

26th World Gas Conference

1 – 5 June 2015, Paris, France



World Scale Boil-off Gas Reliquefaction (BOGR)

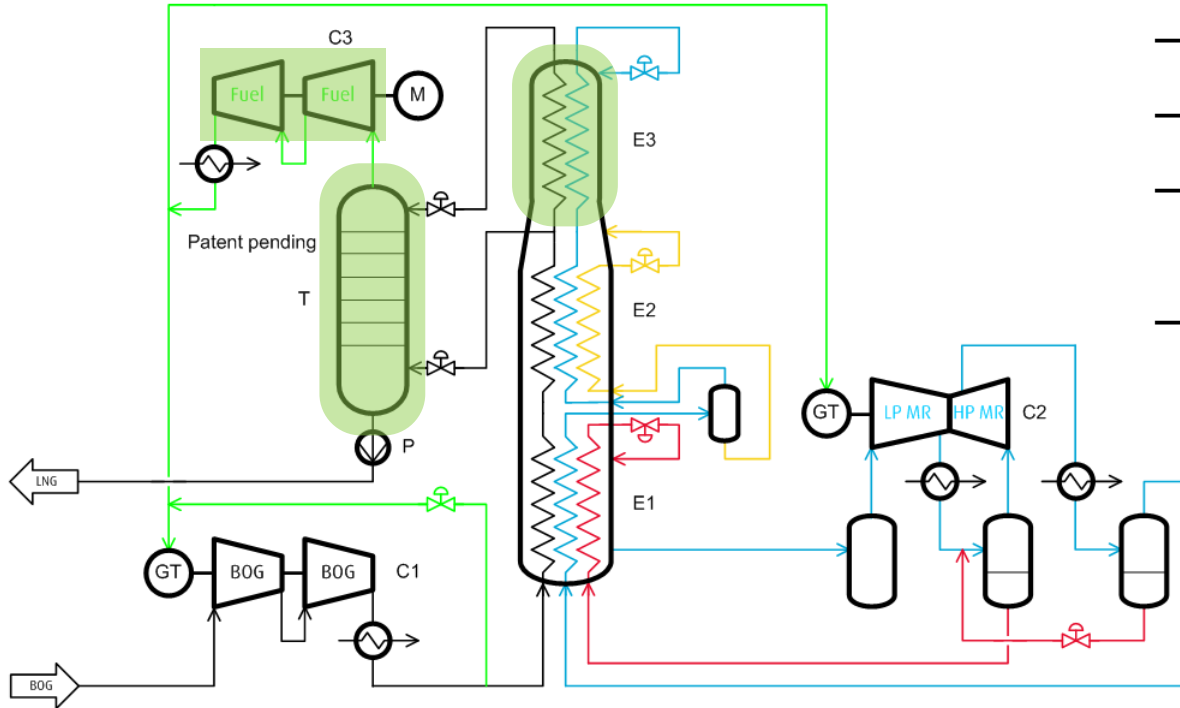
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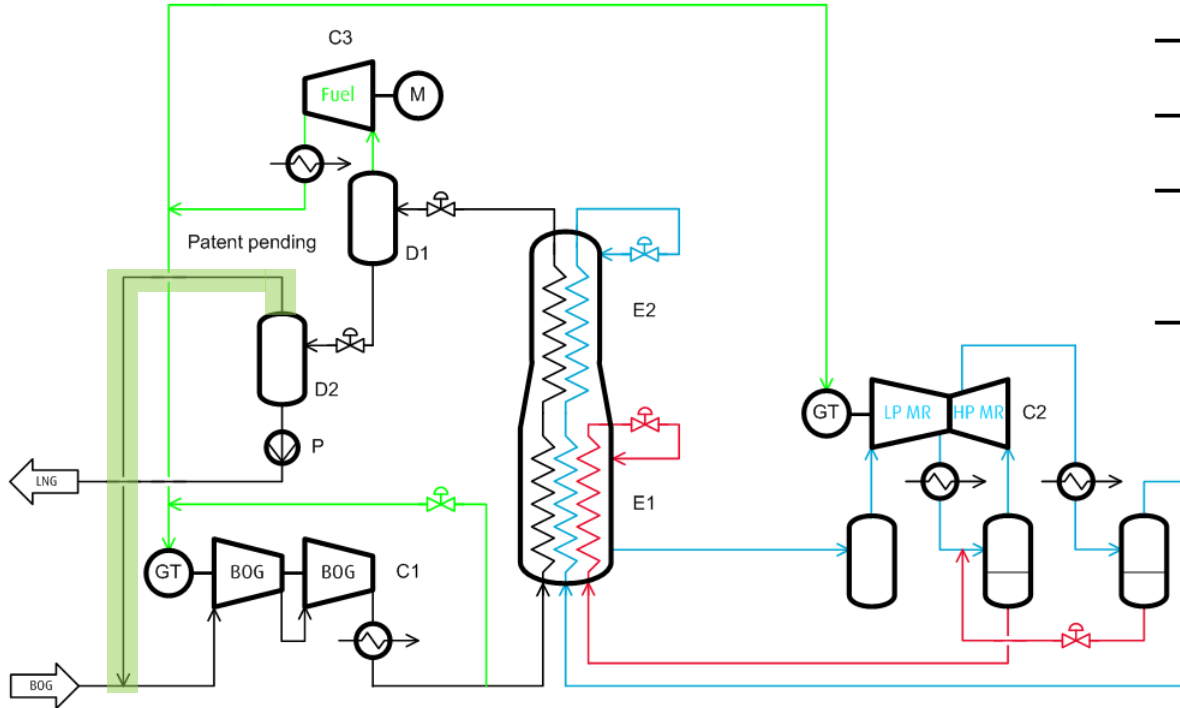
- Large LNG export terminals include a LNG tank farm with large LNG tanks providing storage capacity of several hundred thousand meters cubed. **Low pressure gases** at tank pressure (about 100 to 200 mbarg) originate from several sources like
 - **Boil-off gas** caused by heat ingress through the tank walls and LNG pumps
 - **Flash gas** generated in the run-down line between liquefaction and storage as well as during cool-down of warm send-out systems
 - **Ship return gas** / displacement gas during ship loading
- Total BOG flow rate for a **10 mtpa** facility **~1,000 t/d**

