

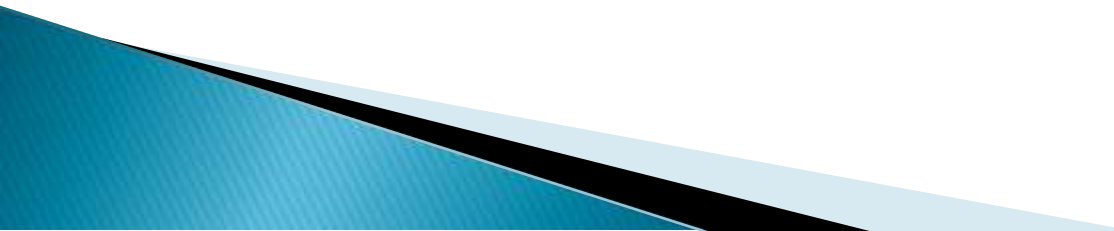


European Leader in Biogas and Biomethane compression

March 2018

Summary



- ▶ Brief history in the Biogas sector
 - ▶ Compressor features
 - ▶ Applications
 - ▶ Product range
 - ▶ Experience
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- A decorative graphic element is located in the bottom left corner of the slide. It consists of several overlapping geometric shapes in shades of blue and black, creating a modern, abstract design.

Brief history

- ▶ 2005 – FORNOVO GAS supplied the first compressor in a biogas plant in Iceland to compress **biomethane** (inlet P 15 bar, outlet P 250 bar)
- ▶ 2009 – FORNOVO GAS supplied the first compressor in a biogas plant in Germany to inject **biomethane** into the grid (inlet P 6 bar, outlet P 35 bar)
- ▶ 2010 – FORNOVO GAS supplied the first compressor in a biogas plant in Sweden to compress **raw biogas** (inlet P 0,20 bar, outlet P 5 bar)



Compressor features



- ▶ Non lubricated cylinders
- ▶ Two or three cylinders, V or W configuration
- ▶ Cylinders for very low suction pressures up to 375 bar (g) MAWP
- ▶ Force fed lubricated crankcase
- ▶ Extremely low vibration amplitudes, velocities and accelerations
- ▶ Rotation speeds from 700 to 1800 rpm
- ▶ Direct coupling (electric or gas engine driven)
- ▶ Up to four compression stages
- ▶ Up to 400 kW (DA300 model)
- ▶ Wide range of inlet pressures, from 0.02 to 70 bar (g)
- ▶ Sturdy yet compact design
- ▶ Oil free option available

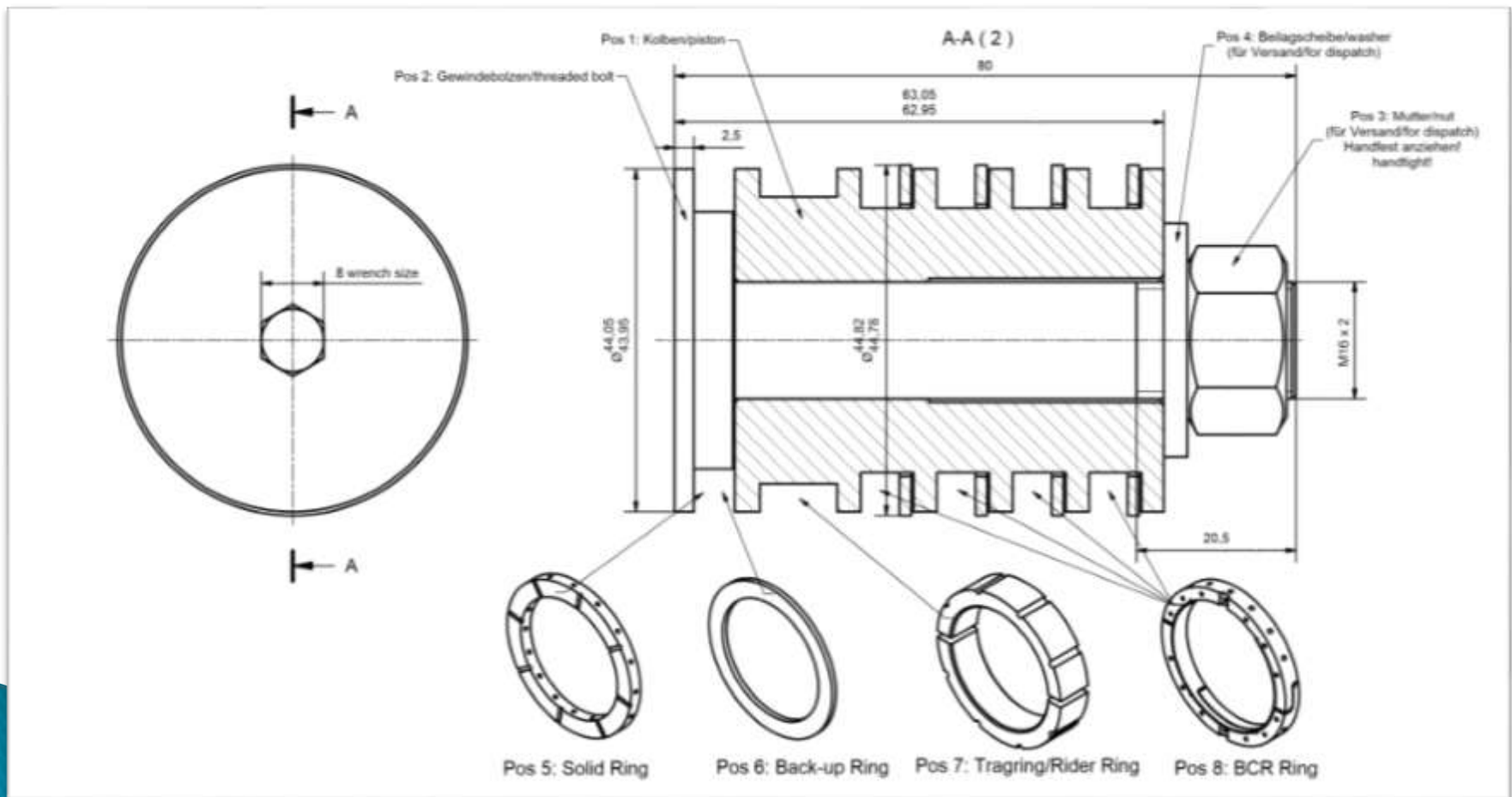
Compressor features

- ▶ Thanks to the special design of FORNOVO GAS pistons, gas helps to lubricate the cylinders and reduces the need for oil.
- ▶ Oil consumption is less than 1 kg every 100 working hours
- ▶ Pistons and valves are manufactured by a specialized Austrian supplier exclusively for FORNOVO GAS



