



Challenges and Barriers in the utilization of Flare gas for Power generation

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GE Power & Water
Jenbacher gas engines

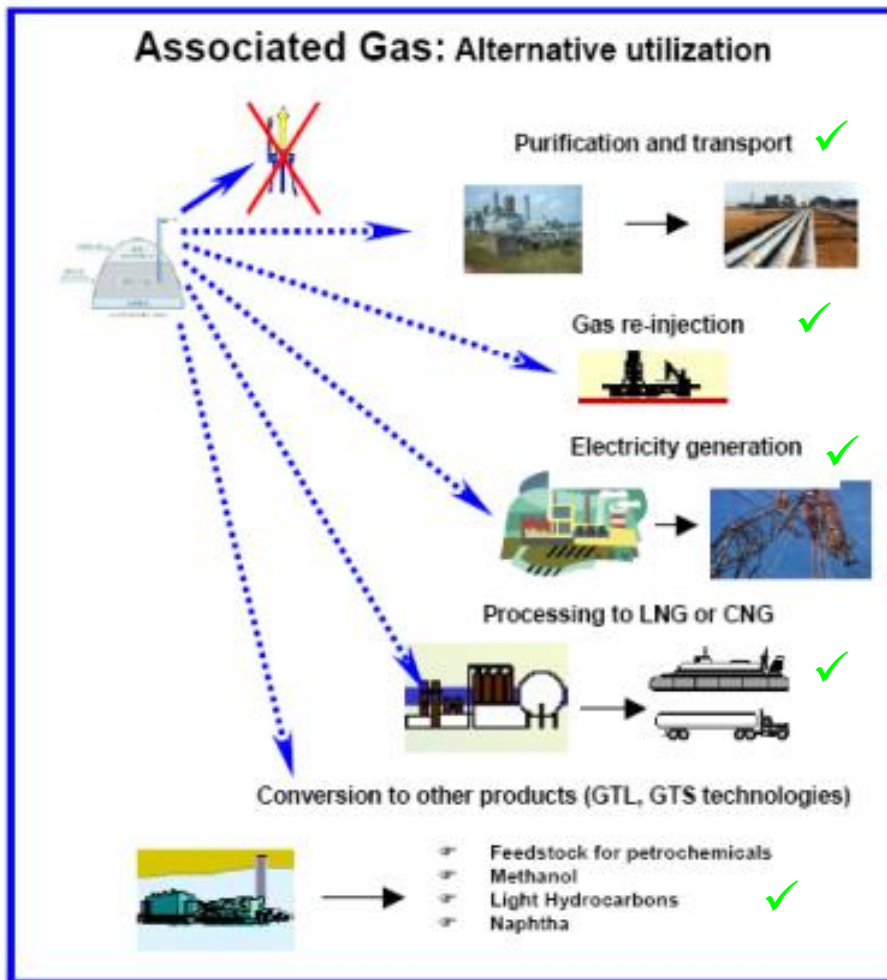


GE Jenbacher - a leading manufacturer of gas-fueled reciprocating engines for power generation.

- Acquired in May '03...100% gas-fueled recip
- Manufacturing/HQ in Jenbach, Austria
- Employees: 1,700 total; 1,300 in Austria
- **Power range from 0.25MW to 4MW**, 4 platforms / 11 products
- **Fuel flexibility:** Natural gas or a variety of renewable or alternative gases (e.g., landfill gas, biogas, coal mine gas)
- **Plant configurations: Generator sets, cogeneration systems, container solutions**

Main requ. for applications in the O&G industry

- Operation with assoc. petroleum gas (flare gas)
 - Fuel flexibility
 - Stable island operation
 - Operation at low Methane numbers
- Operation in hazardous environment
 - Gas engines can not be operated in ATEX zones 0-2
 - Enclosures must be built accordingly
 - Ventilation systems to ensure CH₄ dilution
 - Electrical equipment e.g. according to CSA class 1, div.2.
 - Spark arrestors in exhaust gas systems

