



nordsol

The future is liquid.

BIO-LNG PRODUCTION

HIGHEST VALUE FOR BIOGAS

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Biogas PowerOn

Hamburg, September 28th, 2023



Bio-LNG has the greatest possibility to decarbonize the hard-to-abate long-haul, heavy-duty transport sector today.



Bio-LNG production offers the highest value for biogas.

About Nordsol



Vision on bio-LNG

- ▶ Onsite production
- ▶ Scalability
- ▶ Value
- ▶ Hybrid model



How we can help





nordsol

The future is liquid.

About Nordsol

- Installations for onsite bio-LNG production
- Frontrunner in technology
- All-round bio-LNG expertise
- Make bio-LNG mainstream
- Contribute to a local, circular economy

Biogas upgrading and liquefaction **reinvented**

Key differences between natural gas and biogas offers an opportunity for maximizing economic viability

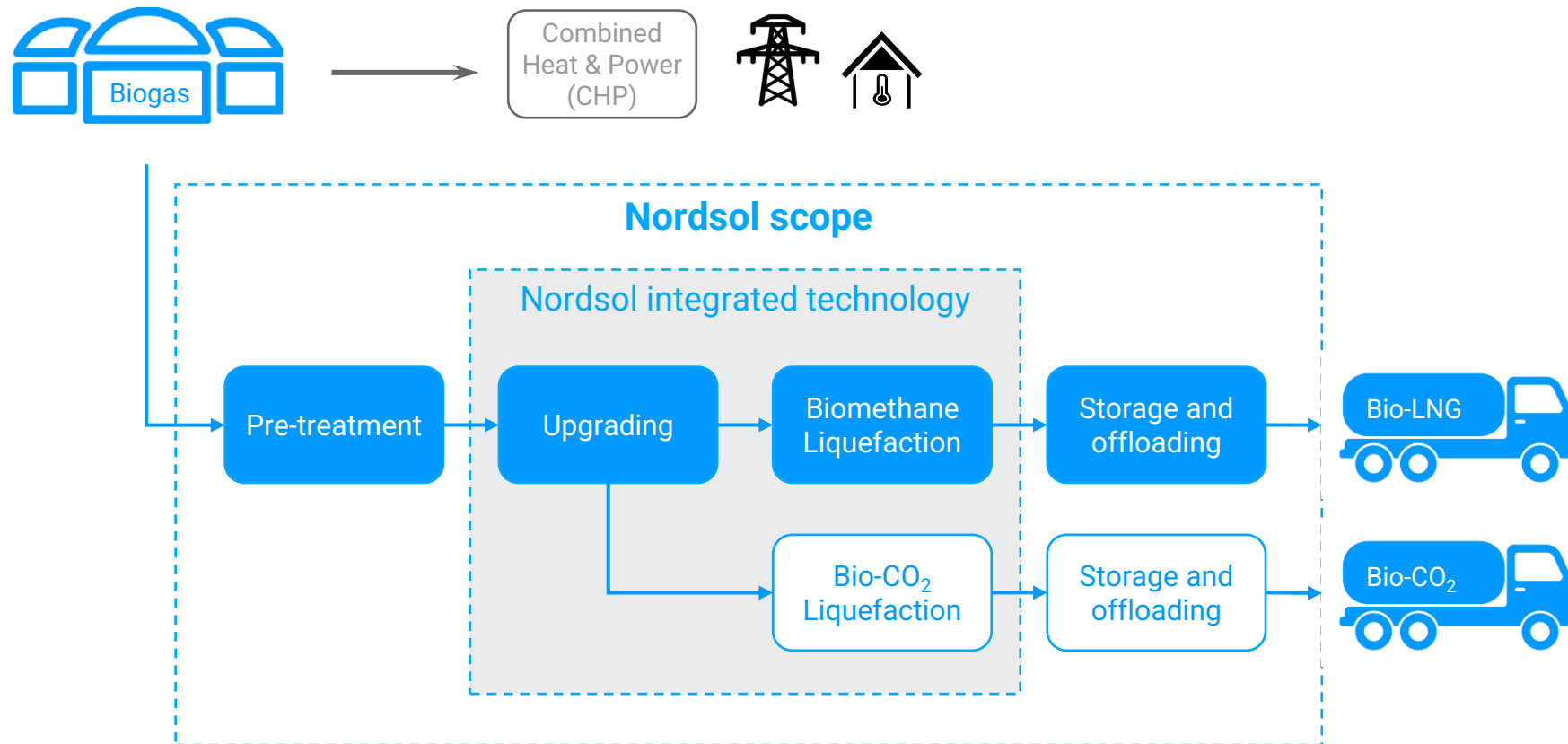
LNG from natural gas

- ▶ Capacity 3 – 15 Mtons/year
- ▶ Consistent flow and composition of gas
- ▶ Complex gas composition
- ▶ Gas is a cheap source of energy for the plant

LNG from biogas (bio-LNG)

- ▶ Capacity 3 – 100 ktons/year
- ▶ Fluctuating flow and composition of gas
- ▶ Simple gas composition
- ▶ Biogas is an expensive source of energy for the plant