Compressor features

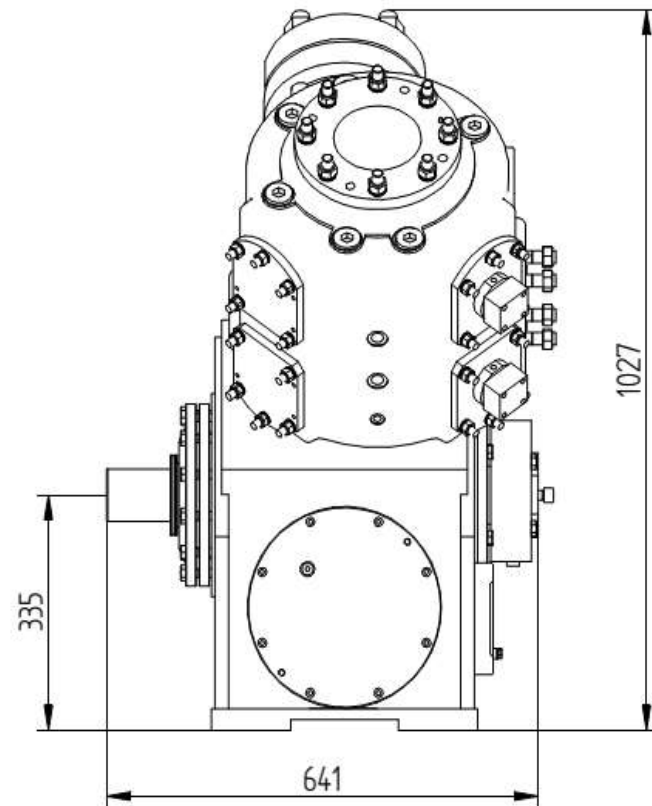
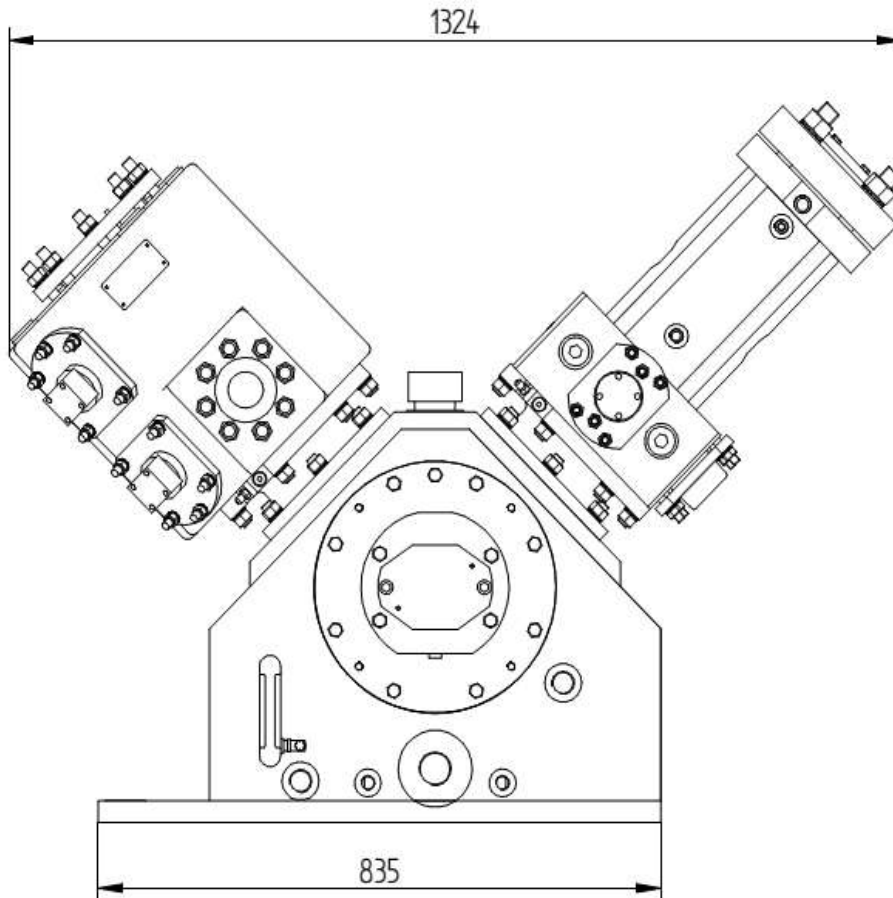
- ▶ Special design of piston rings (long life, up to 8,000 working hours) and compressor valves



Compressor advantages: Oil free option

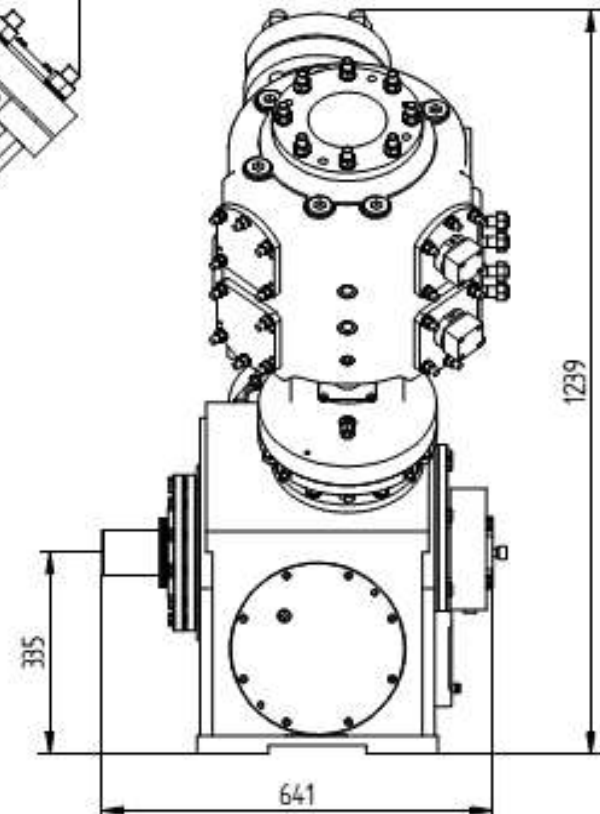
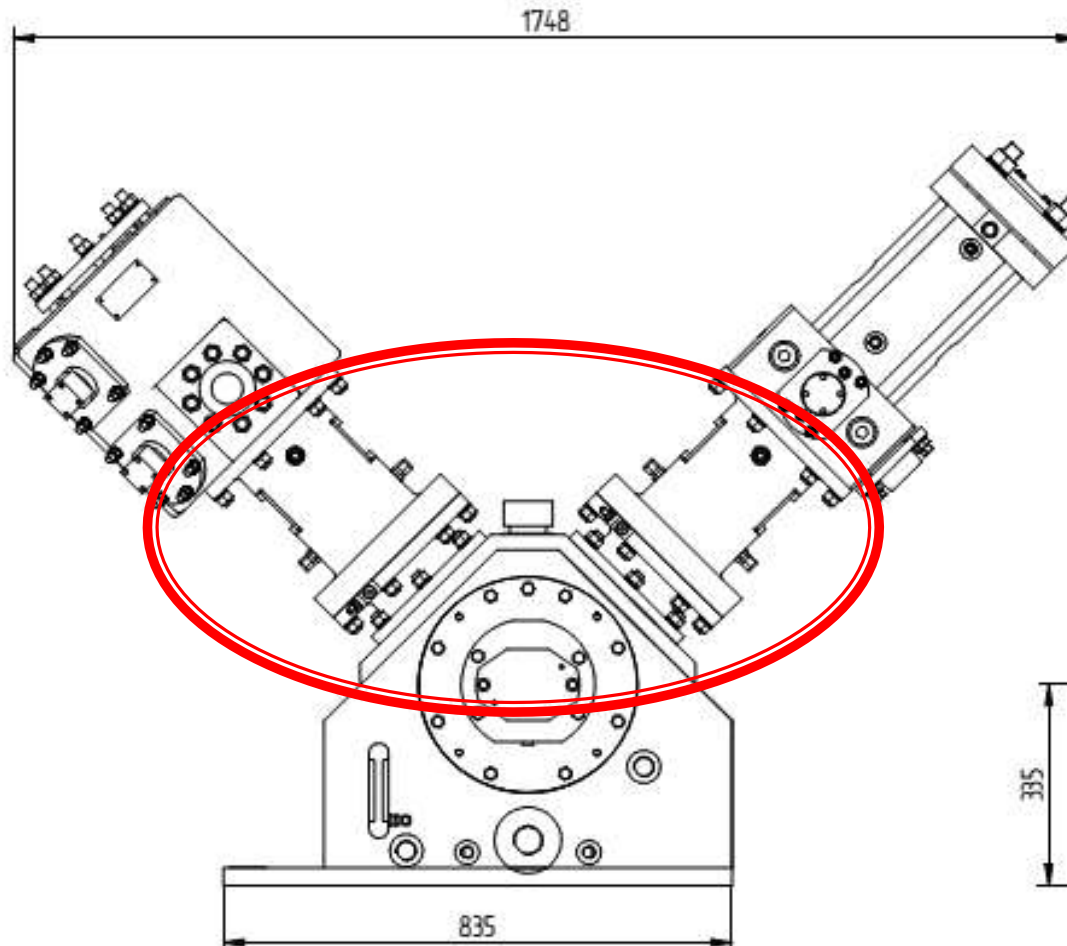


