BIOKAASUN NESTEYTYS: TUOTANTOTEKNOLOGIAT JA KÄYTTÖKOHTEET

14.10.2020 Reetta Kaila, TkT
Wärtsilä Biogas Solutions

BIOLNG PRODUCTION CHAIN

ANAEROBIC DIGESTION → BIOGAS

BIOGAS UPGRADING → BIOMETHANE

BIOMETHANE LIQUEFACTION → BIOLNG

DIFFERENCE BETWEEN BIOGAS – BIOMETHANE - BIOLNG

Biogas

Composition

50-60% CH4

40-50% CO2

Traces of H2S & impurities

Production by

Anaerobic Digestion

~40 Mton/a

360 TWh (2017)

Use

Heat and electricity (CHP)

Domestic use (cooking)

Upgrading to transport fuel

Biomethane

Composition

97-99,9% CH4

1-2% CO2

Production by

Biogas Upgrading

1,02 Mton/a

50 PJ = 13,9 TWh

Use

Transport fuel

Supply to gas grid

Energy storage for base and peak loads

BioLNG

Composition (LBM, LBG)

99,99% CH4

<50 ppm CO2

< 1 ppm H2O

Production by

Biogas Liquefaction

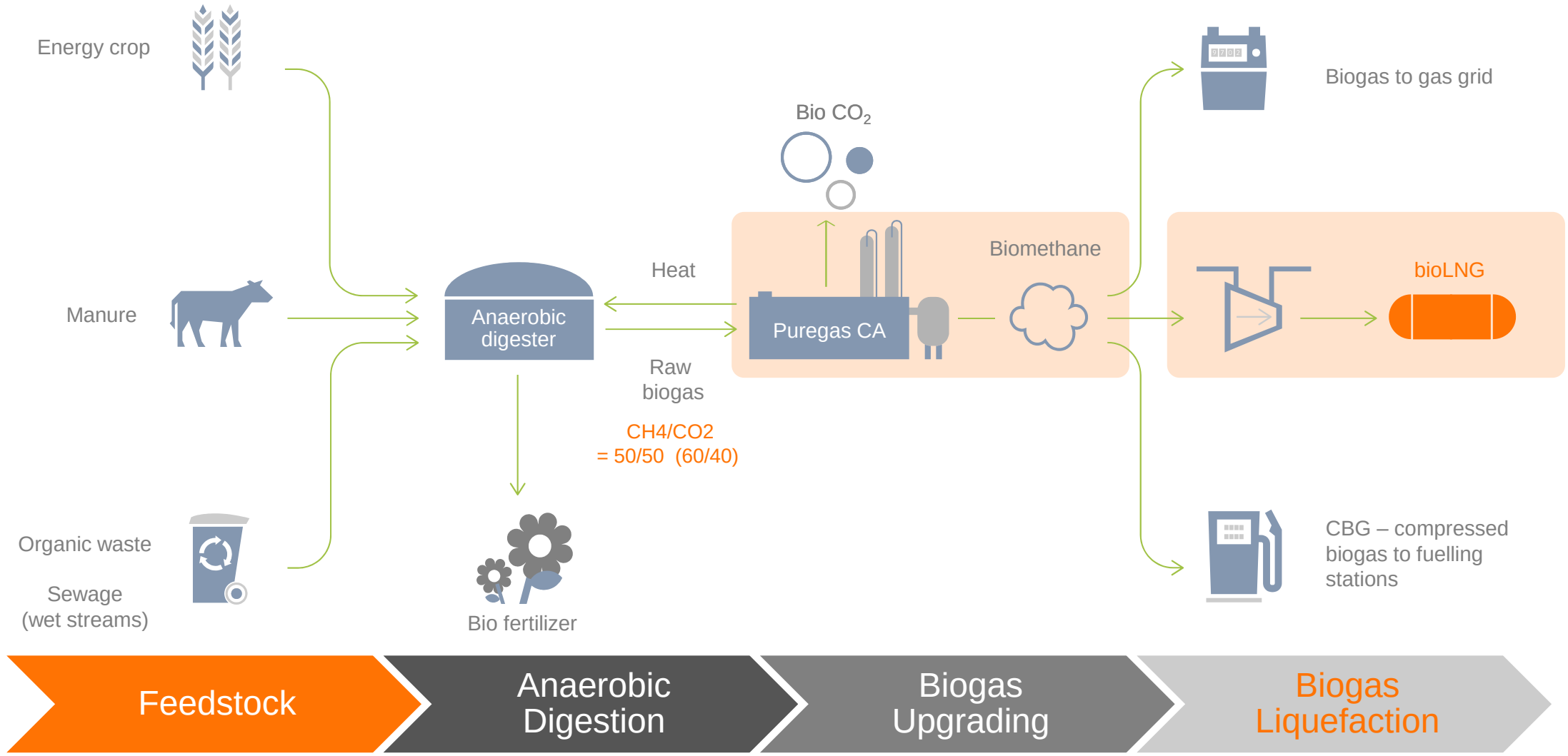
< 0,05 Mton/a

Use

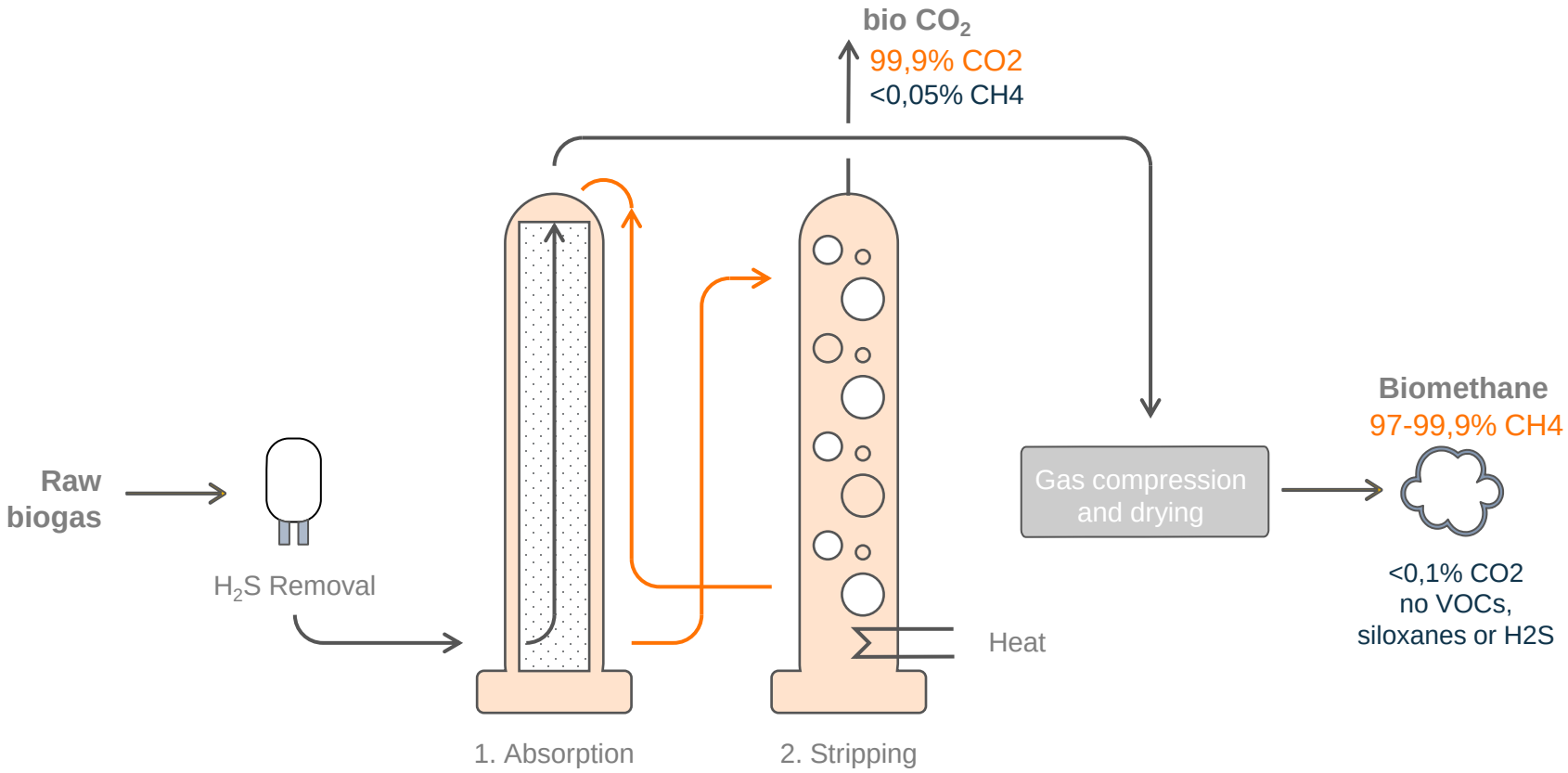
Transport fuel – maritime & heavy duty transpoortation

Sources: World biogas association & Irena

THE BIOLNG PRODUCTION CHAIN



BIOGAS UPGRADING WITH WÄRTSILÄ PUREGAS CA



Puregas CA is based on amine technology (LP)

