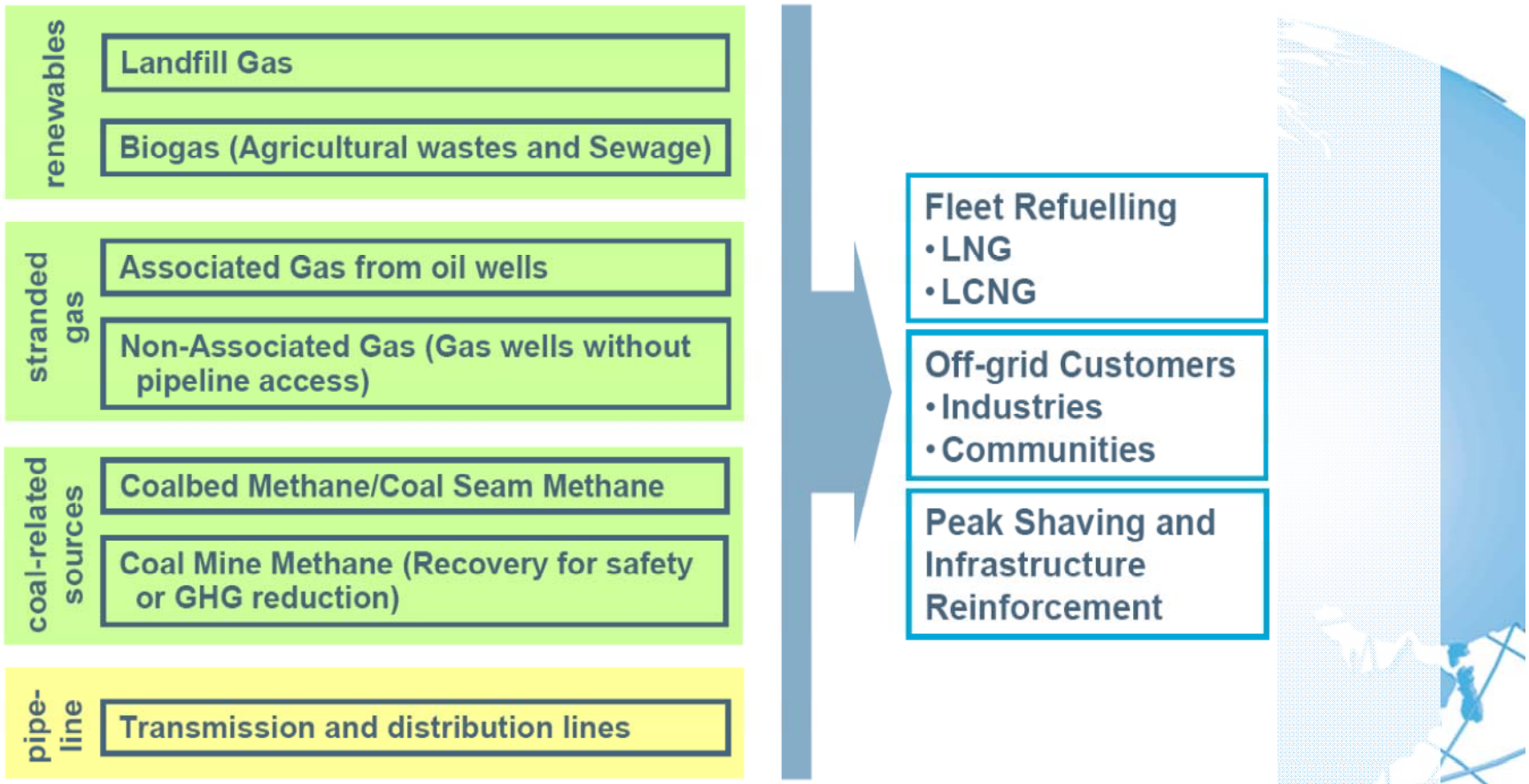
- LNG is natural gas that has been cooled downed and condensed to liquid state
- 1 liter of LNG = 600 liters of Natural Gas at 1 bar
- LNG temperature at 1 bar is -163 °C
- LNG contains in average 93 to 98 % of methane (CH4)



CH4 molecule

- 1 m3 of LNG = 580 liters of diesel in terms of energy content (=25,2 Gigajoule)
- 1 m3 of LNG = 460 Kg
- LNG is available at large import terminals or small scale liquefaction plants (biogas)

Where to get LNG from?