Integrated technology for **economic viability**

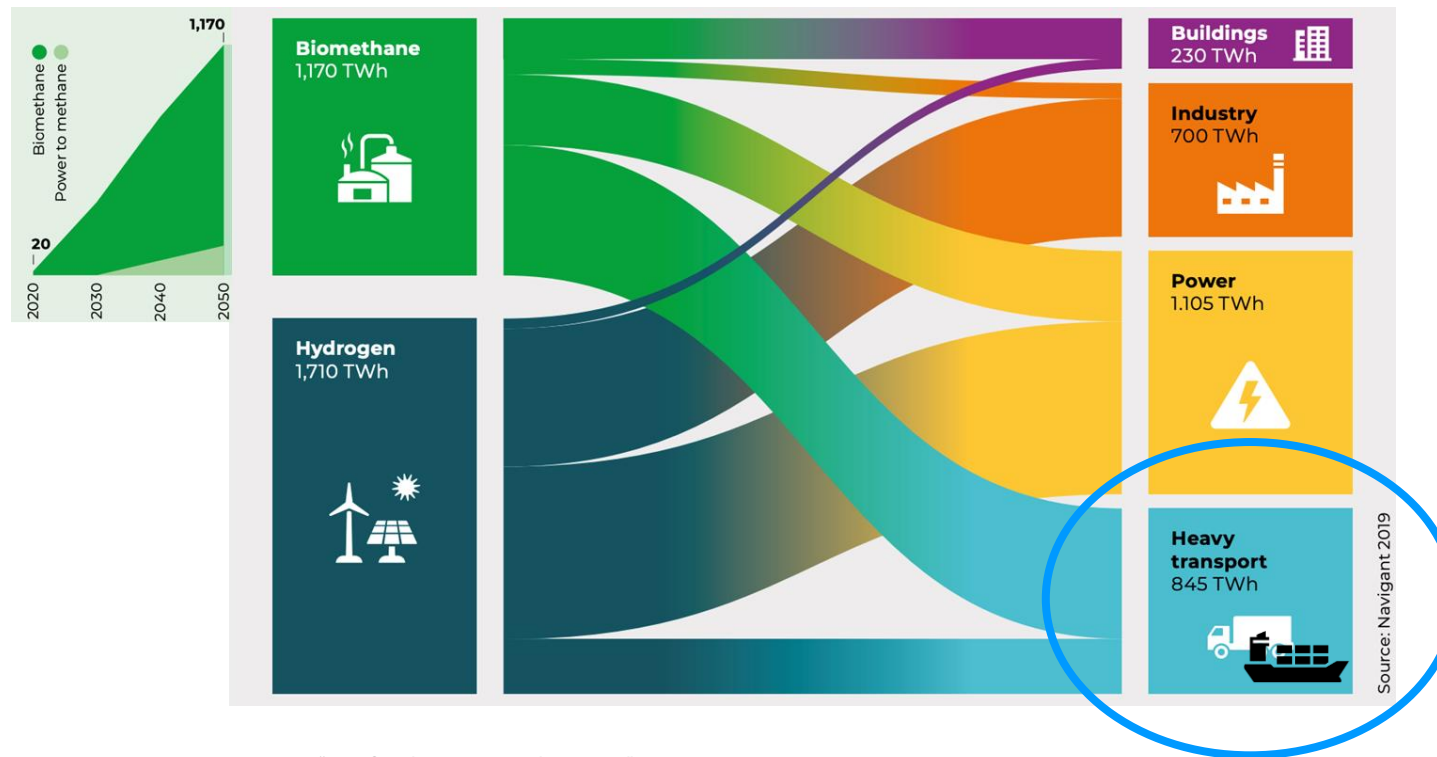


Technology highlights

- ▶ 30% lower TCO, low energy consumption
- ▶ Membranes only - no polishing needed between upgrading and liquefaction
- ▶ Zero methane slip
- ▶ Integrated CO₂ liquefaction
- ▶ Ease of operation, 24/7 unmanned



In 2050, 50% of biomethane will be used as **bio-LNG for transport**



Source: "Gas for climate – a path to 2050"

A bio-LNG installation every 100 kilometers

Unlock the potential in the thousands of biogas plants

- ▶ 20,000 biogas and biomethane plants in 2021
 - ◁ 200 TWh
- ▶ RePowerEU initiative
 - ◁ 35 bcm biomethane
 - ◁ 370 TWh
- ▶ 400 onsite bio-LNG plants in 2030
 - ◁ 47 TWh (3.4 Mton bio-LNG)



Onsite and centralized production

Together meeting demand for bio-LNG

Advantages of onsite production



Onsite and centralized production

Together meeting demand for bio-LNG

Advantages of onsite production

- ▶ **Real bio-LNG.** CH₄ molecules sourced from waste.

