



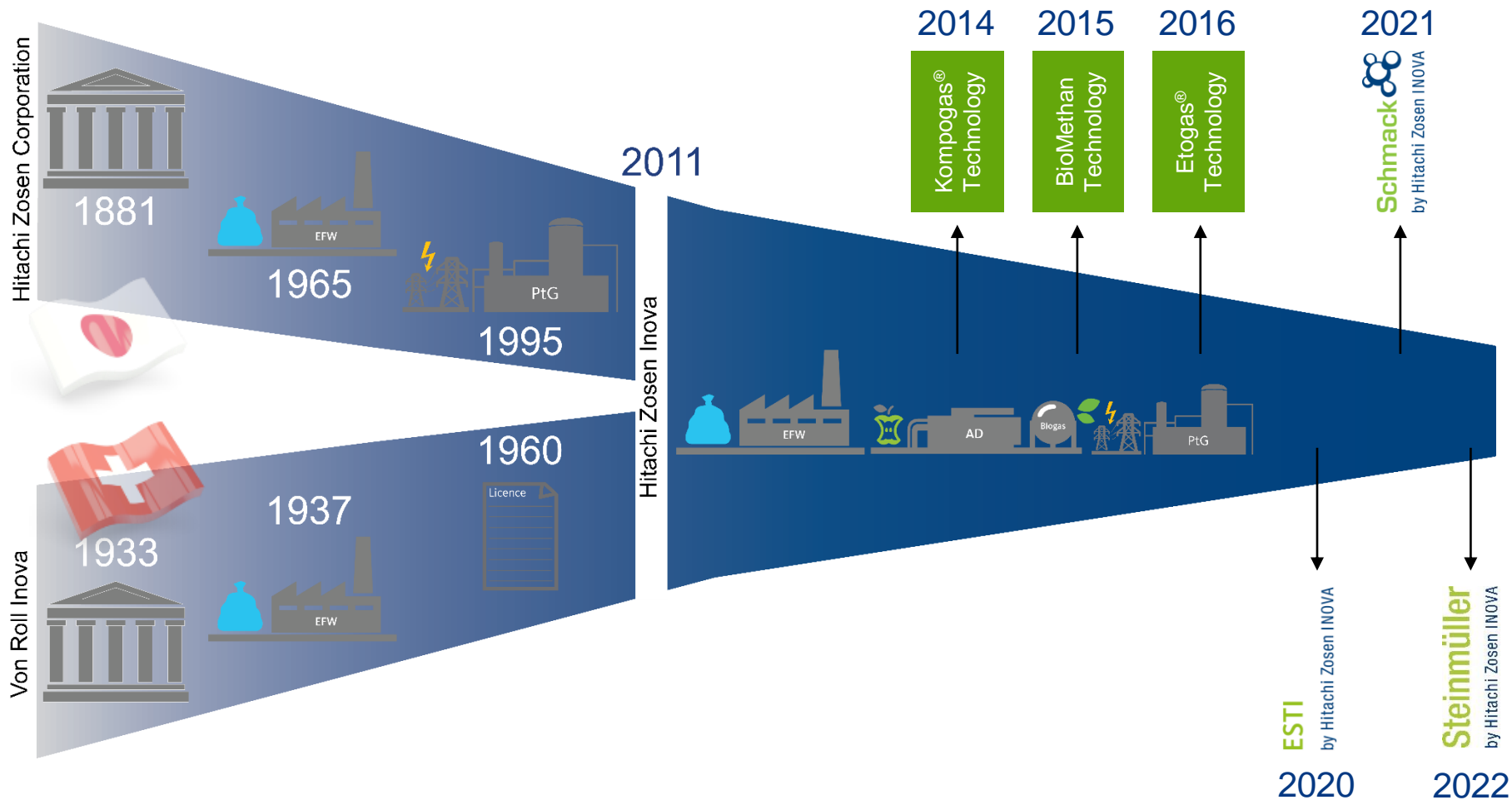
Hitachi Zosen
INOVA

Liquid combo: methane and CO2 liquefaction as a door opener for unexplored markets