LNG and LCNG Vehicles Refueling

LNG + LCNG Refueling Station

- From LNG it is possible to fuel both LNG and CNG into vehicles (Trucks, buses, trains, ships,...)

- LNG and LCNG station usually require LNG delivered by trailer from terminal or small scale production plant

- Colder the LNG is, higher its density is, and longer its storage can be

- The composition of LNG will **not** change from the production source downstream to the vehicles

LNG and CNG Vehicles Refueling

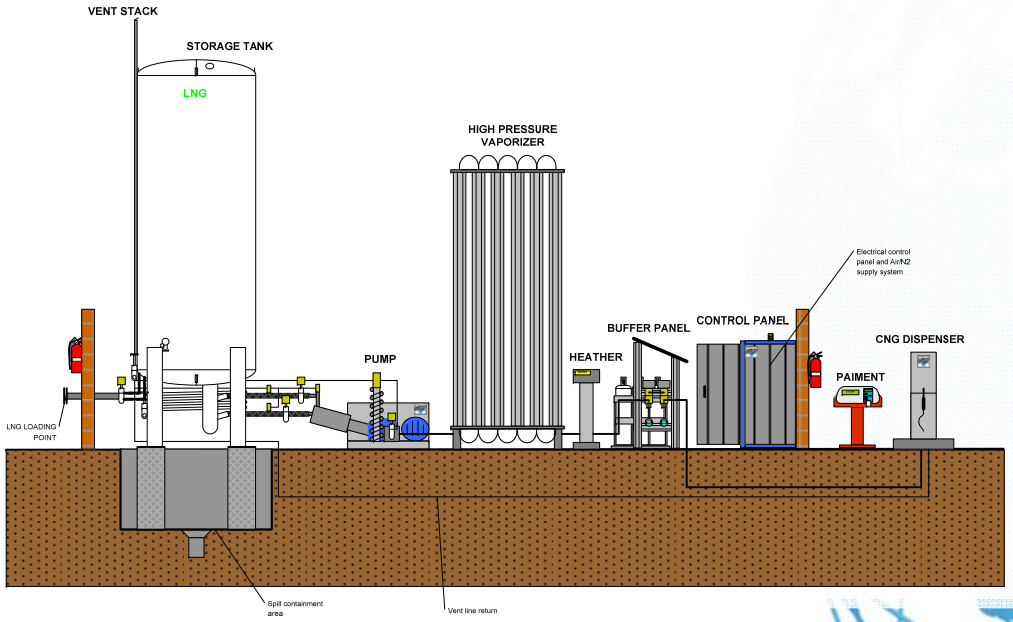
LCNG stations (Liquid to Gas)

- LCNG station allows refuelling of CNG vehicles with a **0,05 KW/kg** specific power requirement

- LCNG station usually require LNG storage at a minimum of **3 bar/-153°C**

- Colder the LNG is, higher its density is, and longer its storage can be

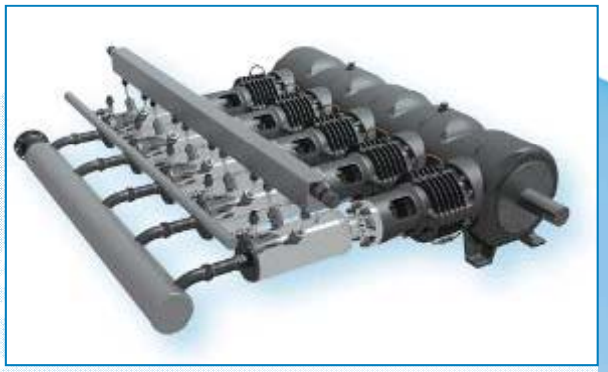
- LCNG stations are not that sensible to heat entries as the LNG is transformed to gas