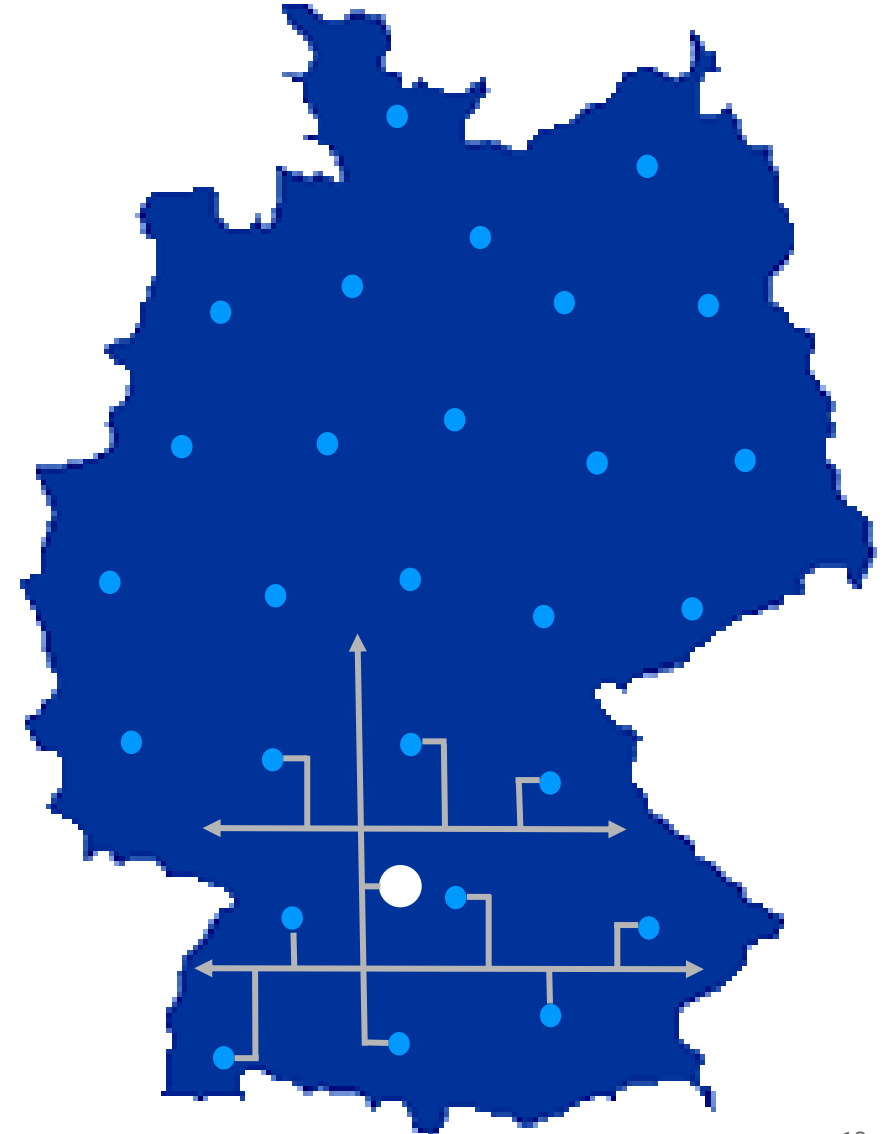


Onsite and centralized production

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- ▶ **Independence** of gas grid connections and capacity



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- ▶ **4 times less transportation** to LNG service stations



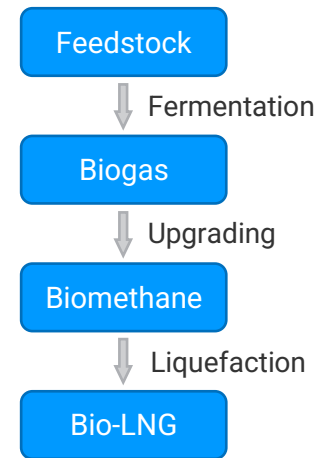