STANDARD CONFIGURATION



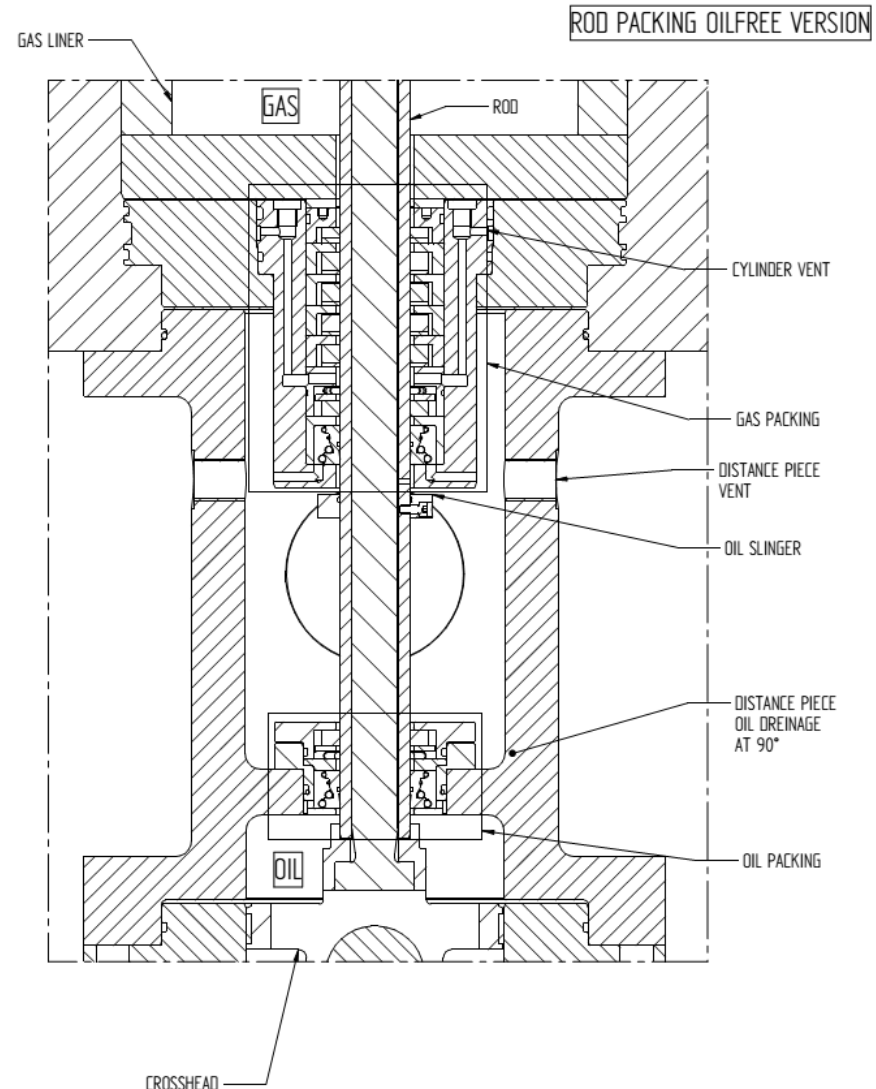
Compressor advantages: Oil free option

OIL FREE CONFIGURATION



Standard version and oil free option

- ▶ Long-Single compartment Distance Piece – Type B accordingly to API 618 standard
- ▶ No outlet filter needed
- ▶ No oil consumption
- ▶ No gas contamination
- ▶ Low maintenance cost



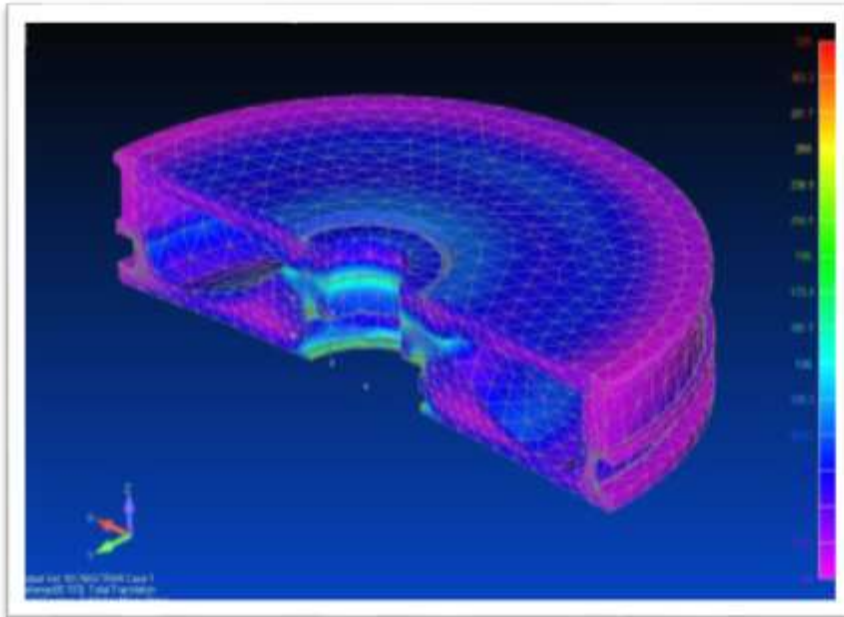
Compressor features



- ▶ FORNOVO GAS technology is one of the most advanced in the CNG compressor market, thanks to the FEA (Finite Element Analysis) of each component
- ▶ This in depth study allows FORNOVO GAS to reach high levels of performance that our competitors cannot reach in terms of durability, stability and vibration control

