



WÄRTSILÄ

BIOGAS | FUELLING THE FUTURE

WEBINAR 18TH OF JUNE

AGENDA

GENERAL INTRODUCTION

Claudia Beumer

MARKET SITUATION

Magnus Folkelid

BIOMETHANE PRODUCTION

Reetta Kaila

WELCOME TO THE WEBINAR 'BIOGAS; FUELLING THE FUTURE'

- Speakers:

- Claudia Beumer
- Magnus Folkelid
- Reetta Kaila



- House Rules:

- Please keep your microphone on mute
- Questions can be asked via the questionnaire section and will be collected by the moderator
- Polls will be posted along the way
- Webinar recording will be made available afterwards
- Let's make this an interactive session and keep sending in questions

GENERAL INTRODUCTION: INCREASING AWARENESS OF BIOGAS POTENTIAL



HURTIGRUTEN TO POWER CRUISE SHIPS WITH DEAD FISH

Cutaways from fisheries and other organic waste will soon be used to power Hurtigruten's fleet of green cruise ships.

NATURAL GAS VEHICLES:

Shell relies on climate-neutral LNG

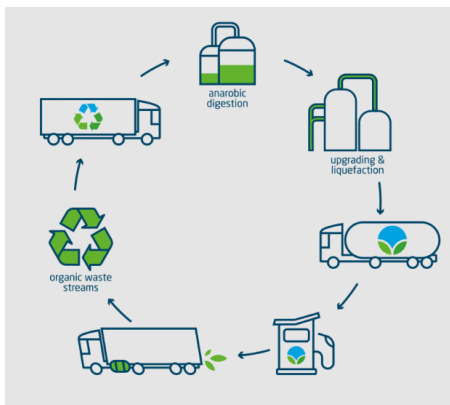
The oil company Shell wants to build a network of 40 LNG filling stations in Germany and is aiming to supply them with climate-neutral gas.

Shell relies on liquefied natural gas (LNG) and biomethane to enable climate-friendly heavy goods traffic. The company is planning to build a gas liquefaction plant in its Rhineland refinery in Cologne-Godorf in order to be able to supply the company's LNG filling stations with CO₂-neutral fuel, said the German group headquarters in Hamburg.

The planned liquefaction plant should have an annual capacity of around 100,000 t. In the second half of 2020, the company plans to submit the application documents, begin construction in spring 2021, and put the plant into operation by 2022/2023. Shell wants to contribute to the fact that heavy goods traffic in Germany in the medium term up to 1 million t CO₂ emits less per year, according to Shell, according to Shell, trucks emitting up to 22% less greenhouse gases than diesel vehicles.

Biomethane plays an important role in Shell plans. The group wants to procure it on the market and feed it into the gas network so that it can be extracted from it in Cologne and - mainly on the balance sheet - processed into bio-LNG. Shell is striving to provide 100% CO₂ neutral LNG, a spokesman for the refinery said. From there it will be transported by tanker truck to the petrol stations.

The plans aimed to obtain as much sustainable biomethane as possible from organic raw materials. The spokesman mentions low, at best negative carbon intensity, animal welfare, sustainable land use and the like as sustainability criteria. Sustainable biomethane, for example produced from liquid manure, is only available in Germany to a limited extent. Shell may therefore have to use fossil natural gas "to balance supply and demand for the LNG plant in the Rhineland refinery".

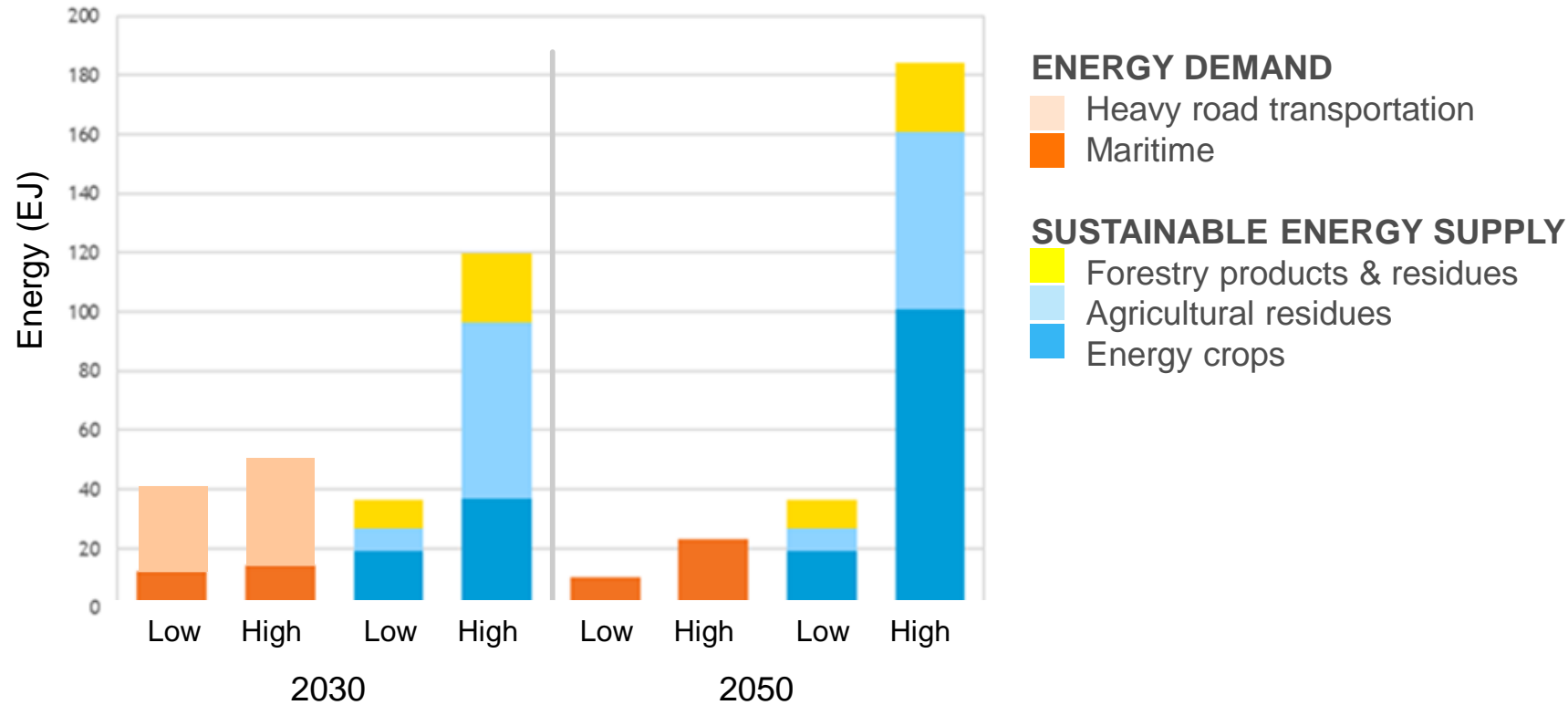



Bio-LNG bunkering services now available in the Port of Gothenburg


June 11, 2019

Rolande delivering bioLNG to the roadtransport

BIOLNG AVAILABILITY ANALYSIS BY CE DELFT FOR SEALNG (03/2020)

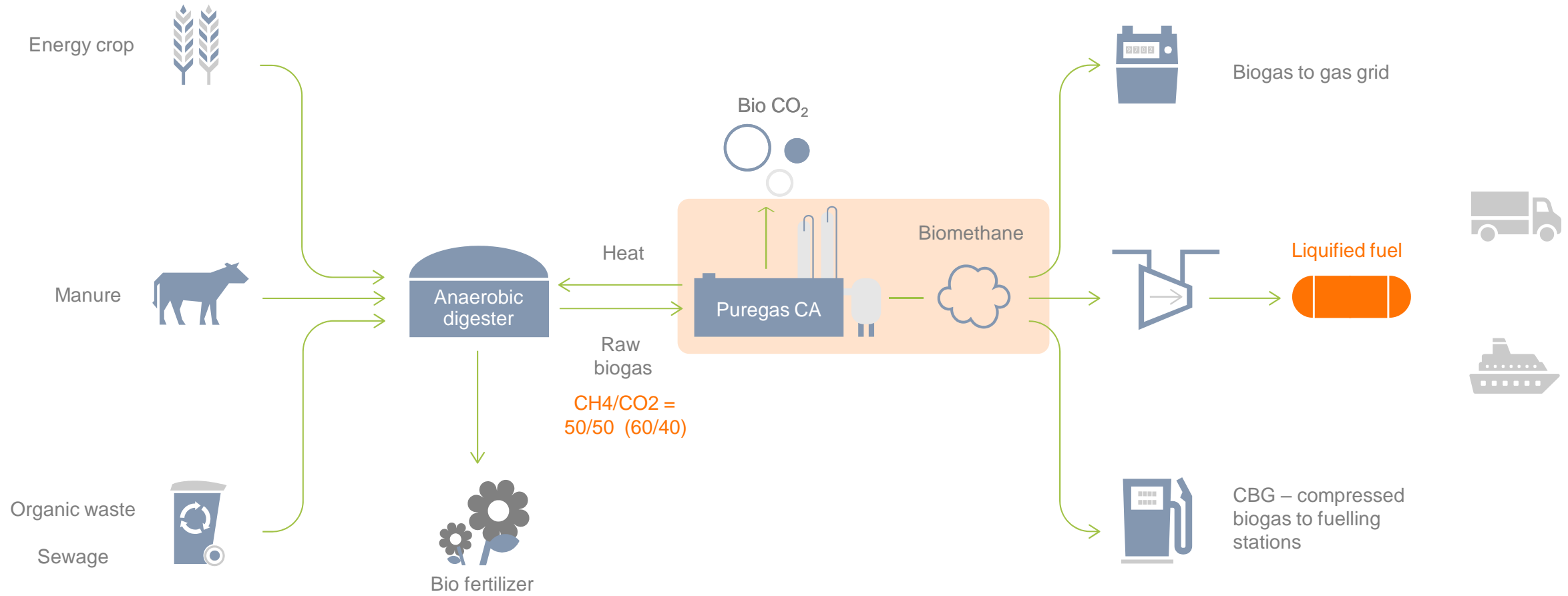


 **Energy crops** are only grown on 'surplus land' i.e. land that is not used for production of food, feed and fibres (ligno-cellulosic, etc)