- A BOG reliquefaction (BOGR) unit with **0.3 - 1.0 mtpa** LNG is similar to a **mid-scale LNG** plant
- Most land based plants of this size use SMR technology with **~350 kWh/t_{LNG}** or 15 MW for 1000 t/d
- **Feed gas compression to >50 bar** requires about the same power as the refrigeration cycle
- The preferred cryogenic heat exchanger is a **coil wound heat exchanger (CWHE)**
- The cost adder for a CWHE is more than offset by its **superior availability**
- Mechanical drive with **gas turbines** is the preferred choice
- **Electric motors** should be considered only, if power supply is reliable and economically attractive



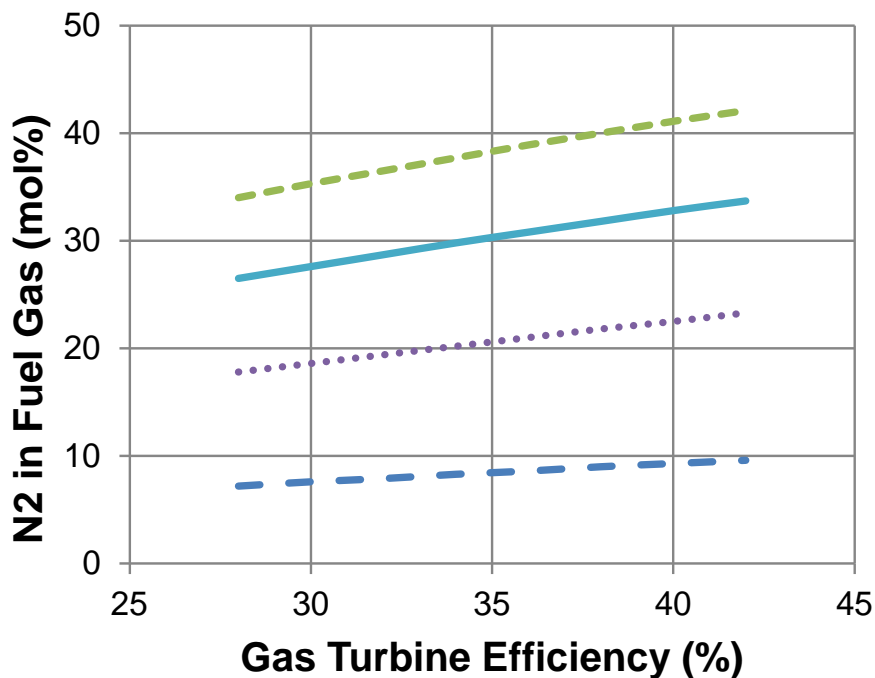
Base Case

- N_2 stripper T
- LNG subcooler E3
- two casing EFG compressor C3
- unbalanced power between C1 and C2