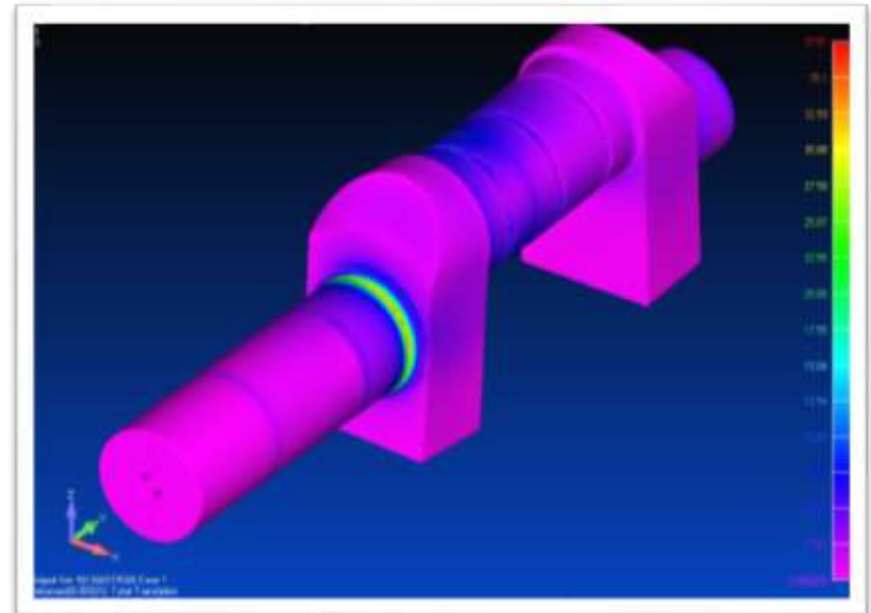


Compressor features

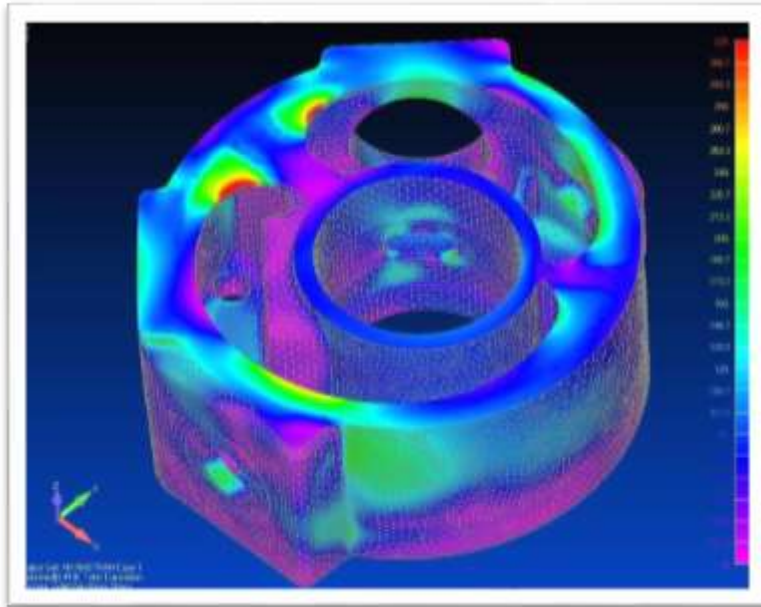


- ▶ Hollow Piston optimization:
 - Increased strength
 - Stress containment
 - Weight saving (inertial loads control)

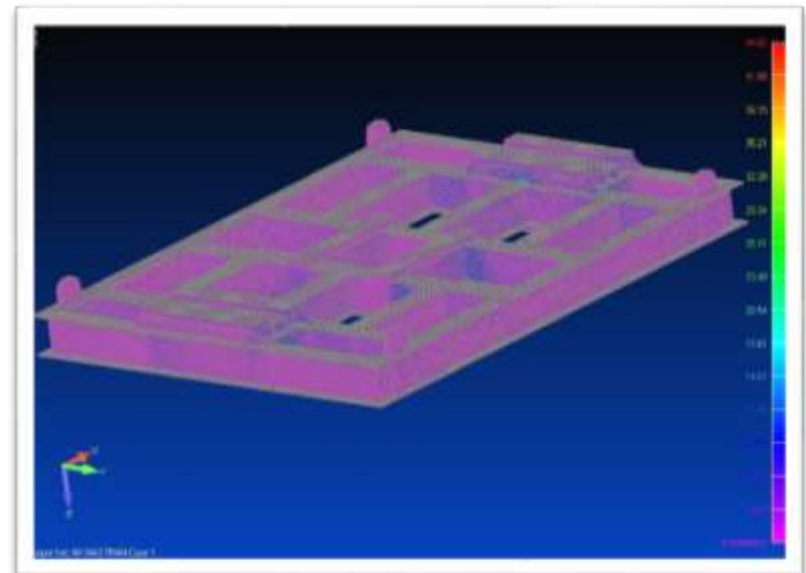
- ▶ Crankshaft optimization:
 - Increased strength
 - Stress containment
 - Weight saving (inertial loads control)



Compressor features



- ▶ Cylinder optimization:
 - Increased strength
 - Vibration reduction
 - Increased inlet pressure range of up to 90 bar



- ▶ Skid optimization:
 - Increased strength
 - Perfect balance
 - Weight saving (inertial loads control)

Quality control

- ▶ Quality control on each single component
- ▶ Hydraulic test performed on all pressure equipment
- ▶ Regular audit done on our main supplier



