

Increasing biomethane availability in the market

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Gasum

### Gasum – a Nordic gas sector and energy market expert

We offer cleaner energy and services to help our customers to reduce their own carbon footprint as well as that of their customers.

Together with our partners, Gasum promotes development towards a carbon-neutral future on land and at sea.

Our services and solutions are used in maritime, road transport, industry and energy production.



Revenue €2,722.5 million

Balance sheet total €1,947.3 million

Personnel\* 321

Energy products Biogas, LBG, Natural gas, LNG, Windpower, Power

#### Services

Gas filling station network, **Bunkering services for** maritime transport, **Energy Market Services, Portfolio Management** Services, Trading services, **Circular Economy Solutions** 

\*in 2022







#### **Operating Environment in the Nordic Biomethane Ecosystem**

- Actions are required to achieve environmental targets
- Demand for low emission energy solutions is a new standard
- Some incentives are already in place, right mechanism enables transition
- Geopolitical situation and war in Ukraine is putting additional pressure on gas deliveries to Europe
- Huge market potential in Nordice -90% by 2035 with total energy consumption 750 TWh/a

#### Demand for biomethane is rapidly increasing and European markets are merging



#### The Gas Ecosystem serving Market Growth



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## **Gasum's Biomethane 2022 in numbers:**

## 1.7 TWh

of biomethane delivered to customers including **775 GWh** of Gasum's own production. That's **65,700** times around the globe in a gas-powered car or **170,000** homes heated for a year.





#### **1** million tons

of different types of waste (**biowaste, manure, sewage sludge**) managed through biogas production process.

# That's **20,000 truckloads**

of waste.

At the same time, we produced **940,000 tons** of recycled nutrients.

# 444,000 tons

of CO<sub>2</sub>eq emission savings for our customers with biogas. This equals the carbon footprint of about **65,000** average EU citizens.

Our goal is to reach a cumulative reduction of **1.8 million tons** of carbon dioxide emissions by 2027.

444,000

Target 1.8 million



#### **Biogas production, plants & projects – Overview**

#### Gasum



## **GÖTENE PLANT**

Planned capacity: 133 GWh<sub>H</sub> LBG Extended capacity: 55 GWh<sub>H</sub> CBG -> LBG

#### Planned feedstock:

- 400 000 t/a liquid and solid manure, food product residues
- 350 000 t/a fertilizer back to farmers, rest to open market
- All in cooperation with regional and local partners



#### Time schedule

- Construction finalized summer 2024
- Start commercial production Dec 2024
- Full production late Q1-2025

#### Investment:

- Total: 54,6 M€
- Investment support: 15 M€
- Net investment: 39,6 M€



#### <u>VIDEO</u>

## **Biomethane Production in the Nordics 2015 - 2021**

- Realistic feedstock potential 40 TWh in the Nordics (maximum 75 TWh)
- Biogas production in Nordics added up to approximately 11 TWh in 2021 (more than double since 2015)
- Fertilizer and nutrient recycling through reuse → non-existent market

Year/GWh	Finland	Norway	Denmark	Sweden	Nordics	EU
2021	907	700	7 279	2 266	11 152	196 000
2020	987	1 000	5 939	2 161	10 087	191 000
2019	630	400	4 509	2 111	7 650	166 000

Reference: European Biogas Association (Values reported as GCV)



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#### DEMAND FOR BIOMETHANE IS INCREASING AND REQUIRES MORE FEEDSTOCK



## Feedstock is the main biomethane cost driver

Energy market changes affects directly to the feedstock value/price

- Transport cost from fuel price
- Gas value from TTF
- Gas value from Certificate markets
- Digestate cost/revenue from nutrient value

# Competition on feedstock has become fierce

#### Feedstock cost, actual and forecast





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### **Feedstock type impact**

 Feedstock alternatives and volumes for a biomethane production of 120 GWh/a.

Feedstock material	Dry matter	Methane potential	Volume for 120 GWh	Logistics
	(% of WW)	(Nm3 CH4/ton WW)	(tonnes WW)	(# of trucks/day)
Liquid cow manure	8	13	891 266	81
Sewage sludge - dewatered	25	57	209 150	19
Biowaste	30	108	<b>••</b> 111 111	10
Salmon silage	30	151	<b>79 224</b>	7
Grain Residues (husks etc)	85	227	52 816	5

- Logistical boundaries with the feedstock alternatives:
  - $\circ$  Local: <30 km • Regional: <200 km
  - National: <500 km





## **The CO<sub>2</sub> Emission Impact**

- CO<sub>2</sub> emission reduction calculations based on the REDII directive (ref. fossil traffic fuel).
- Produced and delivered liquified biomethane at mentioned annual volumes (GWh/a).
- According to REDII: Liquid manure -206% and biowaste -86%.
- Mixture will allow/induce a variation in CO<sub>2</sub> emission impact.



