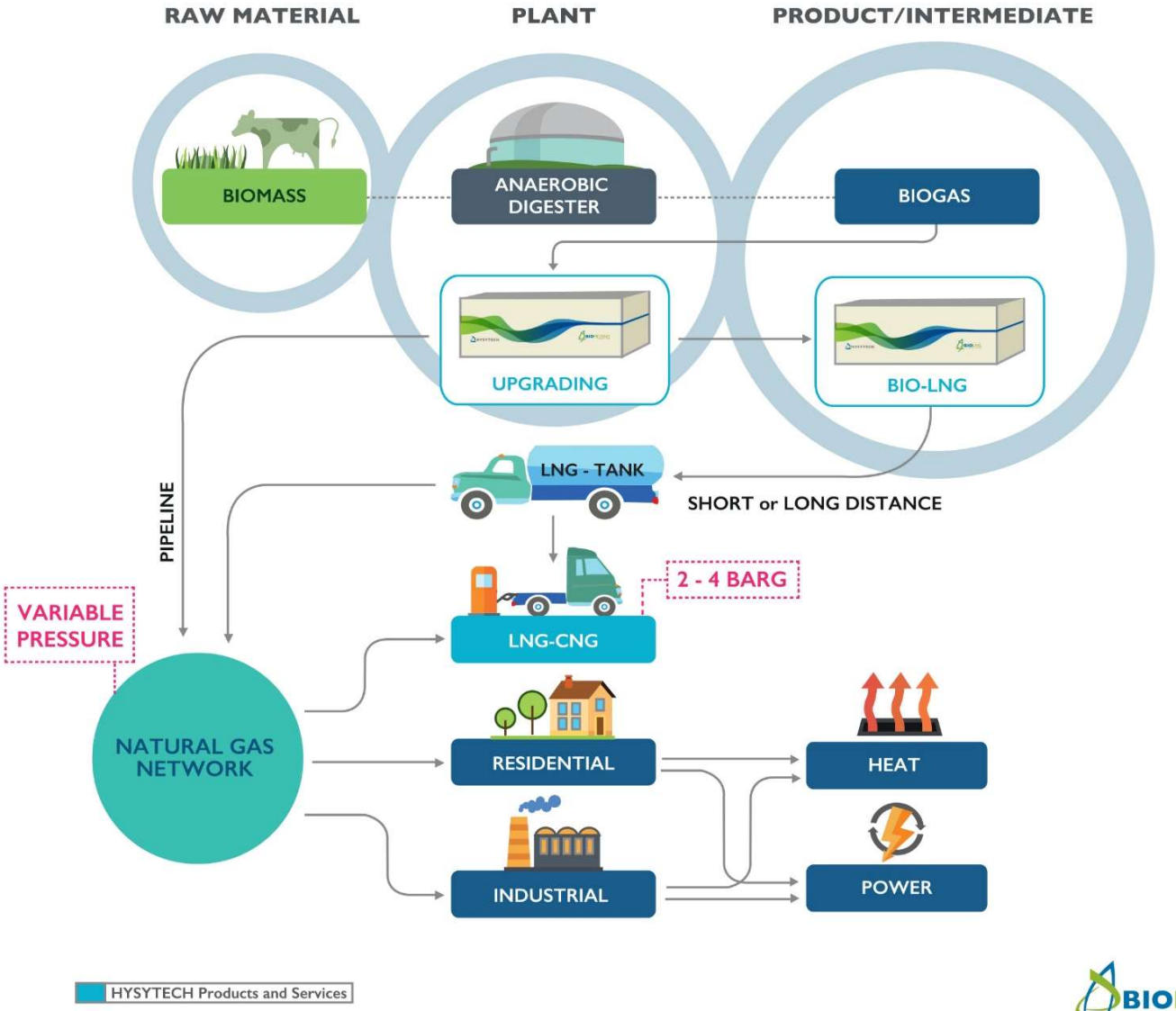
STIRLING CRYOGENICS

HYSYTECH FILLING THE GAP

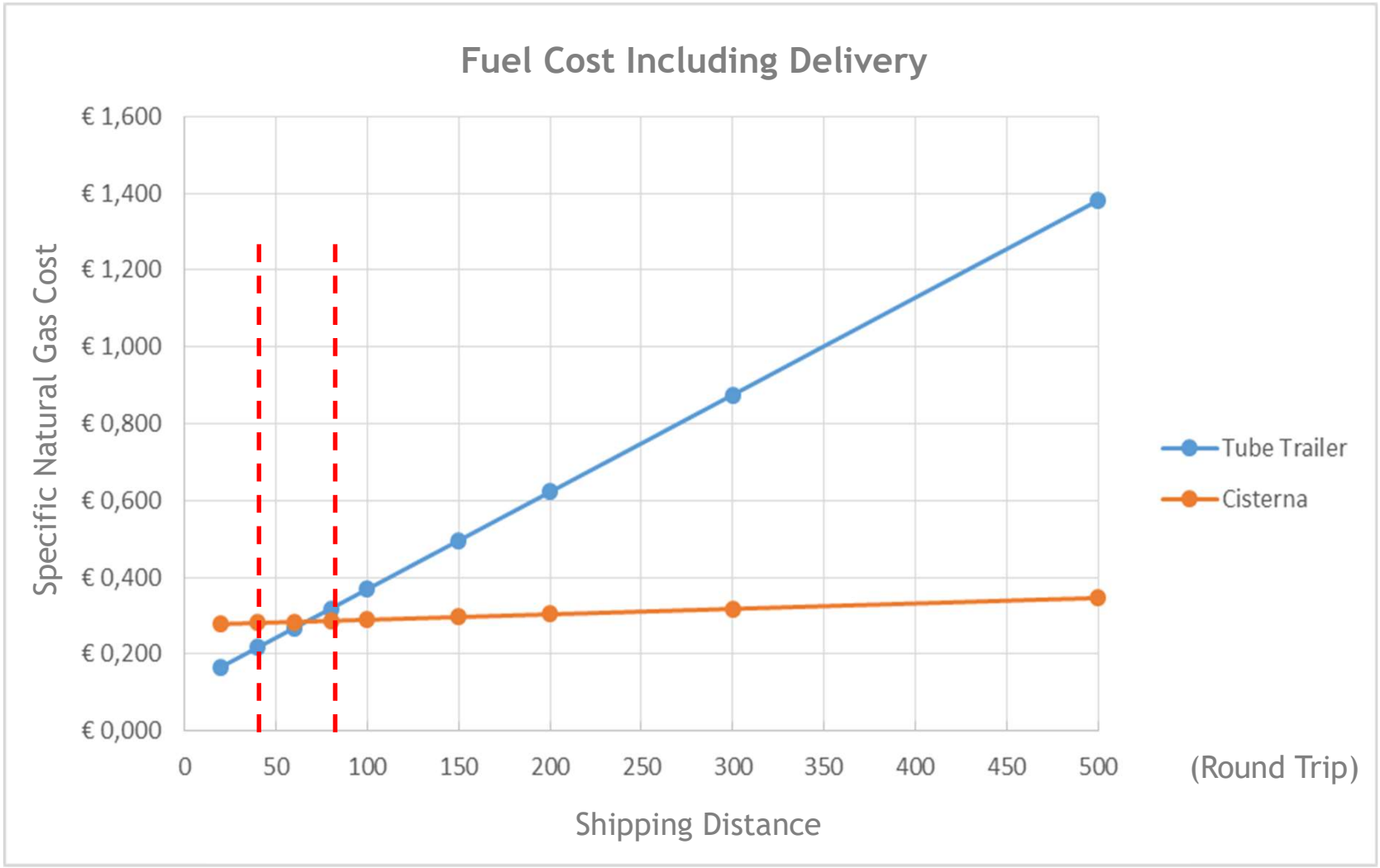
μ-LNG plants
Integrated Conditioning Liquefaction Units

Issues?
Opportunities?

- LNG Small Scale;
- No available LNG solutions on the market;
- 40-60% of Biogas plants does not have access to an existing Natural Gas pipeline