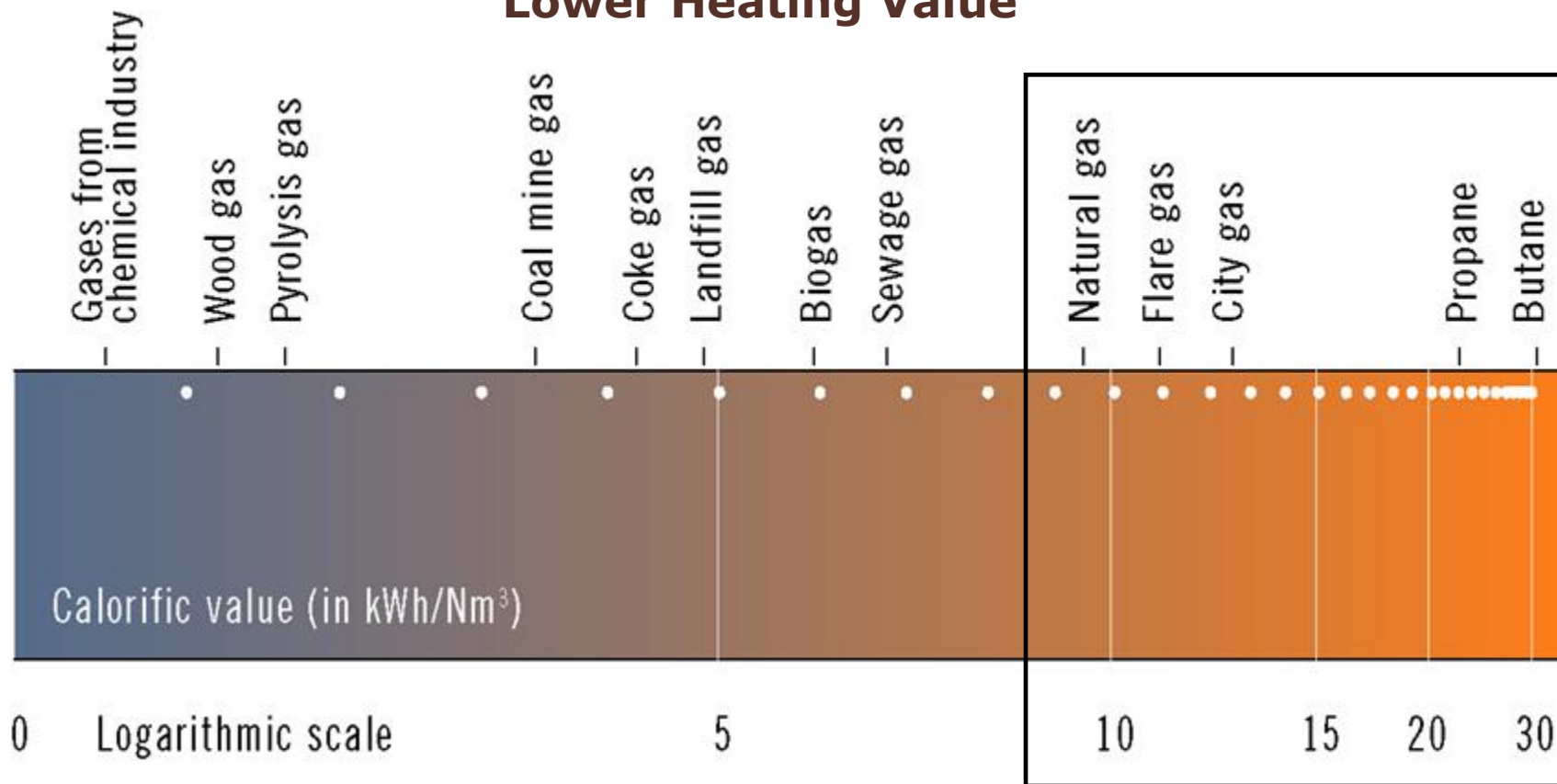


Source= EU-Russia technology center (on Internet)

