



G L O B A L F O R U M

On Flaring and Venting Reduction  
and Natural Gas Utilisation

# Energy efficient LNG technology for recovery of flare gas

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# Content

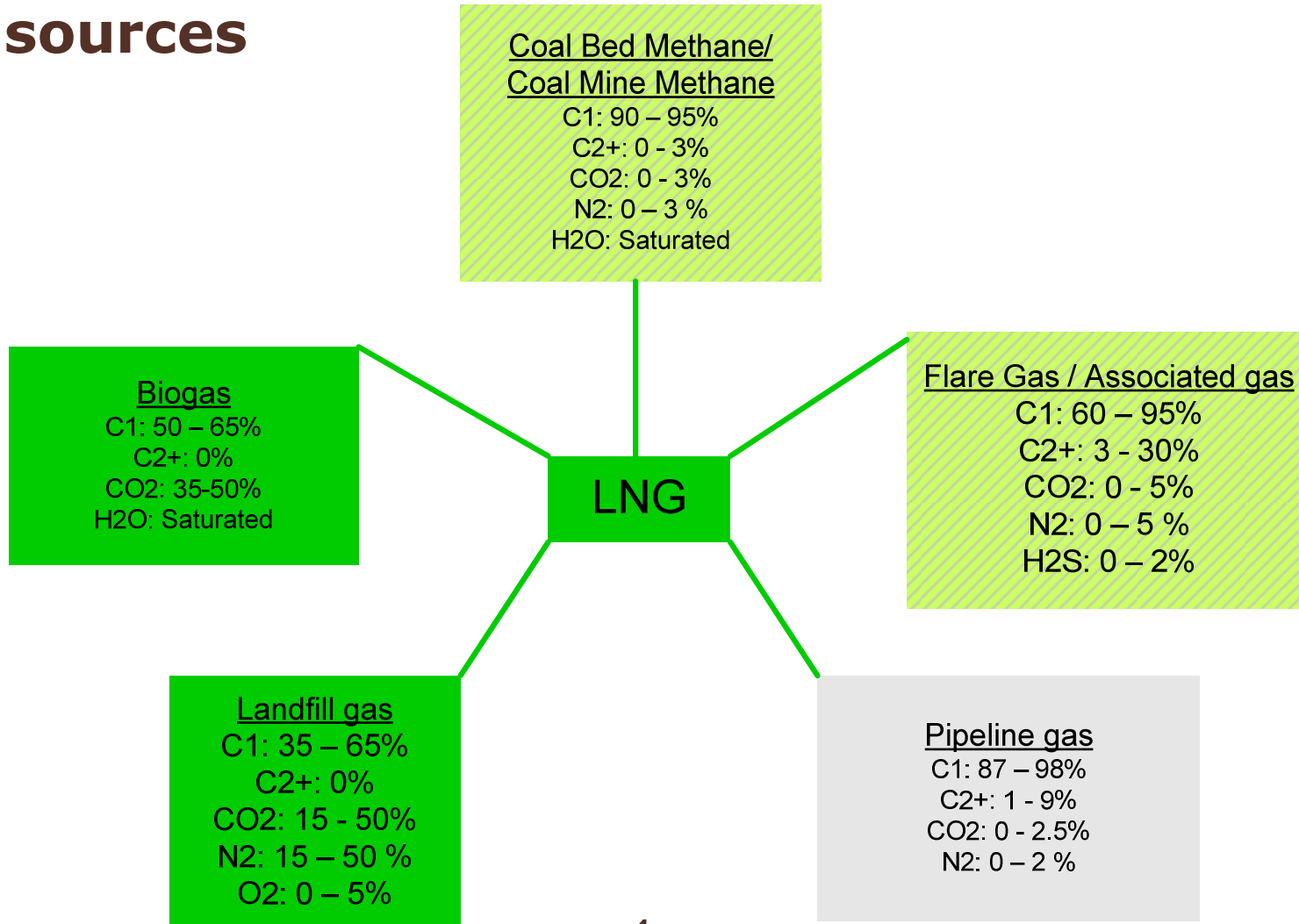
- Background
- The Pre-treatment Challenge
- Unique MiniLNG™ technology
- Efficient Small Scale Liquefaction technology
- Concluding remarks

