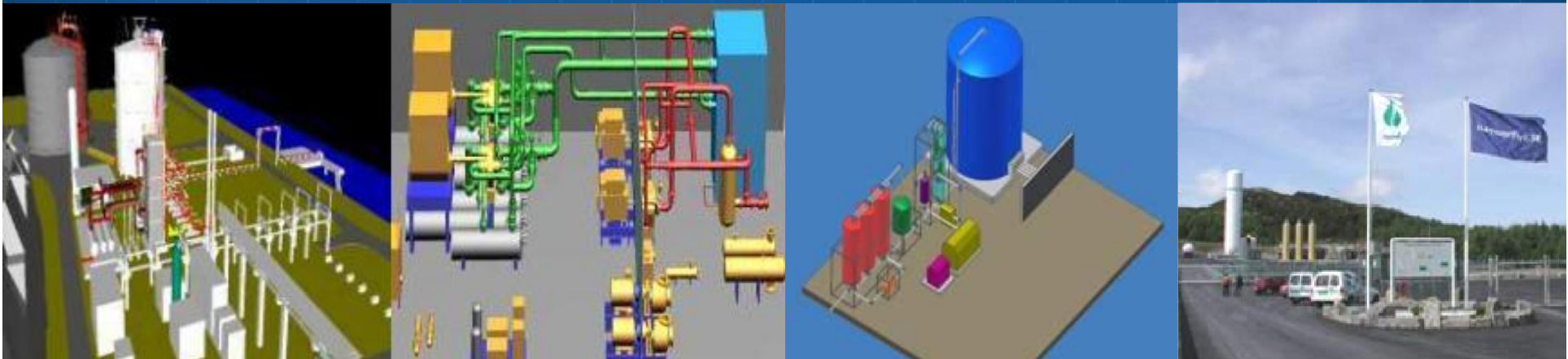


FUEL GAS HANDLING SYSTEM AND BOG RELIQUEFACTION FOR LNG CARRIER

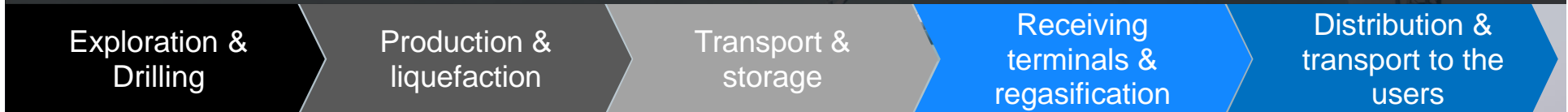
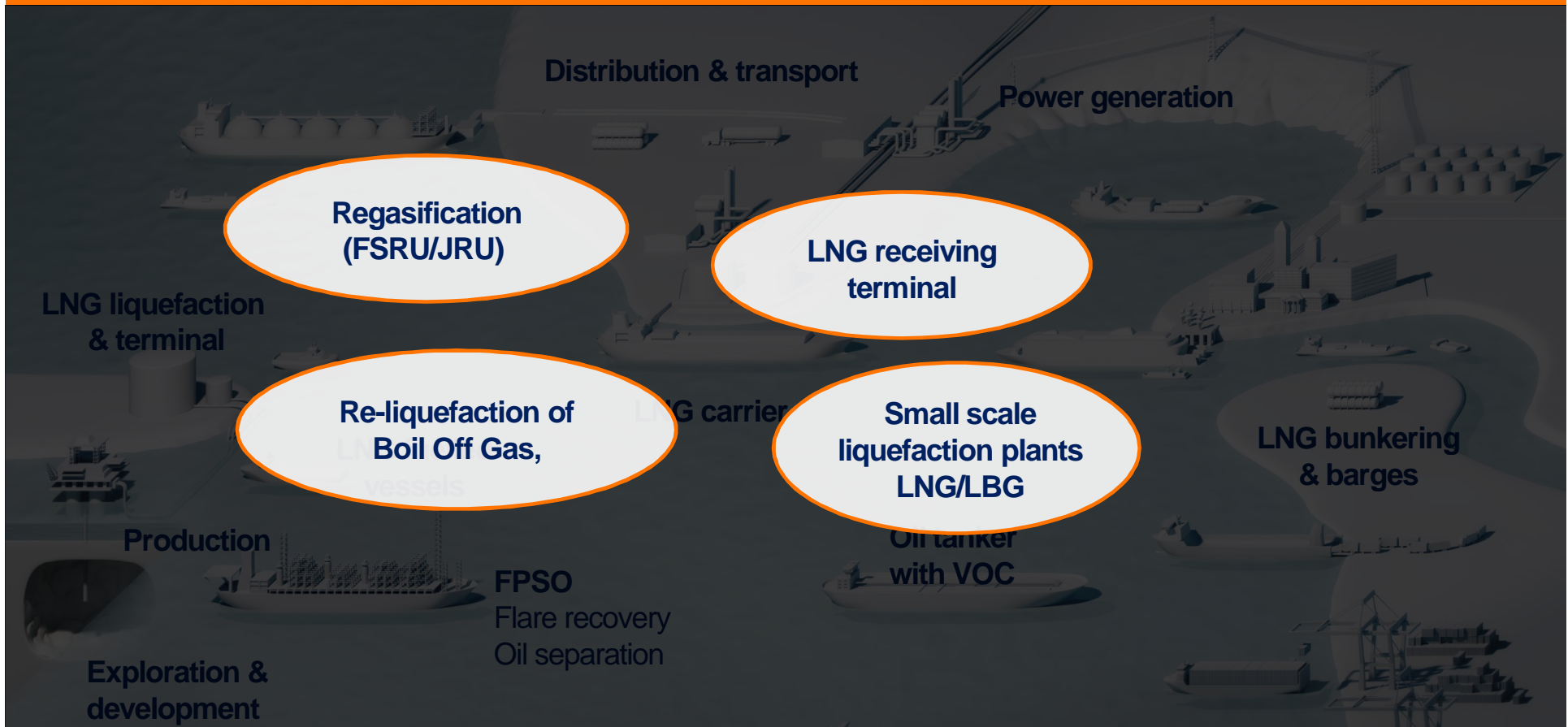
EIRIK MELAAEN
WÄRTSILÄ OIL & GAS SYSTEMS AS

Agenda:

- BOG Reliquefaction plant
- Low Pressure Gas to Engine(e.g. DFDE, 2-Stroke DFE) and BOG Reliquefaction System
- High Pressure Gas to Engine(Gas Diesel Engine) and BOG Reliquefaction System
- Future concepts



Our Expertise in the Gas Value Chain



- LNG fuel gas systems for OSVs
- Gensets

- On- & Offshore small scale liquefaction
- Antiflaring/VOC
- Oil separation
- Gas FPSO

- LNG fuel gas systems
- LPG, LEG & LNG cargo handling

- Jetty & Floating regasification
- Bunkering & barges
- Receiving terminals

- Gas/LNG distribution/logistics
- Feed gas to Power plants

LNG Technology Development



Wärtsilä (Hamworthy) LNG process history



Snurrevarden LNG Plant
(22,000 tpy)

- First free-standing small scale LNG plant in Northern Europe delivered March 2003.
- Hamworthy EPCIC contract with GASNOR.
- Technology feasibility and robustness thoroughly and successfully demonstrated.



35 LNG BOG
Reliquefaction systems



Al Gattara (Hyundai) BOG Reliquefaction
System (58,000 tpy)



Kollsnes II LNG

- 2 x capacity of existing Linde plant (Kollsnes I).
- Hamworthy EPCIC contract with GASNOR.
- Full production August 2007.