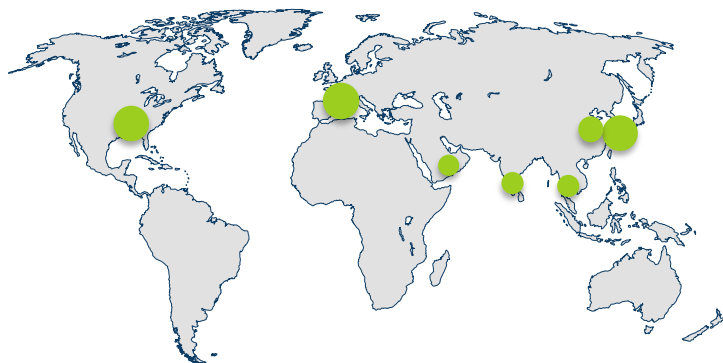
28.09.2023

Alexey Mozgovoy

Hitachi Zosen Inova (HZI): timeline



Hitachi Zosen Inova (HZI): brief intro



 Hitachi Zosen Corporations Locations

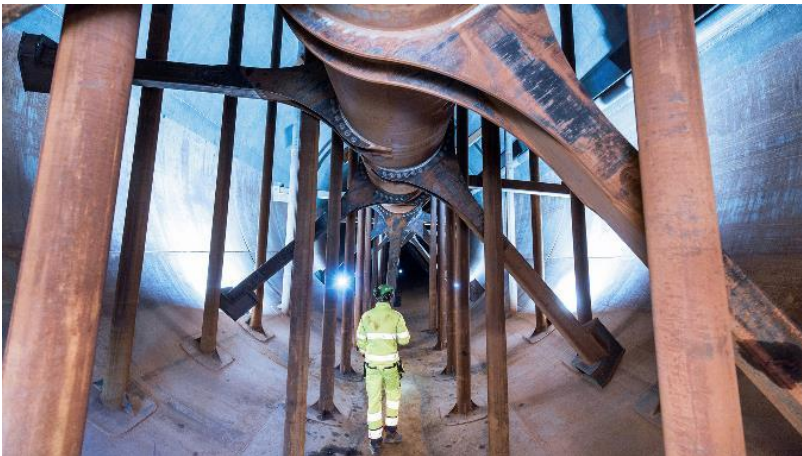
- Zurich-based global leader in Energy from Waste
- Turnkey plants (EPC), system & services, DBOO (Design-Build-Own-Operate) solutions globally
- Proprietary technologies (electrolysis, bio. & cat. methanation)
- More than 600 reference projects worldwide
- More than 80 years experience
- +1'900 employees in CH, DE, US, UK, etc.
- A subsidiary of Hitachi Zosen Corporation

www.hz-inova.com / www.hitachizosen.co.jp

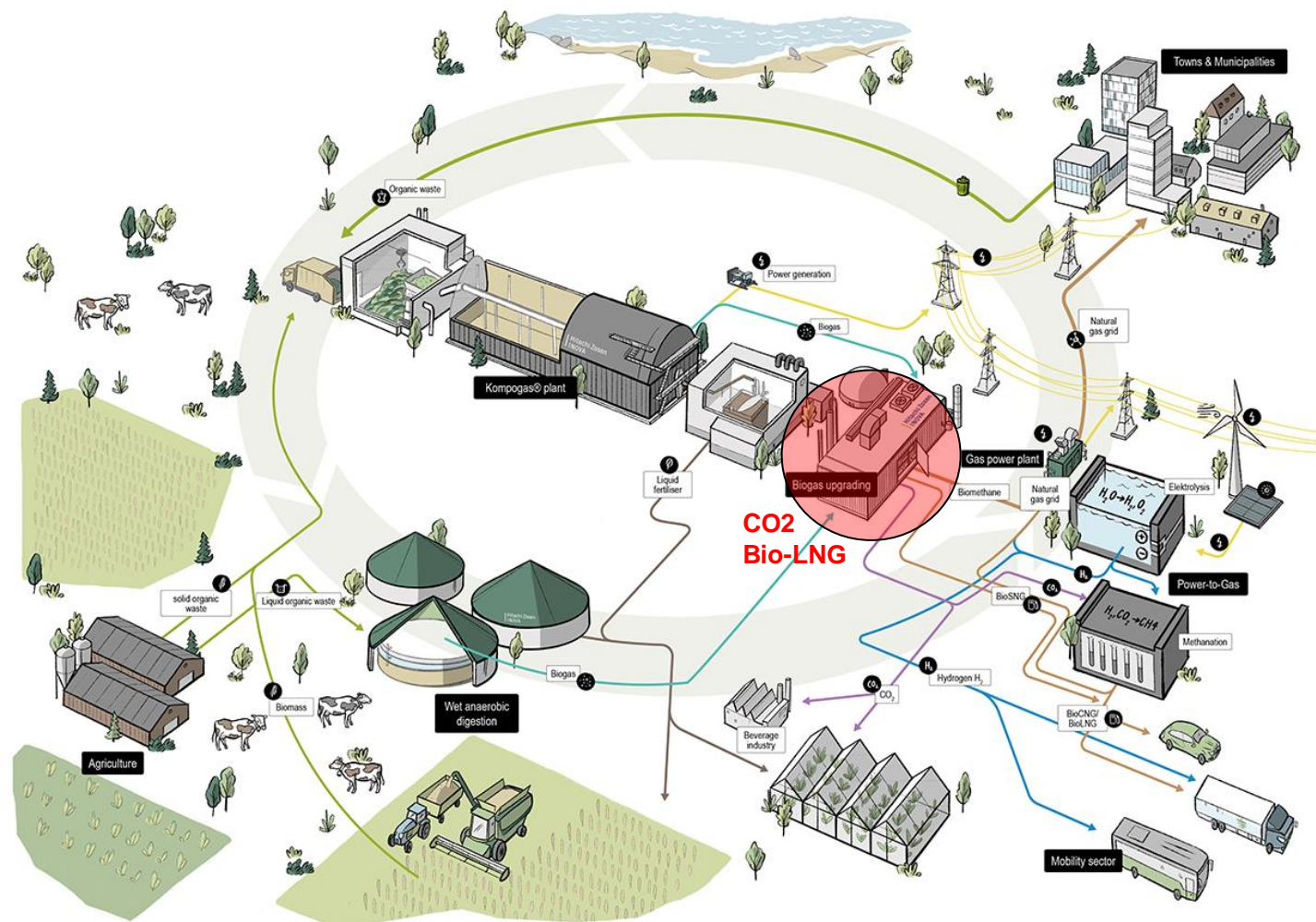


Waste is our Energy – Engineering our Business – Sustainable Solutions our Mission