1. CO2 capture
2. Amine regeneration

→ Max CH4 recovery and highest purity

Alternative CO2 capture technologies

- PSA
- Water scrubbers
- Membranes

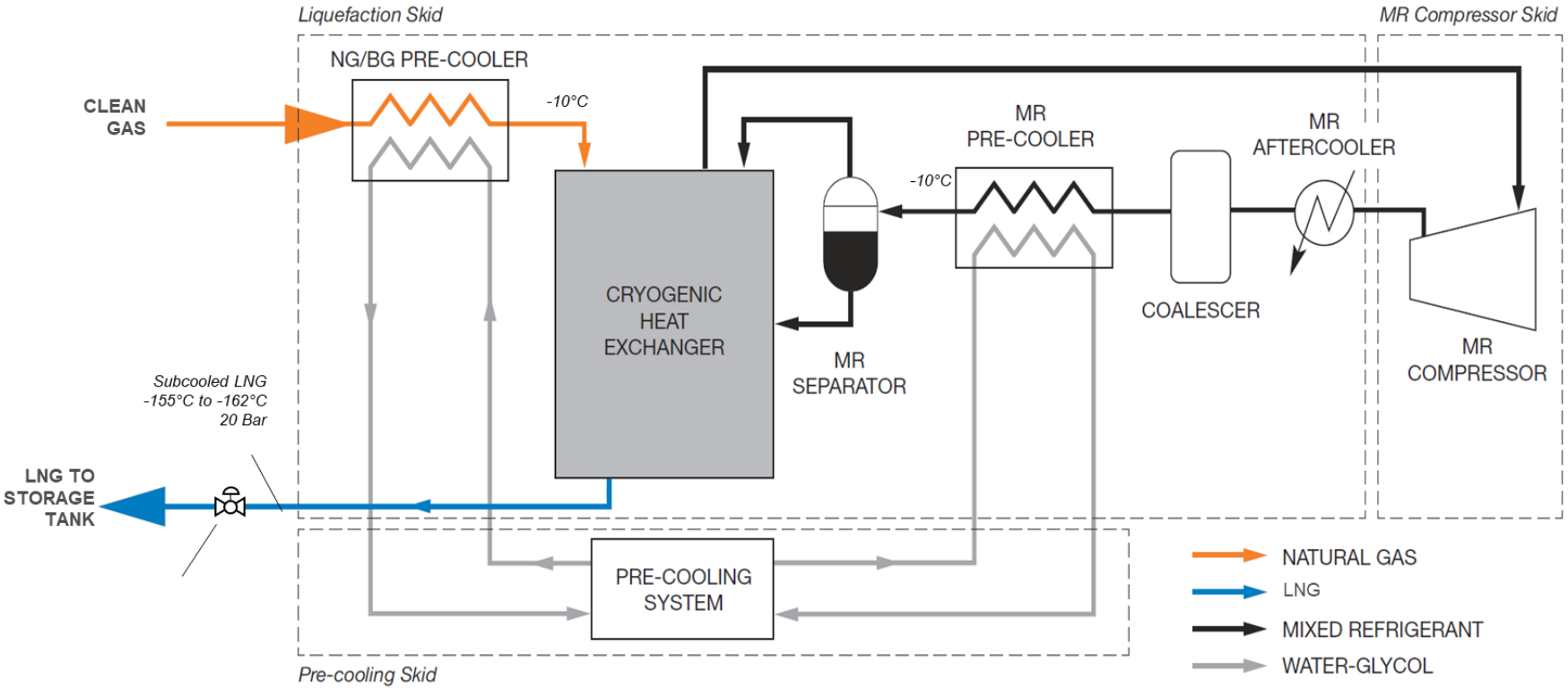
Low OPEX

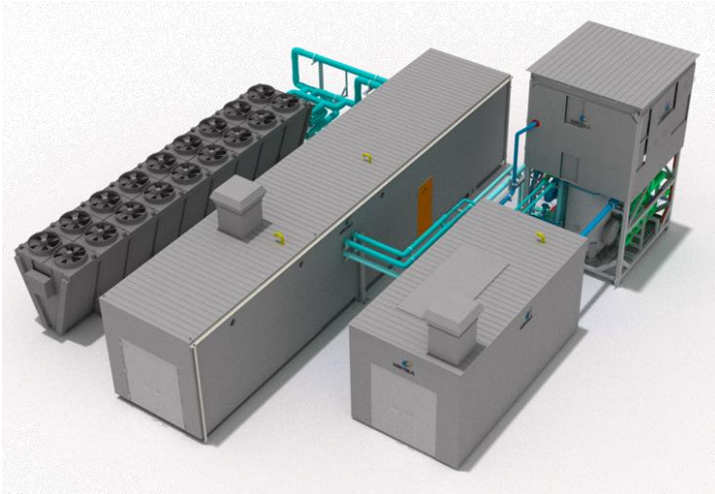
- 75% heat recovery by heat-integration
- Electricity < 0,11 kWh/Nm3
- Closed-loop amine-water system
- Low consumption of water and solvents

Low maintenance costs

98% uptime guarantee

BIOGAS LIQUEFACTION WITH WÄRTSILÄ MR PROCESS (MIXED REFRIGERANT)