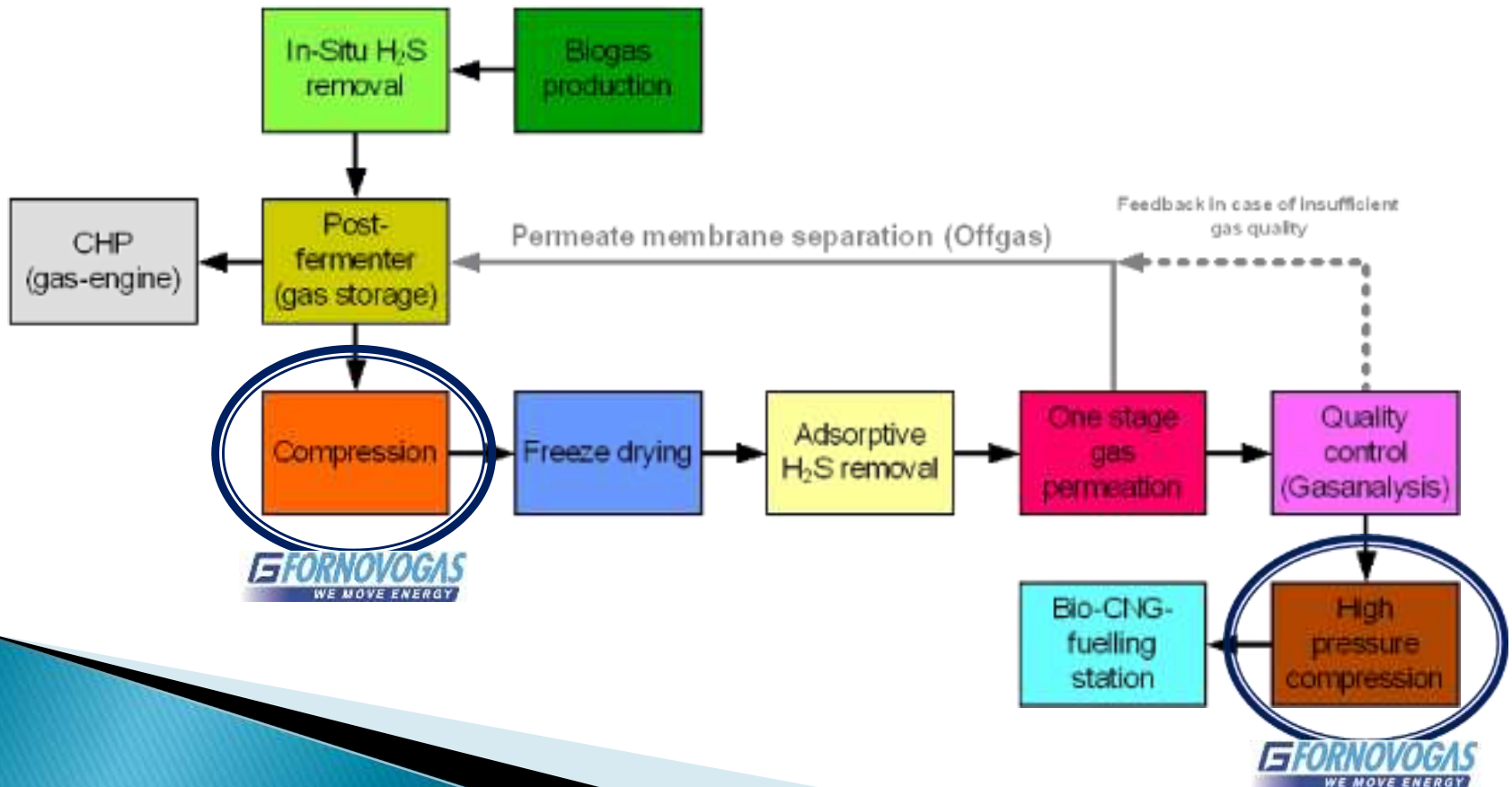
Quality control

- ▶ Every compressor is tested in our facility before shipment
- ▶ According to customer request third party inspector preside over and certify the FATs



Applications

- FORNOVO GAS compressor units can be installed in any type of upgrading plant, independent of the type of upgrading used like Water scrubbing, PSA, Membranes or Amino (chemical) Scrubbing



Example of special application (TANDEM)



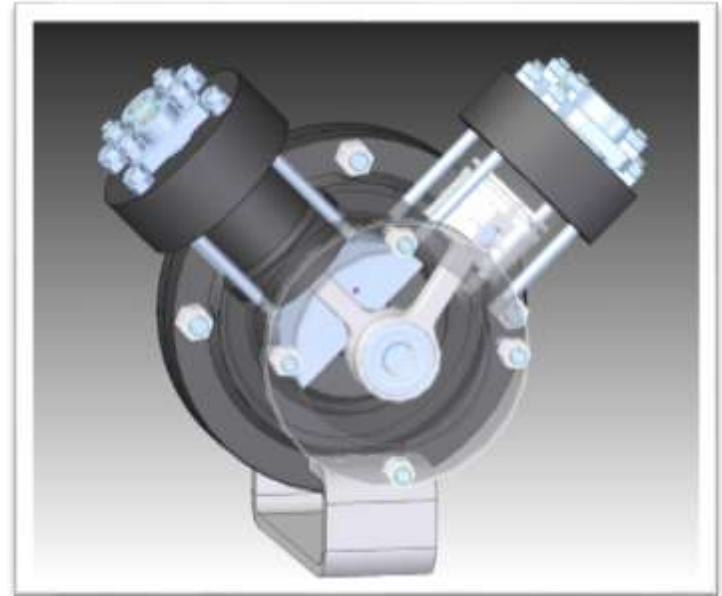
Biogas pipeline injection plant

- Country: Germany
- Fluid: upgraded biogas
- Inlet p: 20 mbar
- Outlet p: 25 bar
- Shaft power: 160 kW
- Stages: 4
- Two DA300 compressors

Product range – SA50



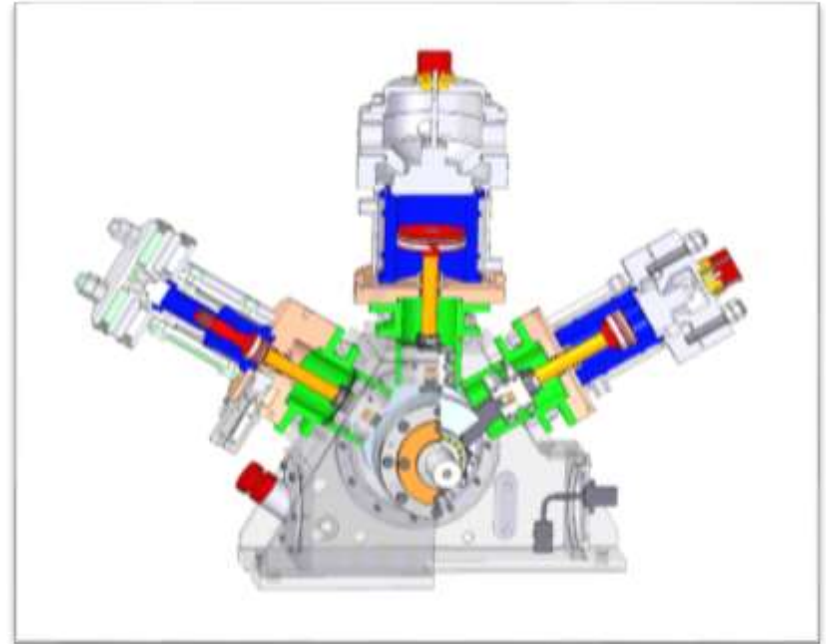
- ▶ Power: 2.2 kW
- ▶ Throws: 2
- ▶ Stages: 2
- ▶ Inlet P range: 0.1 – 5 bar (g)
- ▶ Outlet P range: up to 14 bar (g)
- ▶ Pressurized crankcase
- ▶ Suitable for applications like:
compressed air and technical
gases, gas recovery from other system, gas gathering
from small wells, etc.
- ▶ Available mounted on a compact skid (1000 x 500 x 1000)
with all necessary instrumentation and auxiliary equipment.