Our Technologies: Biogas Production, Upgrading, Power-to-Gas, Liquefaction



Renewable Gas (RG) technologies: application landscape



Usage of LCO2

liquid CO₂



- fire suppression systems
- refrigeration and freezing in food processing and production
- pH balance in water treatment plants
- enhanced oil recovery of oil and gas wells
- welding applications to prevent weld oxidation
- plant growth stimulation in greenhouses

dry ice

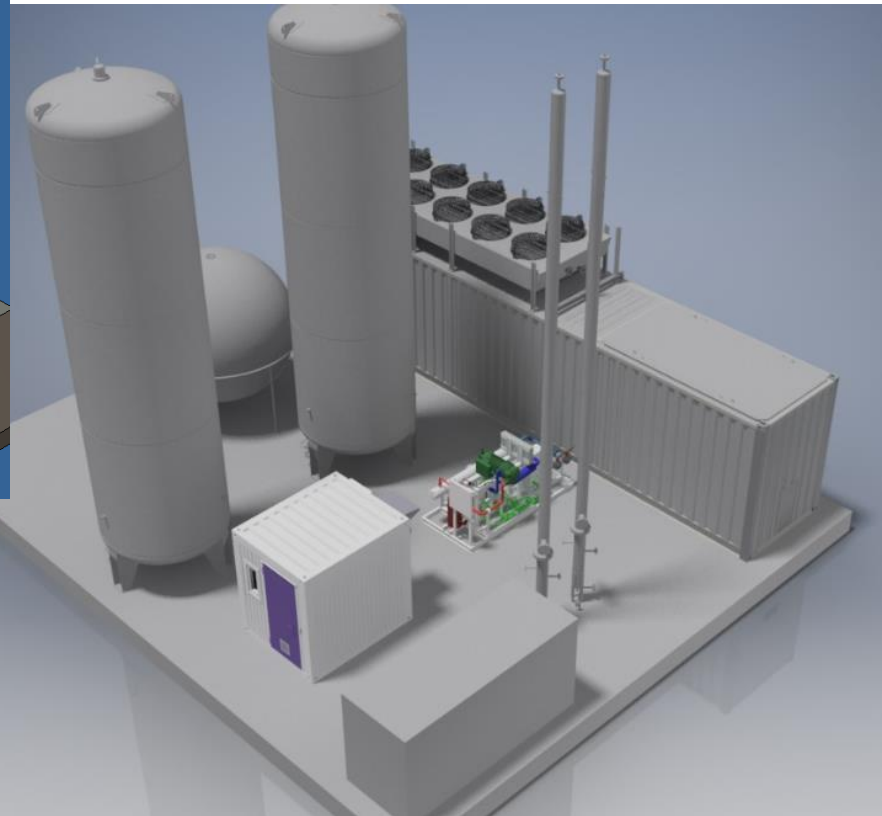
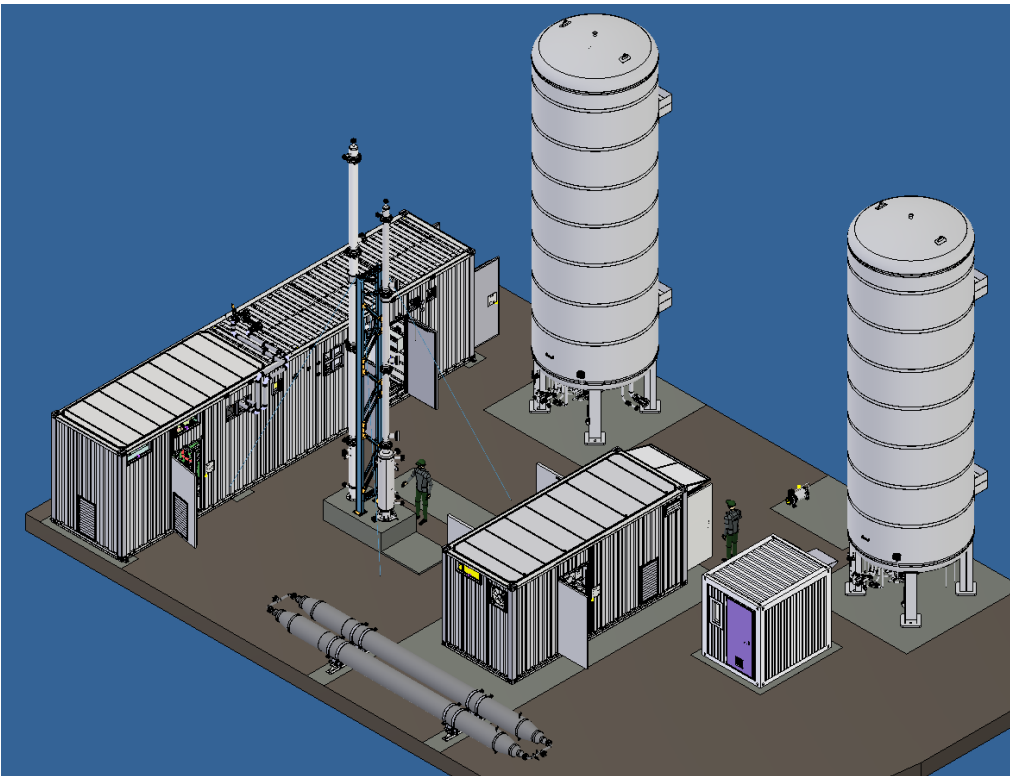