Onsite and centralized production

Together meeting demand for bio-LNG

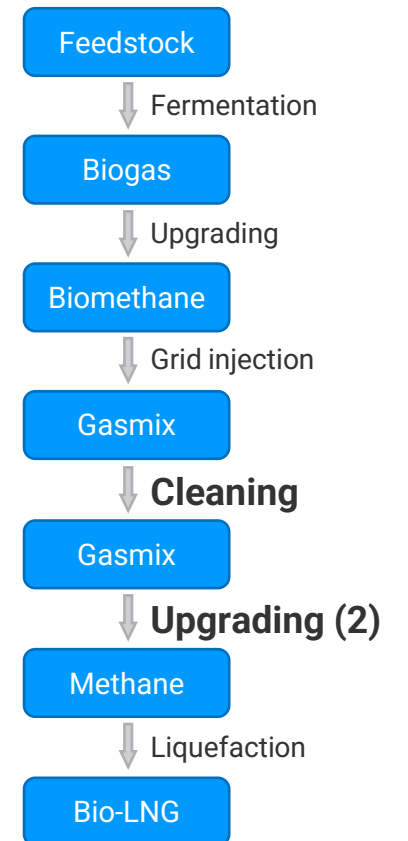
Advantages of onsite production

- ▶ **Real bio-LNG.** CH₄ molecules sourced from waste.
- ▶ **Independence** of gas grid connections and capacity
- ▶ **4 times less transportation** to LNG service stations
- ▶ **Lean production process** – lowest carbon intensity