Product range – SA200



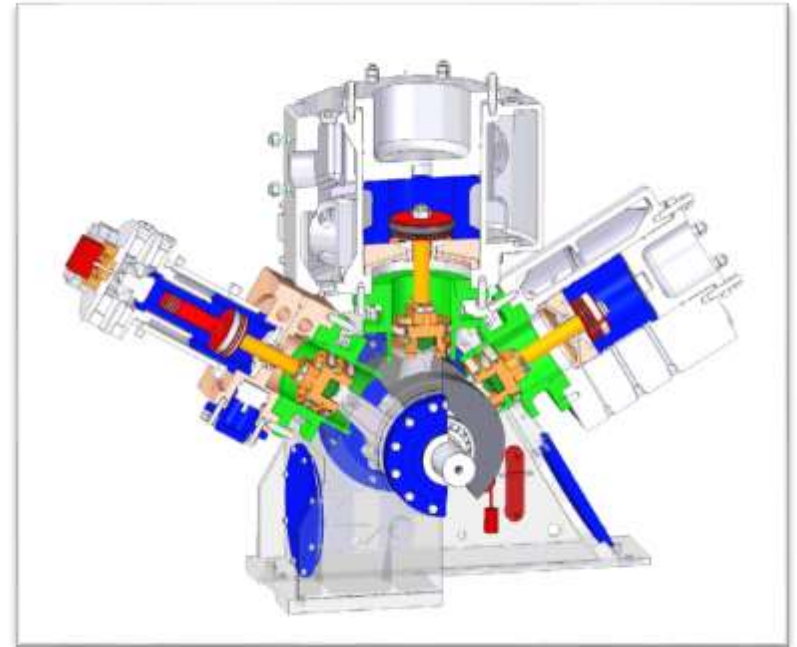
- ▶ Power: 22 – 55 kW
 - ▶ Throws: 2–3
 - ▶ Stages: 1–4
 - ▶ Inlet P range: 0.1 – 220 bar (g)
 - ▶ Outlet P range: up to 275 bar (g)
 - ▶ Rated speed: up to 1800 rpm
 - ▶ Flow rate: up to 2000 Sm³/h
-
- ▶ Suitable for applications like:
Small online and daughter CNG stations, biogas plants,
process and industrial compression stations
 - ▶ Available mounted on a compact skid or in a GASVECTOR cabinet



Product range – DA300



- ▶ Power: 75 – 400 kW
- ▶ Throws: 2–3
- ▶ Stages: 1–4
- ▶ Inlet P range: 0.1 – 220 bar (g)
- ▶ Outlet P range: up to 375 bar (g)
- ▶ Rated speed: up to 1500 rpm
- ▶ Flow rate: up to 8000 Sm³/h
- ▶ Suitable for applications like:
 - Online, mother and big daughter CNG stations, biogas plants, process and industrial compression stations
- ▶ Available mounted on a compact skid or in a GASVECTOR cabinet

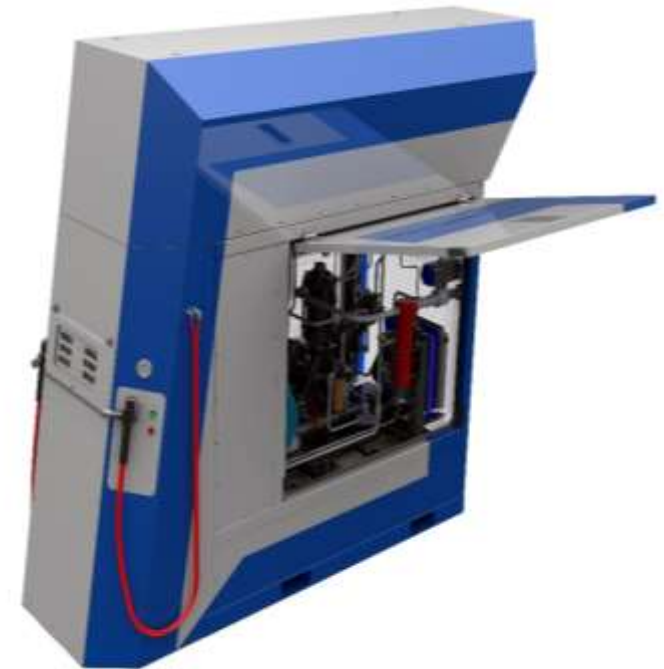


Product range – CITY



- ▶ Power: 37 – 55 kW
- ▶ Throws: 2–3
- ▶ Stages: 3–4
- ▶ Inlet P range: 1 – 20 bar (g)
- ▶ Outlet P range: 200 – 250 bar (g)
- ▶ Rated speed: up to 1500 rpm
- ▶ Flow rate: up to 360 Sm³/h

- ▶ Suitable for applications like:
Forklift and small private fleet station
- ▶ Dimension 1,15 x 2,5 x 2,5(h) m
- ▶ PLC with display and double line storage included



Product range – Cabinet



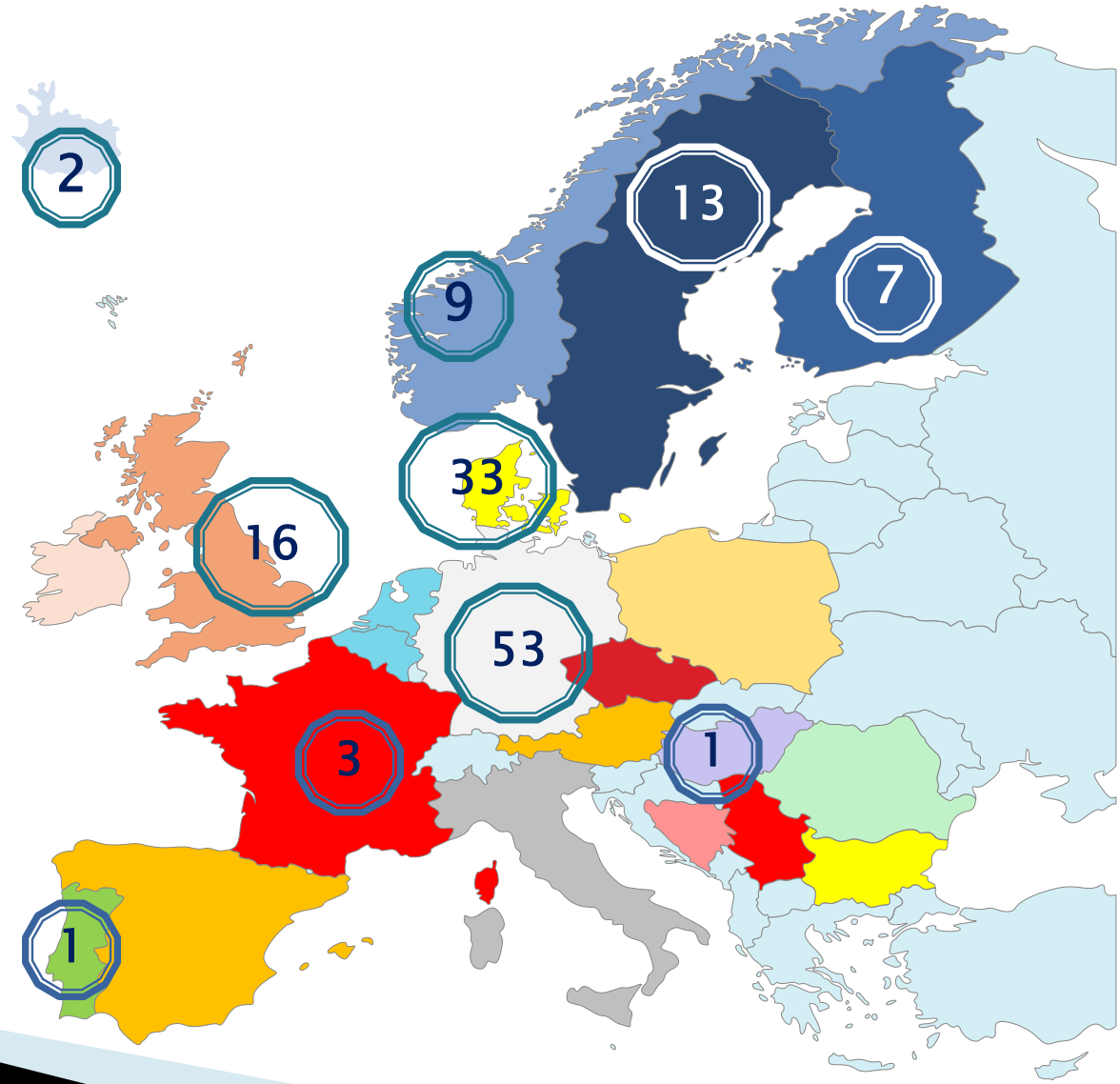
- ▶ Enclosure with level 1 safety certification
- ▶ Plug and play solution
- ▶ Roof mounted air cooler using special fixing brackets
- ▶ Maximum noise level 60dB(A) at 1 meter
- ▶ Door, walls and roof fully clad to guarantee total insulation
- ▶ Single or twin version
- ▶ Easy access for maintenance
- ▶ CE certified