- cool and freeze any type of food products (gifts with cut block dry ice f.i.)
- meat processing industry is using dry ice pellets to cool meat for shipping
- dry ice blast cleaning (f.i. heavy slag in automotive industry, general maintenance or removing flux from electronic circuit board)
- dry ice for use in research (medical centers, government research organizations, as well as R&D companies and universities)
- airline catering

Quality requirements of LCO2

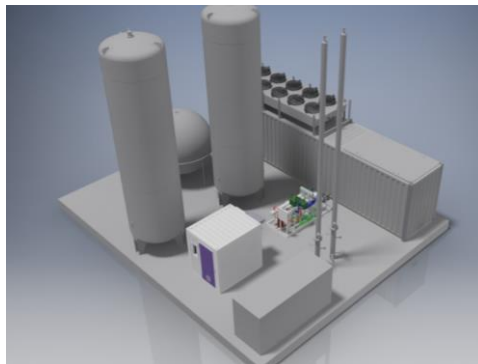
Component	Quality requirement beverages (ISBT standard)
CO ₂	≥ 99.9 %
Water	≤ 20 ppm
O ₂	≤ 30 ppm
CO	≤ 10 ppm
NH ₃	≤ 2.5 ppm
NO/NO ₂	≤ 2.5 ppm
non-volatile residue	≤ 10 ppm (wt)
non-volatile organic residue	≤ 5.0 ppm (wt)
Phosphin (PH ₃)	≤ 0.3 ppm
total volatile HC	≤ 50 ppm
Acetaldehyde	≤ 0.2 ppm
aromatic HC	≤ 0.02 ppm
Total sulphur (H ₂ S/COS)	≤ 0.1 ppm
SO ₂	≤ 1.0 ppm
Other specifications	no coloring or turbidity in water
	no smell, no taste in water

CO2 liquefaction: how does it look like?



CO2 liquefaction: our standard products

Model	S	M
Input (kgCO2/h)	250-500	500-1000
Input (Nm ³ CO2/h)	125-250	250-500
Design	1 x 40 Foot Container	2 x 40 Foot Doppelcontainer
Recovery rate CO2	90-95%	90-95%
Power demand (kWh _{el} /tCO ₂)	210-250	210-250
Sizes (L x B x H)	13 x 16 x 11 m	19 x 19 x 13 m
Input-Gas	Off-gas from biomethane upgrading	Off-gas from biomethane upgrading
CO ₂ quality	EIGA / ISBT	EIGA / ISBT
Annual plant availability	96%	96%