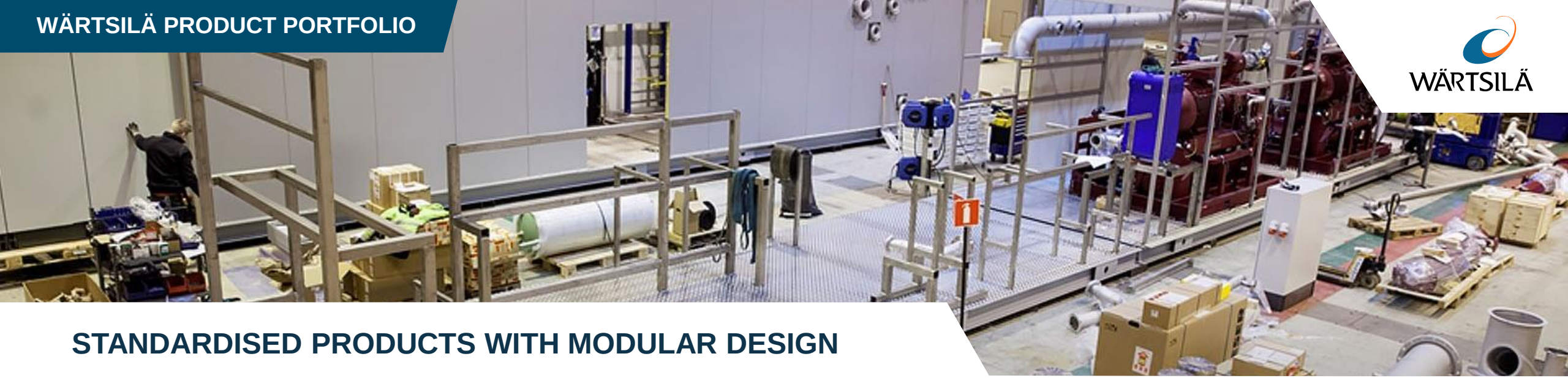
Puregas CA polishing

CO_2 < 50 ppm
H_2O < 1 ppm
H_2S < 4ppm

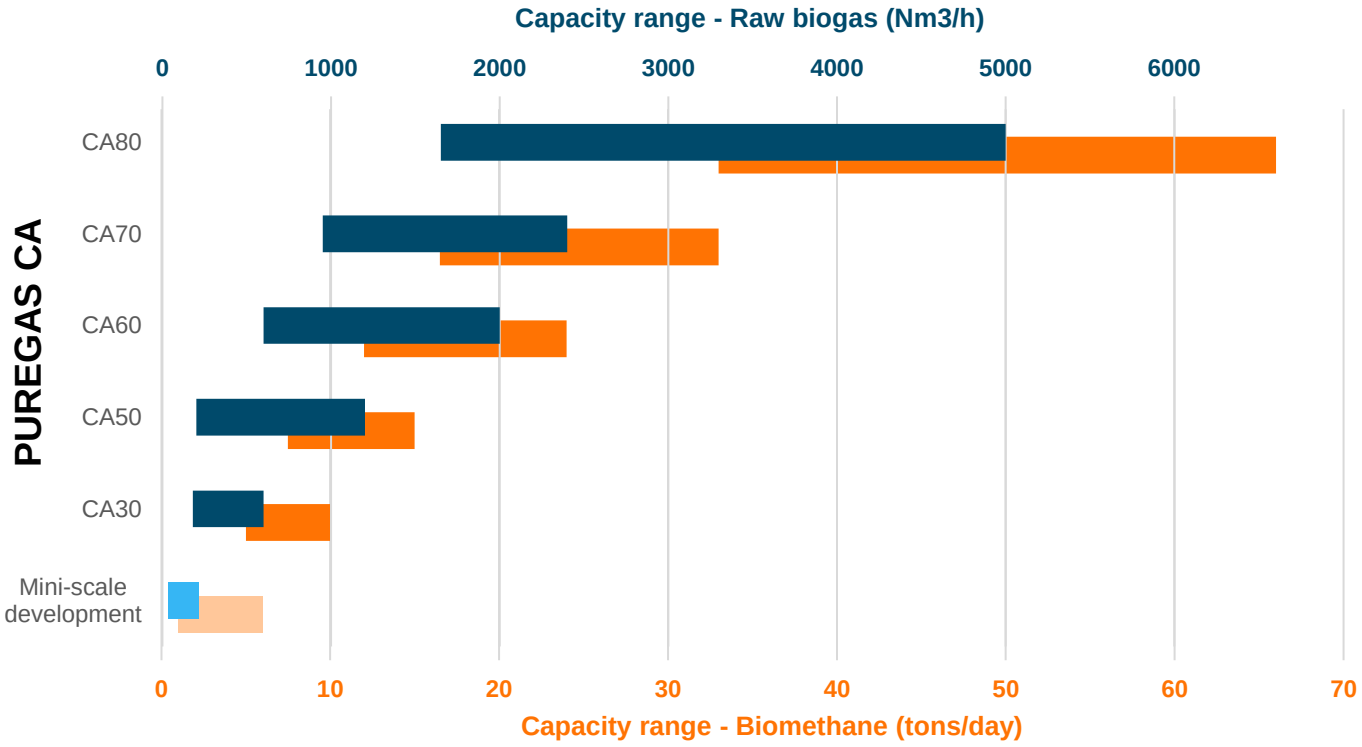
Industrial bioLNG quality

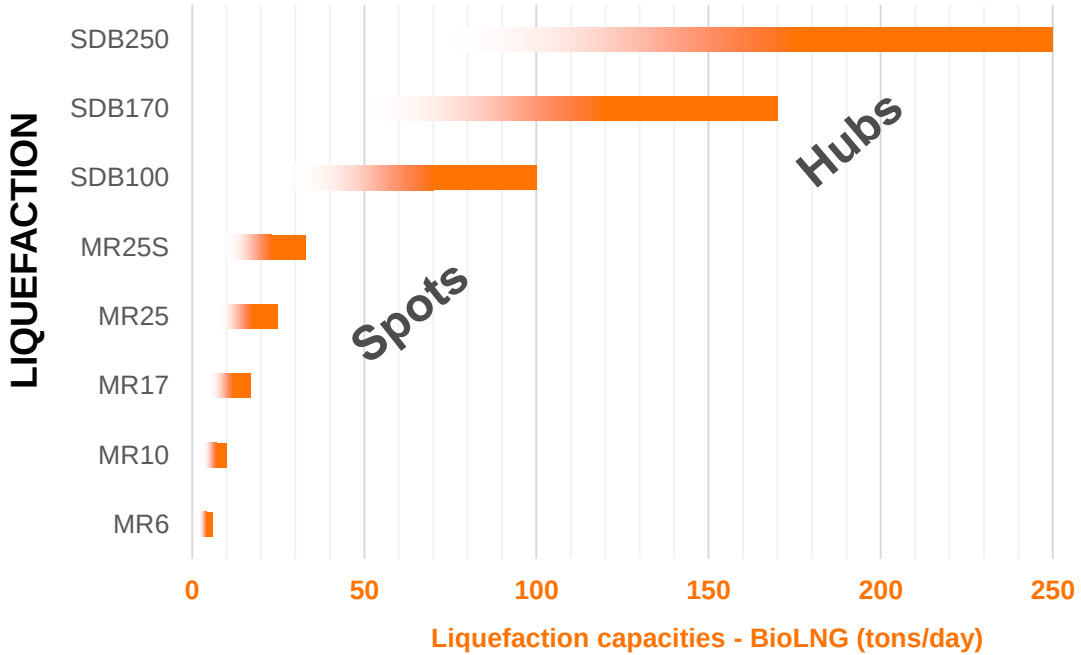
- Subcooled to -162C
- No Boil Off Gas (BOG)
- Lowest OPEX (power < 0.75 kWh/kg)

- MR technology for 6 – 25 tpd
- Semi-dual brayton for 100 – 250 tpd



STANDARDISED PRODUCTS WITH MODULAR DESIGN





WÄRTSILÄ REFERENCE SUMMARY

Upgrading plants: 42
(including 1 membrane plant)