Onsite (decentralized) bio-LNG production

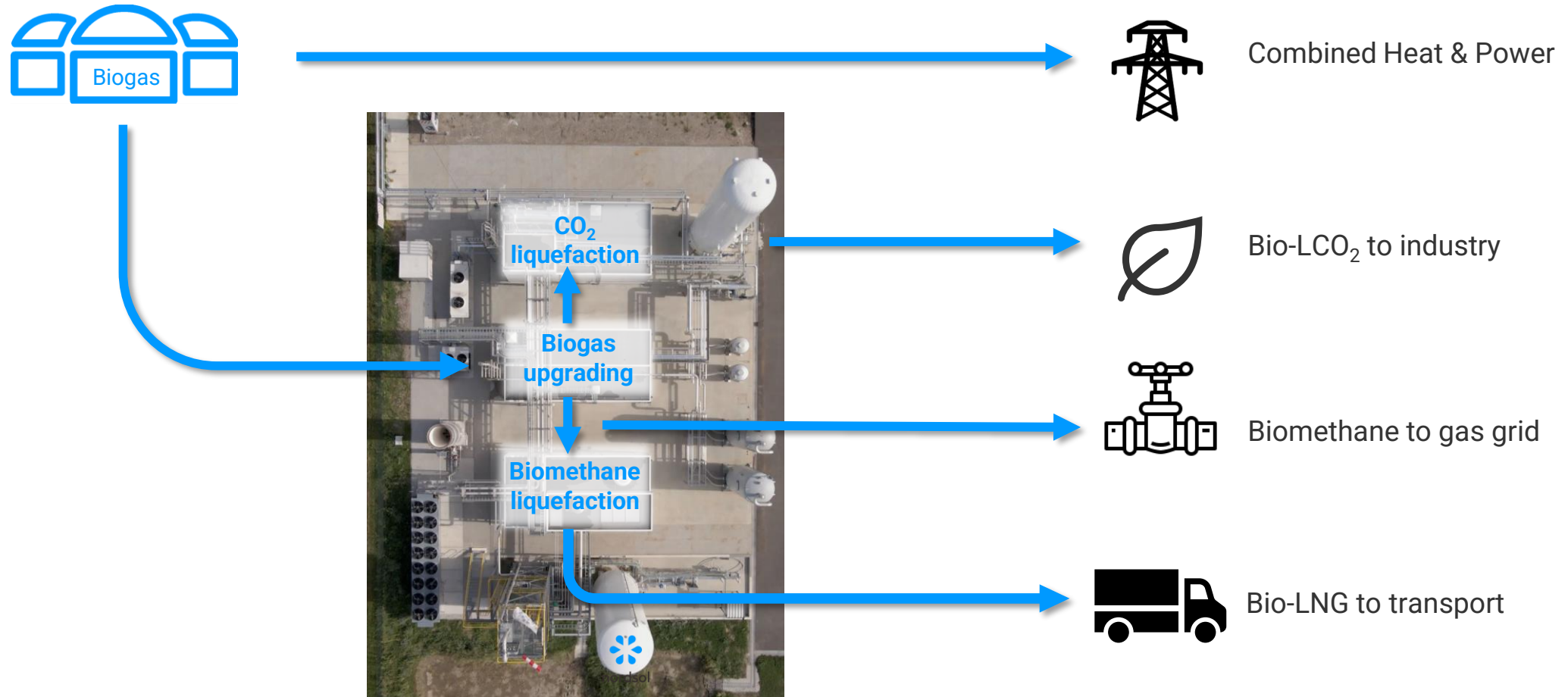


Centralized bio-LNG production