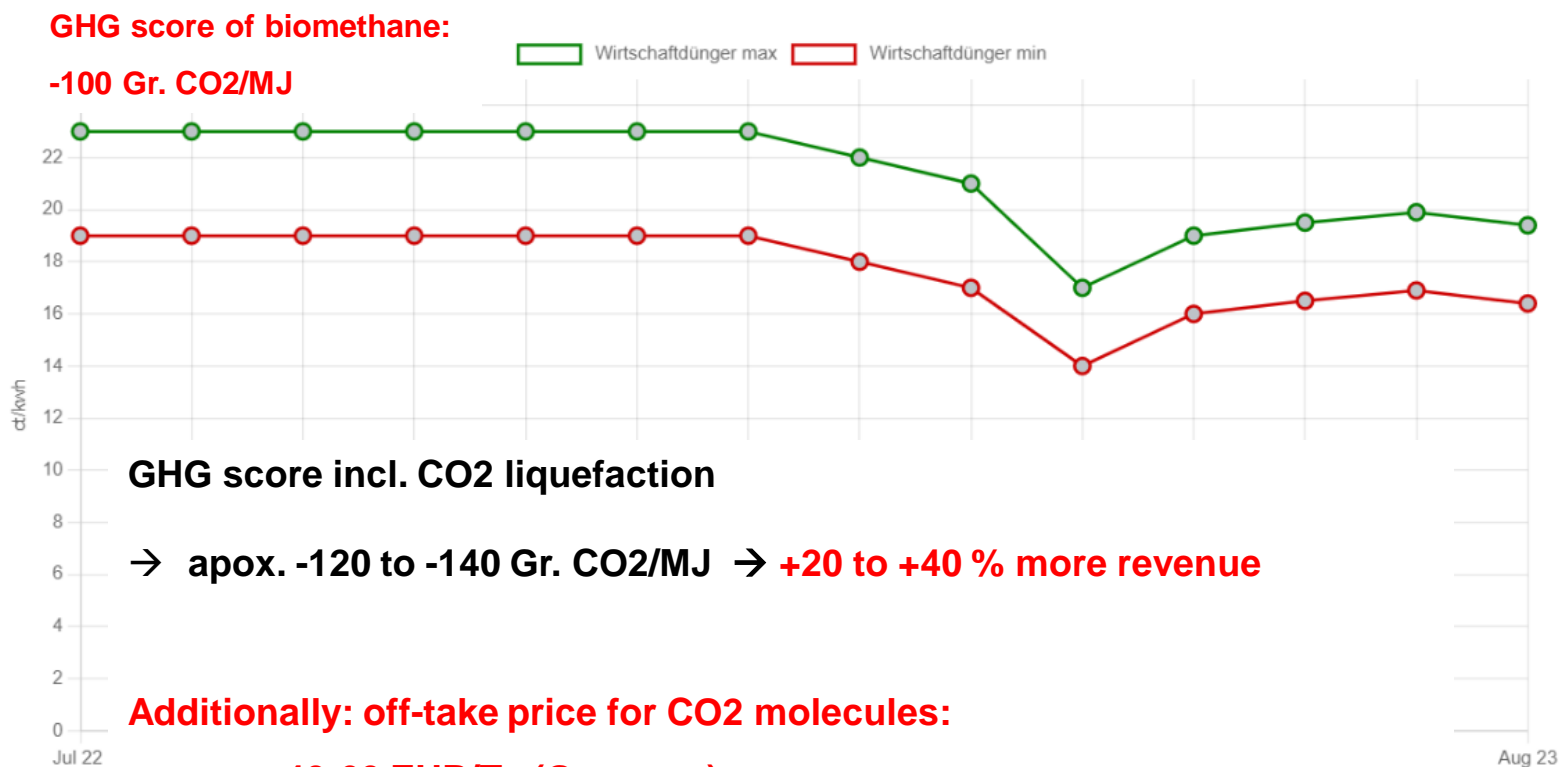


Reference unit in Nesselbach (CH)



Plant capacity	500 kg CO₂/h
Commissioning	2023
LCO₂ quality	LCO₂ accord. EIGA/ISBT

Carbon credits as a main market driver



What is LNG / Bio-LNG (LBG)?

Liquefied Natural Gas (LNG)

- Natural gas in liquid form (**fossil fuel**)
- Predominantly CH₄, plus small amounts of heavy hydrocarbons
No odour, no colour, non-toxic, non-corrosive
- Energy content: 45-50 MJ/kg (12.5-13.9 kWh/kg)
- Density: ~0.45l/kg
- **volumetric energy density:**
 - ~ 240% of Compressed Natural Gas (CNG)
 - ~ 70% of petrol/gasoline
 - ~ 60% of diesel
- Temperature and pressure (for use in trucks): around -160 degrees Celsius at around 2 bar

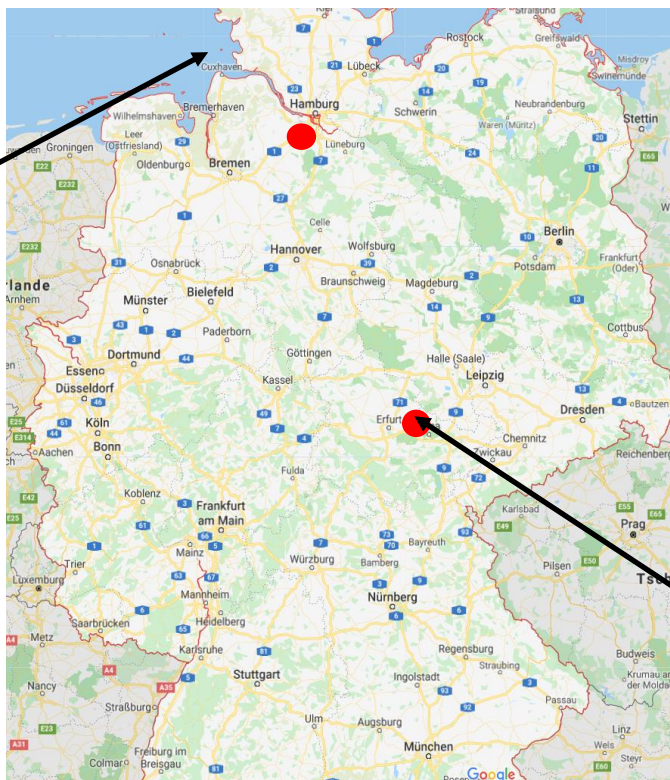
Bio-LNG / Liquefied Biogas (LBG)

- **“Biogenic LNG”**
- ≥97% CH₄ (biomethane directly from upgrader or grid gas based on “mass balance” principle)
- Energy content: 50 MJ/kg = 13.9 kWh/kg
- Applicable norm: EN 16723 (“Natural gas and biomethane for use in transport...”)