 **Aquatic biomass** has a potential of 600-1500 EJ in 2050

1 EJ = Exajoule = 1×10^{18}

THE BIOGAS TO BIOMETHANE VALUE CHAIN



POLL QUESTION

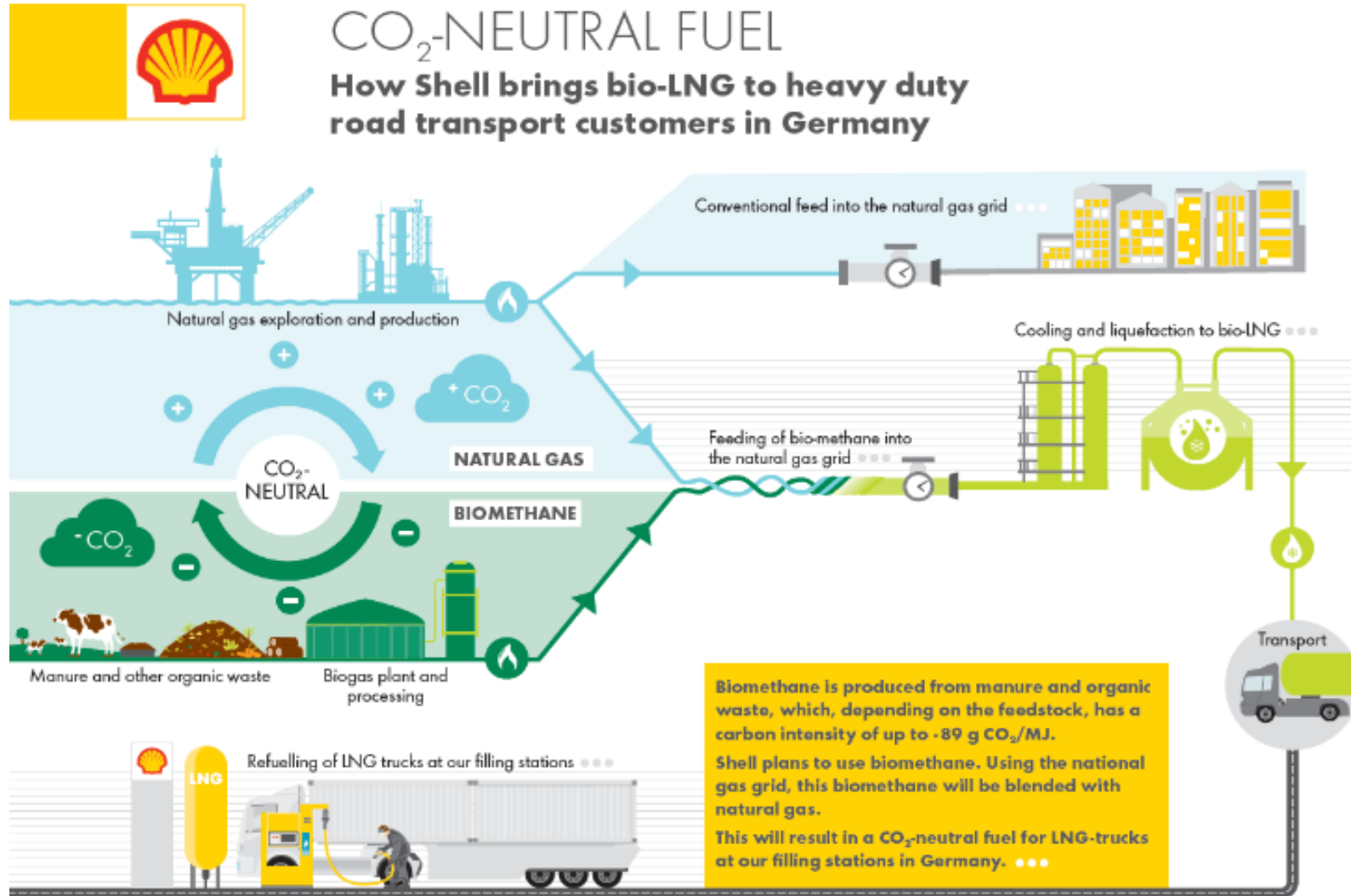
VALUE OF BIOGAS AS ENERGY SOURCE

FUTURE ENERGY MIX

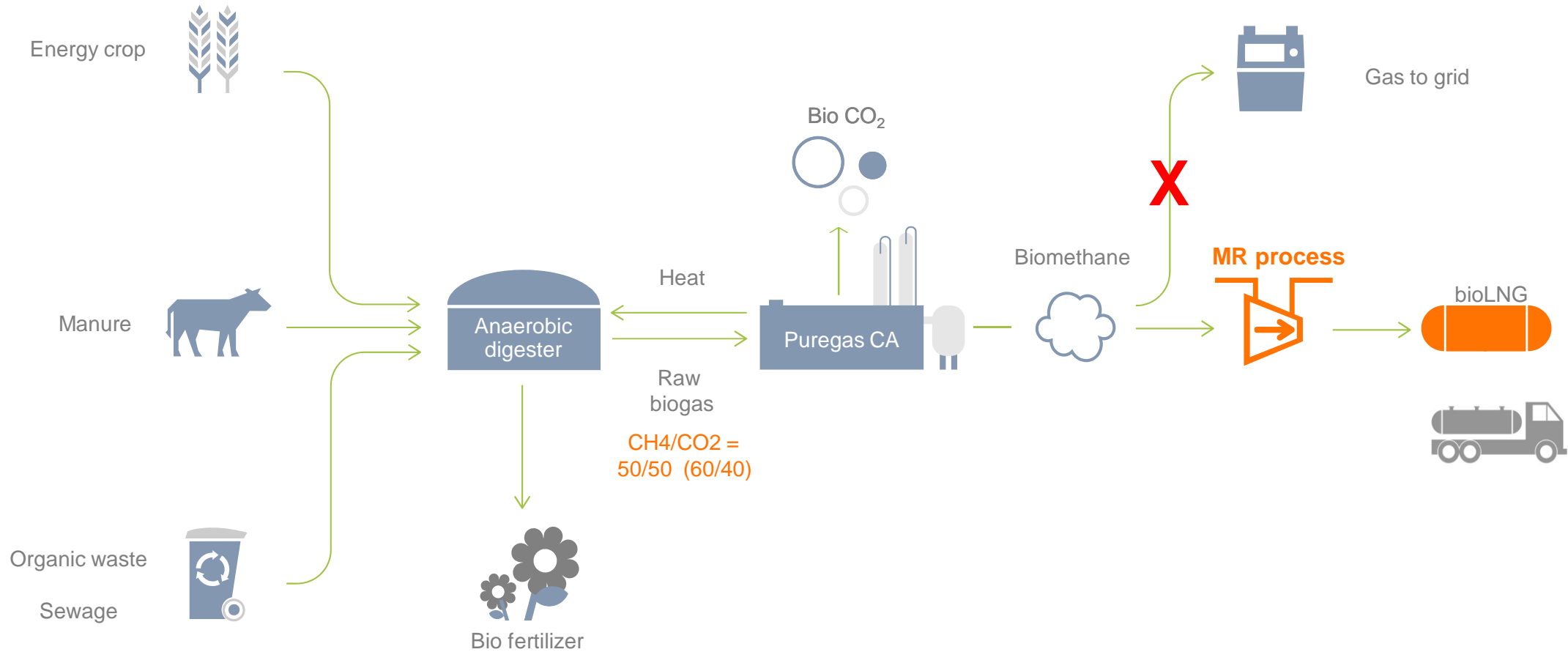
INCENTIVES & REGULATIONS

ECONOMICAL ASPECTS













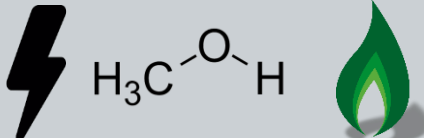











*Copied with pride from Shell













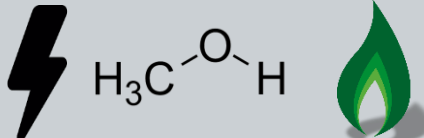







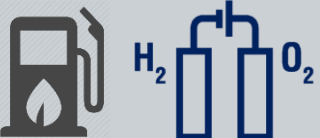

SOCIETY GETS ELECTRIFIED – THE END OF BIOGAS?

Outlook for turning from black to green – a biogas perspective

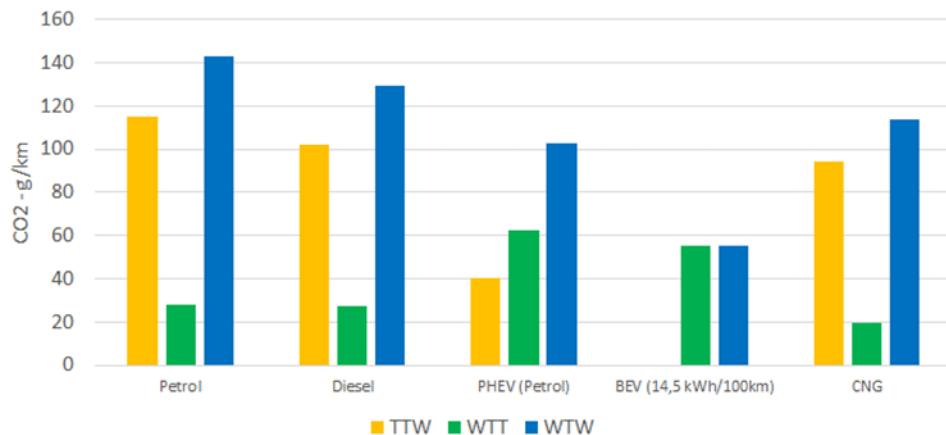
Application	Demand	Competition	Value creation
			
			
			
			
			

SOCIETY GETS ELECTRIFIED – THE END OF BIOGAS?