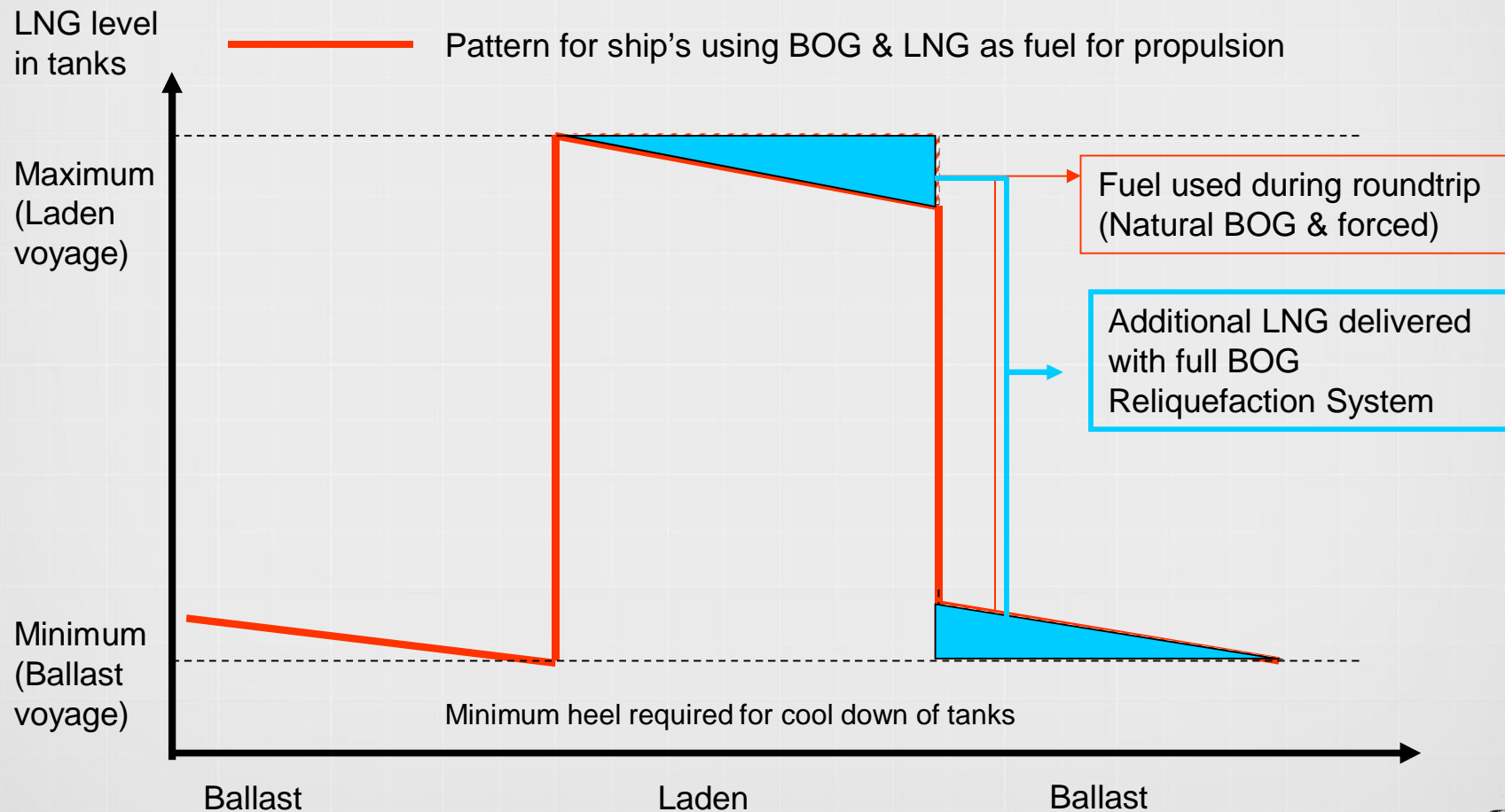
Kollsnes II (Gasnor) LNG Plant
(84,000 tpy)

BOG RELIQUEFACTION PLANT

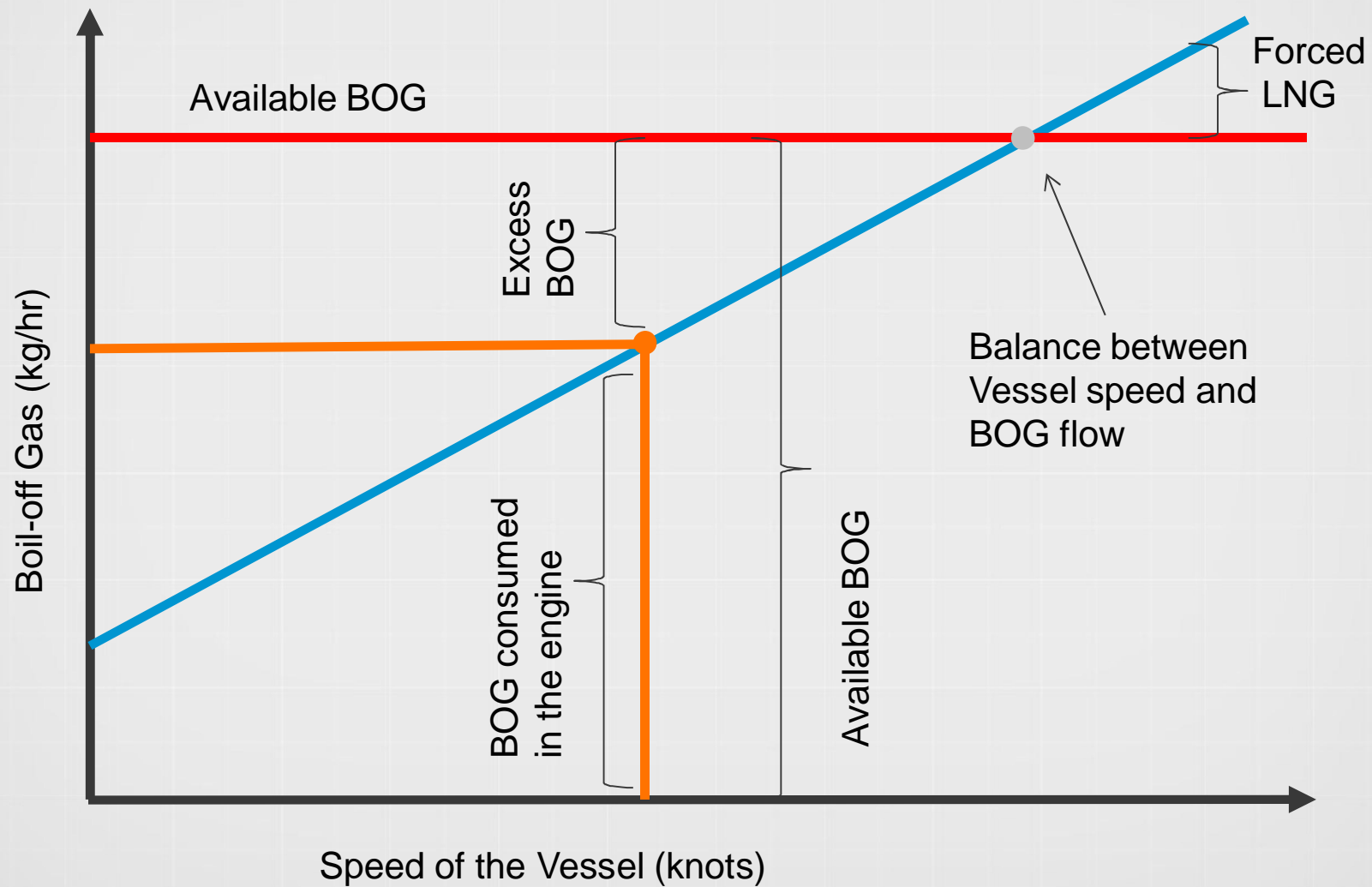
BOG to Engines or Returned to Tank

Different solutions available for LNG carrier propulsion:

1. Use BOG & LNG as fuel e.g steam turbines, dual-fuel diesel electric, dual-fuel engines
2. BOG reliquefaction, *liquefy and sell excessive BOG or all LNG loaded onboard*



Boil-off gas from cargo tanks vs. Fuel gas required by the engine



BOG Reliquefaction System (LNGRS – Mark III) No feeding of gas to engines (QFLEX vessels)