# Background

- Significant amounts of natural gas is flared or vented in relation to oil production
- Reserves of "stranded" natural gas abandoned due to lack of profitability
- Considerable amounts of methane is produced as biological material is broken down
- Lack of infrastructure prevents natural gas recovery
- Liquefaction of natural gas to LNG is a viable and interesting alternative
  - Volume reduction of 600 times
  - Cost efficient shipment around the world
- LNG is a flexible product – can be transported to markets paying the highest price

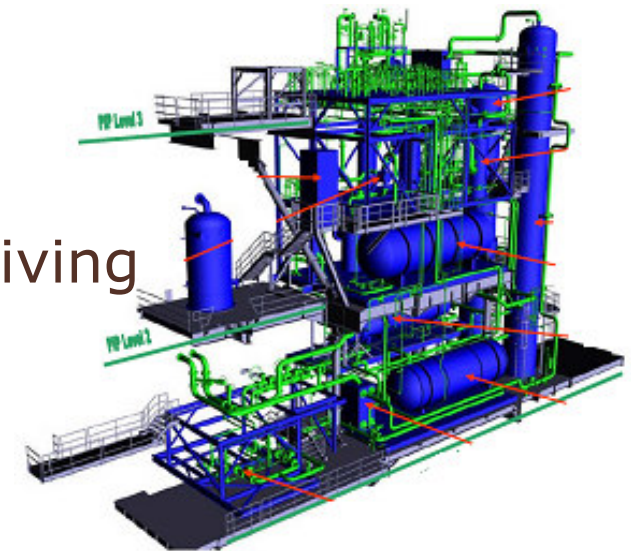
# The Pre-treatment Challenge

## Gas sources



# The Pretreatment Challenge

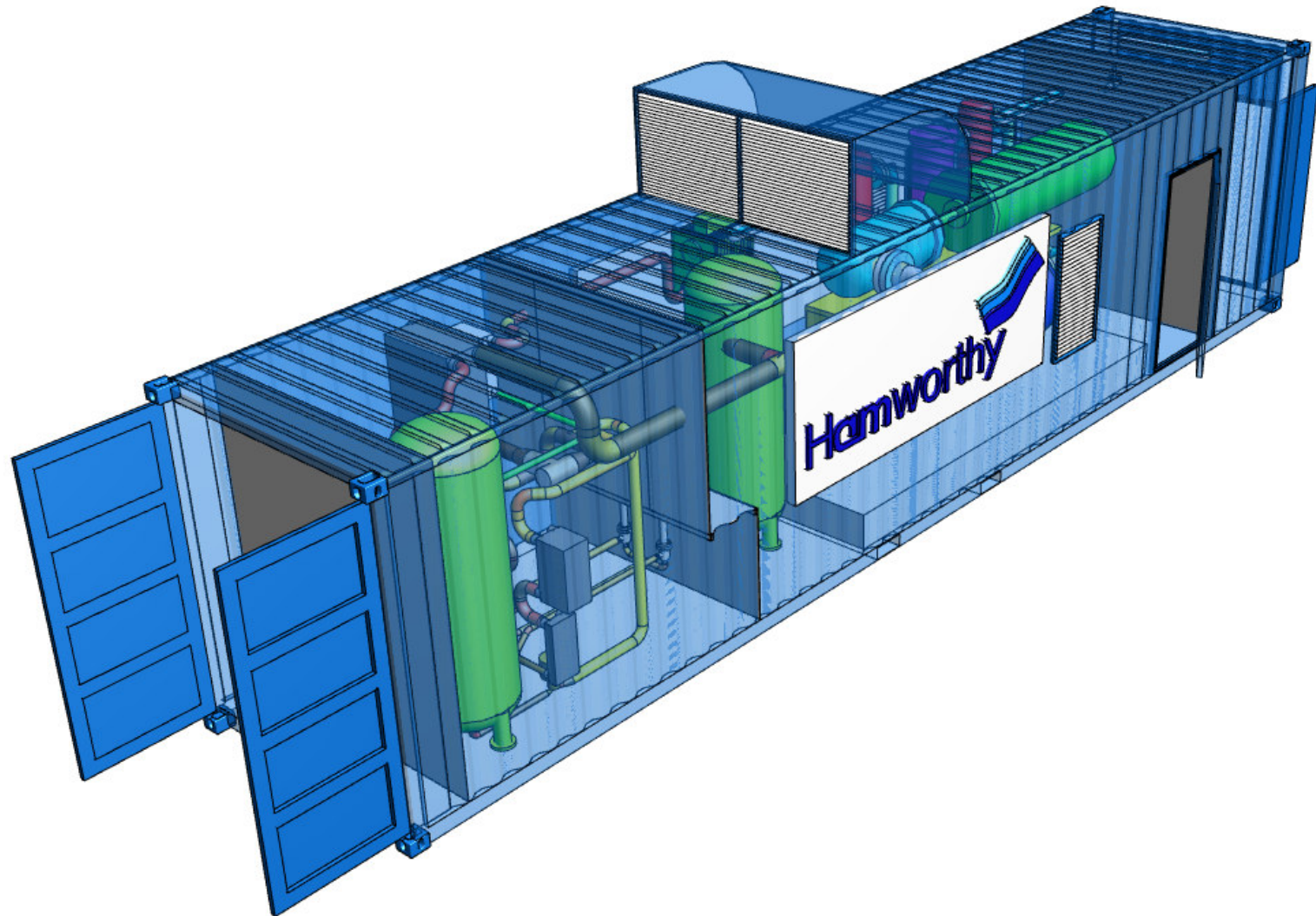
- Requirements to gas entering liquefier
  - CO<sub>2</sub> 50 ppm
  - H<sub>2</sub>O 1 ppm
  - H<sub>2</sub>S 4 ppm
- Pretreatment dependent on gas source:
  - Batch processes, e.g. active carbon
  - Amine systems (CO<sub>2</sub> and H<sub>2</sub>S)
  - Mol sieve (CO<sub>2</sub>, H<sub>2</sub>O, N<sub>2</sub>, O<sub>2</sub>,...)
  - CO<sub>2</sub> Wash (CO<sub>2</sub>, siloxanes, HFC's ...)
  - Membrane technology (CO<sub>2</sub> and N<sub>2</sub>)
- High H<sub>2</sub>S content => potentially cost driving
- Energy consumption
  - Dependent of level of contaminants
  - To a large extent covered by heat