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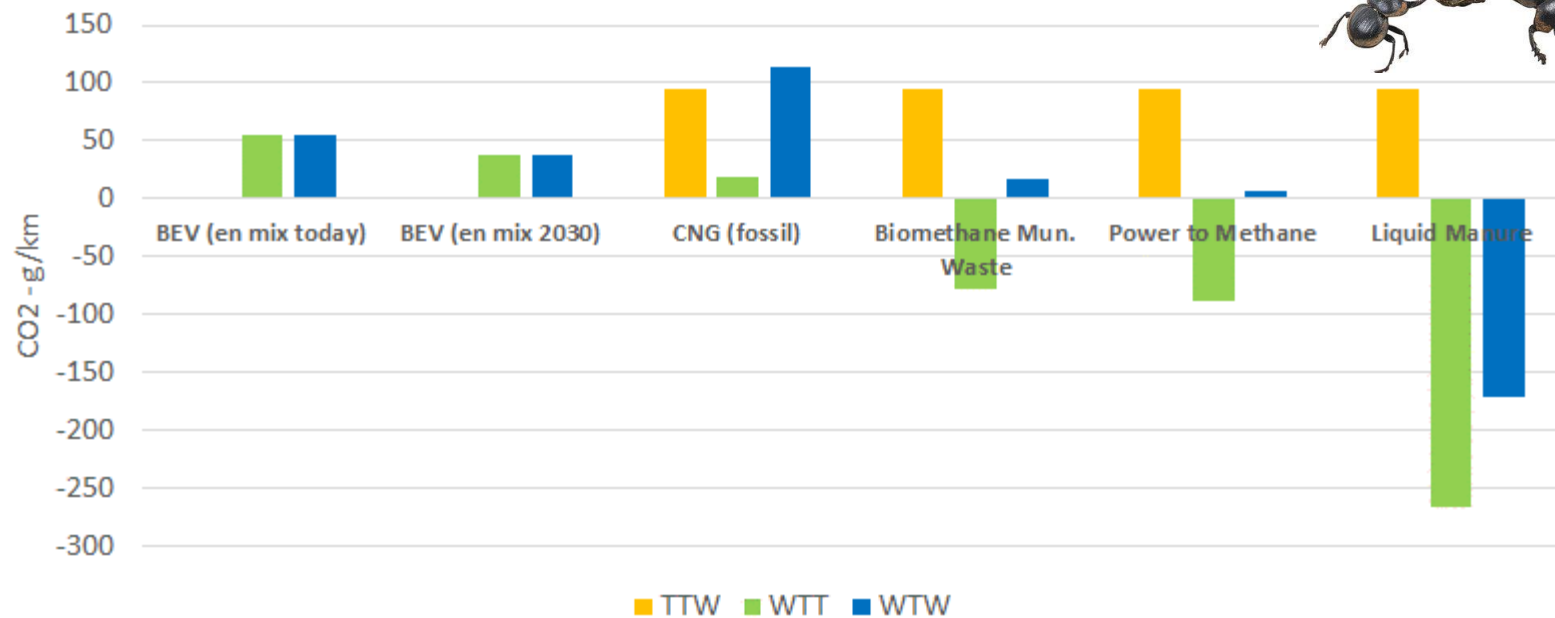
Application	Demand	Competition	Value creation
			
			
			
			
			

WTW emissions comparison
c-segm vehicle - WLTP



CARBON CAPTURE TODAY!