LNG vs CNG as Natural Gas Virtual Network



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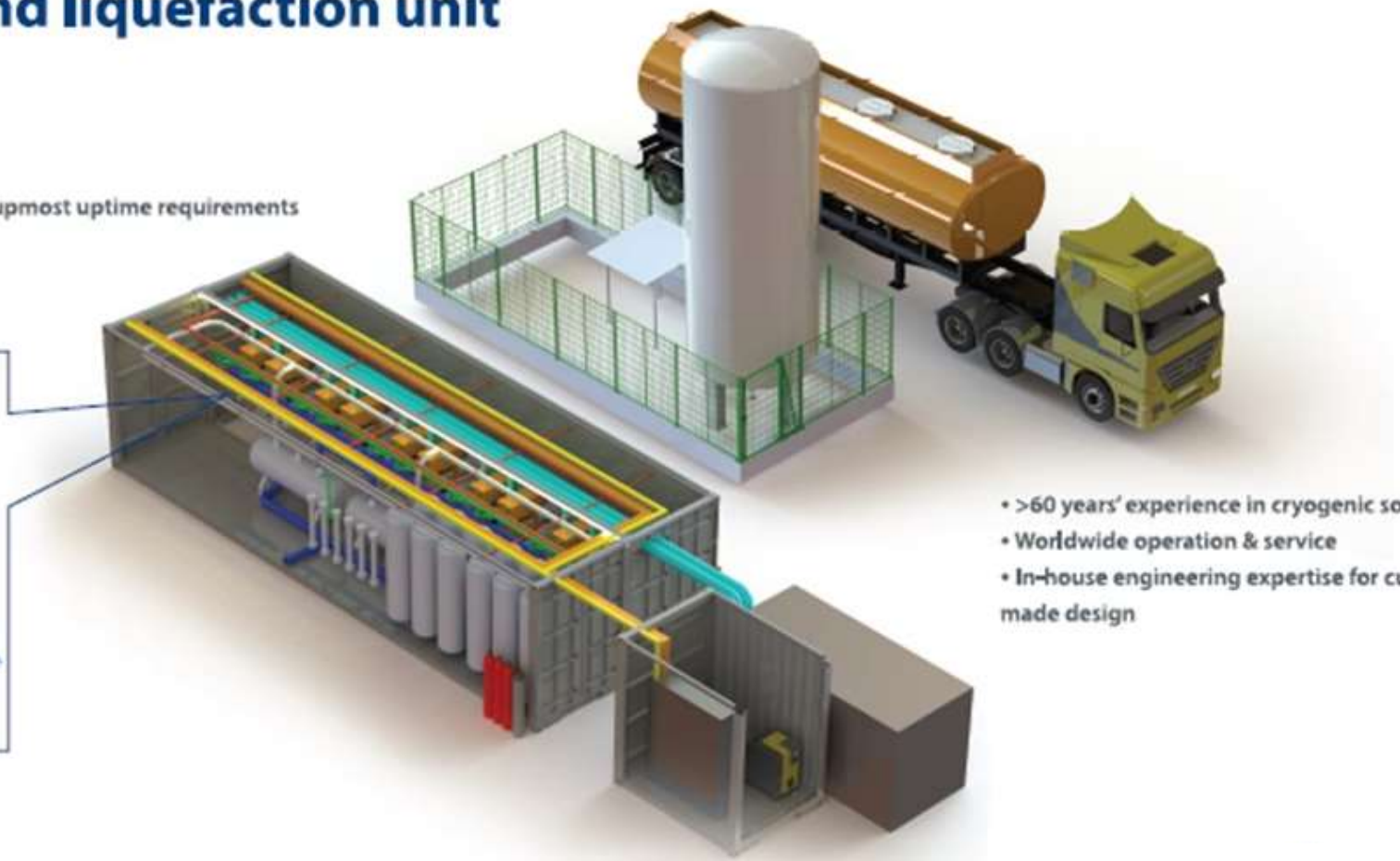