## **The Capex Impact**

 Industrial size bio-methane production brings CAPEX/MWh to a more feasible level with clear advantage in respect to OPEX levels



## **The OPEX Impact**

- Feedstock logistics with some benefit from optimized mixture arrangements (especially larger plants)
- Personnel costs could benefit from larger production units, since similar FTE manning needed.
- Upgrading and Liquification benefits from scaling effect
- Utilities largely impacted by scaling effect.
- Note:
  - Production of Liquified Biomethane (LBG)
  - w/o national production subsidy.



# CASE MANURE FEEDSTOCK



## **MANURE FEESDTOCK SOURCING MODEL**



## The "Bio-Refinery" Impact



## The "Bio-Refinery" Impact





# INCREASING BIOMETHANE YIELD



## **Use of carbon dioxide potential – various possibilities**





#### CO<sub>2</sub> POTENTIAL OF GASUM BIOGAS TODAY

#### All $CO_2$ in produced biogas: 114 000 tn/a

- 40 000 tn/a at > 95 %  $CO_2$  conc.
- 64 000 tn/a at  $\sim 15 \% \text{CO}_2$  conc.
- 10 000 tn/a no current CO<sub>2</sub> stream (no upgrading)

\*Note that potentials are indicative maximum potentials – actual production is depending on operation, own biogas use etc.

Gasum biogas plant

Gasum upgrading plant

Gasum biogas plant under construction



#### **CO<sub>2</sub>** market is under development



#### PERMANENT REMOVAL CREDIT PRICES ARE HIGH & DIVERSE

- There are various ways of to remove CO2, but only handful of emerging technologies that can remove carbon permanently
- CO2 removal prices depends on the type of removals and the technology
- Biogenic CO2 has higher value compared to the CO2 of fossil origin
- Currently high prices are seen, and they are likely to drop when volumes traded in the market are increasing

Source: AFRY 2023:Carbon removal – where will credit prices go next?

https://afry.powerappsportals.com/AFRYCarbonRemovalsWebinar/#msdynttrid=cjUbooIl2Dpo82D2q4Vn8Tjw\_x5\_7b9j8Vv11l0pClA

## **CO<sub>2</sub> to methane**

- Gasum's existing plants and projects in execution phase enables additional 650 GWh/a of synthetic biomethane production with P2G technology
- Increase of biomethane production by 65%
- Total electricity need for electrolysis for hydrogen production sums up to ~1100 GWh/a → exposure to OR benefit from electricity price volatility
- Biomethane production costs extremely dependent on electricity price, rough range 150 – 200 €/MWh



Total	Biomethane	Synthetic biomethane	
Existing & execution projects	1000	650	GWh/a
Total		1650	GWh/a

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## **CO**<sub>2</sub> content impact

- Depending on upgrading technology, CO<sub>2</sub> content varies in exhaust; membrane and amine scrubber >95%, water scrubbing ~15%
- CO<sub>2</sub> content sets limitations to usage:
  - Lower volume content CO<sub>2</sub> is less feasible to be separated from exhaust gas flow  $\rightarrow$  methanize
  - High volume content  $CO_2$  can be utilized  $\rightarrow$  direct use

#### **1. Water scrubbing**

- Proven, robust technology
- Product gas quality not high enough for liquefaction
- Quite high methane slip, ~1% low quality CO<sub>2</sub> stream



#### 2. Amine scrubbing

- High upgrading quality >99% suitable for liquefaction
- Low methane slip, <0.5%, high quality CO<sub>2</sub> stream
- **Requires heat**





## **CO<sub>2</sub> to methane or direct use, depending on content**

#### **Methanization**

- Instead of using low content CO<sub>2</sub> from water scrubbing in P2G production, methanization could be used in increase methane content of raw gas
- Higher raw gas methane content enables to increase biomethane volumes with existing upgrading units
- In Gasum's existing plants, potential increase of biomethane production is be estimated to be ~35%

#### **Direct use**

- High CO<sub>2</sub> content flue gas from upgrading is feasible for direct use
- Demand for biogenic CO<sub>2</sub> is increasing
- Liquid CO<sub>2</sub> production cost is roughly in the range of 100 - 150 €/t
- The market value of CO<sub>2</sub> ton is expected to be higher, either in physical or in the form of Carbon Dioxide Removal credits ("CDR-credits")



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### Keys to increased biomethane availability **Summary**

- 1. Continue developing the gas distribution infrastructure
- 2. Continue to expand cost efficient biomethane production
- 3. Continue to develop the biofertilizer/nutrient market
- 4. Utilize resources fully with new possibilities. Revenues from CO<sub>2</sub> can compensate the increased feedstock costs and increase biomethane availability
- → Secure biogas/biomethane availability to end-users in a sustainable way