Optimized Case

- N_2 flash drums D1 & D2
- no LNG sub-cooler required
- one casing EFG compressor C3
- balanced power between C1 and C2



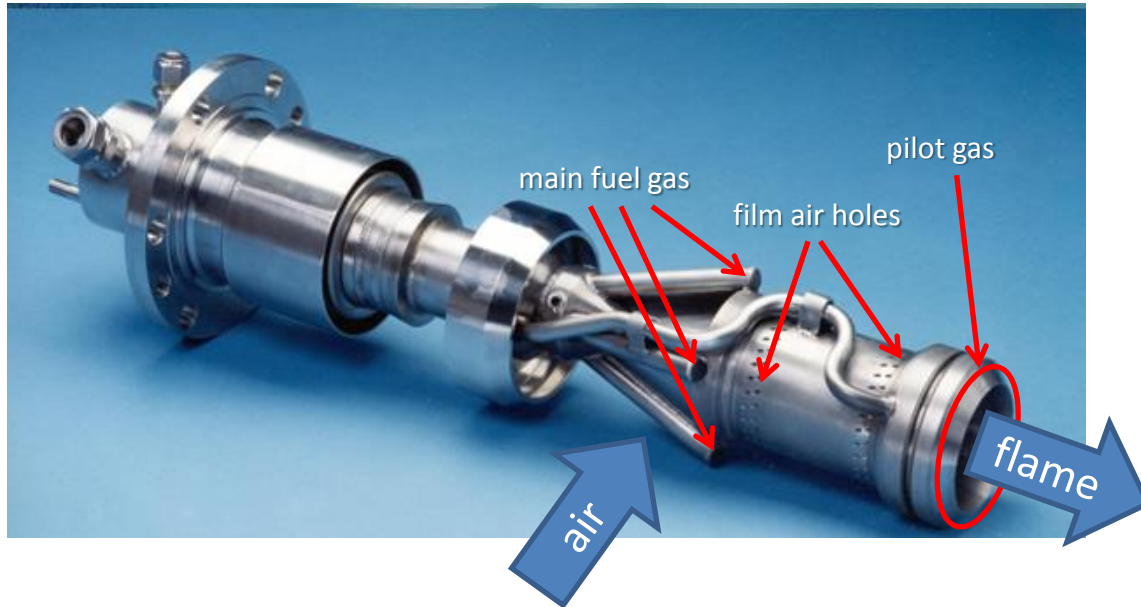
N₂ content
in BOG

- 8 mol%
- 6 mol%
- 4 mol%
- 2 mol%

Material Balance for N₂

- limited amount of N₂ in LNG
- GT's with high efficiency will see high N₂ content in fuel
- max. 8 mol% N₂ in BOG are acceptable for state-of-the-art gas turbines