Bio - LNG Integrated conditioning and liquefaction unit

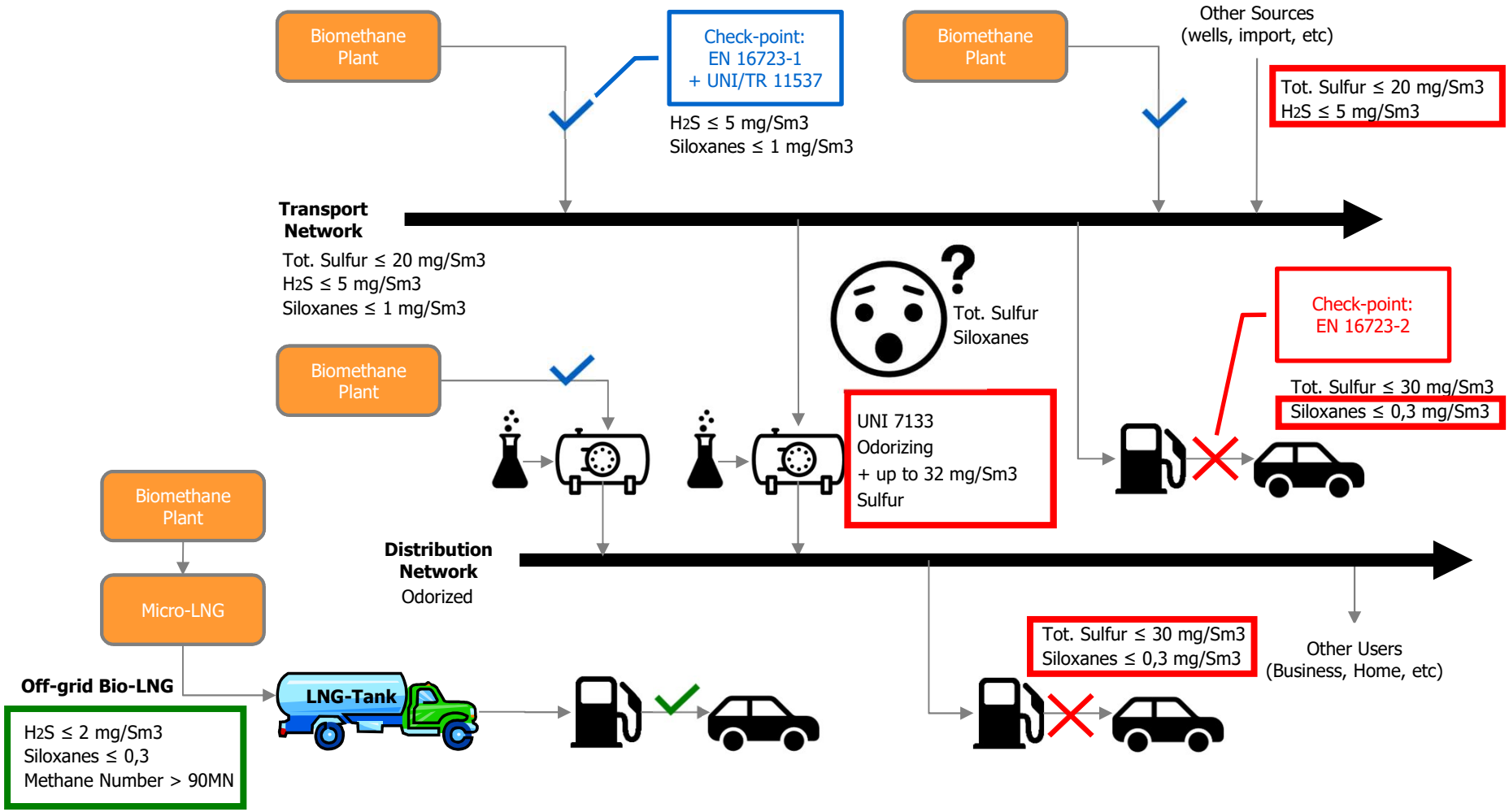
Features:

- Plug-and- Play modular design
- Turn-Key Product
- Cost efficient redundancy to meet upmost uptime requirements
- Easy to expand for future growth

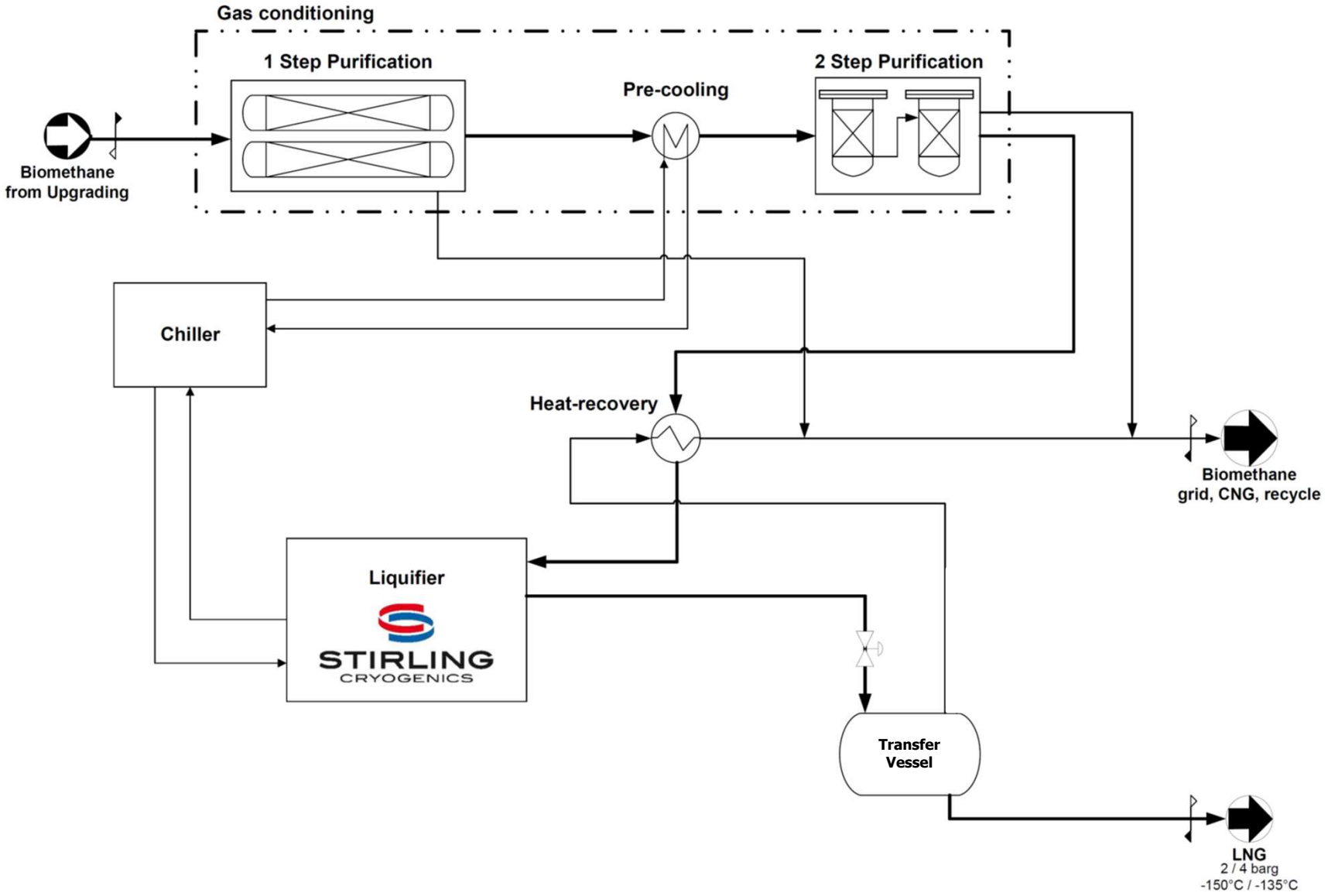


- >60 years' experience in cryogenic solutions
- Worldwide operation & service
- In-house engineering expertise for custom made design

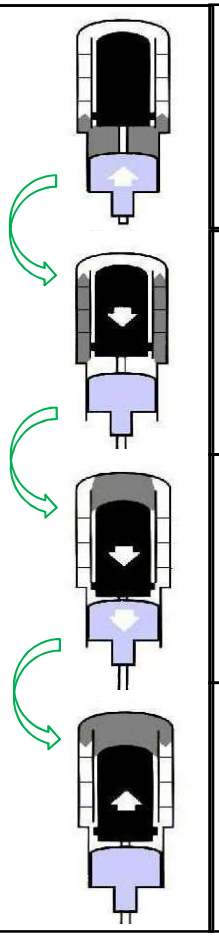
LNG: the Best Fuel Quality



Integrated Conditioning and Liquefaction Units



Cryogenic Cooling: Stirling Reverse Thermodynamic Cycle

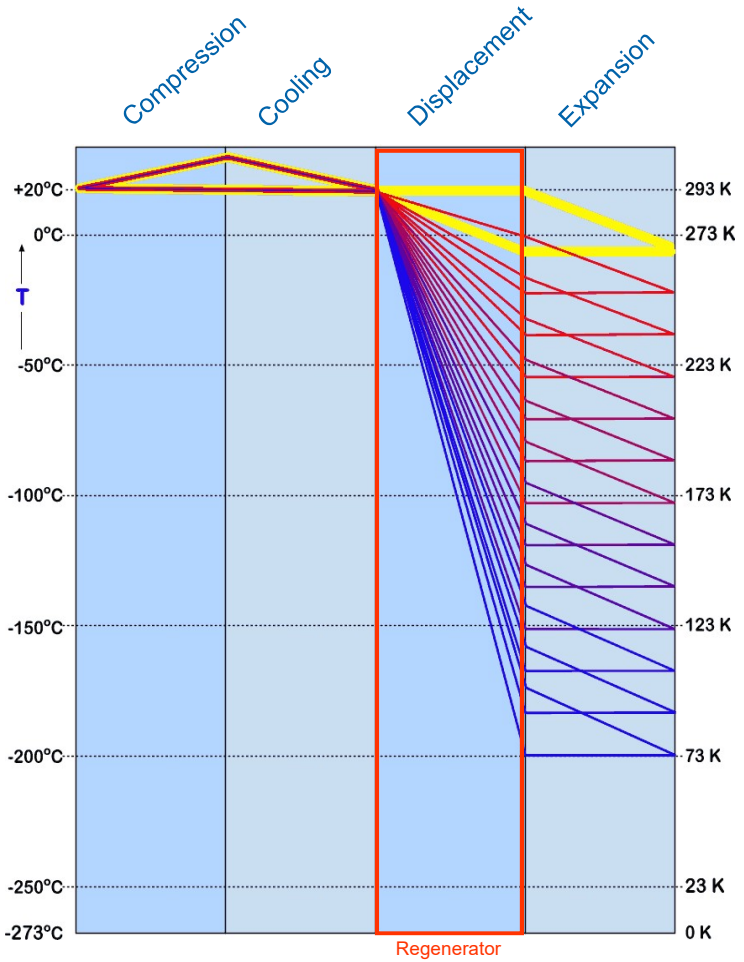


Step 1: Compression
Helium gas is compressed
Gas temperature rises

Step 2: Cooling
Compression heat is removed;
The helium gas is pre-cooled in the regenerator before expansion starts