- Conventional versions: 34
- BioLNG versions: 4
- H2S versions: 5

CO2 liquefaction plants: “2”

H_2S reduction solutions: 5

Liquefaction plants: 4 (SPOTS)
+ 1 HUB (10x capacity)

- Biogas Liquefaction: 3+1
- Boil Off Gas Liquefaction: 1

Compressor stations: 11

Boiler solutions: 9

BIOLNG USE

POTENTIAL SUSTAINABLE FUELS FOR THE TRANSPORTATION SECTOR (WHICH IS RESPONSIBLE FOR 25% OF THE GLOBAL CO2 EMISSIONS)

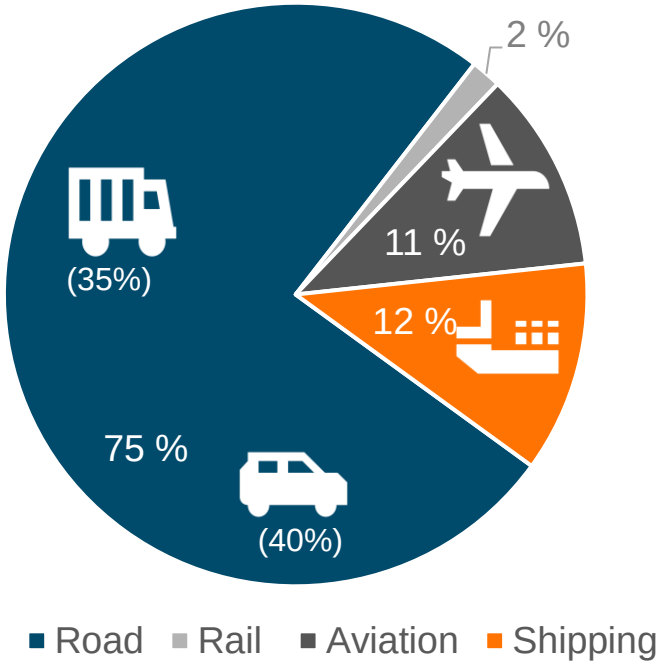
Heavy Road Transportation (35%)

