SMART LNG

Micro and Mini Biomethane or Natural Gas Liquefaction Plant
SIAD Group operates in the industrial gases, engineering, healthcare, industrial goods and services sectors in Europe and throughout the world with production sites, commercial branches and service centers.

SIAD Macchine Impianti, the Group’s engineering company, is a leader in the production of ASUs (Air Separation Units), with over 500 units installed worldwide. Thanks to the wide experience and skills gained in the context of cryogenic technologies, SIAD Macchine Impianti has developed the new line of SMART LNG plant for the production of liquefied natural gas.
SMART LNG plant is the first and only system solution developed in Italy for the liquefaction of natural gas (LNG) on small and medium scales.

The LNG produced in this way can be used locally in filling stations for vehicles or for micro-distribution systems.
SMART LNG Micro and Mini Biomethane or Natural Gas Liquefaction Plant

The liquefied natural gas supply chain

- Production of biogas from the anaerobic digestion of organic substances*
- ALTERNATIVELY Drawing from the gas network
- Biogas upgrading or gas from network purification
- Natural gas liquefaction with cryogenic technology
- Liquefied natural gas storage
- Local use: filling stations for vehicles or micro-distribution systems

* Sludge from sewage treatment plant, livestock waste, food waste and organic fraction of municipal solid waste
SIAD cryogenic technology for LNG
SMART LNG plant has two main process phases:

- **Pretreatment for removing contaminants from natural gas, such as:**
  - water, hydrogen sulphide, heavy hydrocarbons, carbon dioxide and ammonia

- **Liquefaction, implemented through:**
  - a heat exchanger, which takes advantage of the frigories released by the evaporation of liquid nitrogen and by its subsequent heating to ambient temperature
  - or
  - a heat exchanger integrated in a nitrogen recycle liquefaction process comprising compressors and turbines.

Natural gas at ambient pressure liquefies at -162 °C. This temperature is reached by means of the cryogenic technology, widely consolidated by SIAD Macchine Impianti.
Advantages

The technology and system

- Reliable and consolidated technology
- Easy plant start-up, operation and shutdown
- High reliability and efficiency of the machines (compressors and turbines) that treat nitrogen.

The process

- Simple process and control system
- Low influence of changes in the natural gas composition
- Particularly efficient with high-pressure network natural gas
- Flexible liquefaction process: easy load variation and the possibility of continuous operation.

Safety and environmental impact

- Safety in operation: the process refrigerant fluid in the machines is nitrogen, an inert gas, instead of a mixture of hydrocarbons
- No chemicals used
- Absence of liquid hydrocarbon storage systems for refrigerant mixture
- Personnel with specific experience in the management of hydrocarbon mixtures are not required
- Absence of unavoidable hydrocarbon leakages from the seals of the machines.
The SMART LNG range

SIAD Macchine Impianti has developed various types of SMART LNG plant.

SMART LIN-LNG

Micro capacity plant where the liquid nitrogen is brought to the plant with road tankers.

SMART MP-LNG

Nitrogen recycling plant with single expansion turbine and booster.

SMART HP-LNG

Nitrogen recycling plant with double expansion turbine and booster.

SMART INT-LNG

Integrated plant with combined production of liquefied natural gas (LNG) and liquid nitrogen (LIN).
Plant with capacity of 240 Nm$^3$/h LNG from natural gas network
The plant illustrated on this page is the SMART LIN-LNG model and consists of:

- Filtration, measurement and pressure reduction system
- Purification from sulphur compounds
- Liquefier cold box using liquid nitrogen
- Liquefied natural gas storage tank
- Liquid nitrogen storage tank
- Pump for filling road tankers with the liquefied natural gas
- Flare.