✓ - GE Capability

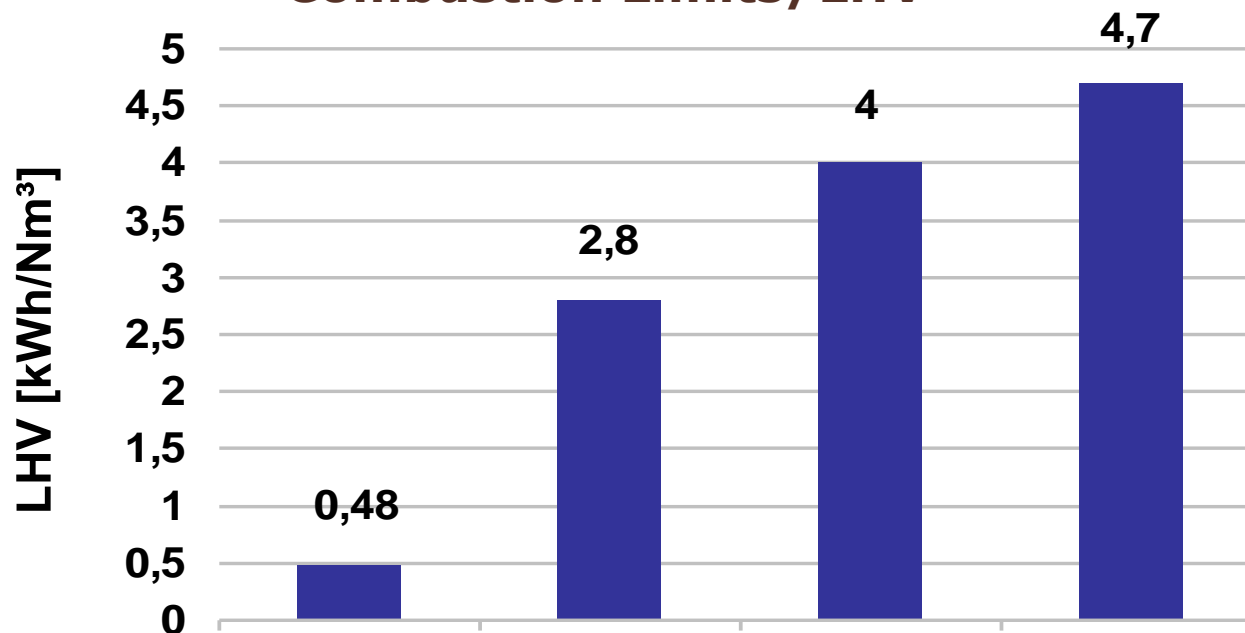
Many solutions for APG utilization available

Lower Heating Value



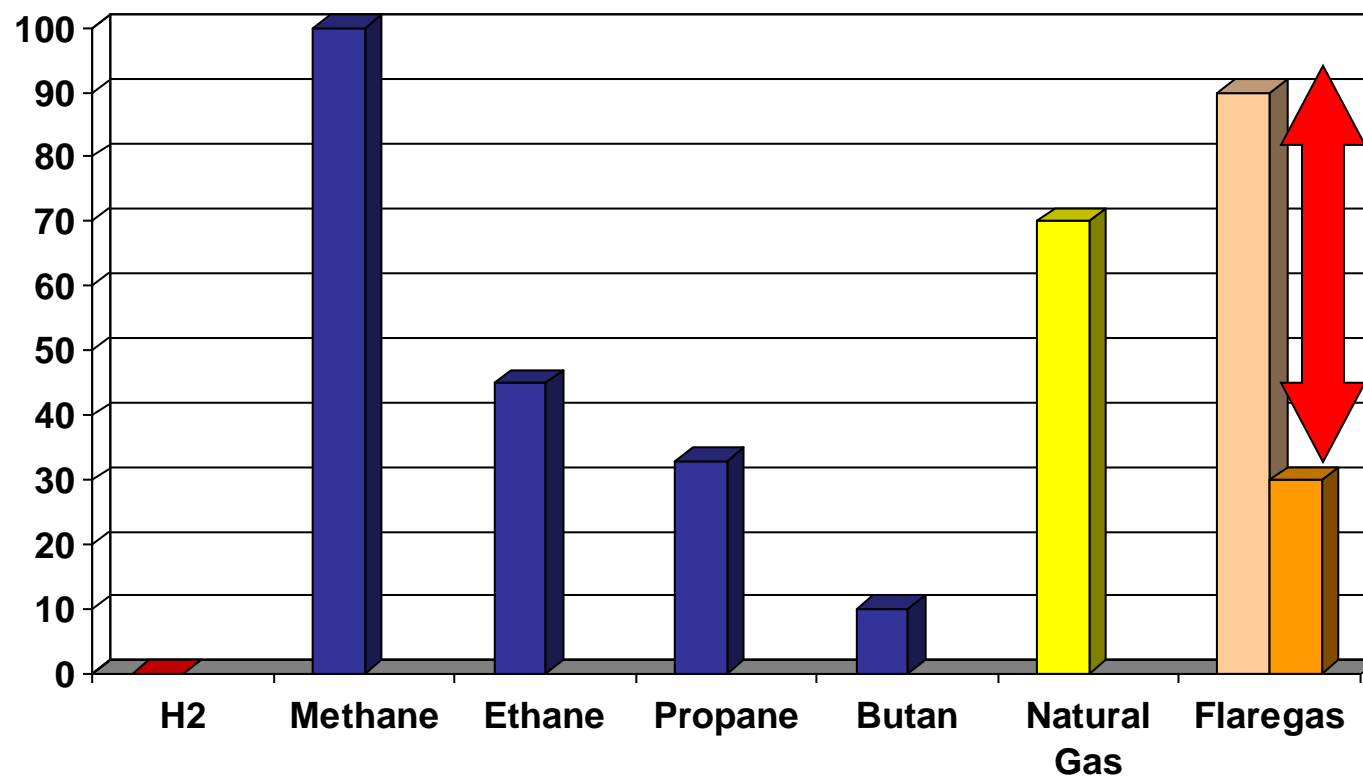
Very wide fuel flexibility with gas engines