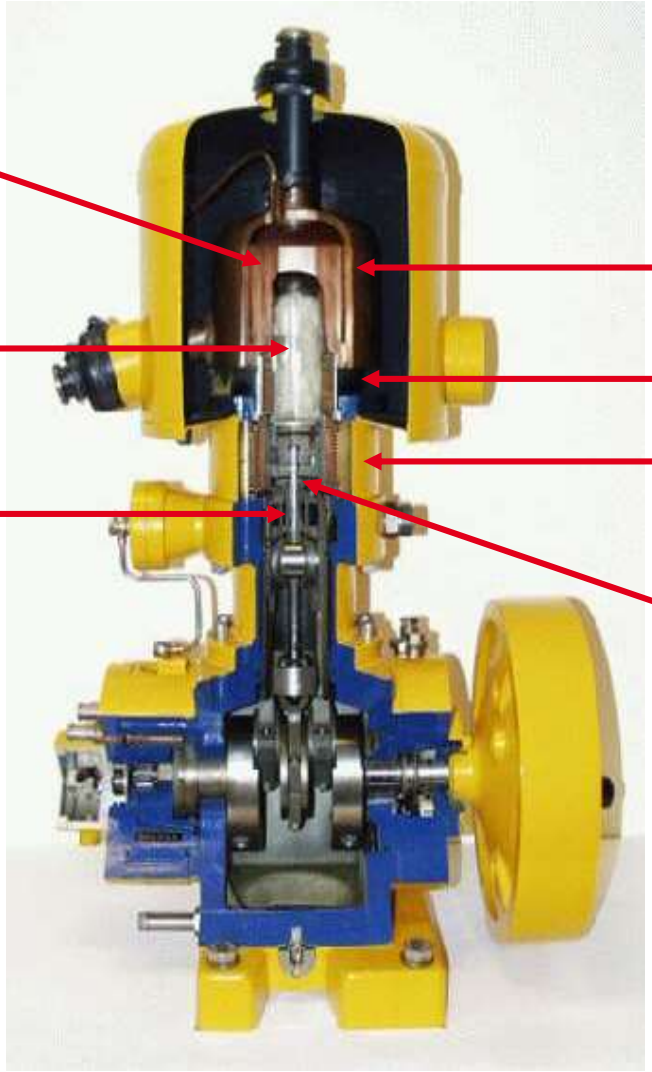
Step 3: Expansion
By expansion, energy is extracted from the gas and thereby the temperature goes down thus cooling the cold head

Step 4: Displacement
Gas is displaced back to the compression space; the cold from the helium gas is stored in the regenerator during displacement to step 1