MRP pump
AGA, SWEDEN

800 Nm3/h typical LCNG stations characteristics

Maximum fuelling pressure:	250 bar @ 15°C
Intermediate storage:	300 bar
Flow regulation:	with VFD for flow regulation
Average refueling time:	2 minutes for a 80 litres tank
Number of vehicles/h:	12 vehicles/dispenser
Fuelling flow at nozzle:	9,5 KG/min (800 Nm3/h)
Measurement accuracy:	99,9% (Coriolis)
Station power requirement:	Approximately 30KW (0,05 KW/kg)



★ LNG and CNG Vehicles Refueling

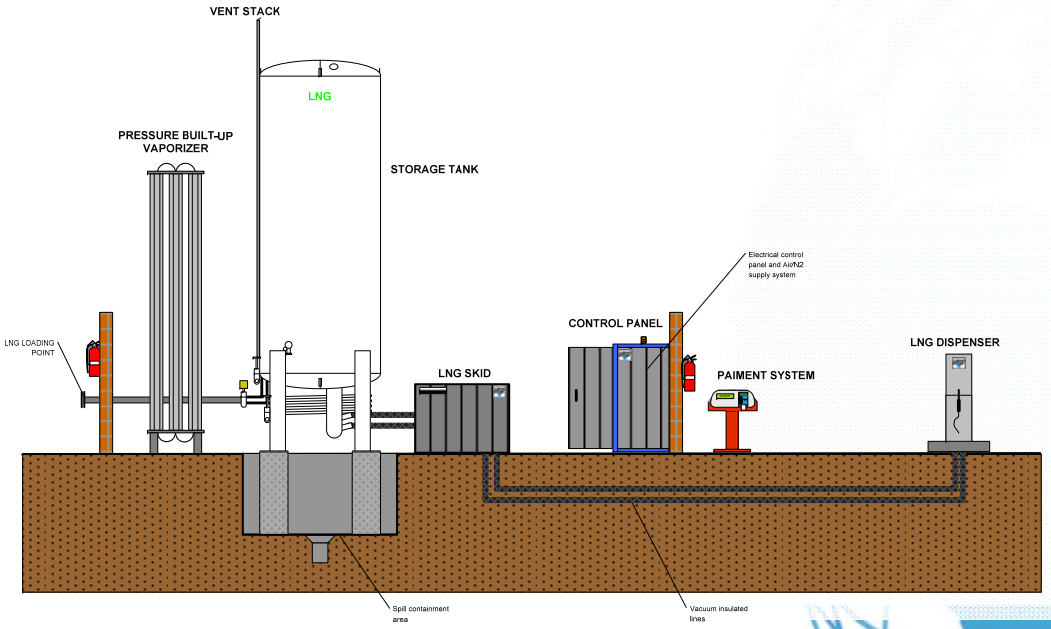
★ LNG stations (Liquid to Liquid)

- LNG station allows refuelling of LNG vehicles with LNG with a **0,005 KW/kg** specific power requirement

- LNG station usually requires LNG storage from **3 bar/-153°C to 10 bar/-125°C**

- LNG at 3 bar and -153°C is called **« cold LNG »** when 8 bar and -130°C LNG is called **« saturated LNG »**

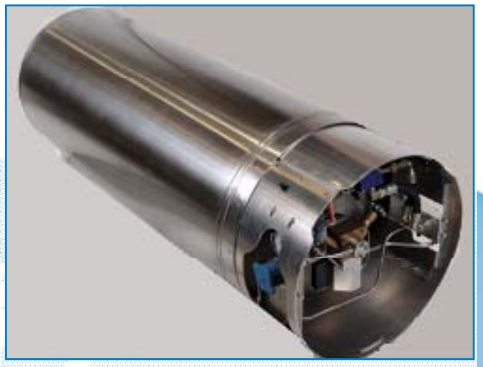
- LNG stations are quite sensible to heat entries as the LNG can boil off quite rapidly