Combustion Limits/LHV



	H ₂ /N ₂	CH ₄ /N ₂	CH ₄ /CO ₂	C ₃ H ₈ /CO ₂
Mixture	H ₂ /N ₂	CH ₄ /N ₂	CH ₄ /CO ₂	C ₃ H ₈ /CO ₂
Volume [%]	16/84	28/72	40/60	18/82
LHV [kWh/Nm³]	0.48	2.8	4.0	4.7

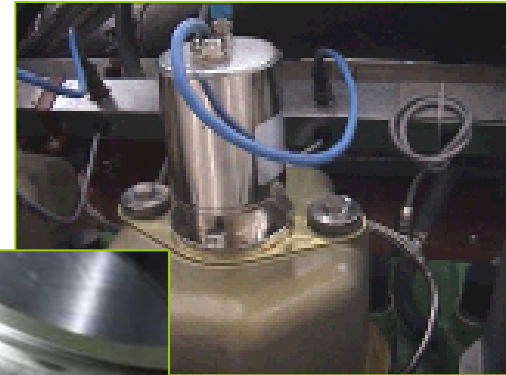
Combustibility depends on the combination of composition and NOT on the heating value of the gas



Methane Number is the main limiting factor for the achievable output of Flaregas Applications

• Three different forms of combustion

- Normal Combustion
- Combustion at the knocking limit
- Knocking combustion

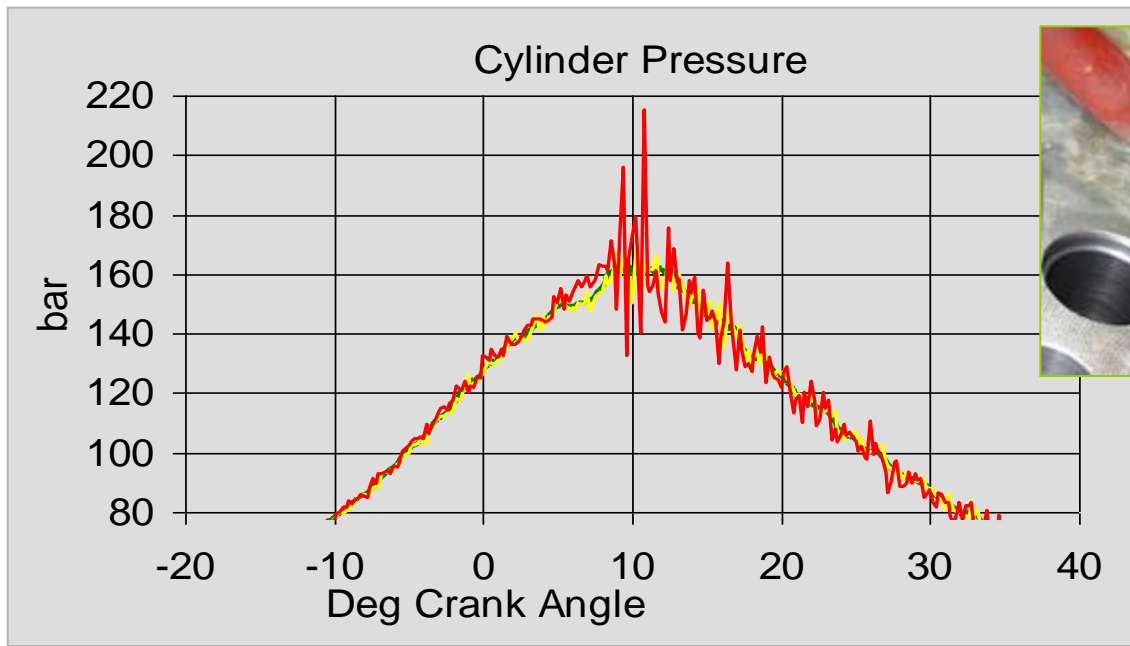


Sensor

Normal Combustion

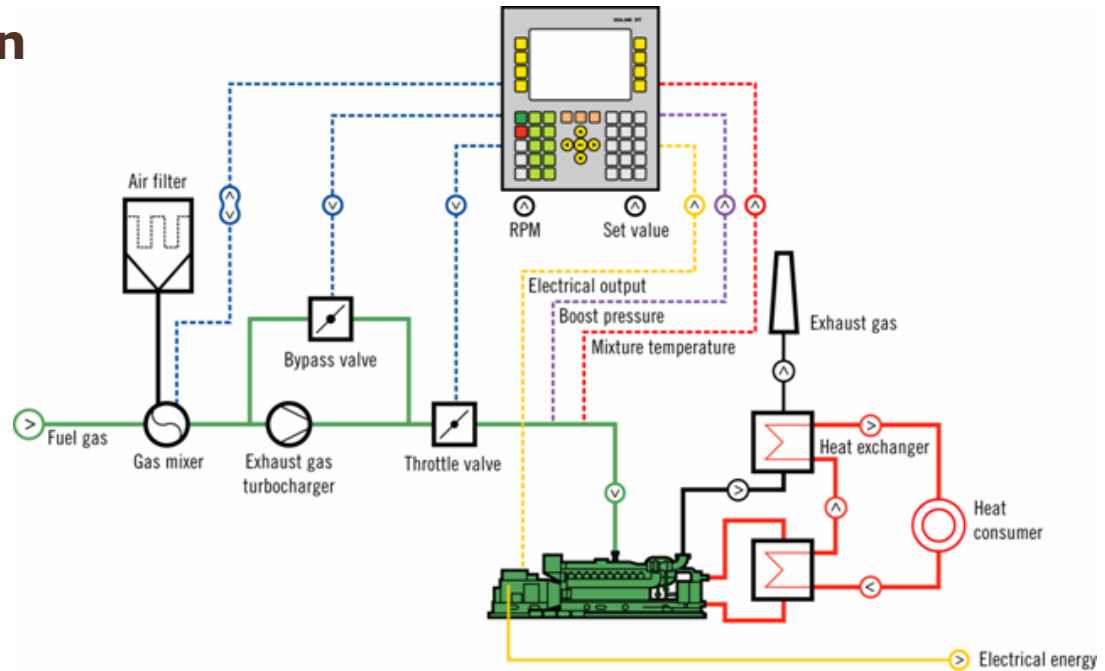
Combustion at Knocking limit
(knocking control active)

Hard knocking – engine damage
soon to arrive



Knocking control: sensors for each cylinder!