WTW emissions comparison
c-segm vehicle - WLTP - Renewable gas options



TTW – Tank to Wheel; WTT – Well to Tank; WTW – Well to Wheel

Producers and Distributors

Products

Users



Gasum

Air Liquide

BIOKRAFT

e.on



IVECO



NEW HOLLAND



WÄRTSILÄ



HURTIGRUTEN



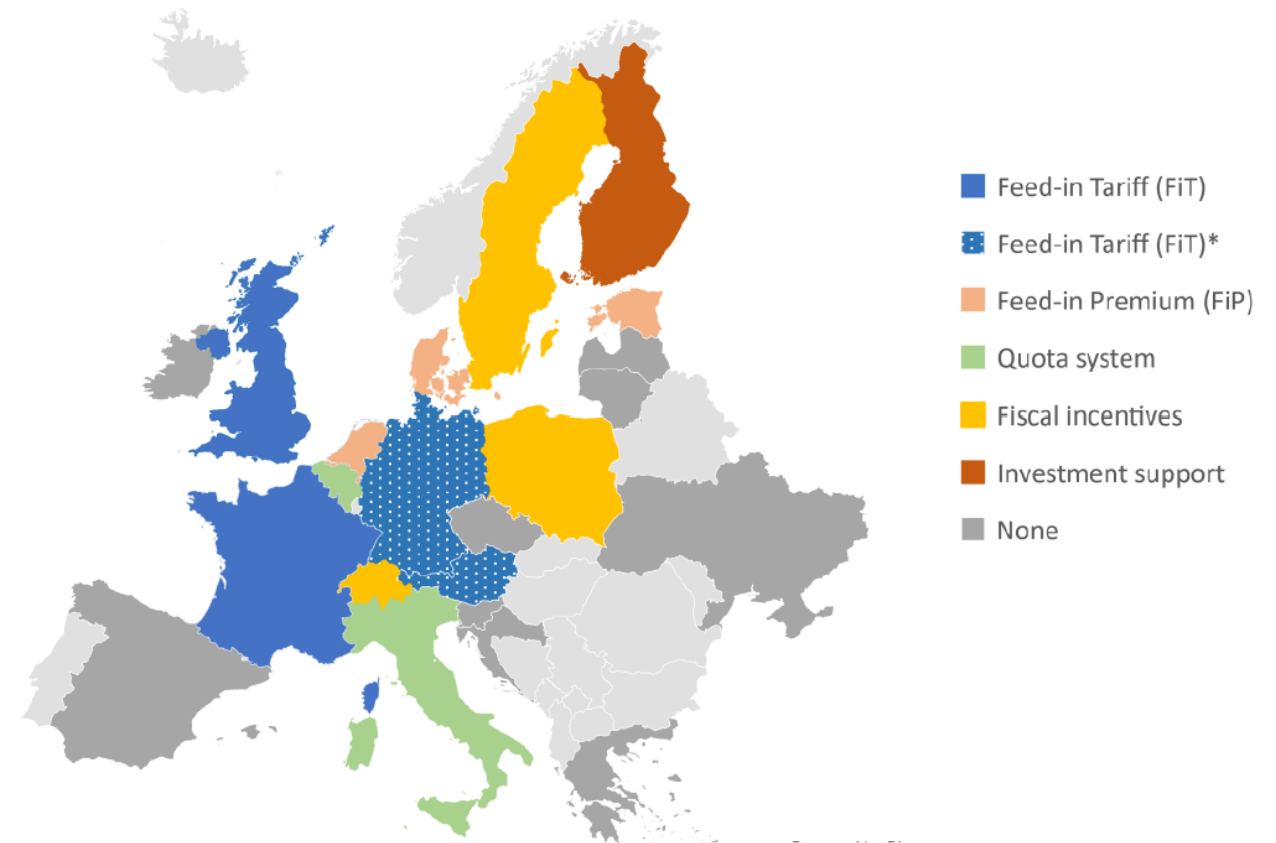
TOYOTA

MATERIAL HANDLING



VIKING LINE

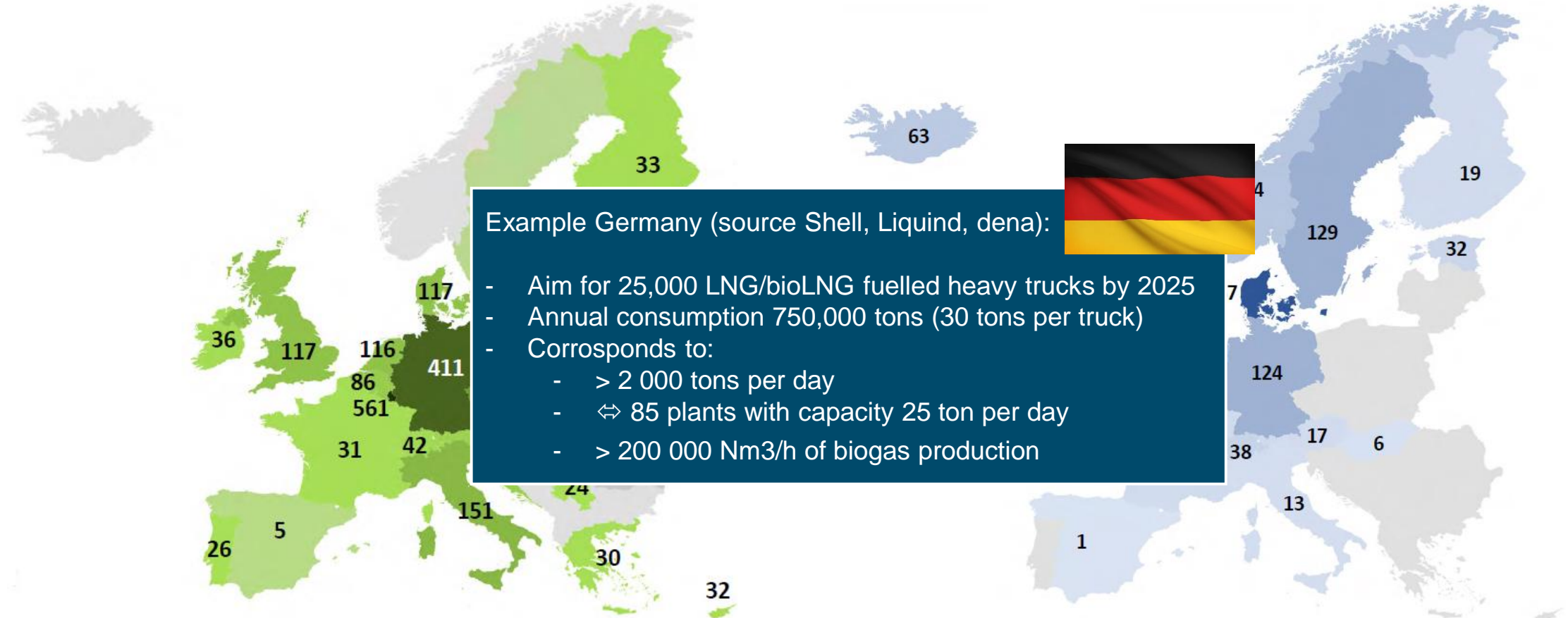
- Incentive schemes do change over time
- A palette throughout Europe from well structured and defined to no incentive schemes formulated at all
- In past focus on de-carbonize the power grid
→ structured incentive schemes and green (power) certificates
- De-carbonizing of power grid +10 years behind
- RED II a EU driver for biomethane as transport fuel
- Initiative for creating a common green gas certificate trading system, partly in place



Source: Regatrace D6.1

BIOGAS ELECTRICITY PRODUCTION; KWH PER HEAD

Biomethane production; kWh per head of population



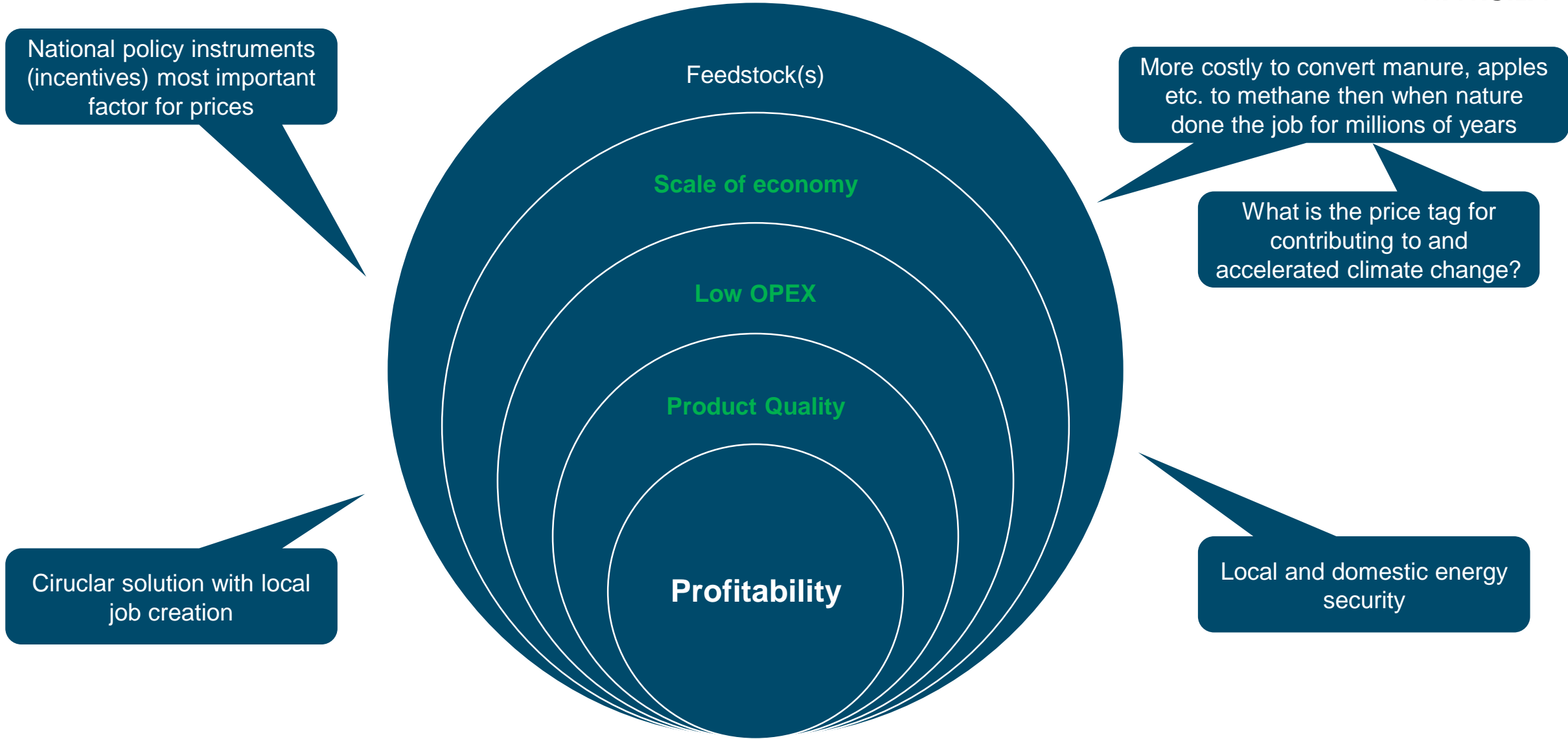
Example Germany (source Shell, Liquid, dena):



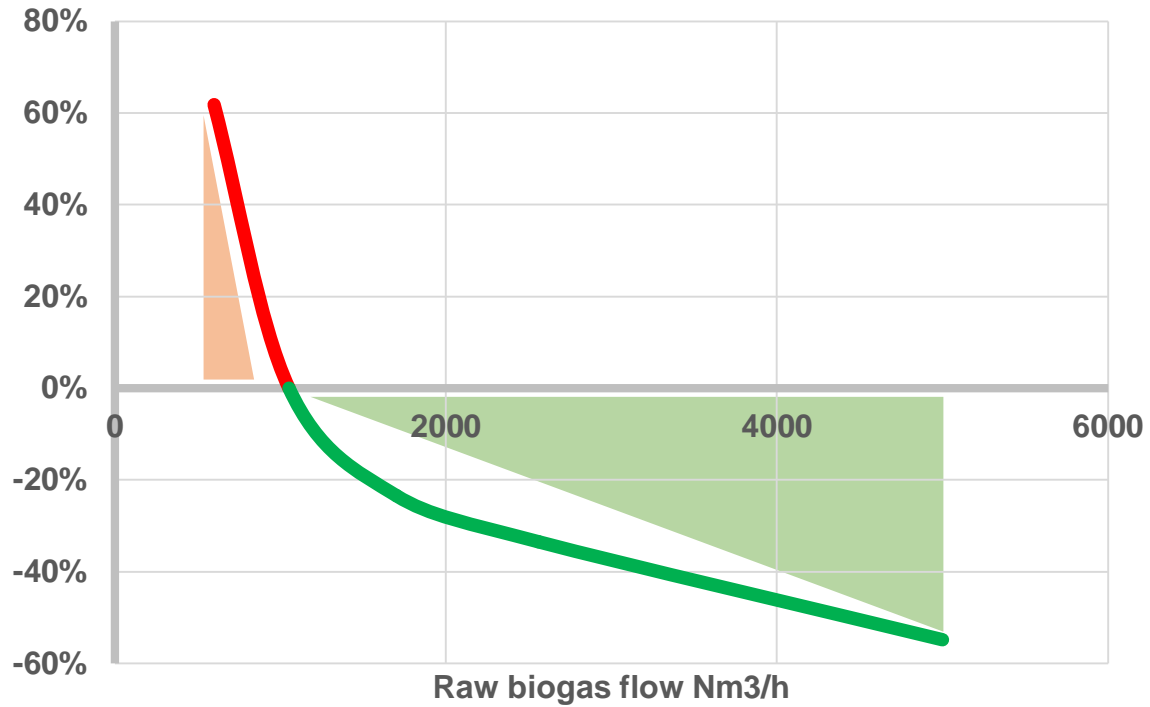
- Aim for 25,000 LNG/bioLNG fuelled heavy trucks by 2025
- Annual consumption 750,000 tons (30 tons per truck)
- Corrosponds to:
 - > 2 000 tons per day
 - ⇔ 85 plants with capacity 25 ton per day
 - > 200 000 Nm3/h of biogas production

Source: EBA Statistical report 2019

- Each kWh electricty equal approximatively 3 kWh of biomethane
- Huge potential for "re-powering" biogas CHP plants into biomethane plants when incentives for electricity ends
- Some countries are already tuned towards biomethane: Denmark, Sweden, Norway