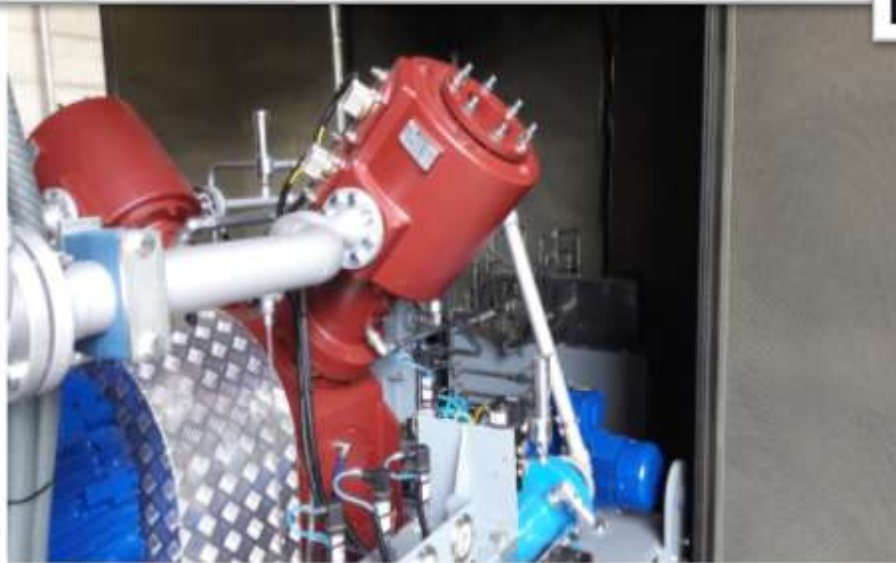
Experience

138 compressors
already operational in
Biomethane production
plant in Europe

21 new compressors to
be commissioned in
2018



Product range – Cabinet



Biomethane upgrading plant (primary compression)

LINKÖPING (Sweden)

- ▶ Model: 2DA300 Gasvector skid
- ▶ Service: Biogas plant primary compressor
- ▶ Gas: wet biomethane
- ▶ Features:
 - ▶ • Inlet pressure 0–0.2 bar
 - ▶ • Outlet pressure 5–6 bar
 - ▶ • Flowrate 500–950 Nm³/h
 - ▶ • Power 132 kW



ZALAEGRSZEG (Hungary)



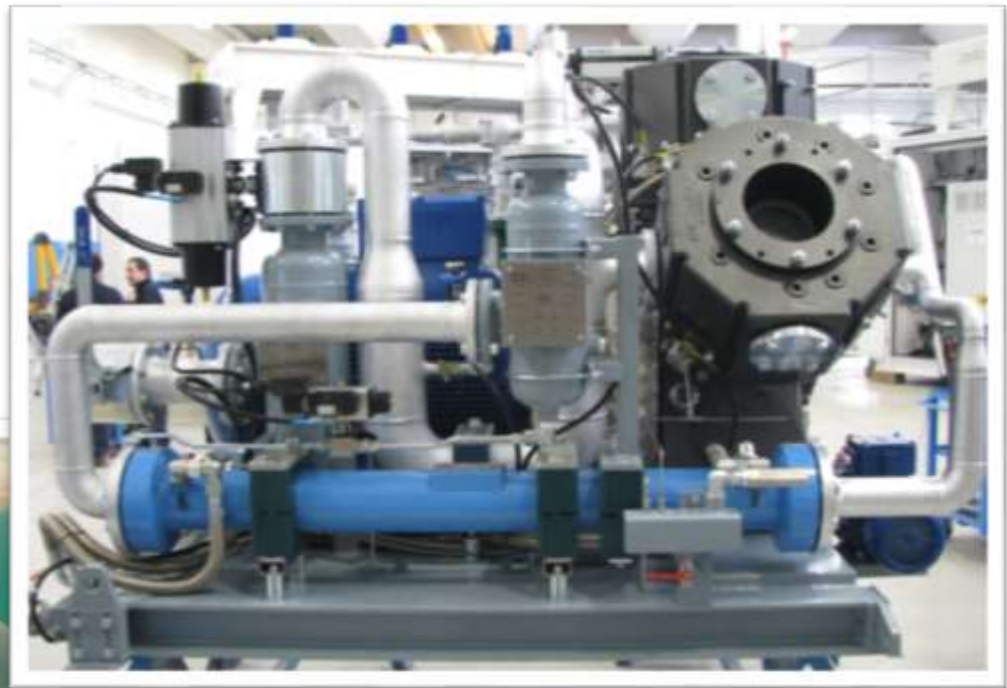
- ▶ Model: 2SA200 Gasvector cabinet
- ▶ Service: Biogas plant primary compressor (CNG station and CHP gas feeding)
- ▶ Gas: Raw biogas
- ▶ Features:
 - Inlet pressure 0.035 bar
 - Outlet pressure 10 bar
 - Flowrate 100 Nm³/h
 - Power 30 kW



CROUCHLAND (Great Britain)



- ▶ Model: 2DA300 Gasvector skid
- ▶ Service: Biogas plant primary compressor
- ▶ Gas: wet biomethane
- ▶ Features:
 - ▶ • Inlet pressure 0.05–0.7 bar
 - ▶ • Outlet pressure 5 bar
 - ▶ • Flowrate 395–1420



Biomethane grid injection

NORDERSCHUBIFELD (Germany)



- ▶ Model: 3DA300 Gasvector skid
- ▶ Service: Pipeline gas injection
- ▶ Features:
 - Inlet pressure 2–6.5 bar
 - Outlet pressure 84 bar
 - Flowrate 650–1150 Nm³/h
 - Power 160 kW



SUOMENOJA (Finland)