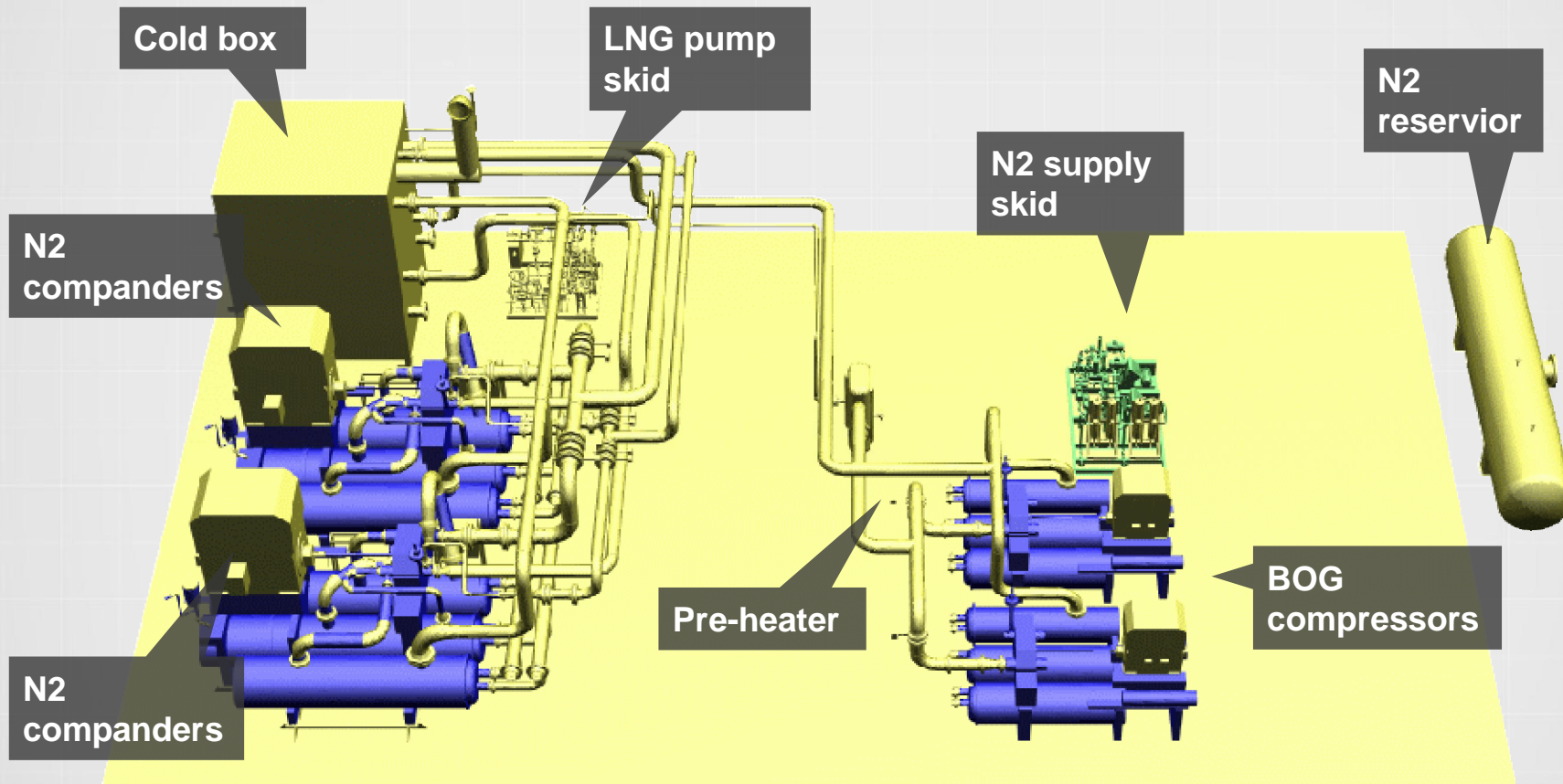
Cargo tank



Expander



Mark III layout/QG

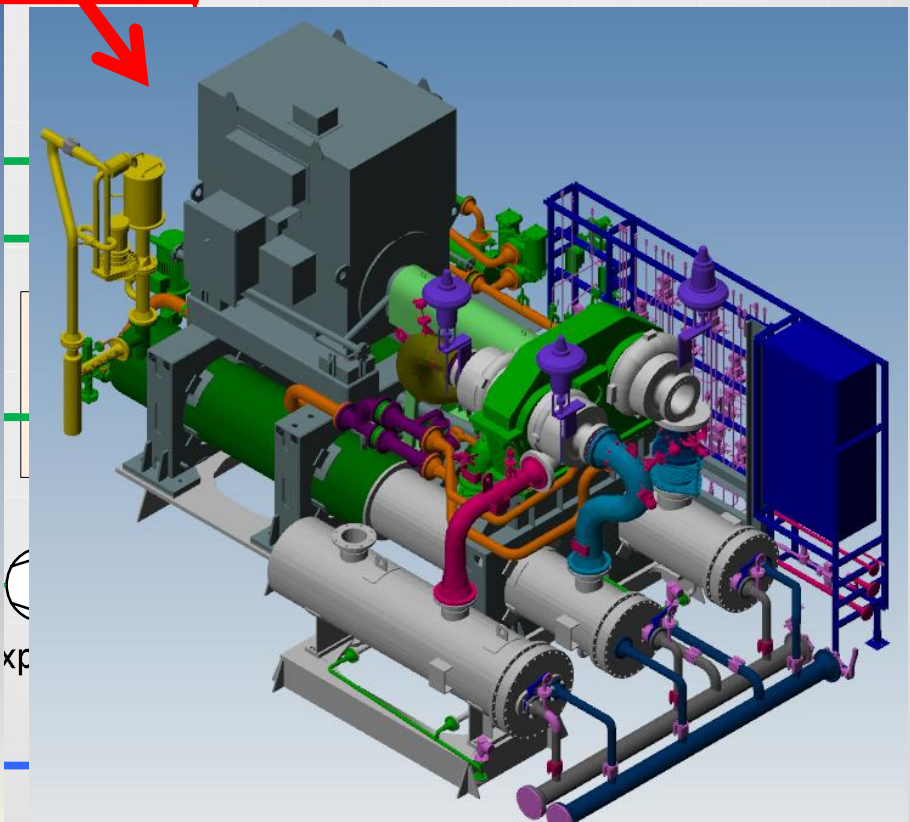
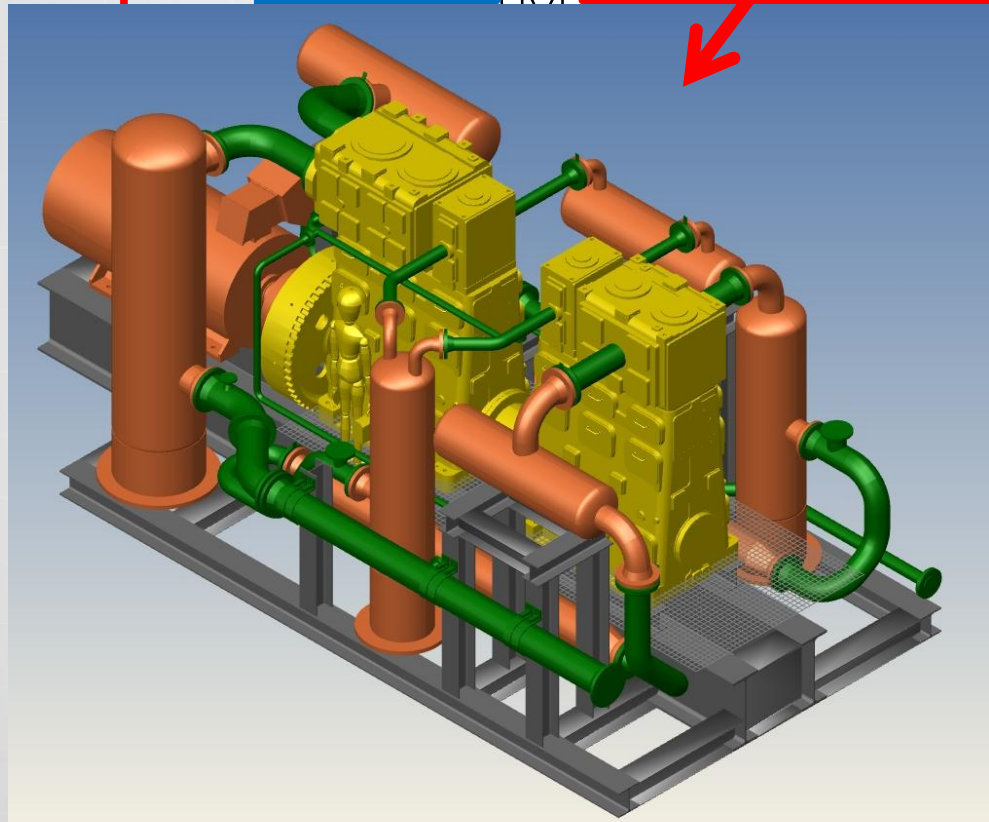
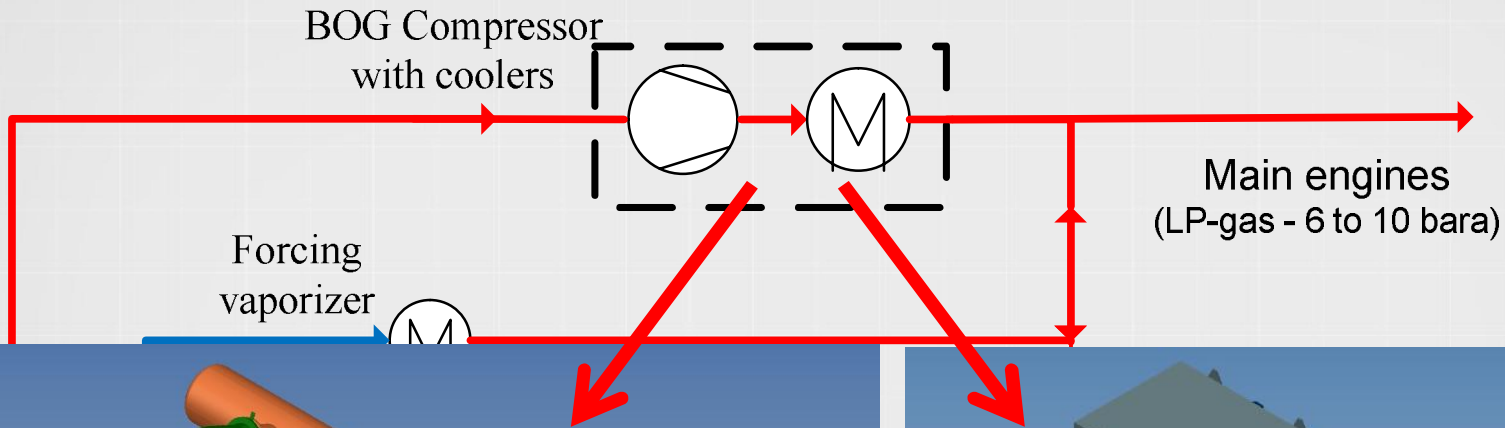