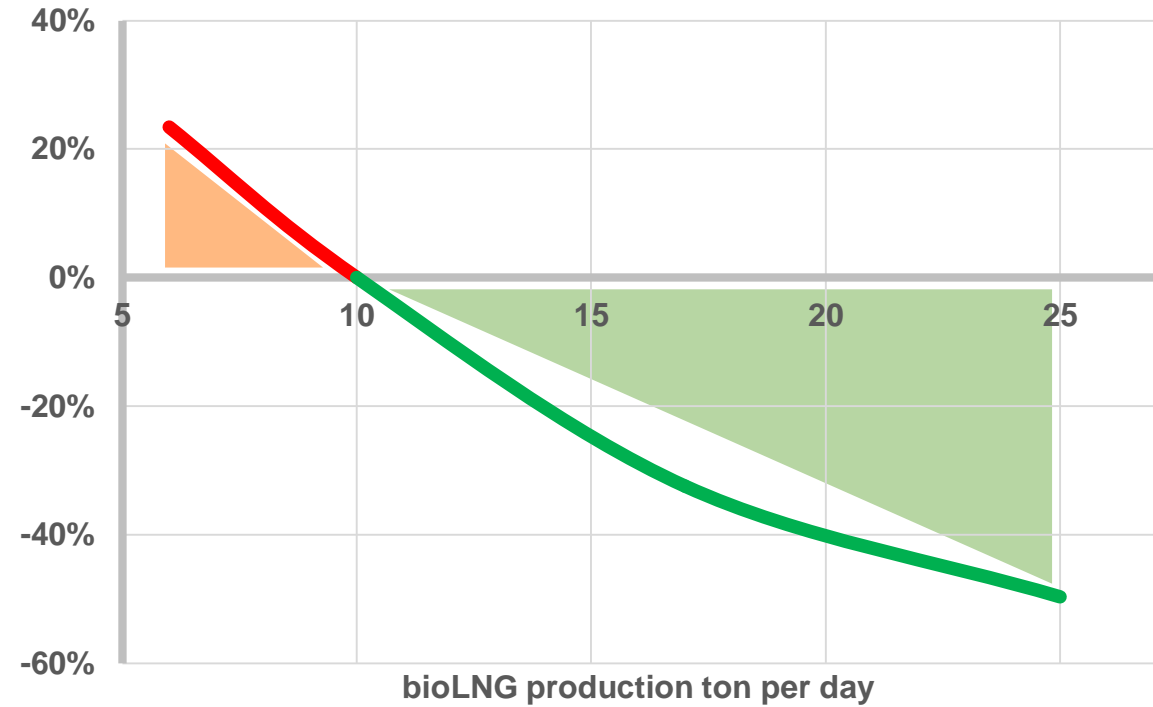


Relative CAPEX biogas upgrading



"1,000 TO 5,000 NM³/H → SCALE EFFECT OF 2,5 – 3 TIMES"

Relative CAPEX biogas liquefaction



"10 to 25 TPD → scale effect of 5 – 6 times"

TYPICAL OPEX SHARES CONSIDERING BOTH HIGH AND LOW OPEX SOLUTIONS

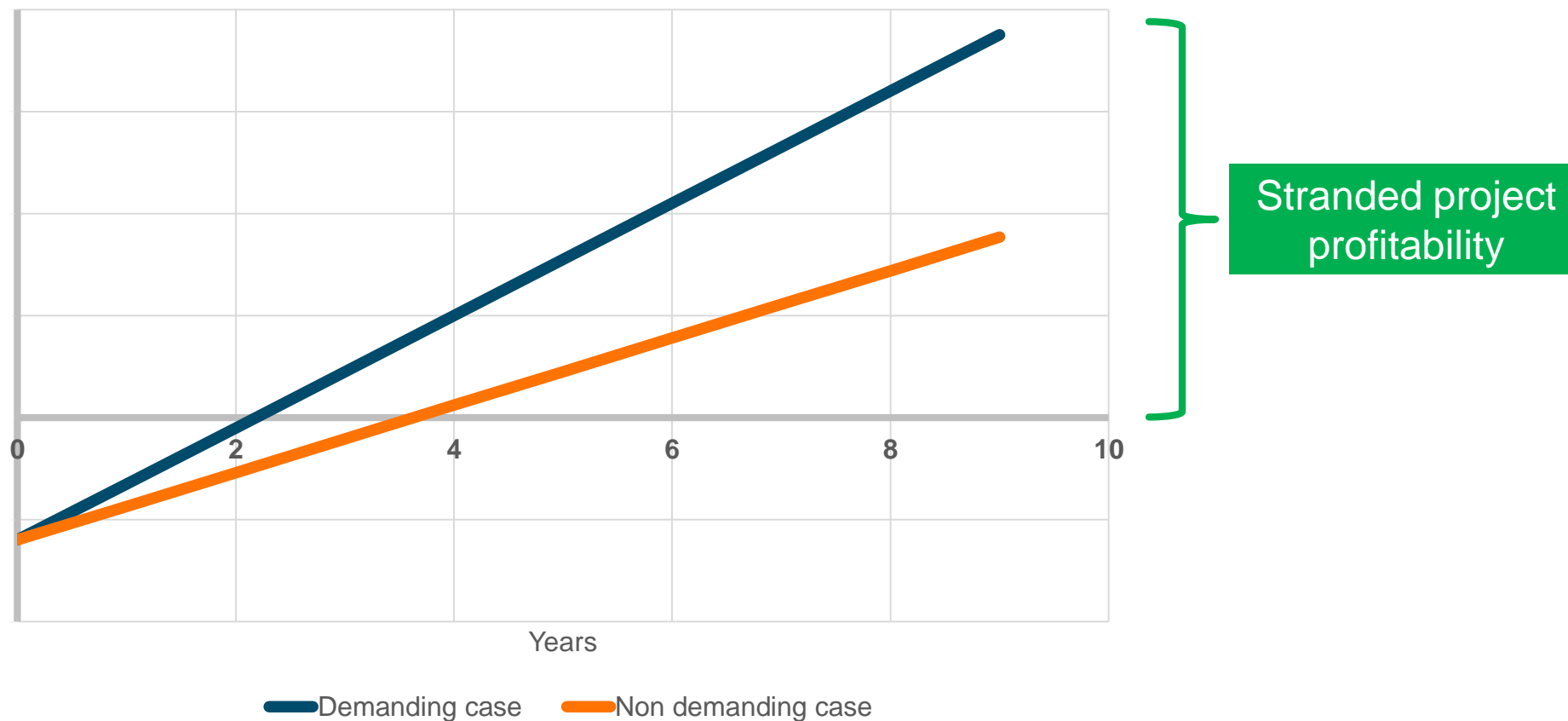
Type	Comment	Share of OPEX
Energy	Electricity and heat (amine upgrading)	30 – 40%
Product gas treatment	Depends on product gas quality and grid injection requirements	0 – 40%
Lost uptime	Availability warranty	10 – 20%
Financial	Loan interest rate	2 – 10%
Methane slip	Lost revenue, need treatment	1 – 5%
Biogas pre treatment	Remove e.g. H ₂ S, VOC	1 – 3%
Annulized re-investments	E.g. Membrane packages, dryer material etc.	1 – 3%
Labor	Remote control but some limited inspection and work (0.2 FTE)	1 – 3%
Other consumables	Water, amine, glycole, compressor oils etc.	1 – 2%

Low OPEX solutions typically have higher CAPEX but:

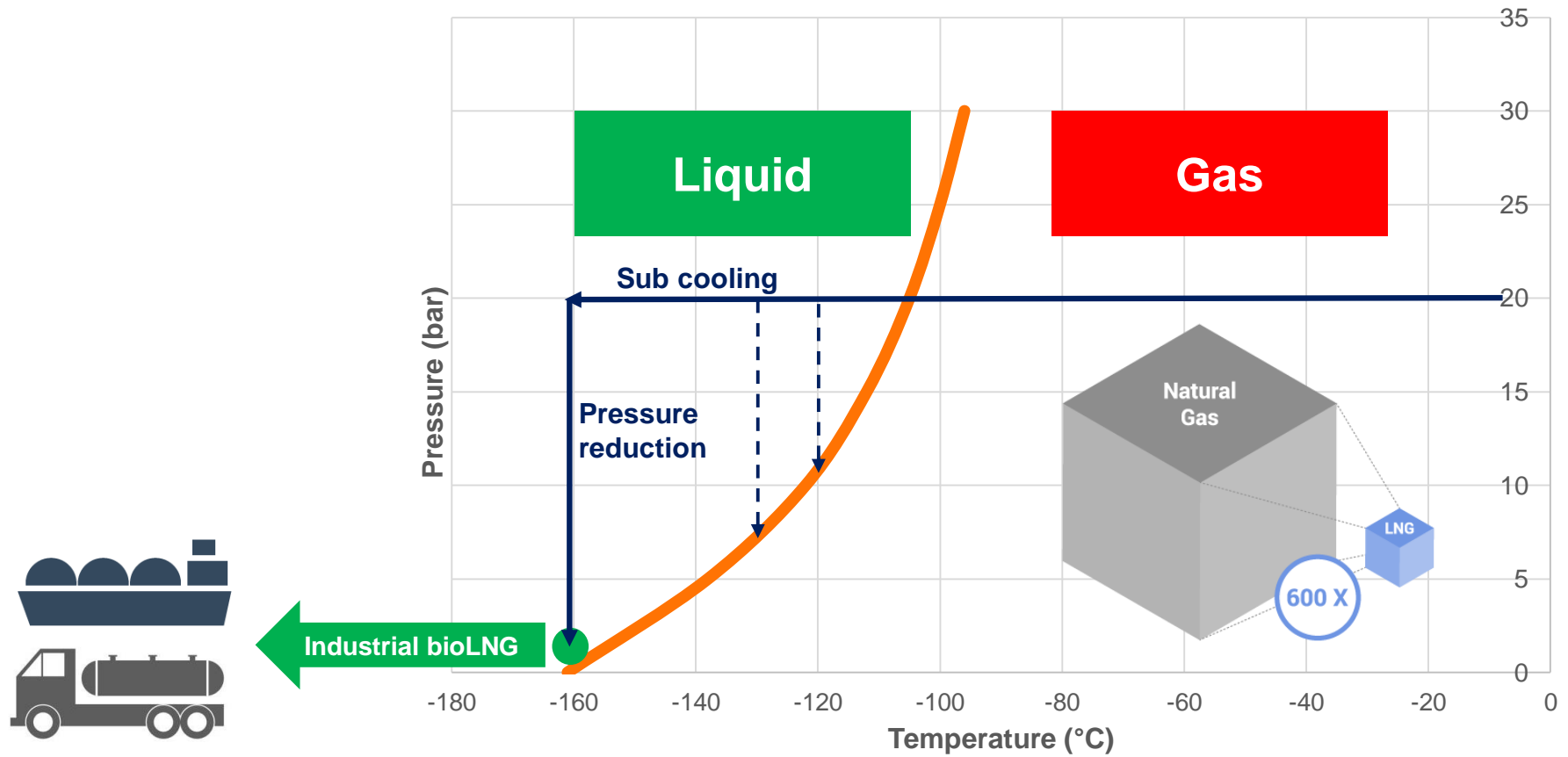
- ✓ Low energy cost
- ✓ Lower or no demand on product gas treatment
- ✓ Higher availability