- Bio/CNG & -LNG (LBM)
- Ethanol
- Biodiesel (HVO, FAME)
- Hybrids

Light Road Transportation (40%)

- Bio/CNG
- Ethanol (gasoline)
- Biodiesel (HVO, FAME)
- Hybrids/batteries
- Fuel cells & H2

Direct GHG emissions by the transport sector



Aviation (11%)

- Bio jetfuel

Shipping (12%)

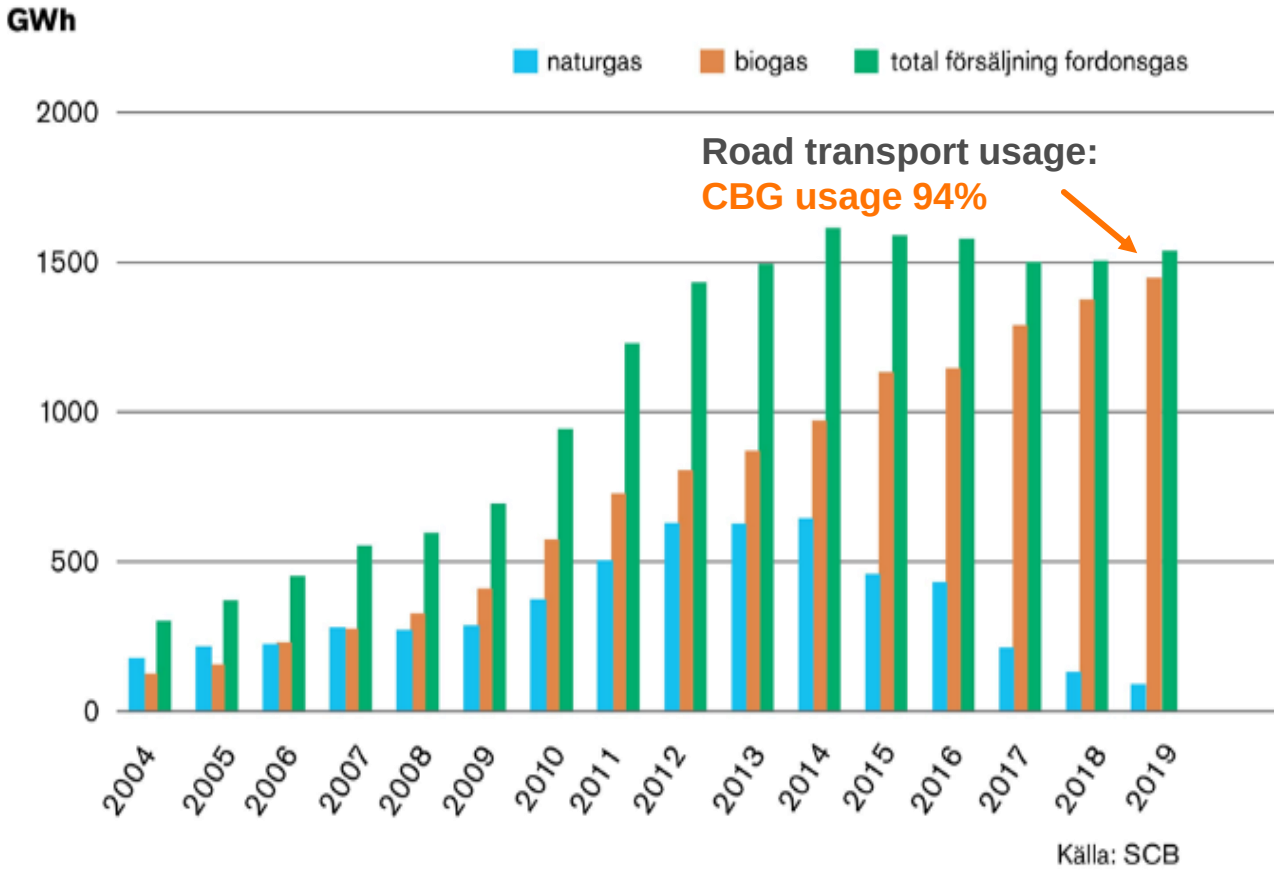
- Bio/LNG (LBM)
- Biodiesel
- Hybrids (short routes)
- Fuel cells?
- Windpower