Project locations and key inputs & outputs

APENSEN (commissioning 2024)

2,100 t LBG,
4,600 t LCO2

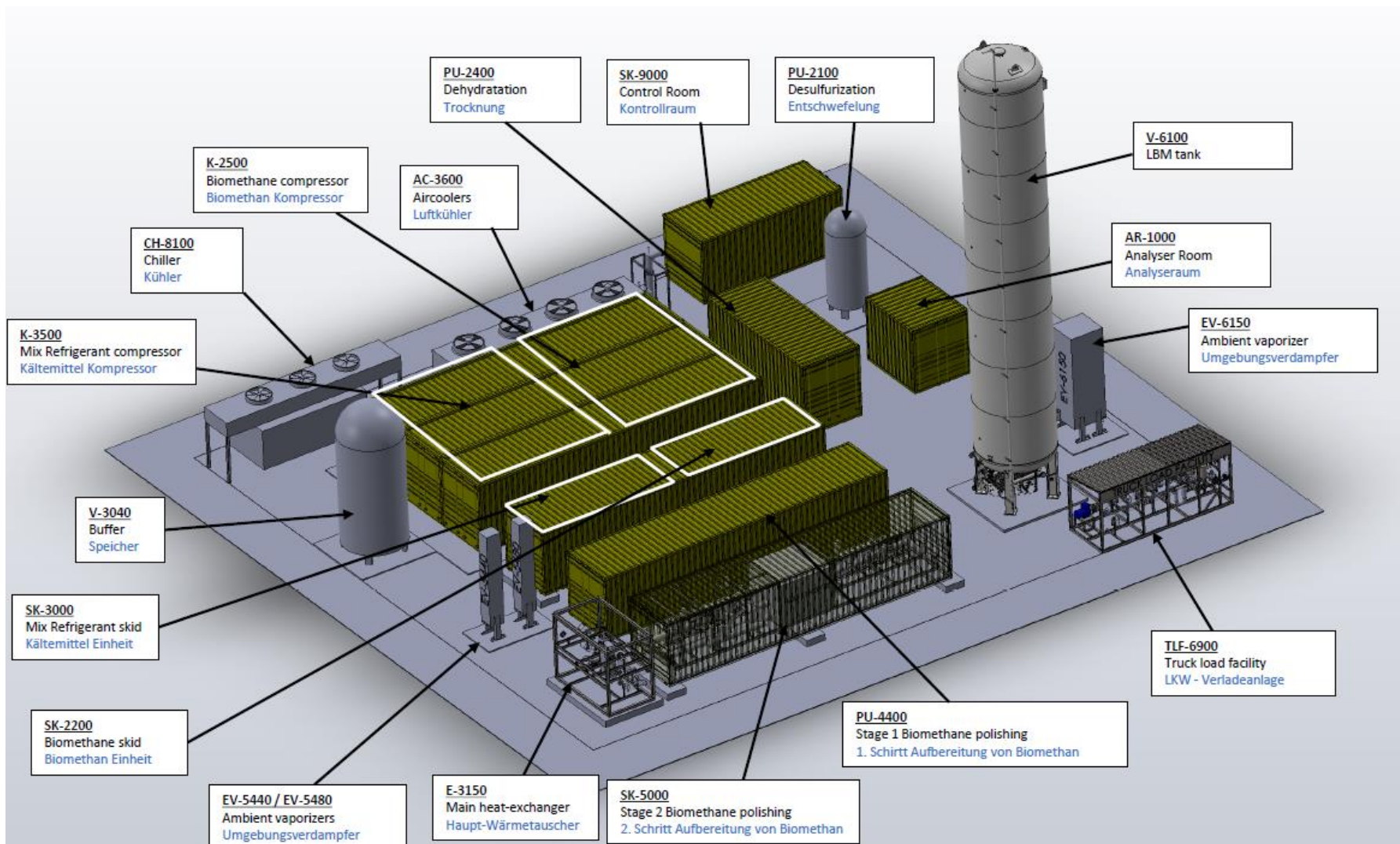


BLANKENHAIN (commissioning 2024)