OPEX difference between high Vs. low OPEX in range of 30% (no or low product gas treatment) to 45%

Typical pay back time for high CAPEX low OPEX solution at 50% (!) higher CAPEX

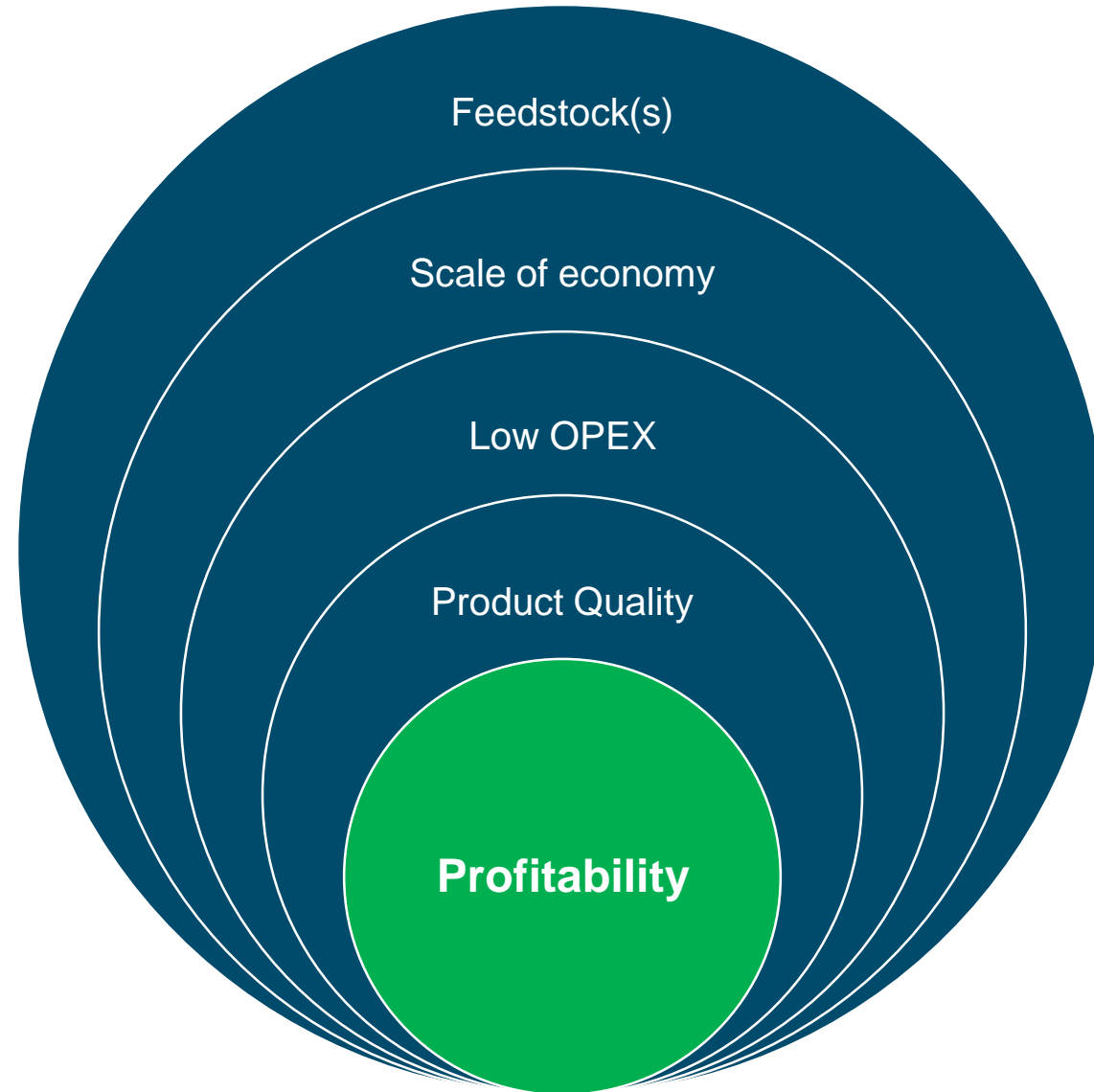


Demanding case: Higher removal of H₂S, VOC and product gas treatment required
Non demanding case: Lower removal of H₂S and VOC and no or little product gas treatment required