# MiniLNG™

A unique mini-scale LNG technology

# MiniLNG™



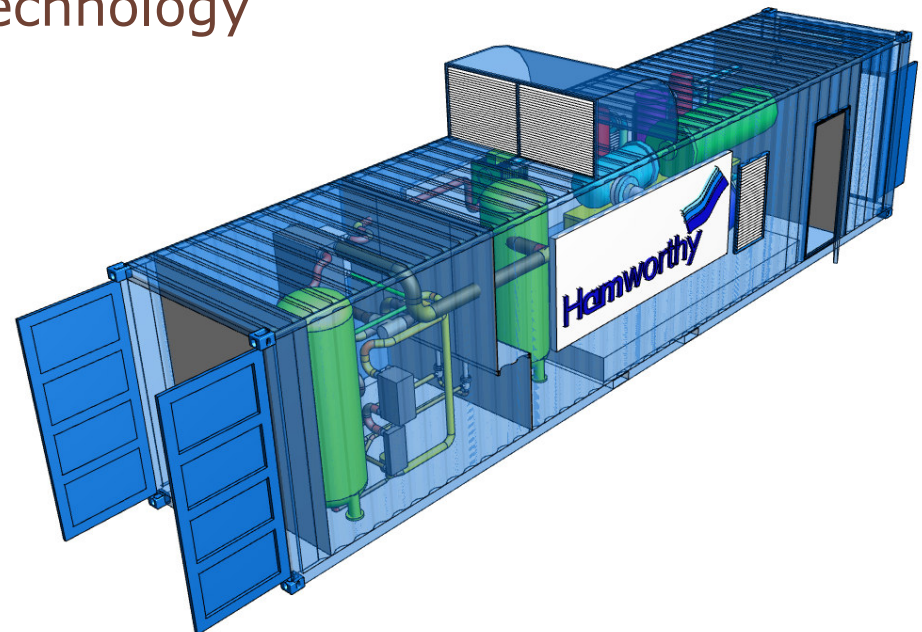
# MiniLNG™

## Characteristics

- MiniLNG™: Capacity up to 15 tons LNG / day
- Based on patented technology developed by SINTEF
- Hamworthy holds an exclusive license
- Fits to small gas sources: biogas, landfill, coal mine methane
- Based on mixed refrigerant technology

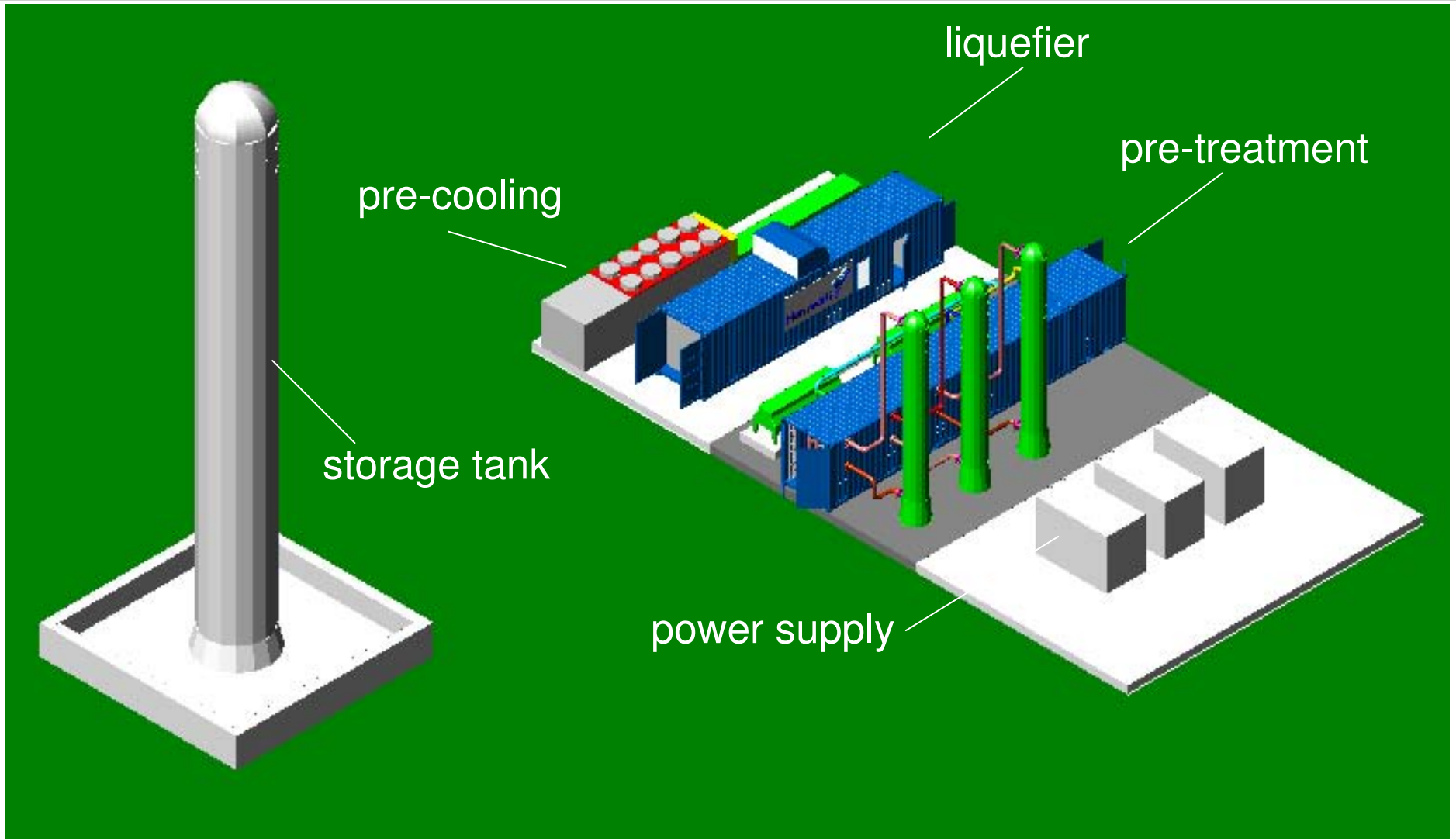
## Benefits:

- Use of standard components
  - Low price
  - Short delivery time
- Low energy consumption
  - 0.6 kWh/kg LNG



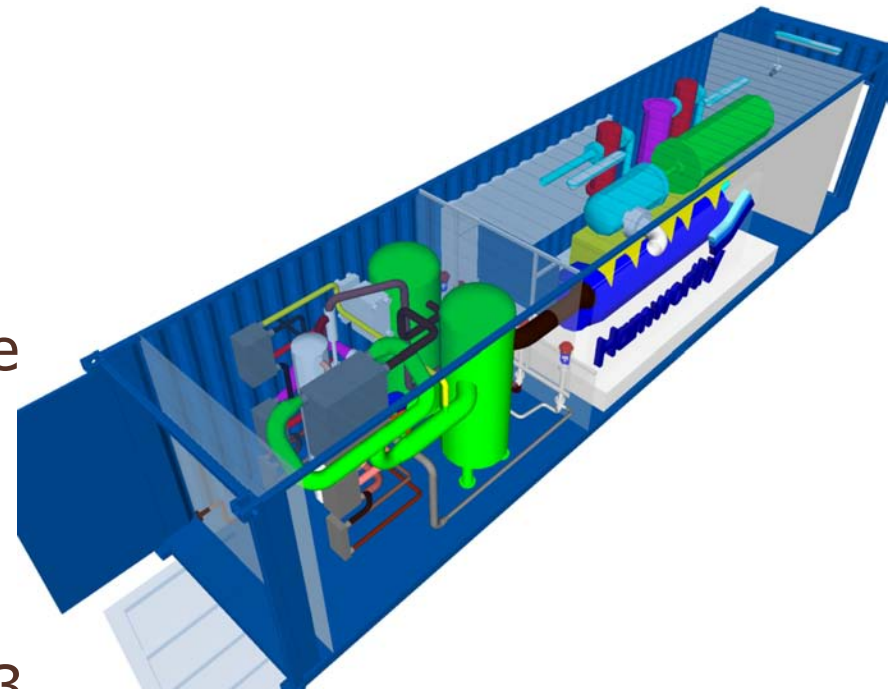


# MiniLNG™ – Pilot Plant



# MiniLNG™

- Standardization:
  - Capacities: 6 and 15 tons LNG / day
  - Containerization
  - Options for customer:
    - Storage tank
    - Type of pretreatment
    - Electric power supply
- Manufactured at assembly site
- Easy shipment
- Plug and play philosophy
- Relocation possible
- Prototype operated since 2003
- Full scale demonstration plant to be launched