Siemens SGT-700/800

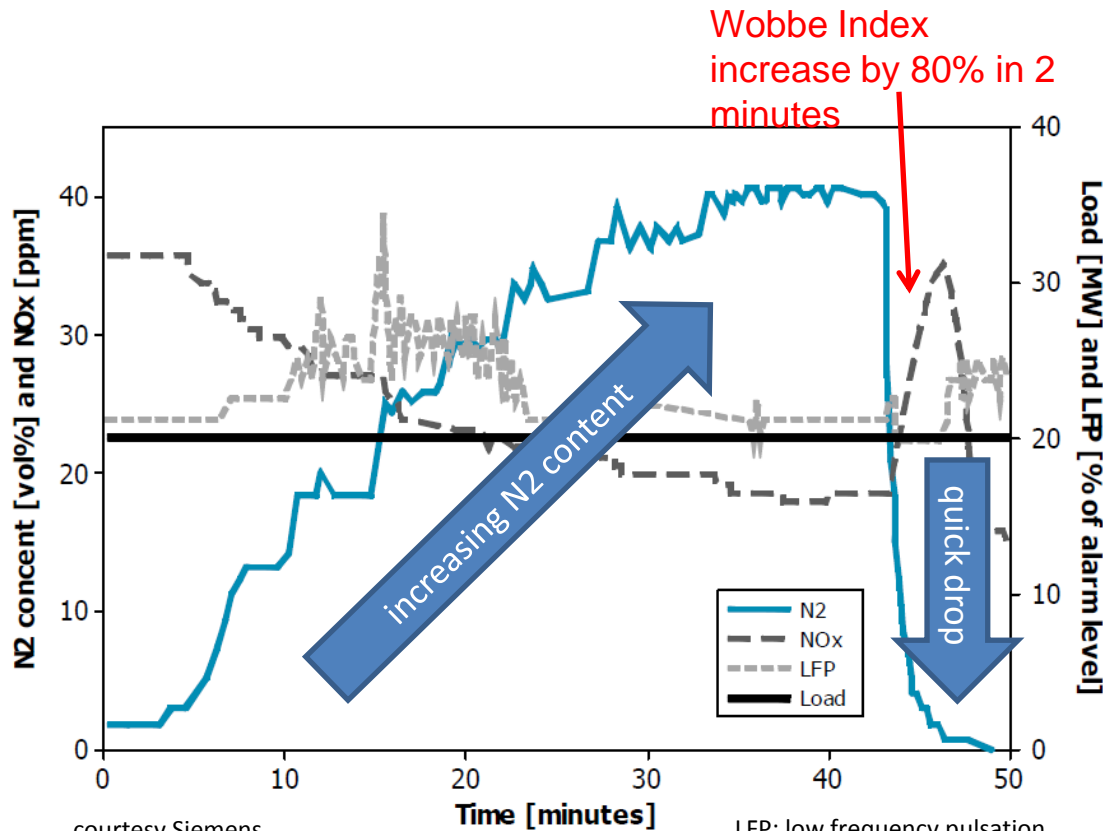


courtesy Siemens

Annular combustor design

- premixed air and fuel as main gas
- pilot flame burns around main flame for stabilization
- 18 3rd generation nozzles (burners)