LEANOX® - Lean-burn combustion control



- Sensors in non critical measurement ranges (pressure, temperature, deposits...)
- Reliable and durable compliance with exhaust emission limit at changing operational conditions (fuel gas compositions...)
- Controlled combustion and subsequently controlled stress of various components (valves, cylinder heads, spark plugs...)

Typical standard condensate removal



Open questions

- Electrical power demand?
- Operation parallel to the grid?
- Voltage level?
- Which gas sources can be used?
- Gas pressure levels – Temperature levels?
- Gas-Flow over time?
- Utilization of heat - trignereation?
- Island operation needed?
- Available area of land?



History

Project initiated by ETAP and Pioneer upon realisation of the presence of associated petroleum gas unused

Location

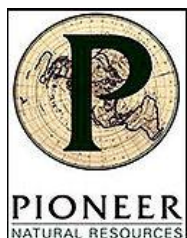
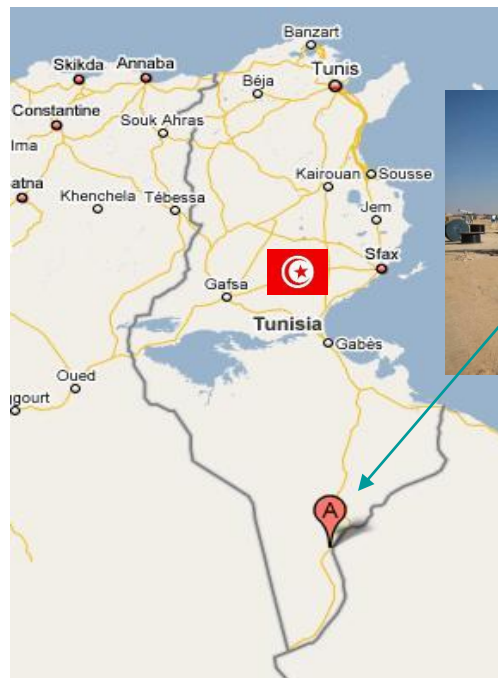
300 km south of Djerba in the Tunisian desert

The client

Pioneer Natural Resources:

- Company created in 1997,
- Natural gas and oil extraction,
- 1700 employees nowadays,
- Based in Texas,
- Exploitations in the USA (Texas, Kansas, Colorado, Alaska), in South Africa and in Tunisia.