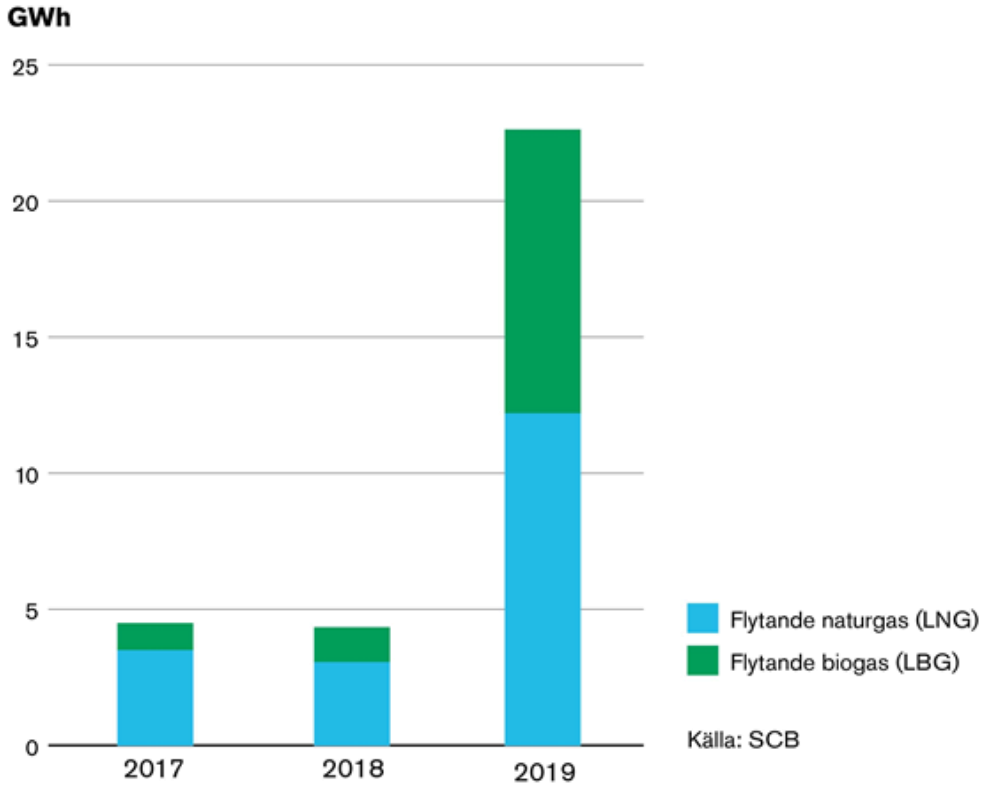
Road transportation 18.7% (Trucks 8.75%)
6788 Mton CO2eq/a

Shipping 2.7%
972 Mton CO2eq/a

Sources: Our world in Data. IPCC 2018, chapter 8: Transportation (year 2010)

TRENDS IN THE SWEDISH BIOGAS MARKETS





bioLNG
Road transport usage in Sweden (+500%)
Potential up to 300 GWh

GLOBAL BUNKER FUEL DEMAND (330 MTON/A)
VS BIOFUEL SUPPLY TO THE TRANSPORTATION SECTOR

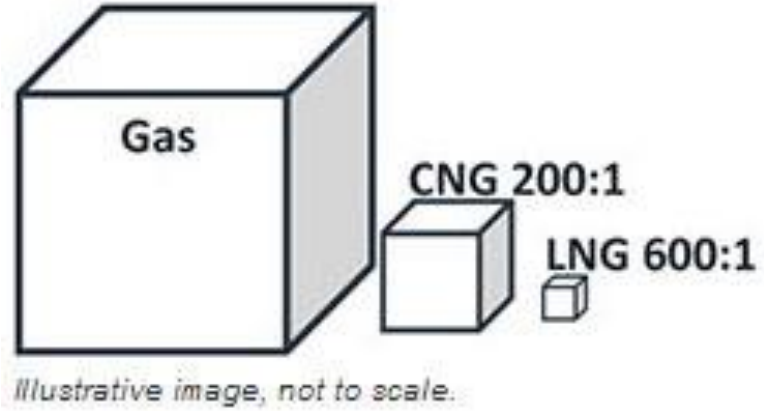
FAME & HVO are part of committed and legislated biofuel mixing into road transportation fuels in various territories (eg. EU & US)

Approx production rates
- *Liq biofuels 40 Mton/a*
- *Bigas 40 Mton/a, of which*
- *Biomethane 1 Mton/a*
- *PtX fuels 0.16 Mton/a*

Synthetic fuels (Power-to-X)

ADVANTAGES OF BIOLNG AS MARINE FUEL

- High energy density, high fuel quality
  - Pure methane, high LHV & MN, -160C
  - Drop in fuel to fossil LNG in all ratios 0-100% compared liquid biofuels



Illustrative image, not to scale.