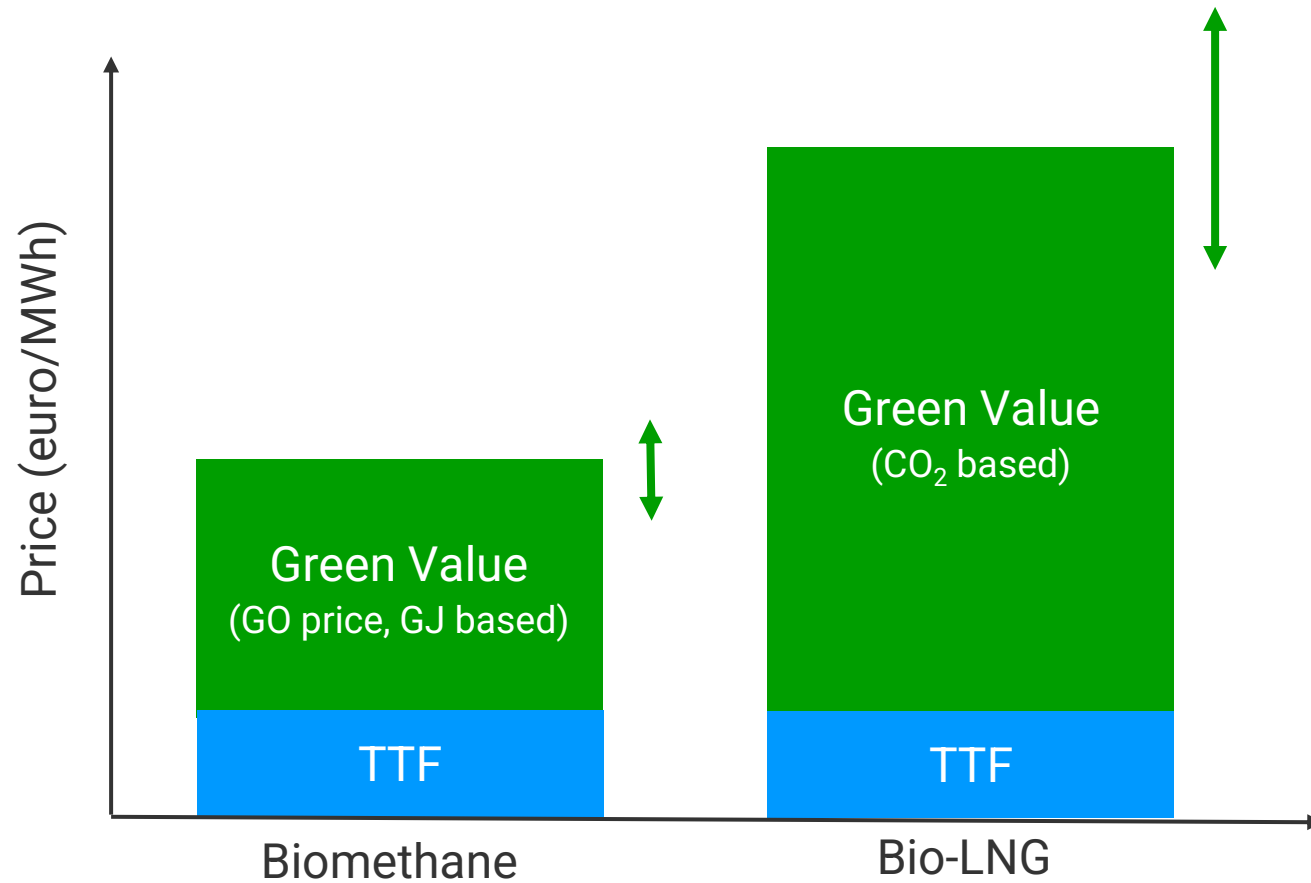
Flexibility to serve a dynamic market for 25 years