- ▶ Model: 2DA300 Gasvector cabinet
- ▶ Service: Pipeline gas injection
- ▶ Features:
 - ▶ • Inlet pressure 4.5–5 bar
 - ▶ • Outlet pressure 54 bar
 - ▶ • Flowrate 400 Nm³/h
 - ▶ • Power 75 kW



JORDBERGA (Sweden)

- ▶ Model: 3DA300 Gasvector cabinet
- ▶ Cylinder: Oil-free
- ▶ Gas recovery: SA50 skid
- ▶ Service: Gas injection
- ▶ Features:
 - Inlet pressure 4 bar
 - Outlet pressure 80 bar
 - Flowrate 975 Nm³/h
 - Power 160 kW



WANZLEBEN (Germany)

- ▶ Model: 4DA300 Gasvector skid TANDEM
- ▶ Service: Pipeline gas injection
- ▶ Features:
 - ▶ • Inlet pressure 0.08–1 bar
 - ▶ • Outlet pressure 16 bar
 - ▶ • Flowrate 850 Nm³/h
 - ▶ • Power 160 kW



HJORRING (Denmark)

- ▶ Model: 2DA300 Gasvector cabinet
- ▶ Cylinder: Oil-free
- ▶ Gas recovery: SA50 skid
- ▶ Service: Gas injection
- ▶ Features:
 - Inlet pressure 5 bar
 - Outlet pressure 45 bar
 - Flowrate 1100 Nm³/h
 - Power 132 kW



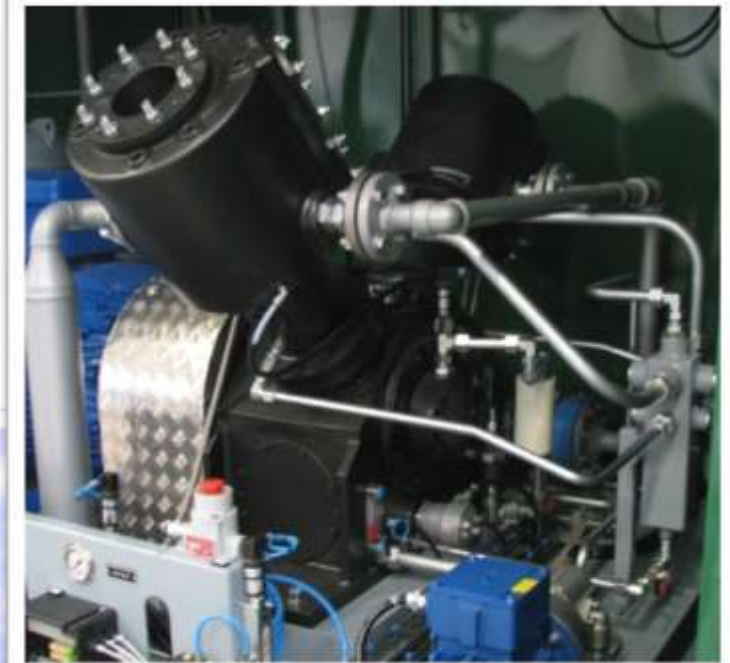
KUJALA (Finland)

- ▶ Model: 2DA300 Gasvector skid
- ▶ Service: Pipeline gas injection
- ▶ Features:
 - ▶ • Inlet pressure 5 bar
 - ▶ • Outlet pressure 54 bar
 - ▶ • Flowrate 580 Nm³/h
 - ▶ • Power 90 kW



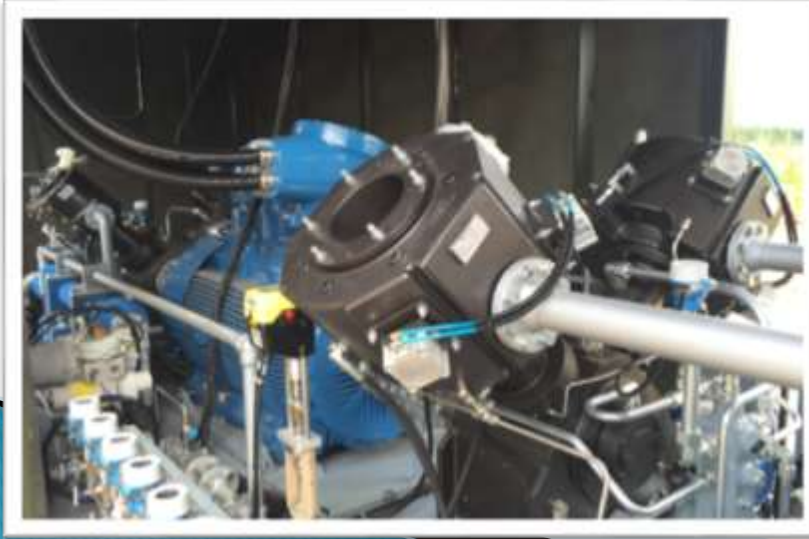
MINWORTH (Great Britain)

- ▶ Model: 1DA300 Gasvector cabinet
- ▶ Cylinder: Oil-free with 'type B' distance pieces
- ▶ Service: Gas injection
- ▶ Features:
 - ▶ • Inlet pressure 4.5–6 bar
 - ▶ • Outlet pressure 21 bar
 - ▶ • Flowrate 500–1000 Nm³/h
 - ▶ • Power 110 kW



SONDERIYSK (Denmark)

- ▶ Model: 3DA300 Gasvector cabinet
- ▶ Cylinder: Oil-free with 'type B' distance pieces
- ▶ Service: Gas injection
- ▶ Features:
 - Inlet pressure 3–4 bar
 - Outlet pressure 47–80 bar
 - Flowrate 1000–2800 Nm³/h
 - Power 450 kW



Storage filling

REYKJAVIK (Iceland)

- ▶ Model: 3SA200 Gasvector skid
- ▶ Service: Storage filling
- ▶ Features:
 - ▶ Inlet pressure 15 bar
 - ▶ Outlet pressure 250 bar
 - ▶ Flowrate 155 Nm³/h
 - ▶ Power 30 kW



BAD KISSINGEN (Germany)

- ▶ Model: 2DA300 Gasvector skid
- ▶ Service: Storage filling
- ▶ Features:
 - ▶ • Inlet pressure 16–64 bar
 - ▶ • Outlet pressure 100 bar
 - ▶ • Flowrate 2500 Nm³/h
 - ▶ • Power 132 kW



GRANVILLE (UK)

- ▶ Model: 4DA300 Cabinet
- ▶ Service: Storage filling
- ▶ Features:
 - Inlet pressure 4 bar
 - Outlet pressure 250 bar
 - Flowrate 900 Nm³/h
 - Power 160 kW



Why FORNOVO GAS?



- ▶ Ten years of experience in compressing biogas and biomethane
- ▶ 0.02 bar(g) to 90 bar(g) inlet pressure and up to 6000 Sm³/h capacity
- ▶ Heavy duty, dry cylinder, dedicated, designed and tested piston glyds for 8000 working hours without substitution
- ▶ No oil in customer's CNG storage
- ▶ Modular technology, high quality equipment (certified process), plug and play or customized solutions
- ▶ Almost 150 compressors working in European biogas plants



Thanks for your attention

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