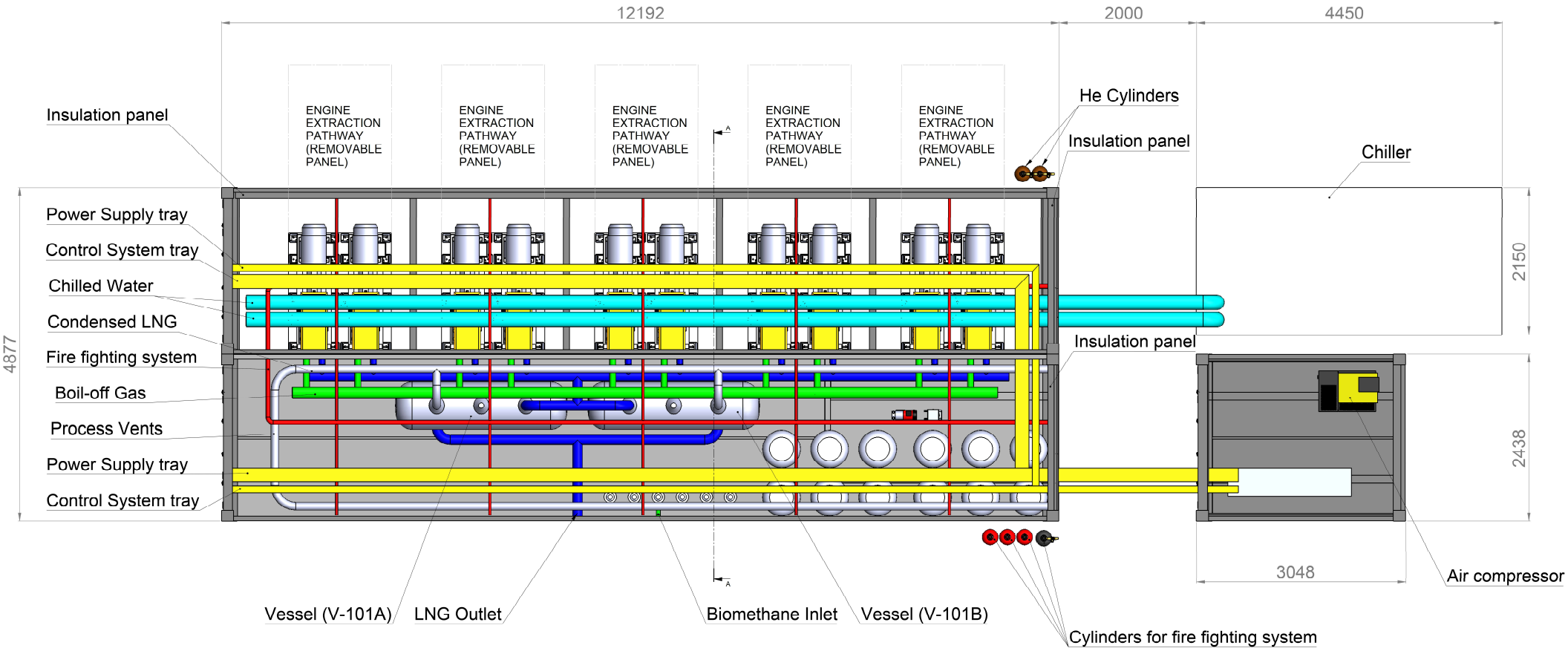


The Stirling Cryogenerator

LNG is not in contact with the mechanical parts



Typical Layout for 10 tpd LNG Installation



Our Technology Takeaways

Main Features:

- Integrated solution “Purification + Liquefaction”
- LNG Quality (Automotive: MN>80, other applications MN>90)
  - Greater vehicle efficiency +20% (less fuel consumption)
  - Lower maintenance costs (+ vehicle availability and less costs)
- Operating pressures from 6 to 20 barg while delivering LNG product at low pressures (LNG @ 2-4 barg or lower)
- “Plug and Play” and Modular design (currently we deliver modules from 1 and up to 20 tpd)
- Scalable for future growth (allows to grow/invest along with demand)
- Energy Efficiency: from 0,60 kWh/kg LNG
  (0,80 kWh/kg LNG including chilled water generation)
- High Uptime (>8.400 h/y)
- Experience from the field and broad assistance network worldwide

LNG main Process Options

- **Liquid Nitrogen cycle**

LNG produced with
2,4 kgN2/kgLNG
(1,6 Sm3N2/Sm3NG)
= EUR 0,34/kgLNG

- **Cryogenic Cycle for micro-scale Liquefaction**

LNG produced with
< 0,90 kWh/kg
= EUR 0,04-0,15/kgLNG

Power Cost
0,05-0,16 EUR/kWh

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References in Cryogenic Liquefaction

- >3.000 projects installed since 1955
- > 60 years of experience in liquefaction
- Tailor made design by in-house engineering
- Standardised solutions where applicable
- Worldwide operations and service network

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References in Natural Gas Liquefaction

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References in Natural Gas Liquefaction

3 ton/day BOG - LNG Bunkering for Shell, Antwerp/Rotterdam (March 2019)

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References in Natural Gas Liquefaction

6 ton/day BOG - LNG Bunkering for TOTE, Jacksonville, USA (Sep 2018)

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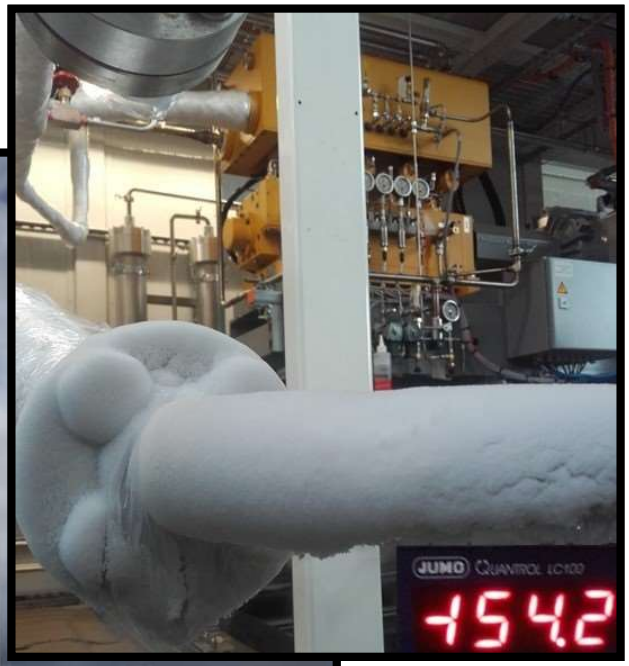
References in Natural Gas Liquefaction

1 ton/day Bio-LNG plant Foggia, Italy (Sep 2018)



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References in Natural Gas Liquefaction

2 ton/day Test plant in USA

Stirling Cryogenics

Stirling Cryogenics designs, builds and supplies cryogenic solutions based on the (reversed) Stirling thermodynamic cycle, with a long history, highly reliable record and high efficiency, with **over 3,000 installations world wide**.