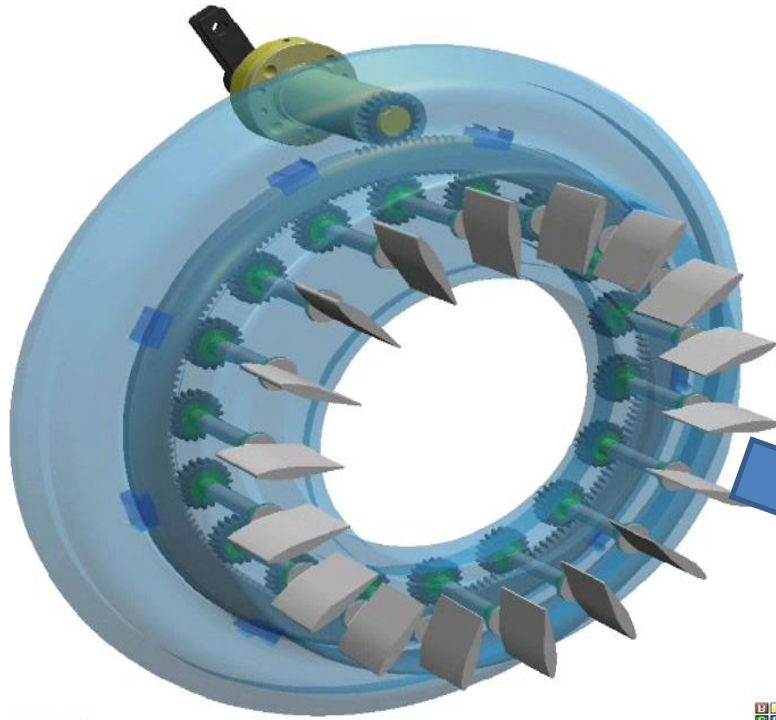




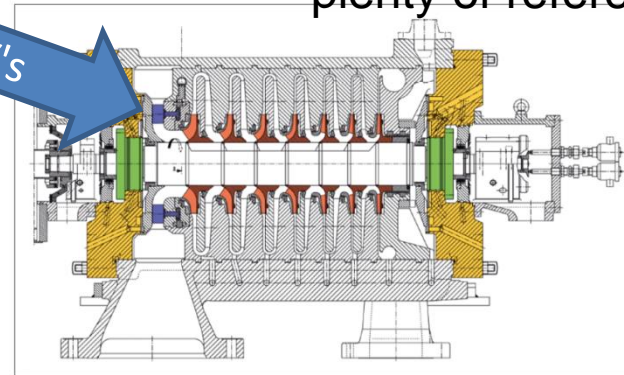
courtesy Siemens

Operational flexibility

- DLE system can operate on fuel gas with high inert gas
- stable combustion without pulsations up to 40 vol% N₂
- emission performance independent of N₂ content

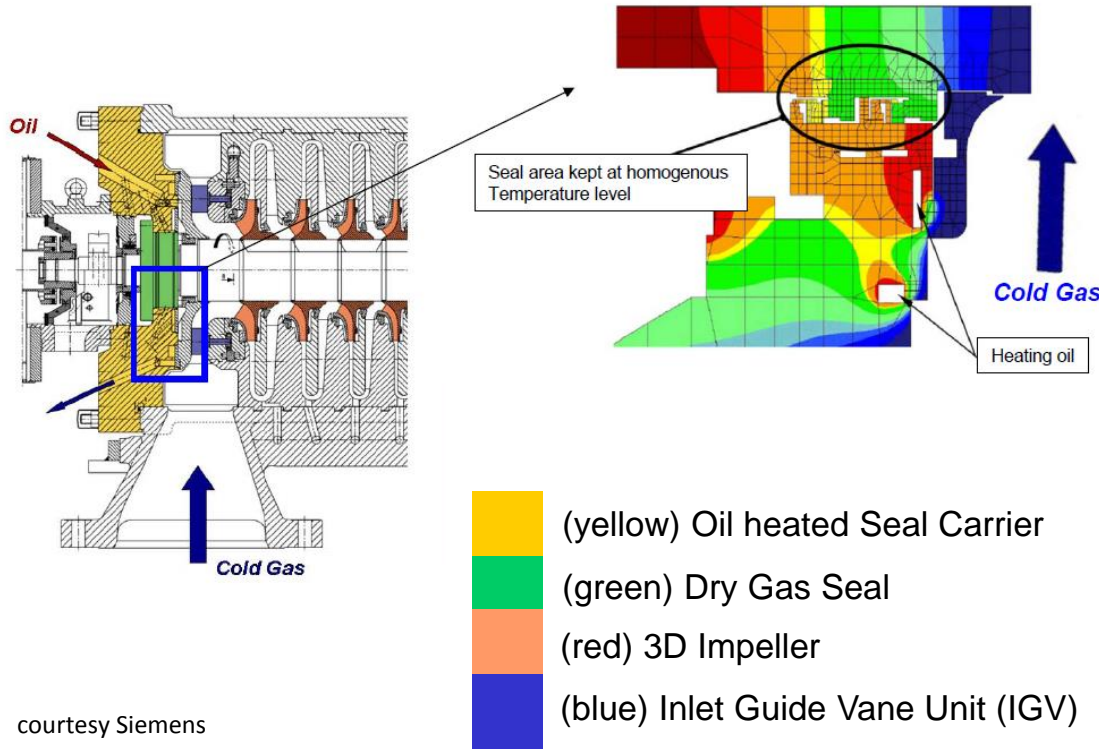


IGV's



Adjustable inlet guide vanes

- direct online start-up possible
- compact design
- large turn-down
- low maintenance
- plenty of references



Heated dry gas seal carrier

- avoids thermal shocks (e.g. during start-up)
- protects from low and high temperatures and from rapid temperature fluctuations
- avoids condensate build-up

- **World-scale BOG reliquefaction** has become reality
- **Linde Engineering** has successfully developed a new product for the LNG industry
- **Siemens** contributed with innovative compressor and gas turbine designs, which are proven in service and are highly respected worldwide
- The first plant, which is based on this novel concept, is under execution for **Malaysia LNG** in **Bintulu** and is scheduled for start-up in mid 2015

Marlin Project in Bintulu/Malaysia

World Scale Boil-off
Gas Reliquefaction

THE LINDE GROUP

Linde

Thank you for your attention.