LNG Dispenser
BOC, Australia

Typical LNG station characteristics

Fuelling temperature:	-150°C (cold) to -130°C (saturated)
Fuelling pressure:	3 to 10 bar
LNG pump skid flow:	320 l/min @ 12 bar diff. pressure
Fueling flow at nozzle:	160 l/min
Average refueling time:	3 minutes for 450l tank
Number of vehicles/h:	10 vehicles/dispenser
Measurement accuracy:	99,5% (W&M MID approved)
Power requirements:	Approximately 20 KW (0,005 KW/kg)



Advantages of LCNG stations

- The best and most efficient solution for mother daughter station system

- Possibility to distribute CNG when no grid is available nearby

- High purity CH4 source, indeed LNG is already purified at liquefaction stage

- Operational cost reduction compared to a compressor solution (Power)

- Lower investment than a compressor solution (in case of low pressure grid)

-LNG for transportation takes 600 times less space than CNG at 1 bar

-Great solution to start with LNG fueling and small trial fleets

Advantages of LNG stations

- Independent refueling stations allowing for alternative gas sourcing

- The unique solution to distribute LNG to heavy duty vehicles

- Huge operational cost reduction compared to CNG or LCNG stations (power)

- Can be installed anywhere on public or private areas

-Much lower investment cost than LCNG or CNG stations (in €/kg.min capacity)

-Possibility to have mobile stations for easy trials

Basic requirements for LCNG and LNG stations

-There is no CNG grid where I want to install my station!

-I need to fuel LNG vehicles…

-I want to set-up a mother daughter stations concept

-I need to fuel large amounts of CNG into vehicles

-I want to be able to chose my gas provider

-I need both CNG and LNG fueling capability on my station

-I have an available LNG source available

-Piggy back on industrial power supply through LNG

Economics of LCNG and LNG stations

Typical investment cost:

Investment for a typical LCNG station of 800 Nm3/h flow (1 disp.): **550'000 €**

Investment for an LNG station with 1 LNG dispenser: **600'000 €**

Investment for a moveable LNG station: **450'00 €**

Investment for an LNG + LCNG station (above performances): **900'000 €**

Economics of LCNG and LNG stations

Typical operational costs:

Electrical consumption for a typical LCNG station of 800 Nm3/h flow: **0,05 Kwh/Kg**