Our main products are stand-alone liquid Nitrogen production systems (StirLIN's), which produce liquid Nitrogen (LN_2) on site and custom made cryogenic cooling systems based on our Stirling Cryocoolers (Liquid Oxygen, Methane, Argon, Helium and CO2, besides Nitrogen)

Typical applications are:

- **Biotech (Cryo-storage: Cell, Tissue, insemination)**
- **Healthcare (on-site LOX)**
- **High Temperature Superconductors (HTS)**
- **MRI magnet cooling and Nuclear applications**
- **Space simulation chambers**
- **LNG/Bio-gas liquefaction, Boil-off recovery and Maritime**
- **Space Observatories**

HYSTECH

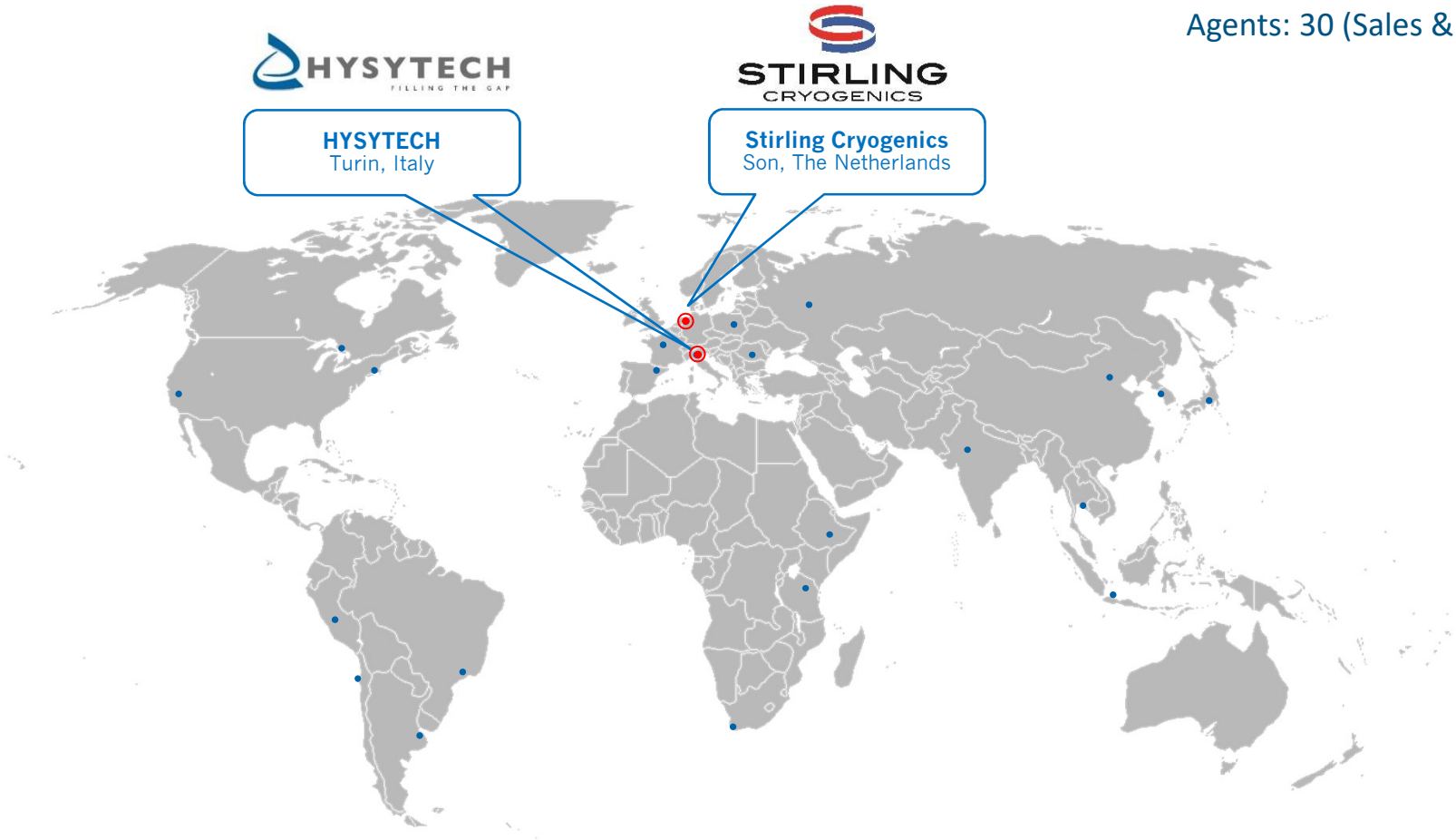
HYSYTECH is an engineering company, specialized in the design, development and industrial implementation of **new turn-key process technologies and equipment**. HYSYTECH is the owner of STIRLING CRYOGENICS.

Our skills start from the know-how in chemical and process engineering, up to commissioning, monitoring and maintenance.

We operate mainly in the field of **generation, treatment and recovery of industrial gases, organic liquids and energy**, according to the best engineering practices, also through the implementation of our technologies.

Sales and Service Agency Network

Agents: 30 (Sales & Service)



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