Capital allocation: 50% for ETAP and 50% for PIONEER



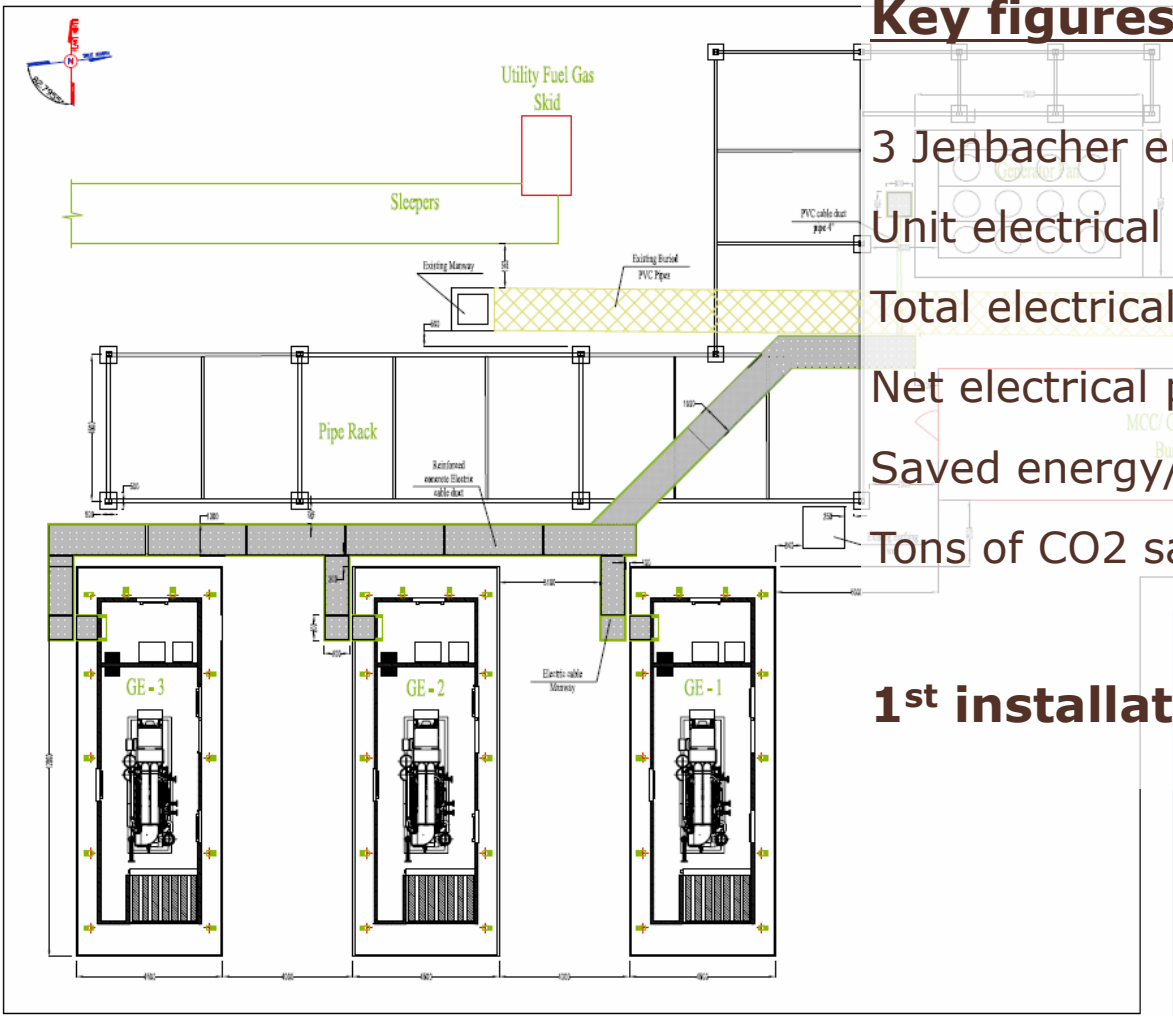
Platform operations..

As the facility works on its own, there is no local electric network. Therefore to operate the platform, the client supplies himself with refined petroleum from Tunis.

The implementation of 3 Jenbacher engines will allow the platform to run by itself in complete autonomy.

This power plant is now the main electrical power source.





Key figures of Waha..

- 3 Jenbacher engines JGS 312 GS-N.L
- Unit electrical power : 380 kW
- Total electrical power : 1 140 kW
- Net electrical performance : 37,9%
- Saved energy/year : 9500 MWh
- Tons of CO2 saved/year : 2574.5 tons

1st installation of that kind in Tunisia!



Installation performances

The 3 covers realised have been made to measure and are:

- sandstorm resistant up to 180 km/h
- equipped with a 2 floors sand filtration
- equipped with a ventilation authorizing a room temperature of max. 55° c
- soundproof to 65 dBA to 10 m
- the gas type (oil gas – rate of methane 73%)

**Middle East & North Africa Forum
on Flaring Reduction & Gas Utilization**



J.F. Secco /ARG
15 x JGS 420 GS-S.L
Electr. Output: 21,225kW
Gas composition:
CH₄ ... 48.5 %
C₂H₆ ... 2.4 %
C₃H₈ ... 1.0%
C₄H₁₀ ... 1.1%
N₂ ... 1.5%
CO₂ ... 46.0%

Commissioned: 2004

Colombia: tropical 35°C with 90% rel. humidity



OXY – Caricare / COL

9 x JGC 320 GS-N/S.L

Electrical Output: 9,567 kW

Gas composition:

CH₄ ... 41.5 %

C₂H₆ ... 7.0 %

C₃H₈ ... 9.0%

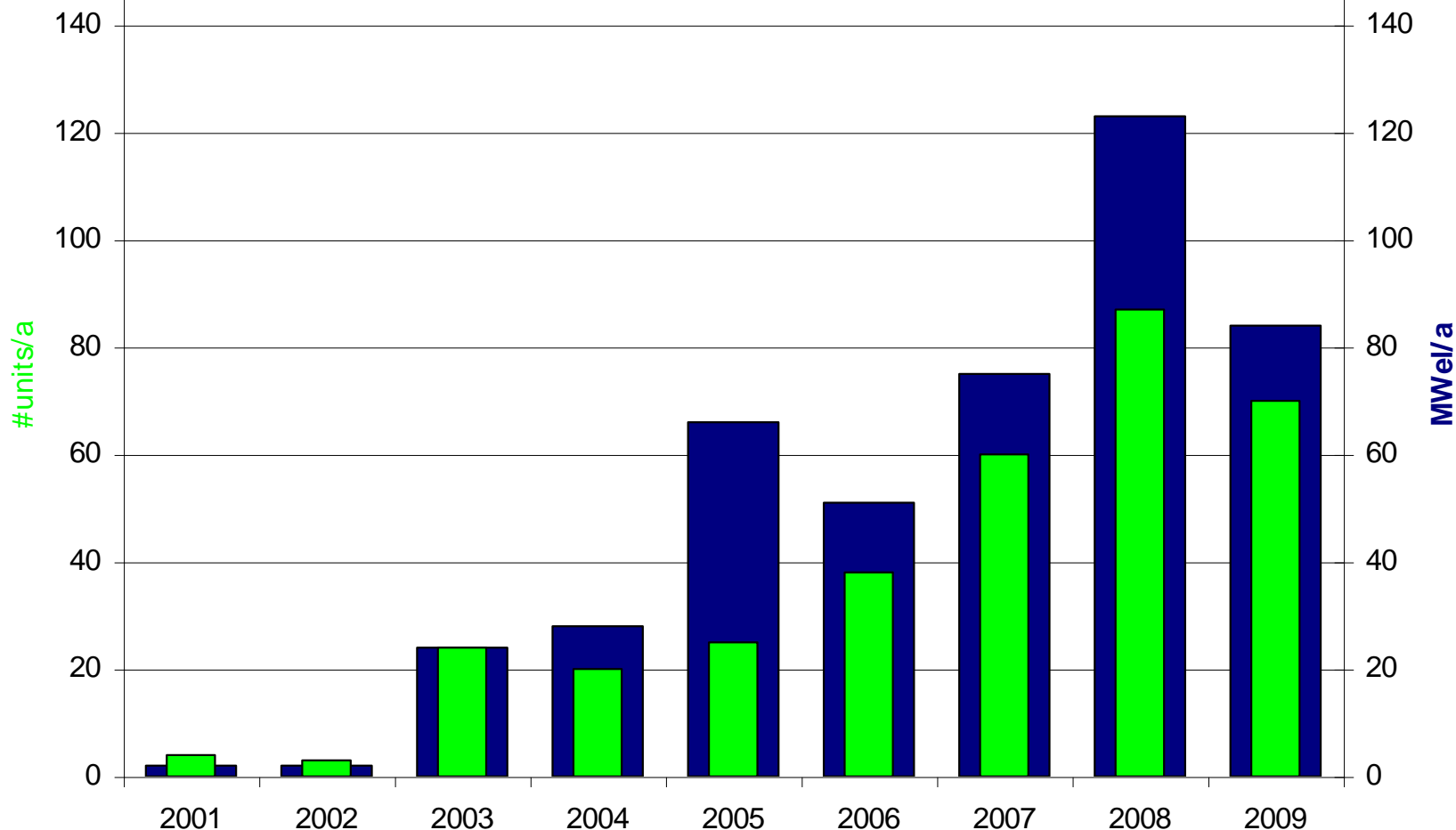
C₄H₁₀ ... 6.0%

N₂ ... 6.5%

CO₂ ... 27.5%

Commissioning: 2007

More than 300 engines in APG-applications



Summary:

- **Utilization of Flare gas with gas engines is a great solution**
 - On-site Power generation in remote areas
 - Avoidance of Flaring
 - Reliable power supply in the oil field
- **Challenges and Barriers:**
 - Knowledge about gas engines in the O&G market
 - Gas composition and Flow development over time
 - Operation in island mode can be challenging
 - Trained staff for maintenance at site
 - Adaptation to site conditions project specific.