3,700 t LBG,
7,500 t LCO2

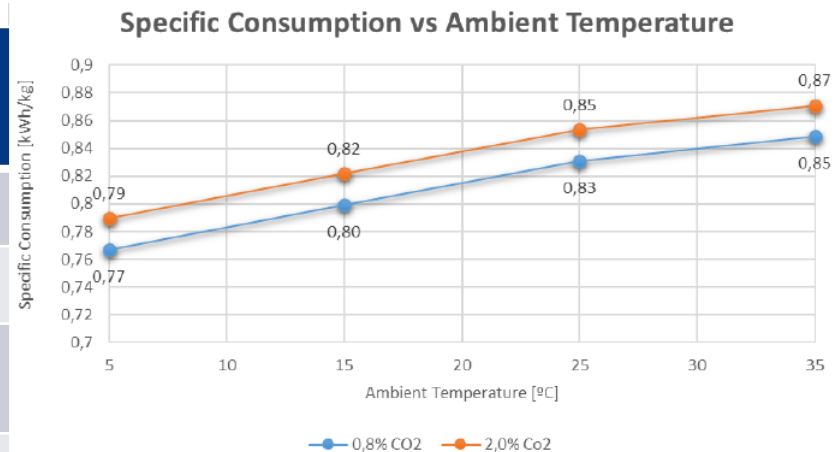


CH₄ liquefaction: plant design



CH4 liquefaction: technical specifications

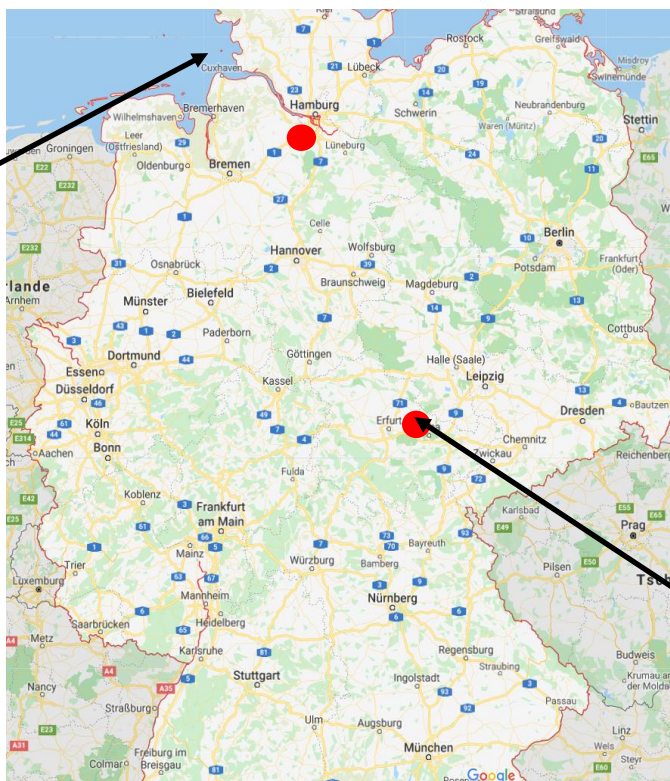
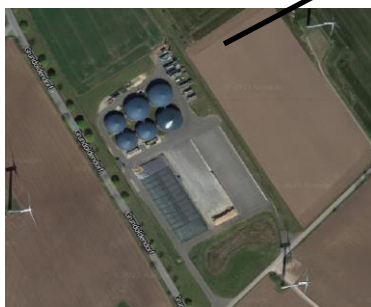
Type	Unit	Model S (Apensen as a prototype)	Model M (Blankenhain as a prototype)
Nominal Input	Nm3/h	385	880
Min. Input	Nm3/h	192	440
Nominal Output	tpd	6.7	15.8
Specific energy consumption	kWh/kg	0.70-0.85	0.70-0.85
Ambient Temperature	° C	-20 / +35	-20 / +35
Voltage	V	400 / 3-P	400 / 3-P
Availability	-	97%	97%



Project locations and key inputs & outputs

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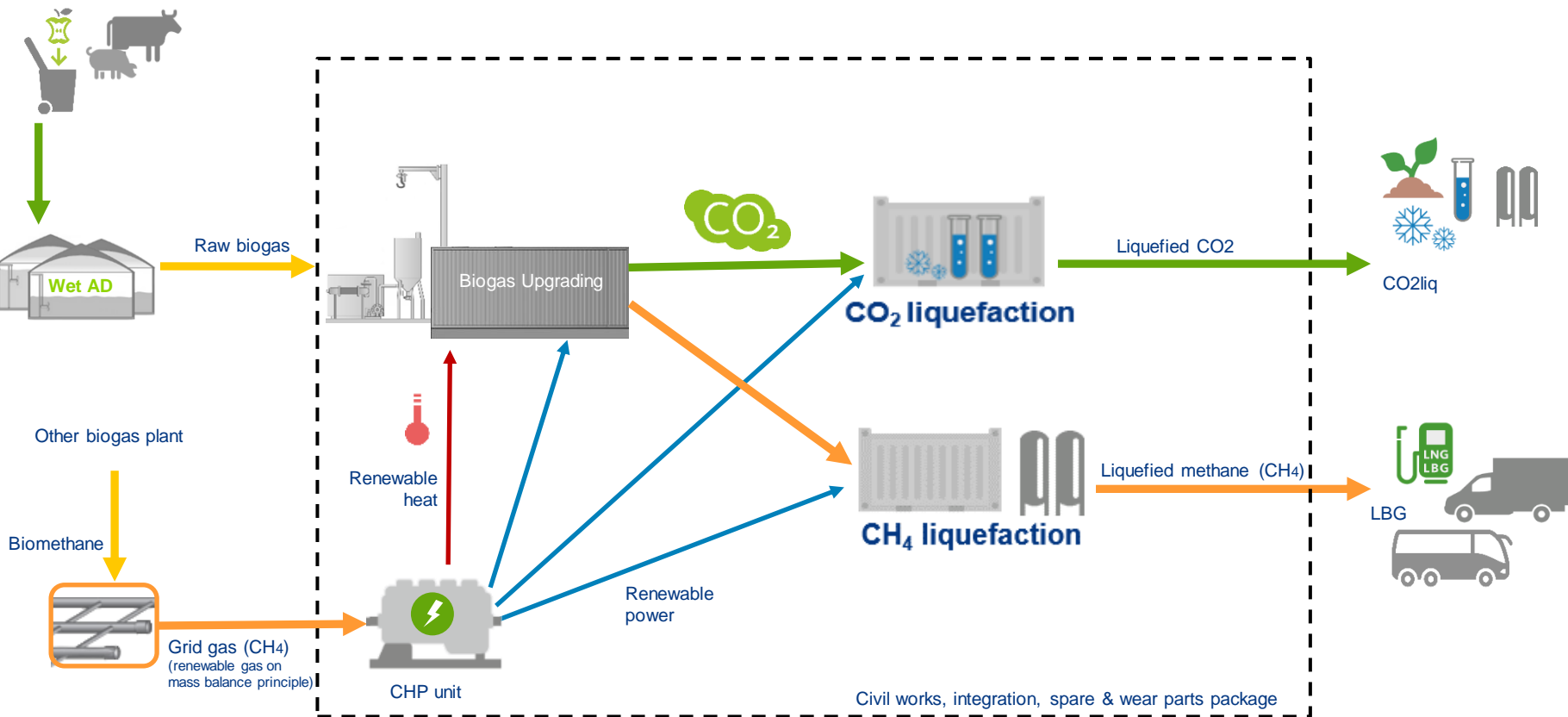