Typical dimensions: **30 x 22,5 x 7 m (L x W x H)**
Equipment weights: **240 ton**

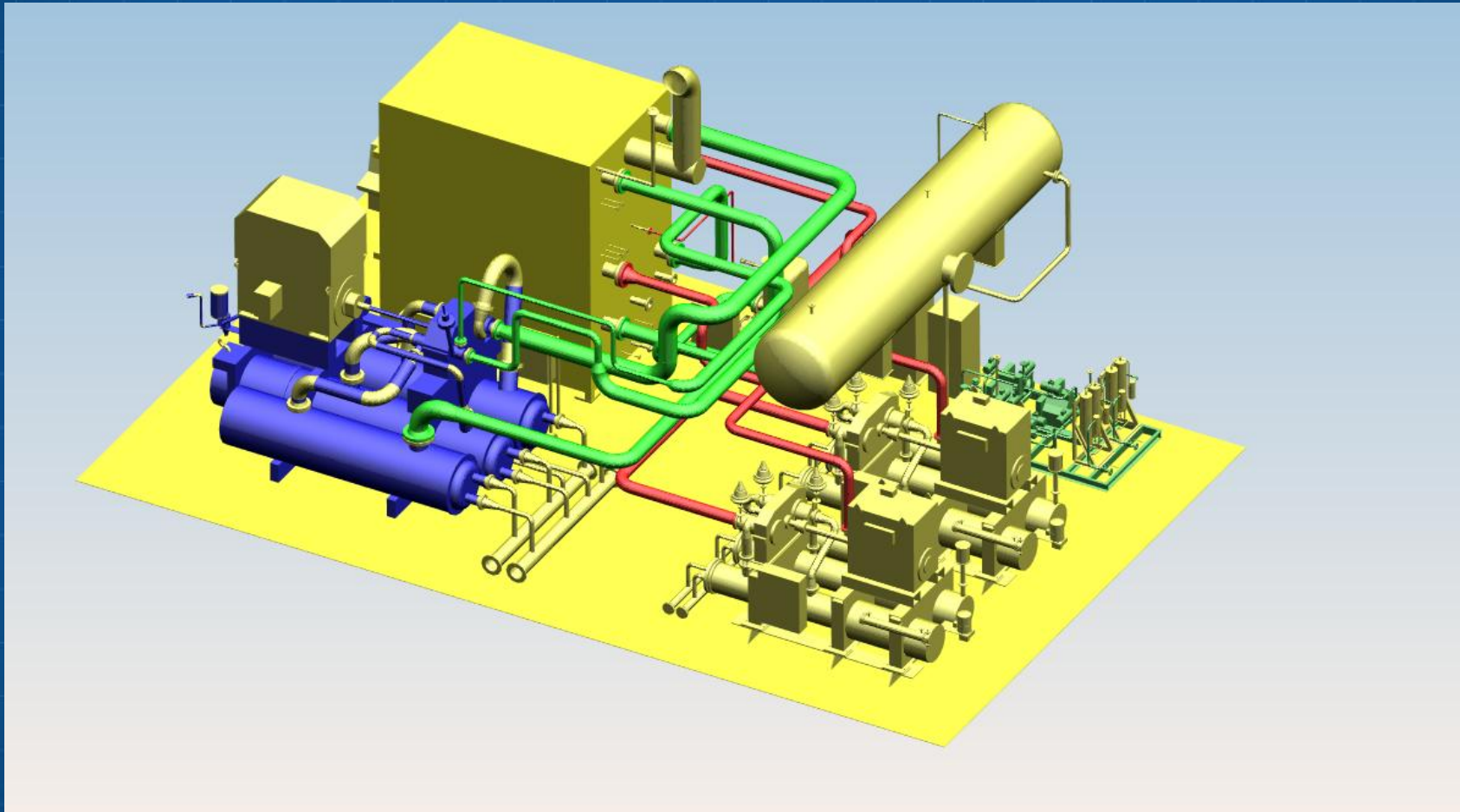
ENGINES REQUIRING LOW PRESSURE GAS (DFDE, 2-STROKE DFE) AND BOG RELIQUEFACTION PLANT

BOG Reliquefaction System (LNGRS) Low-Pressure Fuel Gas Supply System (LP FSSS)