- ✓ Share infrastructure with LNG
- ✓ Fully mixable with LNG

} Required to create value on the transport fuel market



POLL QUESTION

BIOGAS TECHNOLOGIES PROVIDED BY WÄRTSILÄ

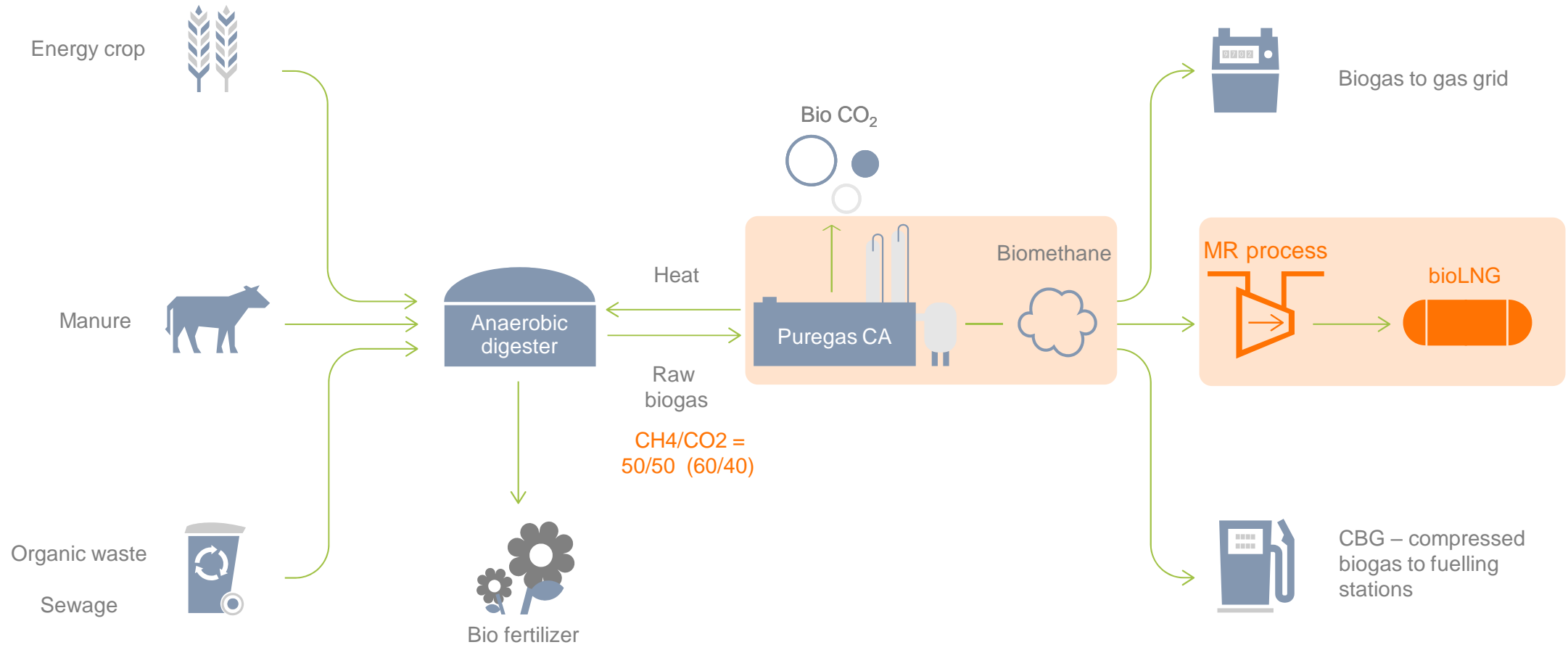
BIOGAS UPGRADING

LIQUEFACTION

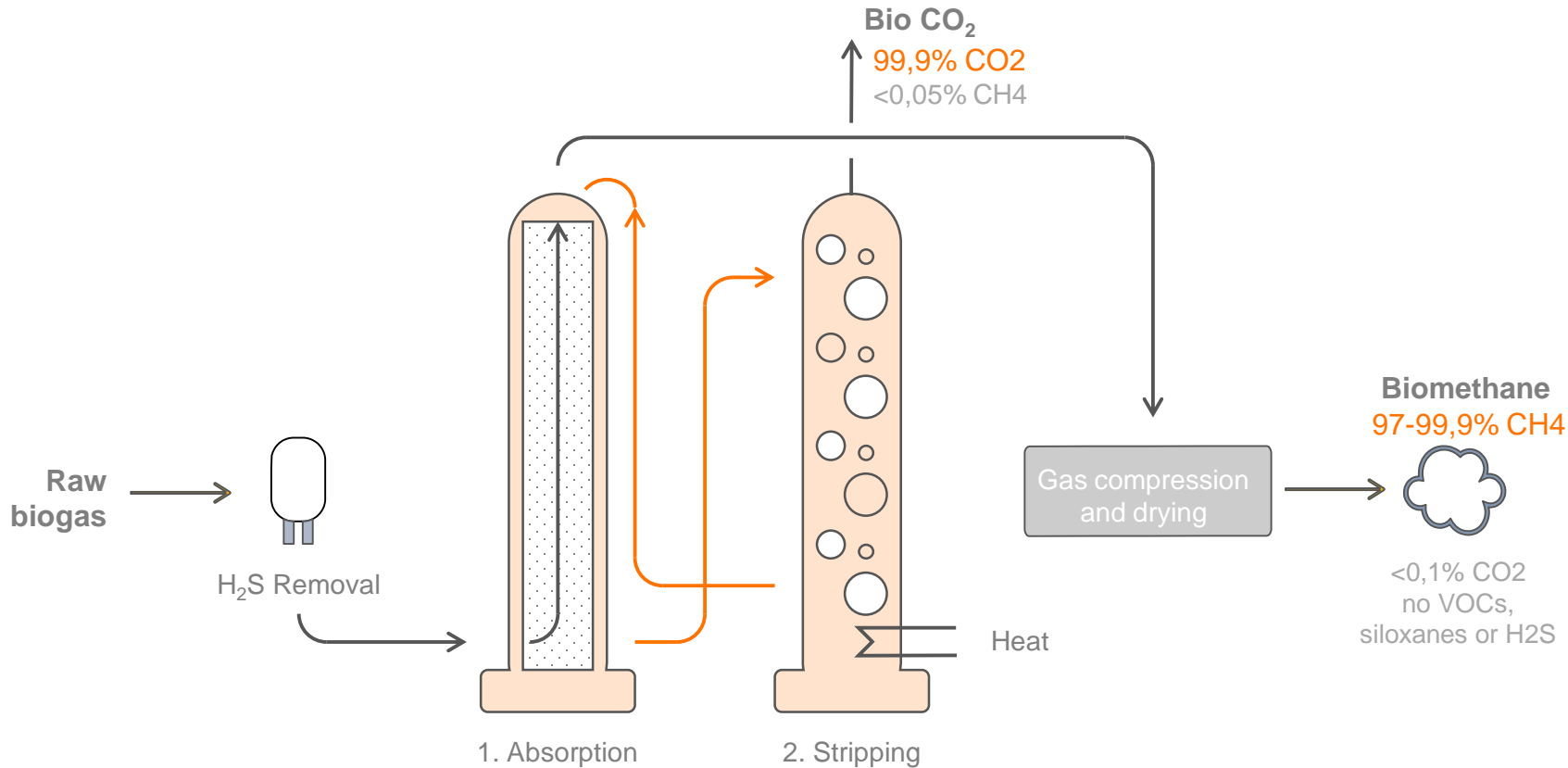
MODULAR DESIGN & EPC-IC



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

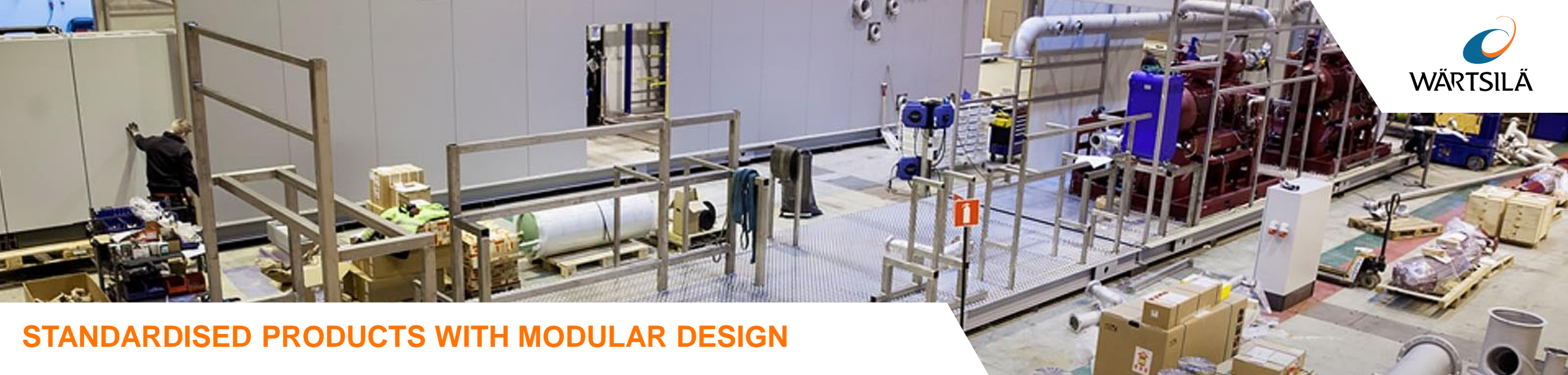


Low OPEX

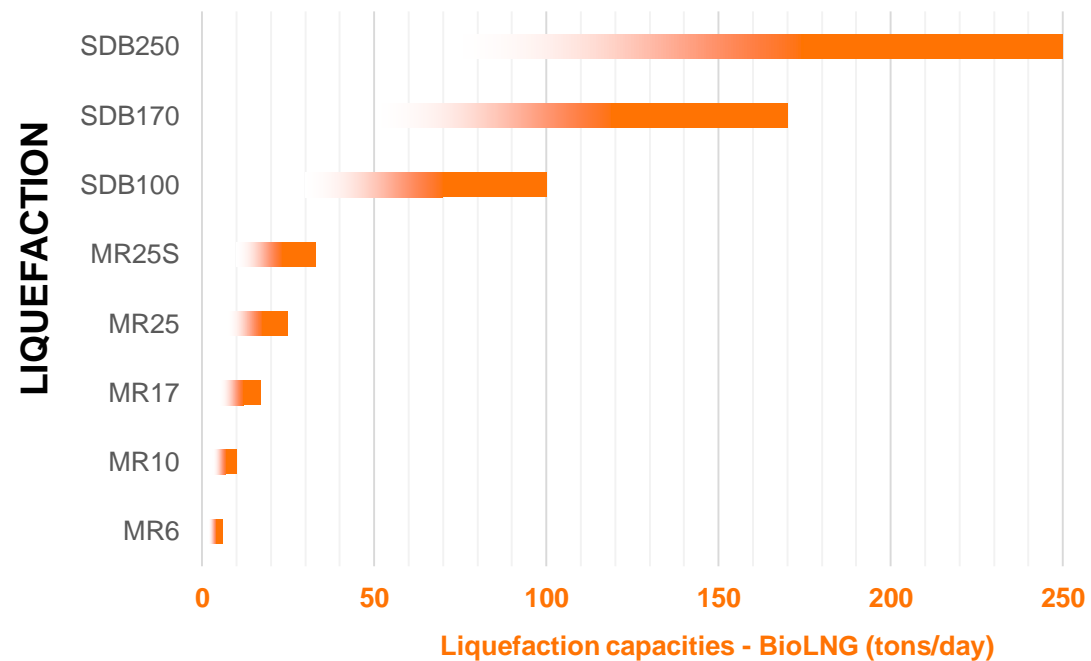
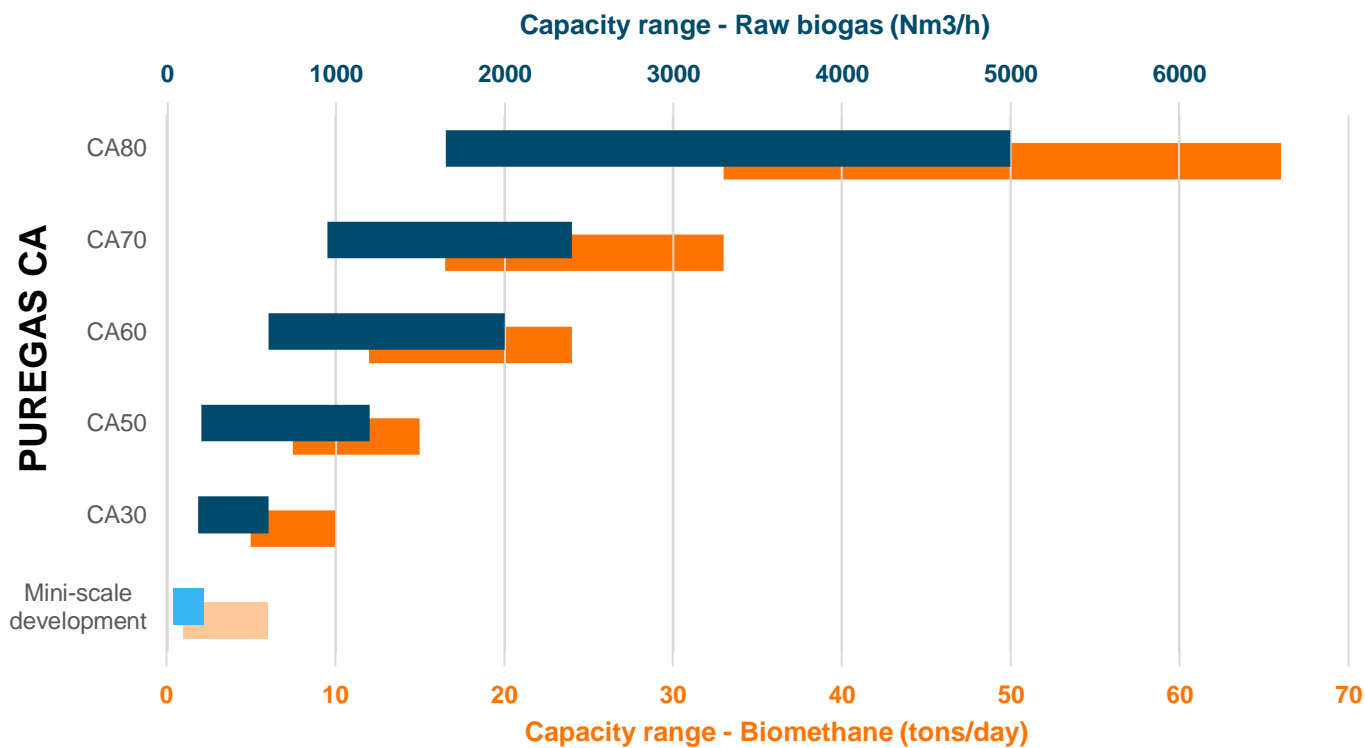
- 75% heat recovery by heat-integration
- Electricity <math>< 0,11</math> kWh/Nm³
- Closed-loop amine-water system
- Low consumption of water and solvents

Low maintenance costs

- 98% uptime guarantee



STANDARDISED PRODUCTS WITH MODULAR DESIGN



WHY WÄRTSILÄ BIOGAS UPGRADING & LIQUEFACTION?