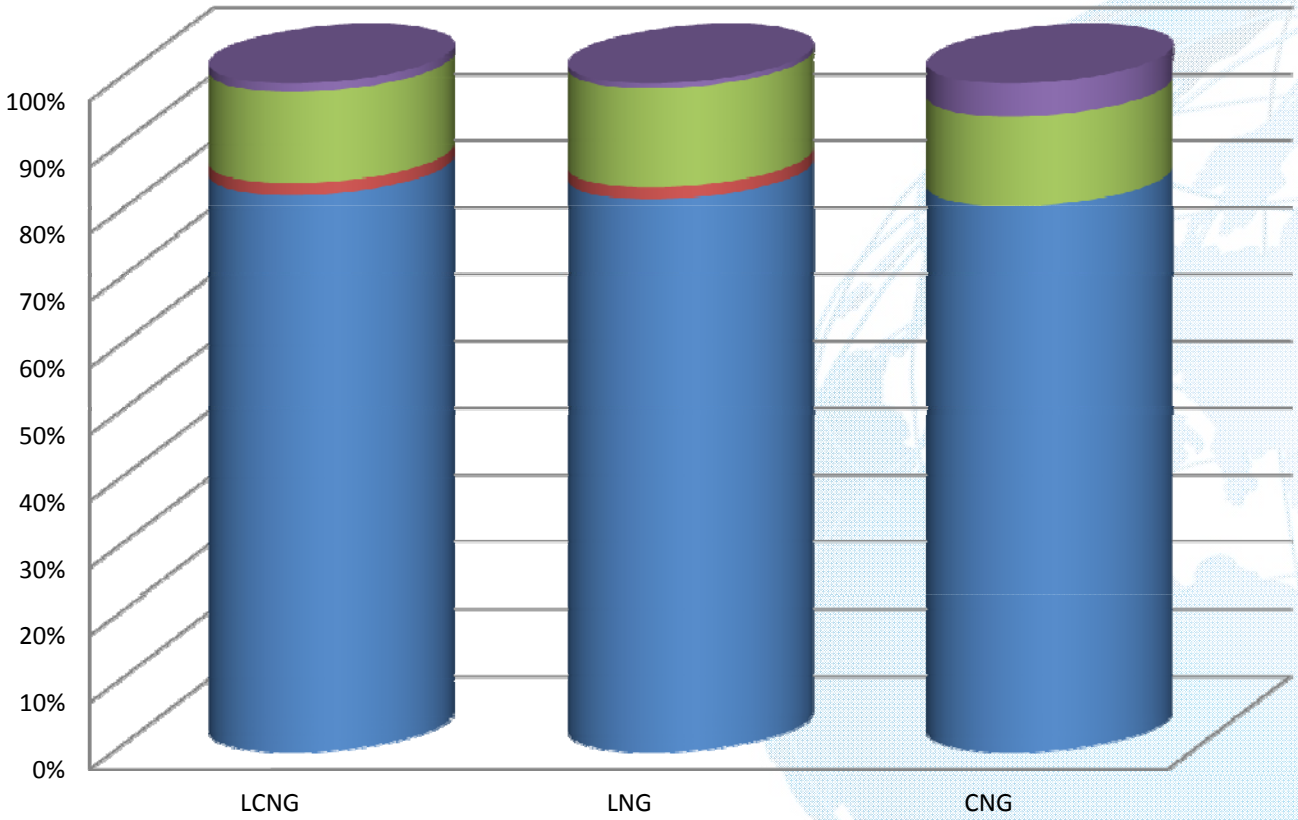
Maintenance cost for a typical LCNG station with 1 dispenser: **0,005 €/Kg**

Electrical consumption for a typical LNG station with 1 dispenser: **0,005 Kwh/Kg**

Maintenance cost for a typical LNG station with 1 dispenser: **0,001 €/Kg**

If combined LNG + LCNG station, these costs can be cumulated

Economics of LCNG and LNG stations



Data:

Consumption: 1700 T/year

Equivalent to 800 Nm3/h

Electricity price: 0,1 €/kwh

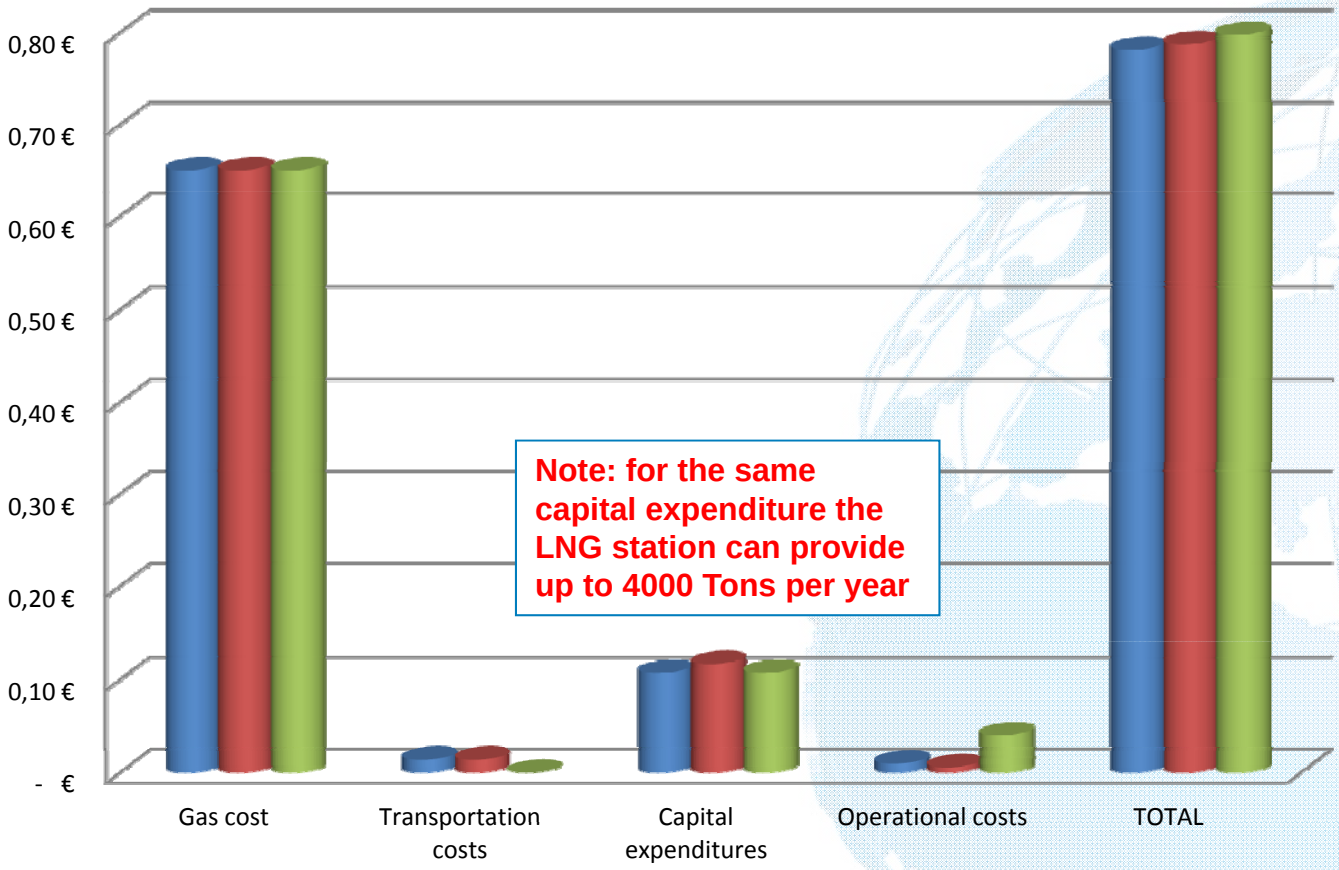
Gas price: Equivalent

ROI: 3 years

- Operational costs
- Capital expenditures
- Transportation costs
- Gas cost

Economics of LCNG and LNG stations

Gas prices matrix



Note: for the same capital expenditure the LNG station can provide up to 4000 Tons per year

Data:

Consumption: 1700 T/year

Equivalent to 800Nm3/h

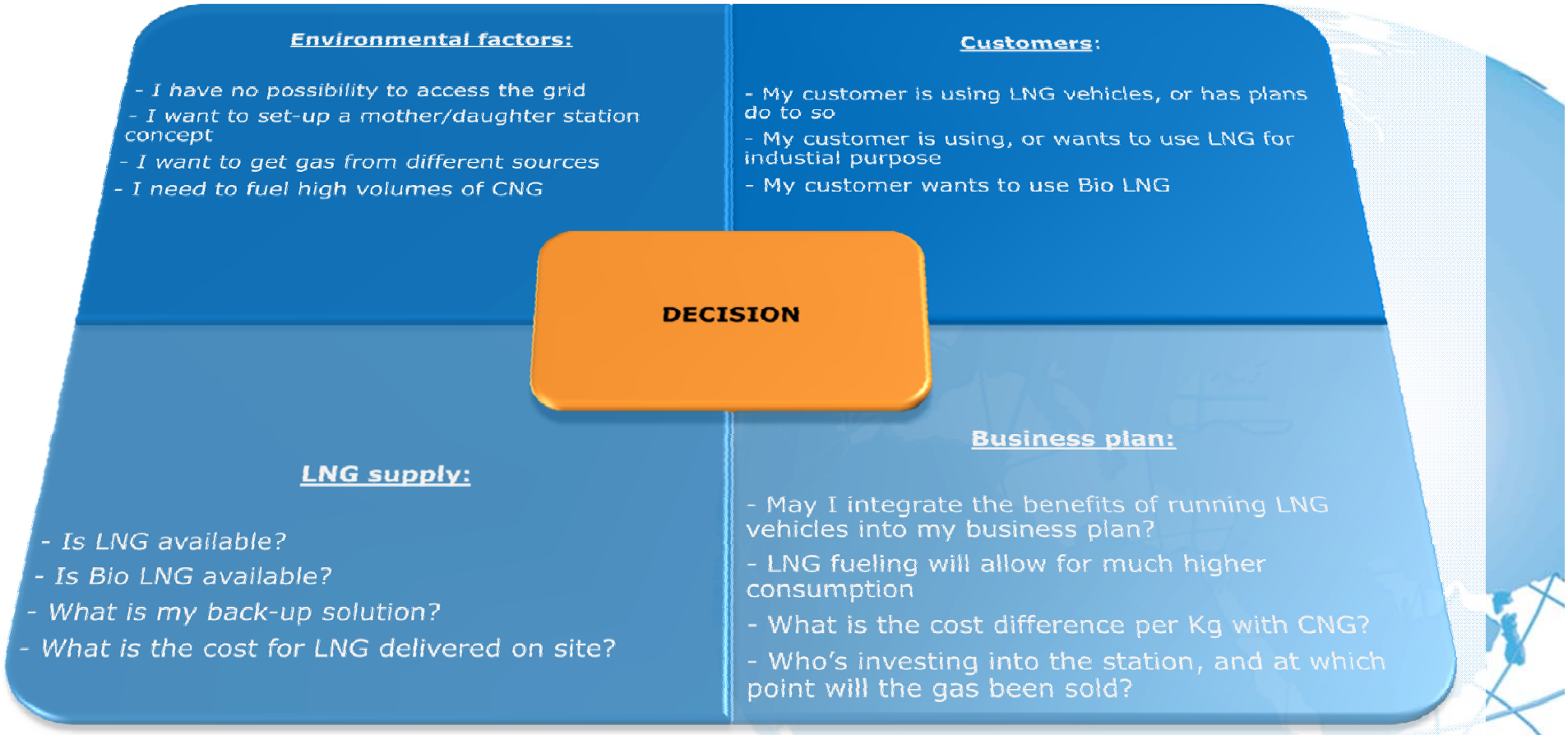
Electricity price: 0,1 €/kwh

Gas price: Equivalent

ROI: 3 years

LCNG
LNG
CNG

Decision matrix



Reference Project – LCNG station Brazil

Reference Project – Public LCNG station Sweden

Reference Project – LNG and LCNG station POLB (CA)

Reference Project –LCNG station for HDV's Sweden

Reference Project – LNG station Australia (Tasmania)

Reference Project – LNG and LCNG station Sweden (Göteborg)

Reference Project – LCNG and LNG station Los Angeles (CA)

Conclusion

- LNG and LCNG stations are ideal in some specific cases

- They allow for an alternative to CNG stations allowing for different business model

- With increasing number of LNG trucks, LCNG becomes a serious option

- ISO Standards are being discussed for LNG and LCNG stations construction

- The increasing LNG trade worldwide will provide for more on-shore LNG

- LCNG and LNG stations are ideal when using liquefied biogas or landfill gas

Thank you for your attention

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