LP-compressor



Dual-fuel propulsion system

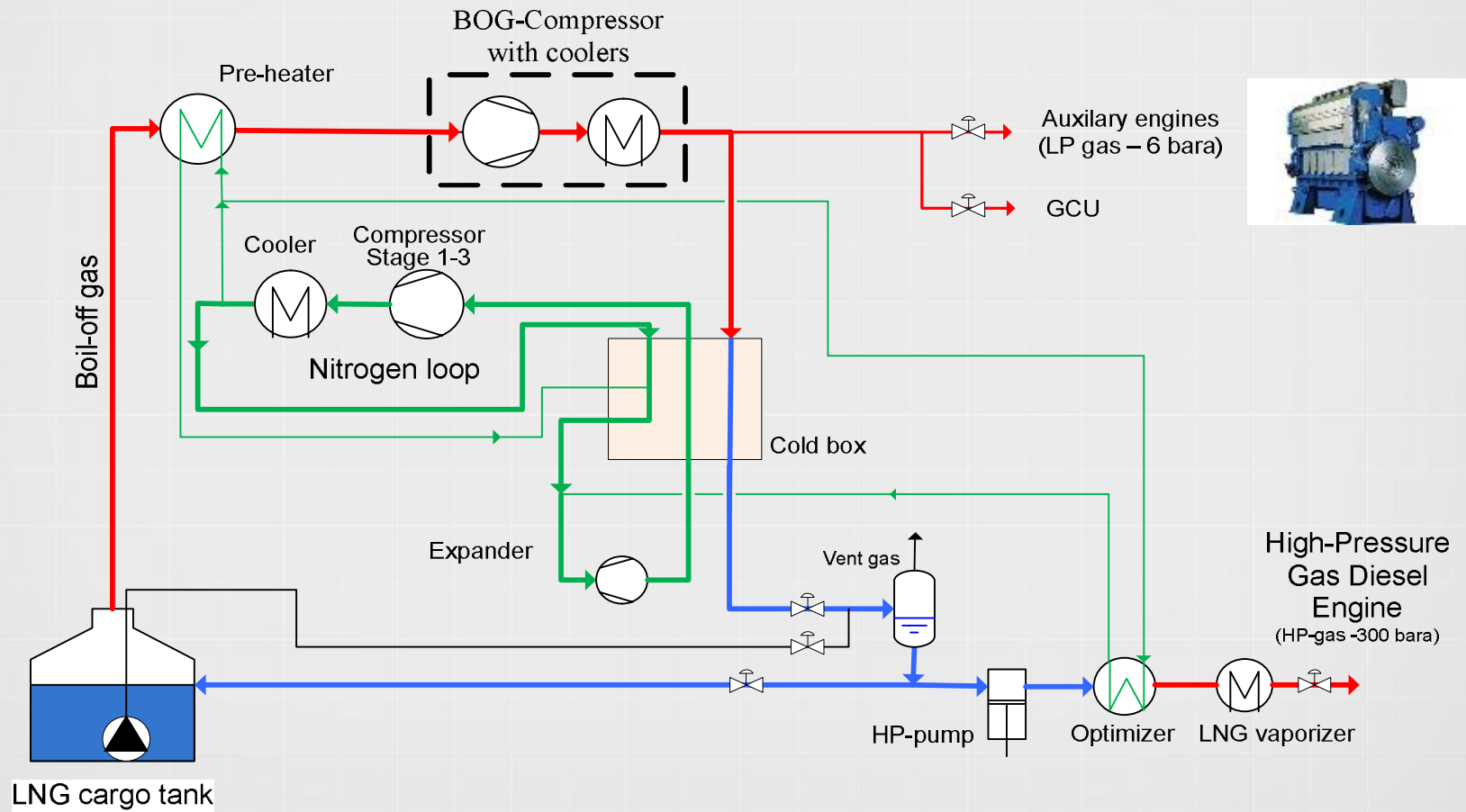


ENGINES REQUIRING HIGH PRESSURE GAS (Gas Diesel Engine) AND BOG RELIQUEFACTION SYSTEM

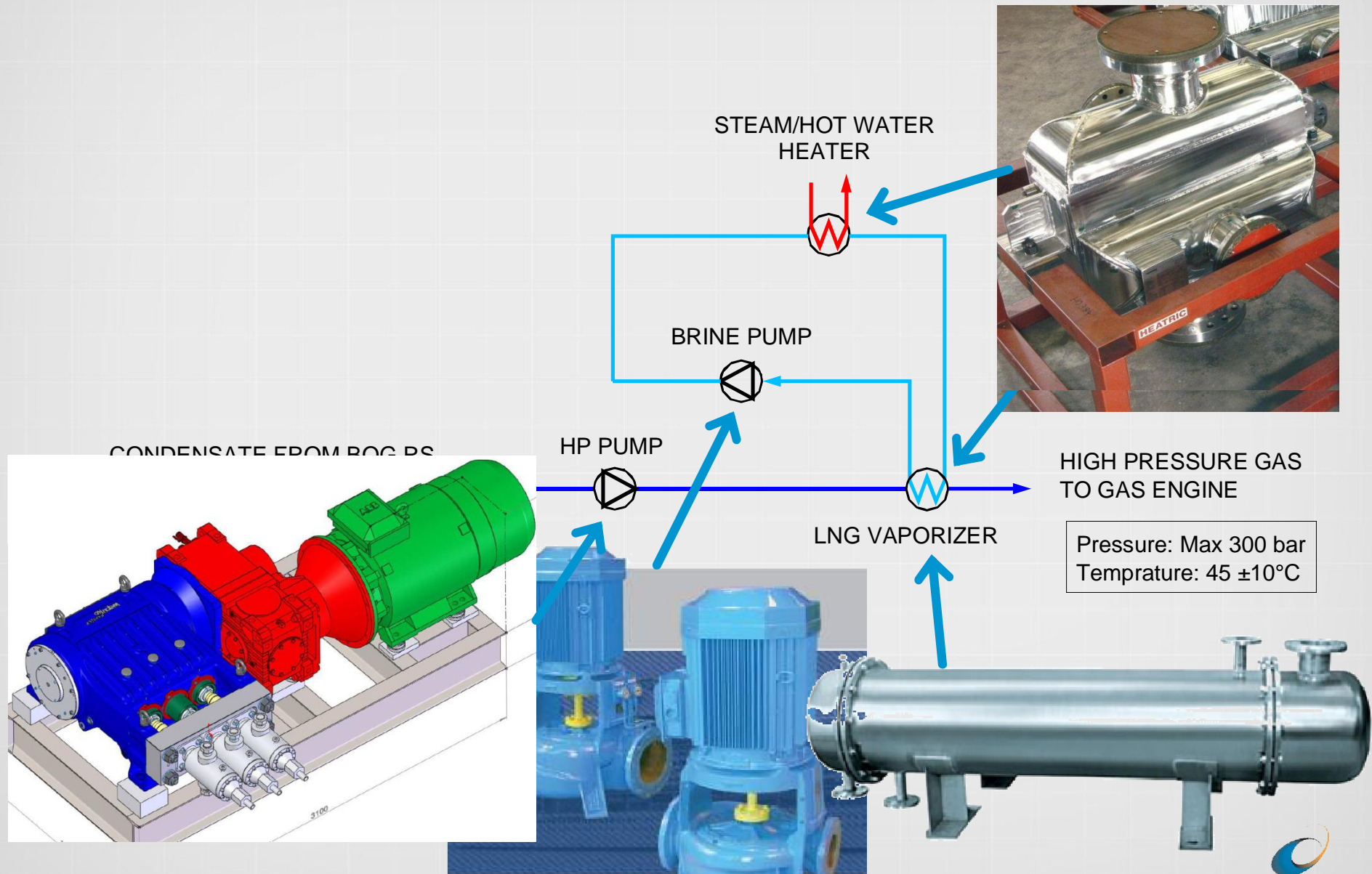
BOG Reliquefaction System (LNGRS) High-Pressure Fuel Gas Supply System (HP FGSS)