- Less competition from other transport sectors (price) compared to liquid biofuels (aviation) or H2-derived fuels (H2 use in industry, such as steel and ammonia production)

- Availablity & maturity throughout the value chain
  - Can utilise a wide range of feedstock
  - Minimised number of process steps (minimised loss in efficiency)
  - Logistics & infra from LNG can be utilised
  - No conversions of on-board technologies needed – Ready to go!

- Long term off-take contracts would speed up the increase of production capacties even more

Circular economy & sustainable societies

SKOGN BIOKRAFT LBG

Owner	Biokraft AS, Norway
Type	LBM plant
Tank net volume	350 m^3
Capacity	25 TPD / 9,125 TPA
Size of upgrading liquefaction unit	20 m x 30 m 12 m x 20 m
Gas source	Biogas from fish industry and paper mill waste
Details	Biogas to be used on city buses in Trondheim and as bunker fuel for Hurtigruten RoPax
Scope of supply	Liquefaction plant, incl. • **Puregas CA biogas upgrading** • Cooling system • **MR liquefaction process** • Storage tank • Electrical and control systems • Service agreement • Installation of plant Excl. Civil works
Delivery method	EPC
Delivered	2017

https://www.Biokraft.no/biokraft-skogn

Skogn 21. august 2017

"We expect strong demand for liquefied biogas as fuel. Wärtsilä's biogas upgrading and liquefaction solution represents an important step forward in realising this potential."

TEKNISKA VERKEN

- Biogas upgrading – polishing – liquefaction

- LBG production capacity 20 tpd
- Waste management 100.000 tons/a
  - Municipality & food waste from restaurants & industry

→ Biofertilisers 90.000 ton/a top 70 farms

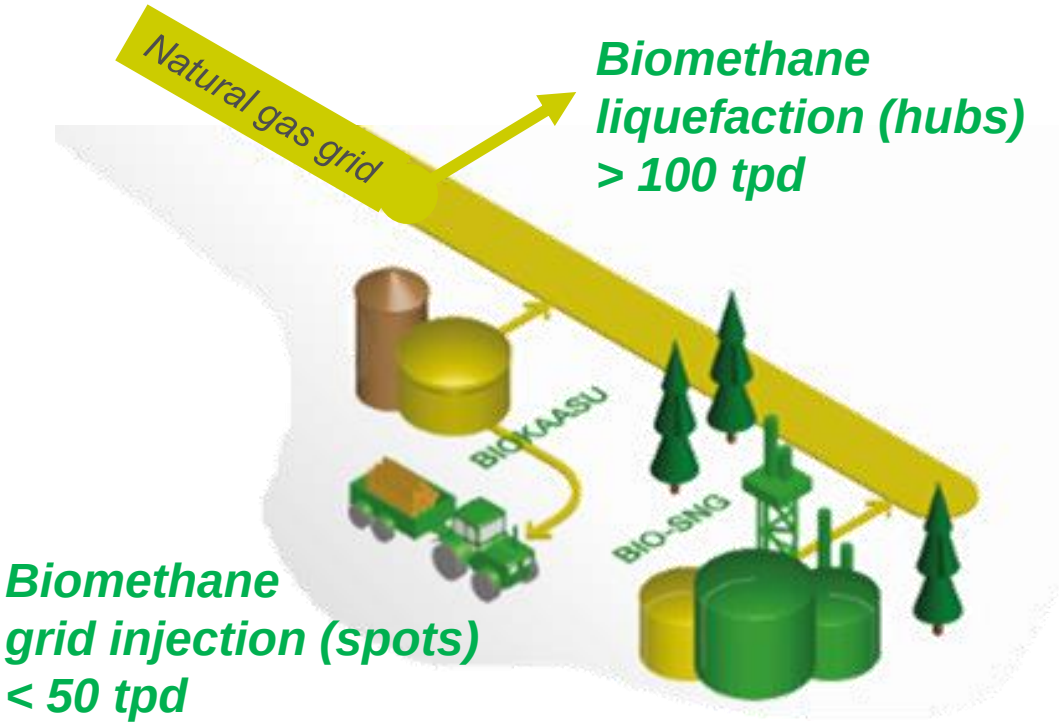
→ 120 GWh of CBG & LBG for fuelling stations and export

WÄRTSILÄ TO SUPPLY A MAJOR LNG/BIOLNG PRODUCTION PLANT FOR CO2-NEUTRAL TRANSPORT FUELS

- Capacity 100.000 tons/a bioLNG, located in Cologne/ Germany
- The feedstock for bioLNG is based on biological waste material e.g. liquid manure and food waste

- **Wärtsilä scope:**
  - Gas treatment system based on Wärtsilä's Puregas CA technology
  - Liquefaction unit utilising Wärtsilä's Semi-Dual Brayton technology
  - Storage tanks & truck filling stations
  - All necessary safety, flare and auxiliary equipment

- EPC-IC delivery incl civil works
- Fully operational by autumn 2022



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