Technical specification:

- LNG production: 240 Nm³/h = 170 kg/h = 4.1 t/d
- Natural gas pressure: 16 bar
- Carbon dioxide content: 0.4 mol%
- Electric power specific consumption: 0.05 kWh/Nm³ LNG = 0.07 kWh/kg LNG
- Liquid nitrogen specific consumption: 1.42 Nm³ nitrogen / Nm³ LNG
- Cooling water flow rate with deltaT 10°C: not required
- LNG minimum storage pressure: 3 bar
- LNG storage volume: 40 m³ for 3 day endurance
- Liquid nitrogen storage volume: 50 m³ for 3 day endurance.
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- LIN storage
- LNG storage
- Drying and decarbonating unit
- Pressure reduction unit and valves skid.
- Purification from sulphur compounds
- Filtration and measuring system
- Cold box
- Purification from sulphur compounds
Plant with capacity of 240 Nm$^3$/h LNG from biogas produced from agricultural and livestock waste and silage
The plant illustrated on this page is the SMART LIN-LNG model and consists of:

- Purification system with adsorption of hydrogen sulphide and hydrocarbons
- Biogas compressor with precooler and aftercooler
- Carbon dioxide separation system using membranes
- Drying and decarbonating system to eliminate residual water and carbon dioxide from biomethane
- Liquefier cold box using liquid nitrogen
- Liquefied natural gas storage tank
- Liquid nitrogen storage tank
- Pump for filling road tankers with liquefied natural gas
- Flare.

Technical specification:

- LNG production: 240 Nm³/h = 170 kg/h = 4.1 t/d
- Biogas specific consumption (with 53% methane in biogas):
  \[
  1.75 \text{ Nm}^3 \text{ biogas} / \text{ Nm}^3 \text{ LNG}
  \]
- Electric power specific consumption for purification:
  \[
  0.59 \text{ kWh/Nm}^3 \text{ LNG} = 0.82 \text{ kWh/kg LNG}
  \]
- Electric power specific consumption for liquefaction:
  \[
  0 \text{ kWh/Nm}^3 \text{ LNG}
  \]
- Liquid nitrogen specific consumption:
  \[
  1.42 \text{ Nm}^3 \text{ nitrogen} / \text{ Nm}^3 \text{ LNG}
  \]
- Cooling water flow rate with \( \Delta T \) 10°C:
  not required
- LNG minimum storage pressure: 3 bar
- LNG storage volume: 40 m³ for 3 day endurance
- Liquid nitrogen storage volume: 50 m³ for 3 day endurance.
Micro and Mini Biomethane or Natural Gas Liquefaction Plant

Carbon dioxide separation system using membranes

Biogas compressor

Biogas drying and decarbonating system, HC, H₂S absorption unit

Cold box

LIN storage

LNG storage

[Diagram of a micro and mini biomethane or natural gas liquefaction plant with labeled components: Biogas compressor, Carbon dioxide separation system using membranes, Biogas drying and decarbonating system, HC, H₂S absorption unit, Cold box, LIN storage, LNG storage.]
Plant with capacity of 2000 Nm$^3$/h LNG from biogas produced from Organic Fraction of Municipal Solid Waste
The plant illustrated on this page is the SMART MP-LNG model and consists of:

- Hydrocarbon adsorption and ammonia scrubbing system
- Carbon dioxide and hydrogen sulphide separation system with selective solvent
- Biomethane compressor with aftercooler
- Drying and decarbonating system to eliminate residual water and carbon dioxide from biomethane
- Cold box liquefier
- Nitrogen recycle compressor
- Turbine/booster unit
- Booster aftercooler
- Liquefied natural gas storage tank
- Liquid nitrogen storage tank
- Pump for filling road tankers with liquefied natural gas
- Flare.

Technical specification:

- LNG production: 2000 Nm³/h = 1430 kg/h = 34 t/d
- Biogas specific consumption (with 64% methane in biogas): 1.52 Nm³ biogas / Nm³ LNG
- Biogas hydrocarbon content: 1 g/Nm³
- Electric power specific consumption for purification: 0.25 kWh/Nm³ LNG = 0.35 kWh/kg LNG
- Electric power specific consumption for liquefaction: 0.56 kWh/Nm³ LNG = 0.78 kWh/kg LNG
- Liquid nitrogen specific consumption: 0.16 Nm³ nitrogen / Nm³ LNG
- Steam specific consumption: 1.7 kg vap/Nm³ LNG
- Cooling water flow rate with deltaT 10°C: 290 m³/h
- LNG minimum storage pressure: 3 bar
- LNG storage volume: 250 m³ for 3 day endurance
- Liquid nitrogen storage volume: 50 m³ for 3 day endurance.