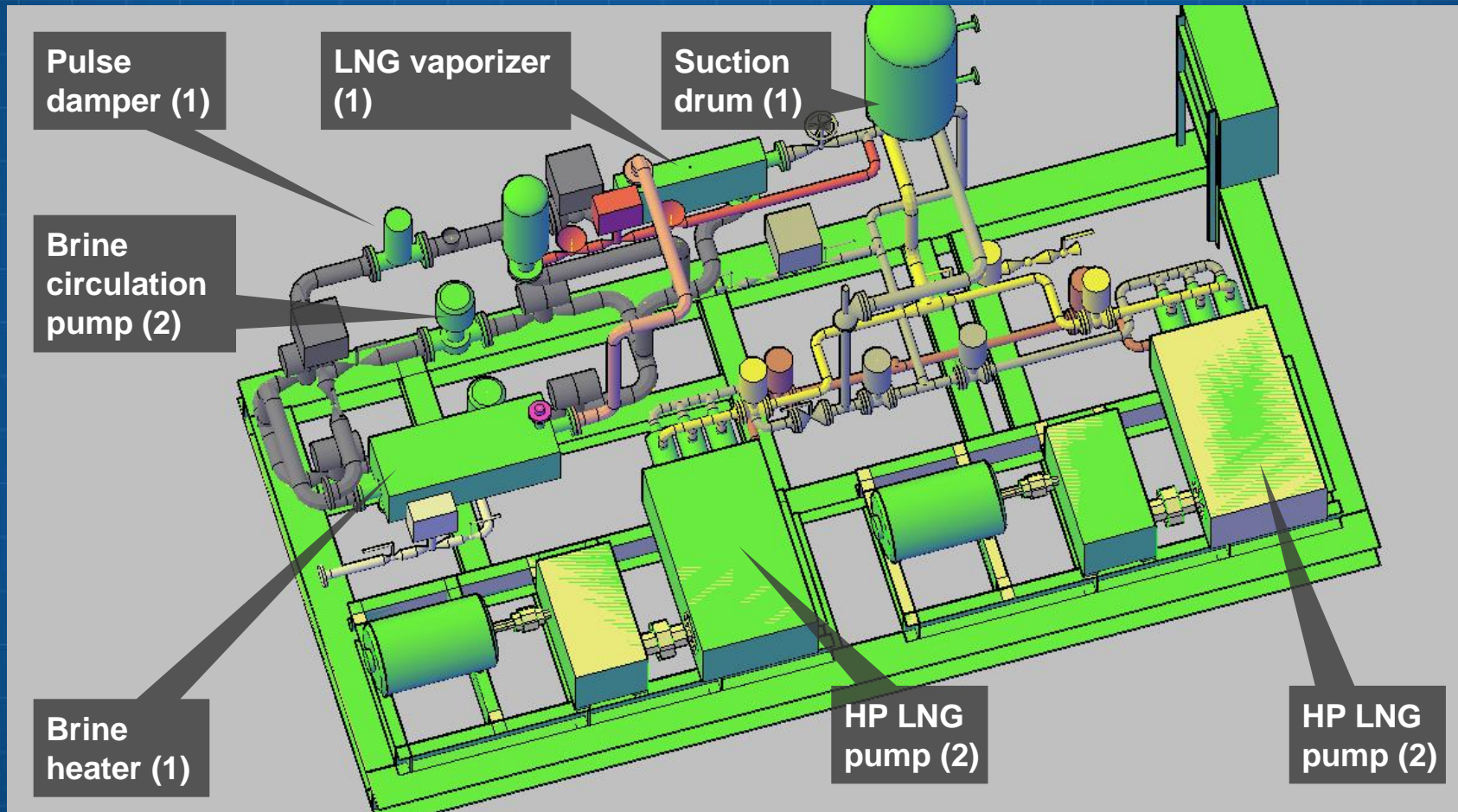
HP-pump and Optimizer



PFD – Vaporization System



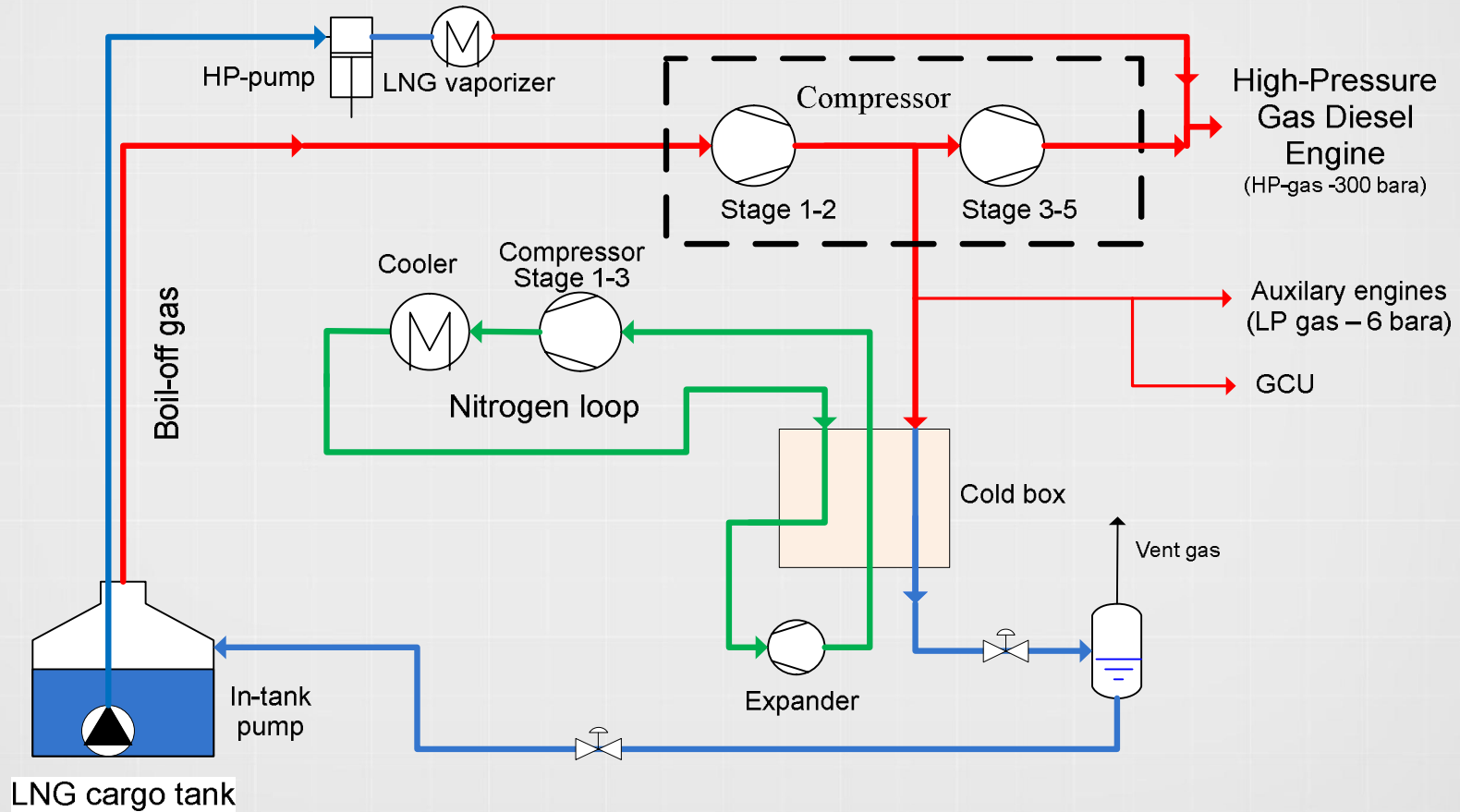
Updated Arrangement - Gas Supply System



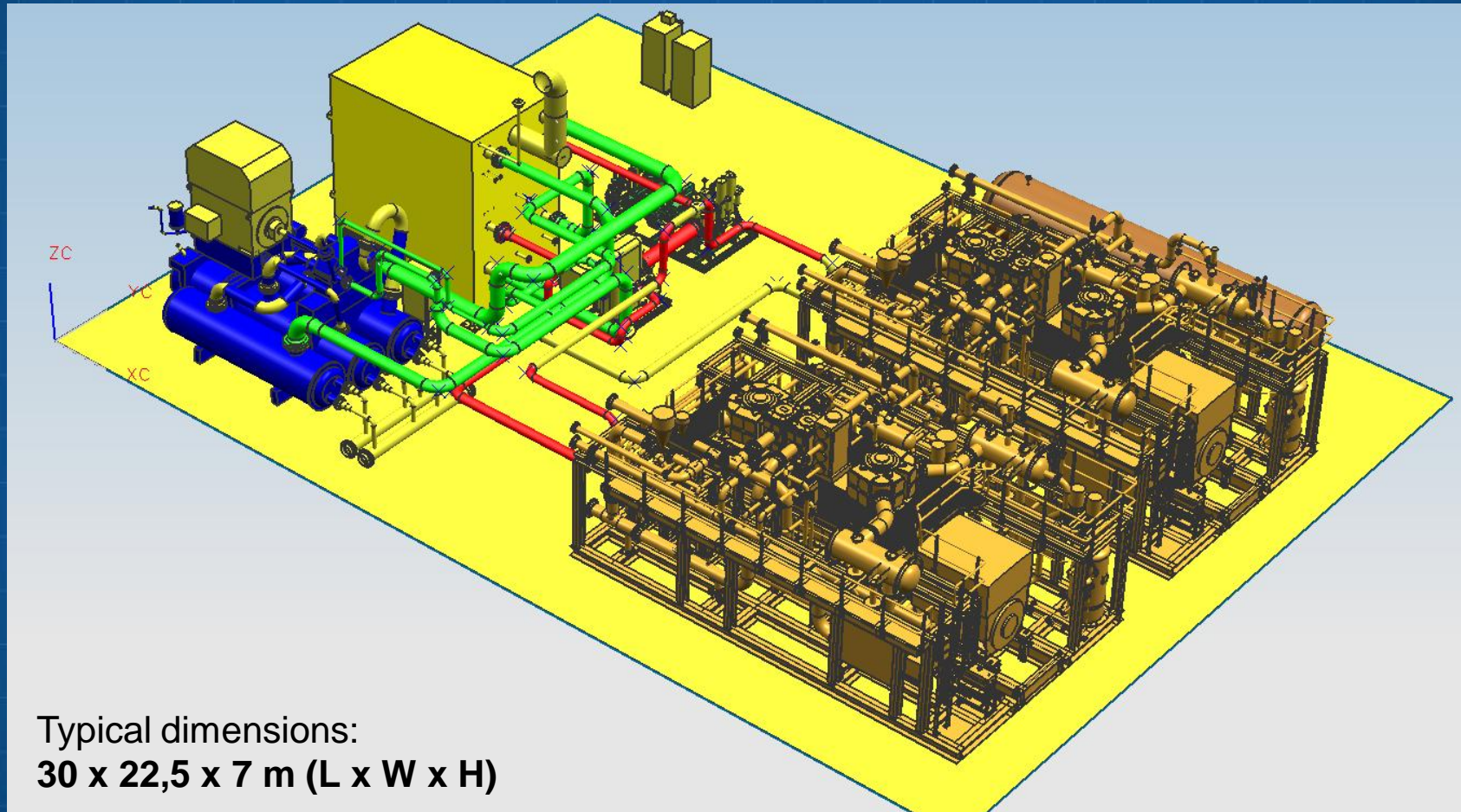
Typical dimensions: **7 x 3 x 2 m (L x W x H)**
Equipment weights: **Ca 25 ton**