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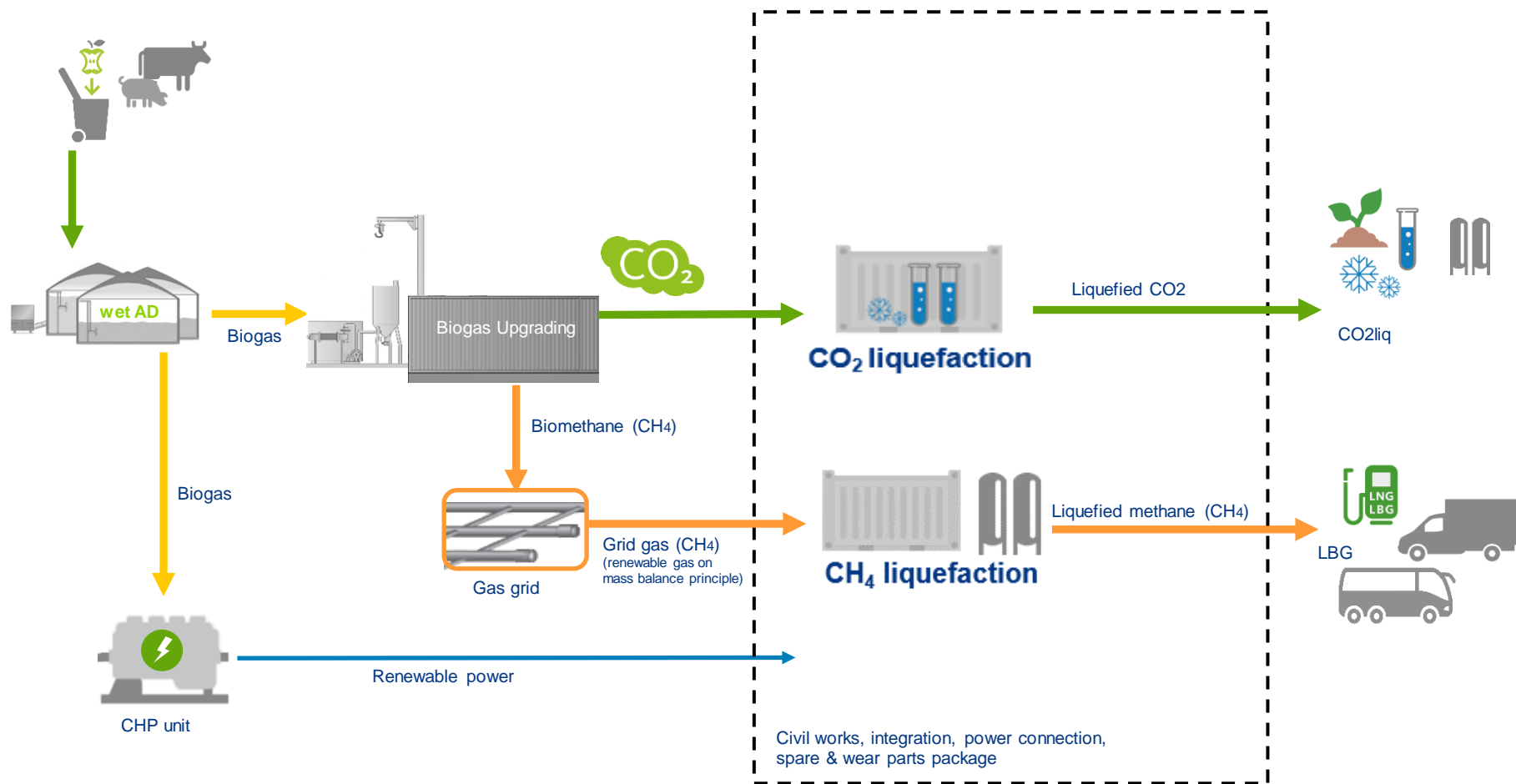
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Blankenhain - project scope (direct / "on-site" liquefaction)



Apensen - project scope (grid connected liquefaction)



LCO2 and LNG/LBG solutions from one hand

HZI's offering

- HZI offers a **comprehensive renewable gas technology suite**, including small-scale liquefaction systems for CH₄ and CO₂.
- HZI offers **integrated solutions** = engineered plants.
- In addition, HZI offers **full O&M and investment/co-investment** into related projects, when suitable.
- HZI can also offer **“tolling models”**, i.e. invest, build and operate liquefaction systems or whole plants against a service fee.

**HZI technical & commercial offerings enable partners to tap into
“Renewable Gas future”**

Thank you!



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