Multiple valorization routes



Flexibility to serve a dynamic market for 25 years

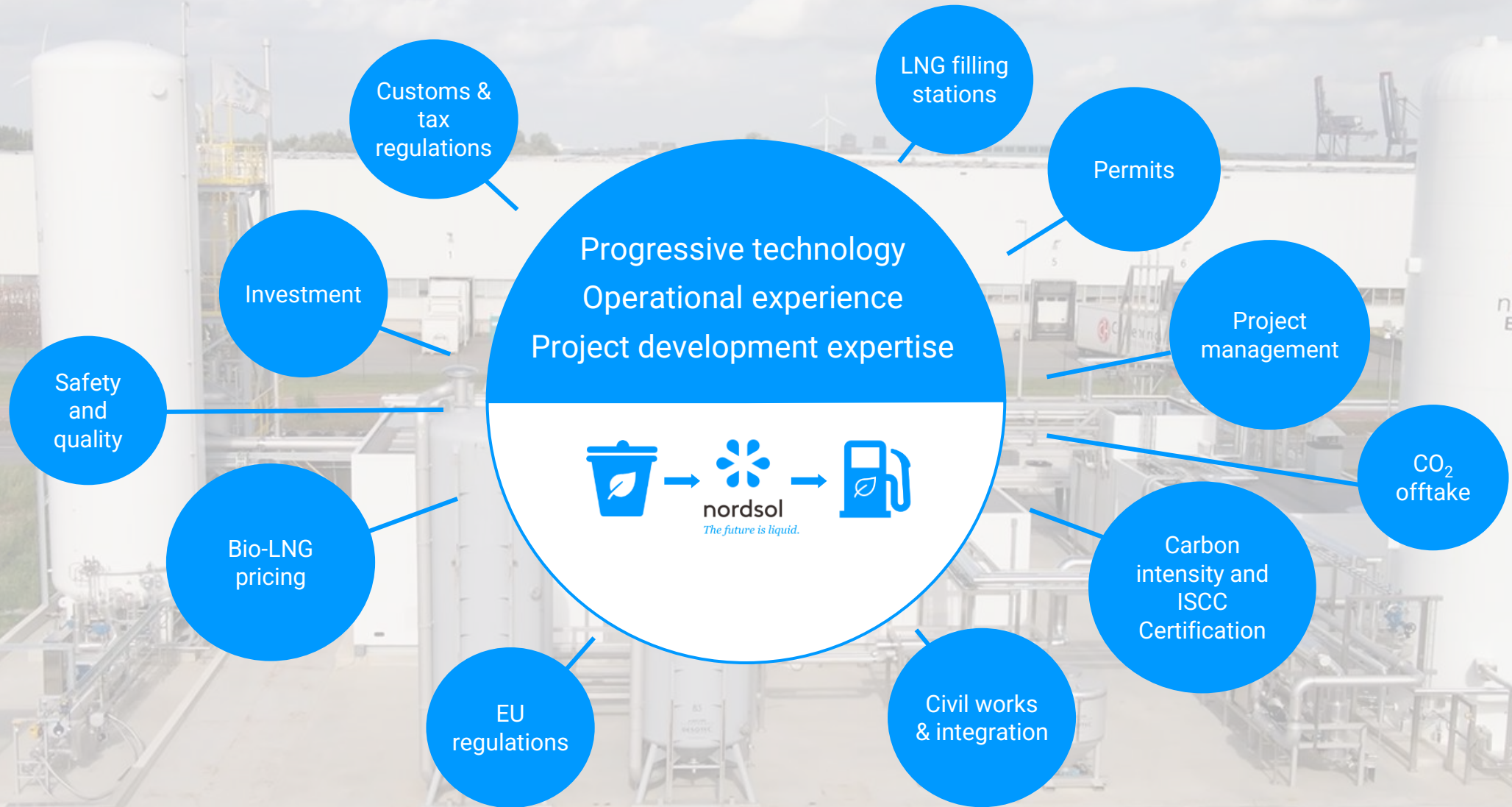
Multiple valorization routes



Example
Manure

Green value bio-LNG: **150 euro/MWh**
Green value biomethane: **80 euro/MWh**
Opportunity cost indication: **5-10 euro/MWh**

How Nordsol can help



Bio-LNG technology references



Bio-LNG Amsterdam, NL

- ▶ 10+ tpd
- ▶ Q4 2021



Bio-LNG Wilp, NL

- ▶ 7 tpd
- ▶ Q1 2024



Bio-LNG UK

- ▶ 10 tpd
- ▶ Q4 2023

6 additional projects in final stages of development

- ▶ Nordics, Belgium, Poland, Netherlands
- ▶ 5/10/20/45 tpd



Key take aways

Onsite bio-LNG production

- ▶ Highest value for biogas
- ▶ Scalable and economically viable
- ▶ Technology designed for the best CI and low TCO
- ▶ Flexibility in valorization routes
- ▶ How Nordsol can help
 - ◊ Technology
 - ◊ Permitting
 - ◊ Certification
 - ◊ Bio-LNG offtake