BOG Reliquefaction System (LNGRS) High-Pressure Fuel Gas Supply System (HP FGSS)

HP-compressor and HP-pump
LNGRS for excessive BOG?



Layout – Burckhardt compressors + BOG Reliq plant



Typical dimensions:
30 x 22,5 x 7 m (L x W x H)

FUTURE CONCEPTS NEW MR

TWO REFERENCES:

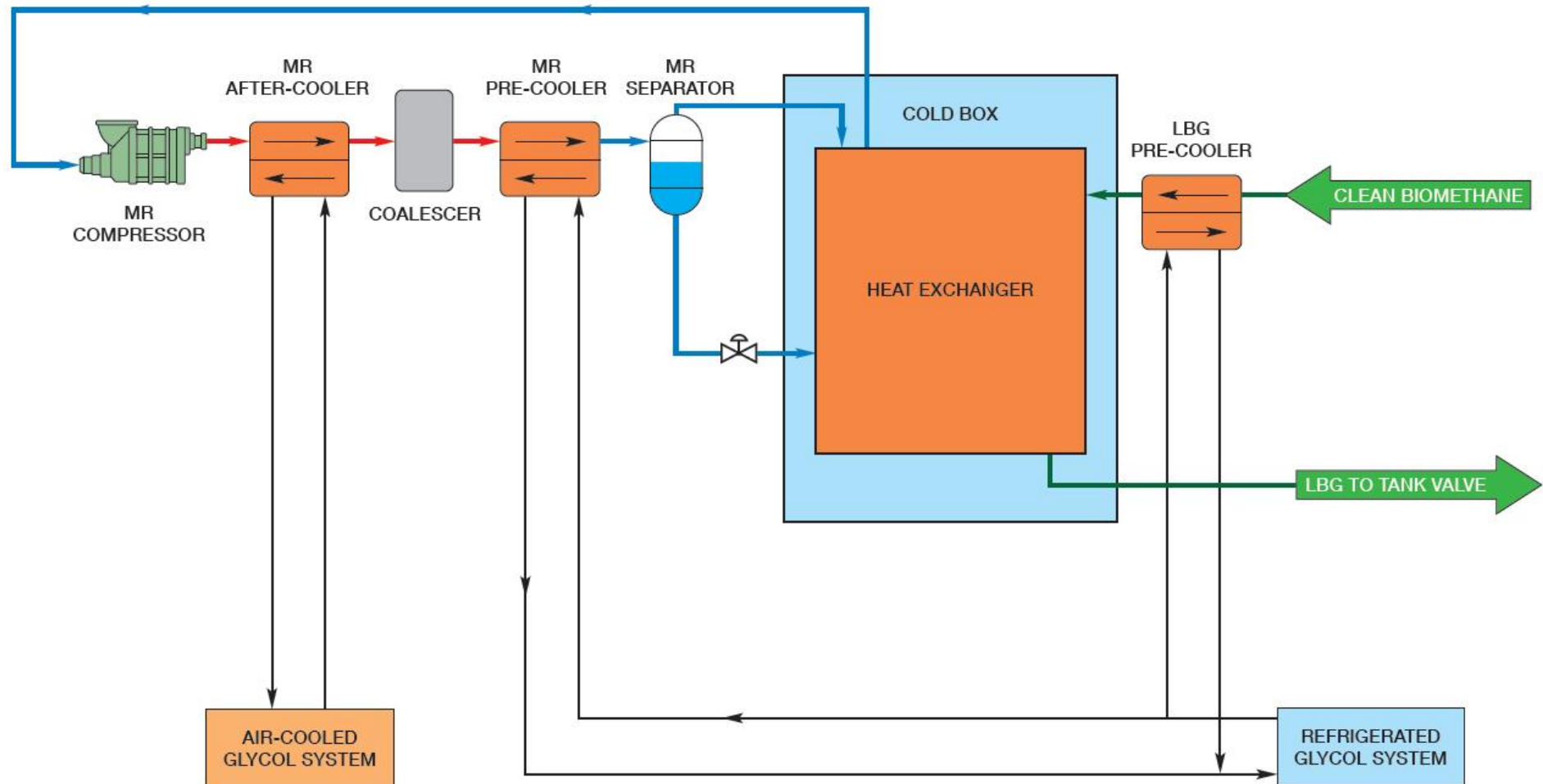
NEW MR DEMONSTRATION PLANT – 2,5 TON/DAY