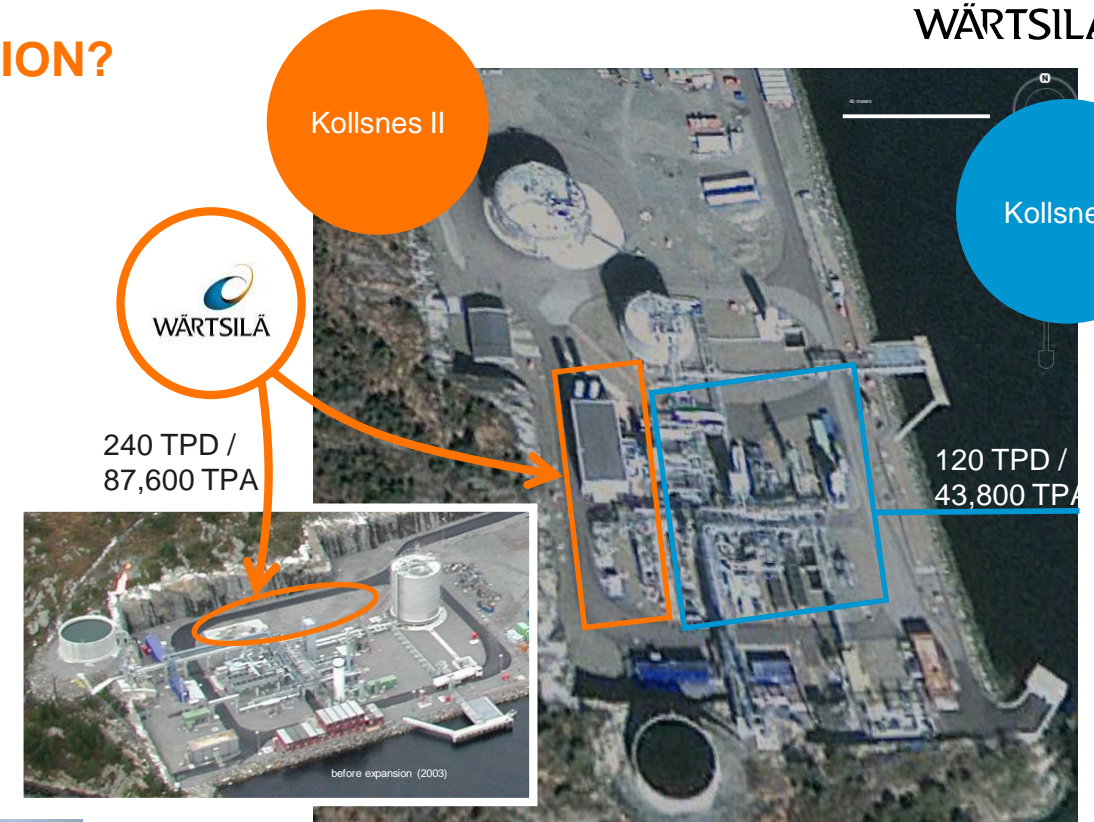
- **Modular & standardised design**

- Integrated housing
- Compact footprint
- Relocation possible

- **EPCIC delivery**

Engineering/ Procurement/ Construction/ Installation/ Commissioning

- Manufactured and FAT tested before delivery
- Quick site installation (min site disturbance)
- Short lead time (<6/11 months delivery to site)



Twice the capacity – half the foot print

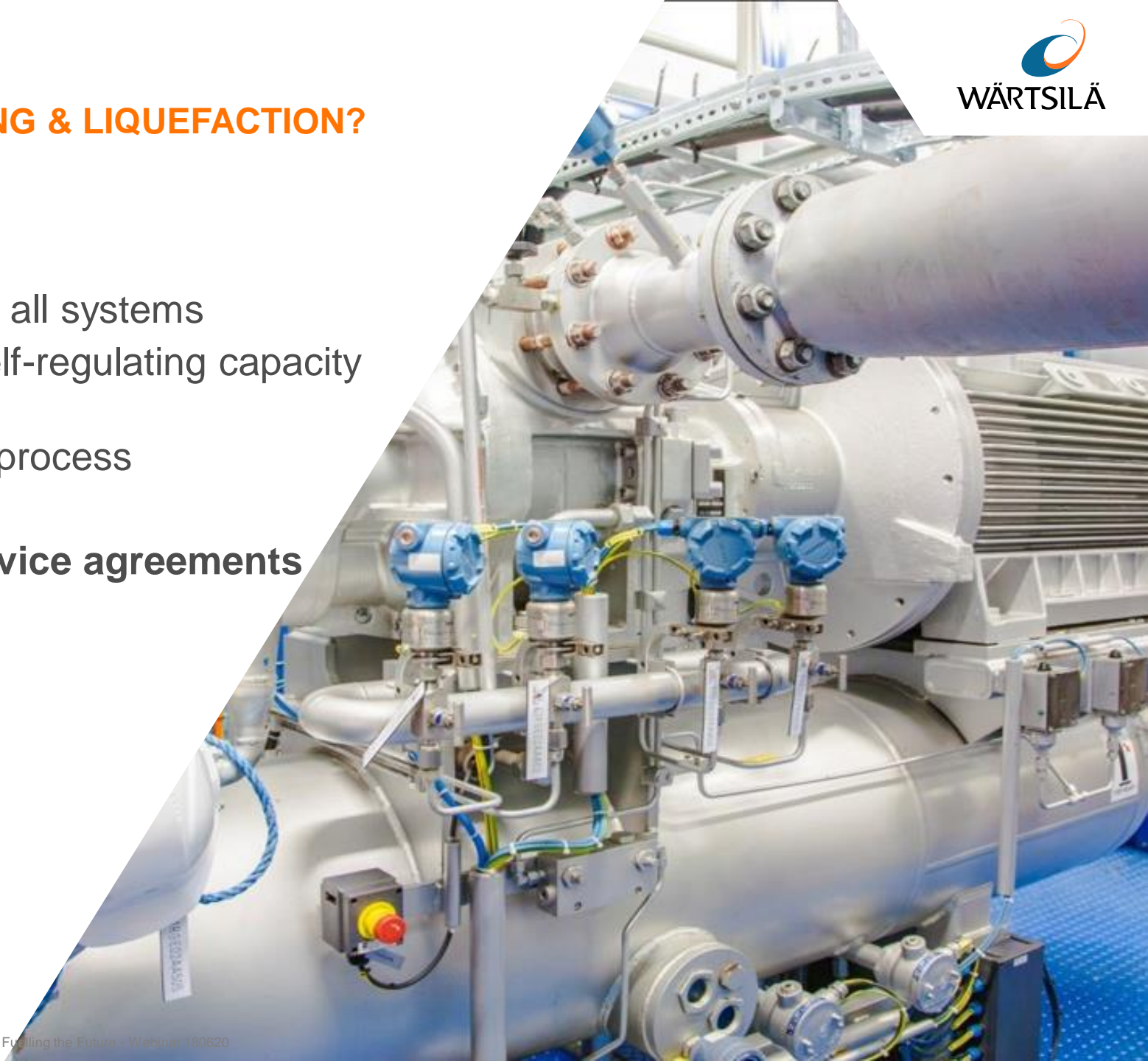


Skive CA80H2S, 24.10.2019

WHY WÄRTSILÄ BIOGAS UPGRADING & LIQUEFACTION?

- **Easy operations**
 - Quick start-up and shut-down of all systems
 - Fully-automated cool down & self-regulating capacity control from 0 to 100%
 - Integrated operations for whole process
- **24/7 service support through service agreements**
 - Remote monitoring & control
- **Design for unmanned operation**
 - Local control of export station
 - Self-operated by truck drivers

→ **Well-proven technology
as a turn-key solution!**



Upgrading plants: 42
(including 1 membrane plant)

CO2 liquefaction plants: "2"

H₂S reduction solutions: 5

Conventional
versions: 34

BioLNG
versions: 4

H₂S
versions: 5



Liquefaction plants: 4

Compressor stations: 11

Boiler solutions: 9

Biogas
Liquefaction: 3

Boil Off Gas
Liquefaction: 1



Biokraft LBG

Owner	Biokraft AS, Norway
Type	bioLNG 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 on the Hurtigruten LNG-driven ferries
Scope of supply	Liquefaction plant, incl. <ul style="list-style-type: none"> • 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



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.”

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

POLL QUESTION

Q&A

MAGNUS FOLKELID

REETTA KAILA

CLAUDIA BEUMER



WÄRTSILÄ