NEWMR EGE PLANT – 11 TON/DAY

Demonstration plant – 2,5 ton/hr



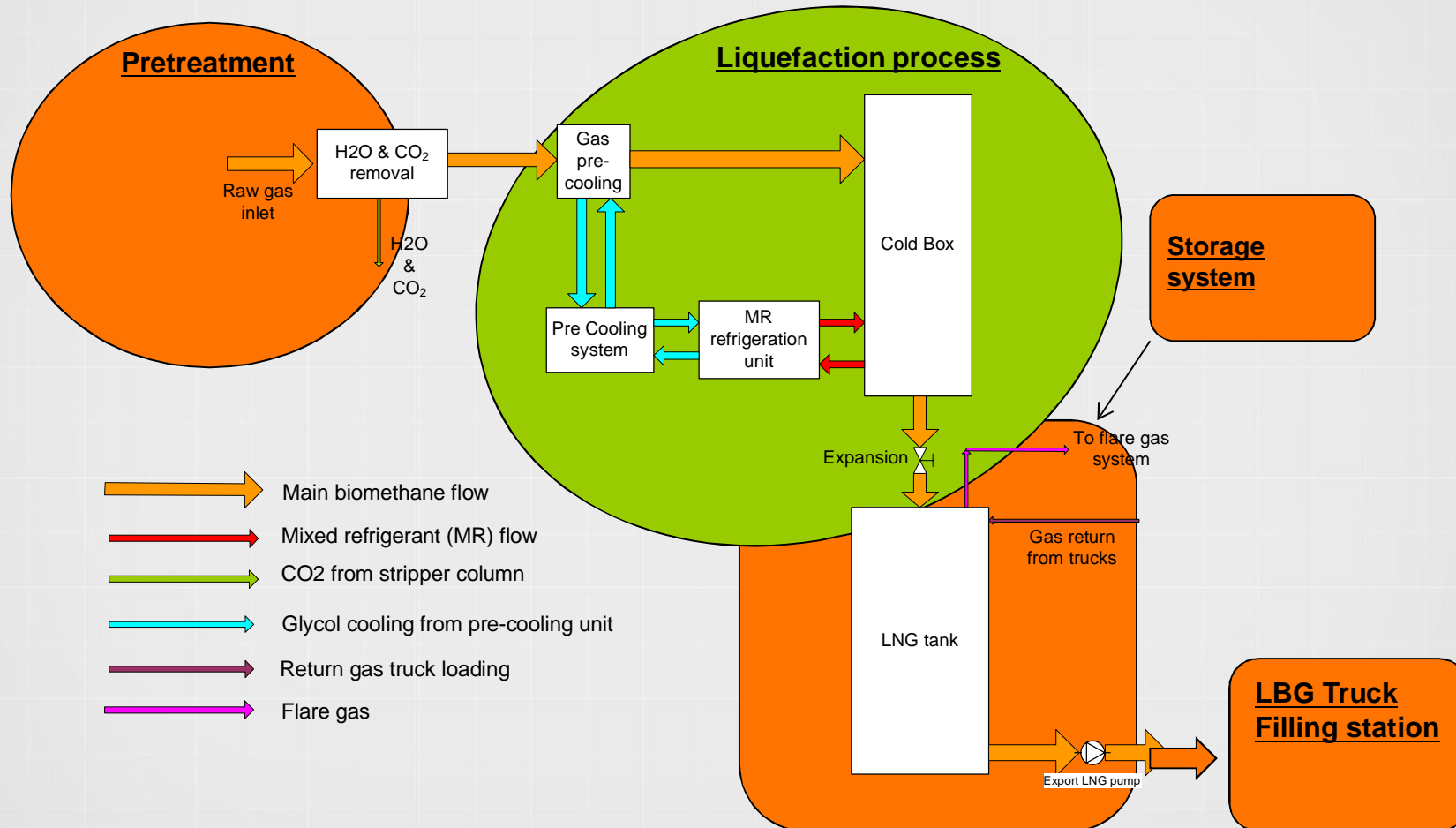
New MR Process Overview



Pictures EGE - Project

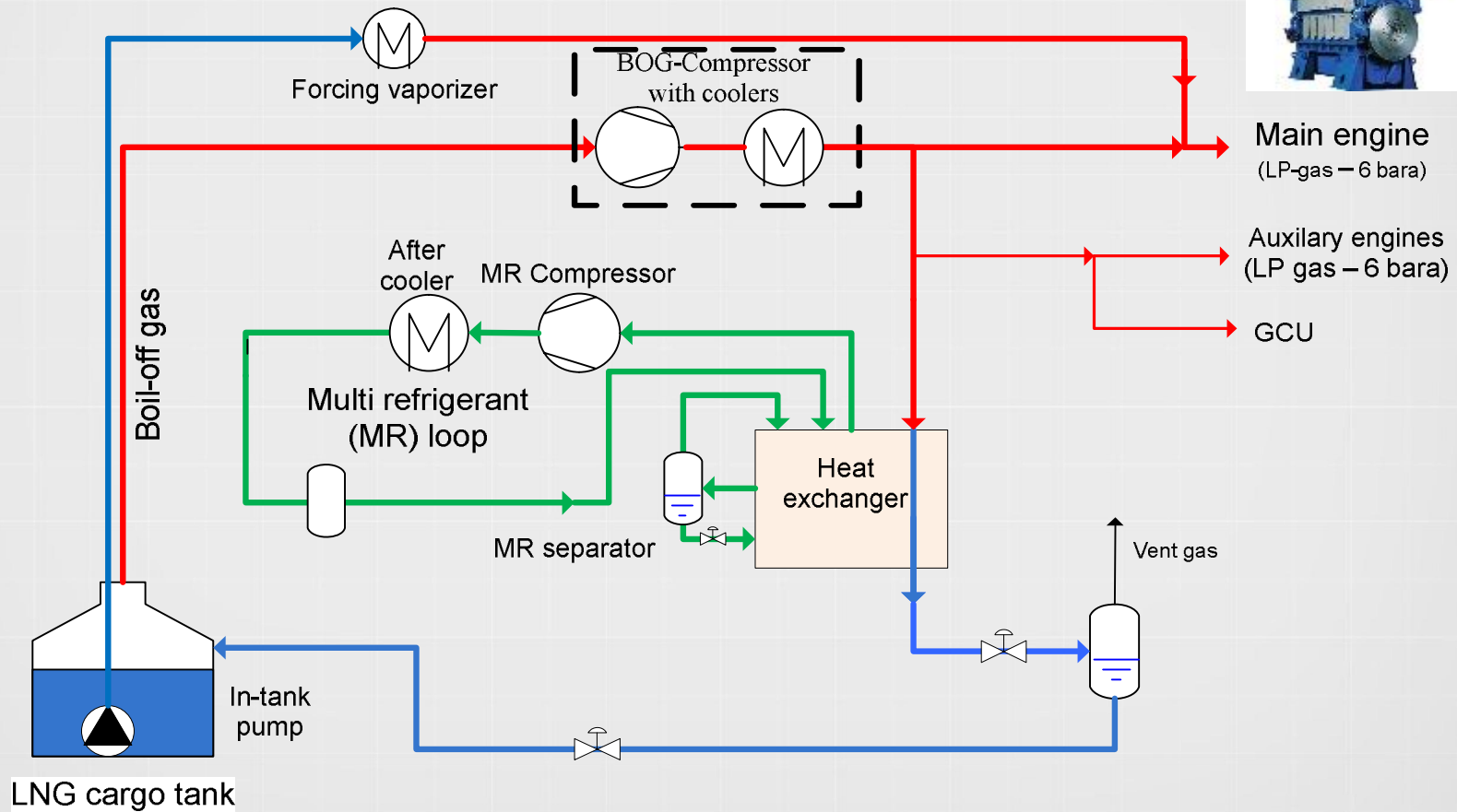


Flow Sheet of Liquefaction Plant



BOG Reliquefaction System (LNGRS)

NewMR LP-Pressure Fuel Gas Supply System (LP FGSS)
Compressor and Forcing Vaporizer
LNGRS for excessive BOG



Summary – Wärtsilä NewMR technology

BOG reliquefaction system on LNG vessels in the future → NewMR

Why?

- Demonstration plant proven to be successful
 - Robust
 - Low OPEX
 - Load variations
- Robust main rotating machinery with high efficiency
- Designed for unmanned operation
- Shorter delivery time
- Simple energy supply,
- only electric power needed
- Easy and quick start up and shut down of all systems
- Standardisation of capacities: 1,5 ton/hr, 2,5 ton/hr etc.
- Supplied as modules
- Refrigerant process with phase changes which reduce the size of equipment and piping
- Simplified maintenance
- Reduced CAPEX compared to Nitrogen loop
- Two references



Thank you for your attention!

2STROKE
DEBUT OF DUAL-FUEL
WÄRTSILÄ ENGINE TRIESTE 12/11/2013

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