# **Small and medium scale LNG**

Based on reversed Brayton technology

# Offshore installations

- Strong limitations on:
  - Volume
  - Weight
  - Footprint
- Restrictions to gas processing  
Typical products:
  - Commercial LNG
  - Heavy hydrocarbons
  - LPG or NGL
- Low specific energy consumption
  - Reduces CAPEX and OPEX
- Strong focus on safety
- Flexible to gas composition changes
- Power production required
- Mechanical drives



# Onshore installations

- Electric power
  - Can be available for smaller plants
  - Production necessary for larger plants
- Low or negligible building lot cost
  - Limited weight, footprint and volume restrictions
- Distance to sea might be a challenge
- Low specific energy consumption
  - Reduces CAPEX and OPEX

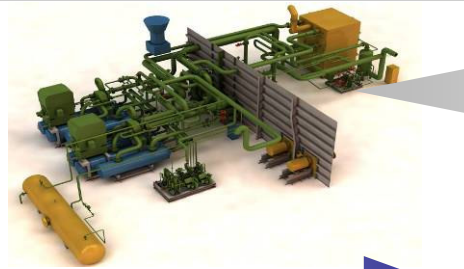


# Hamworthy Experience



Snurrevarden LNG Plant, Norway (22,000 TPA)

- 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 TPA)

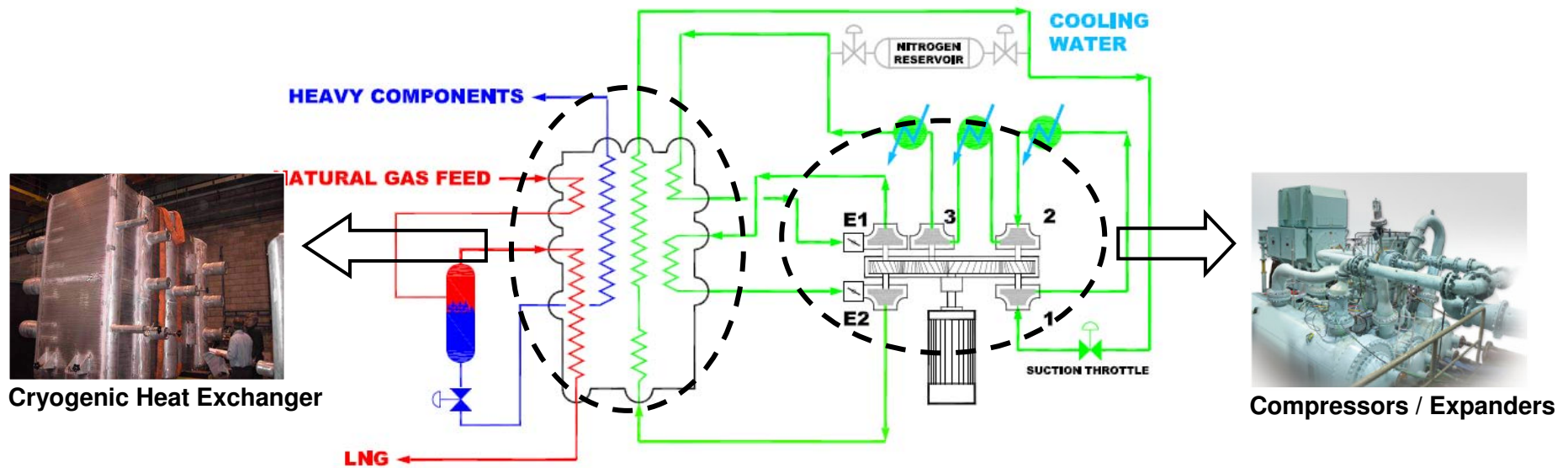
**Kollsnes II LNG**

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



Kollsnes II LNG Plant, Norway  
(84,000 TPA)

# Nitrogen Expander Cycle



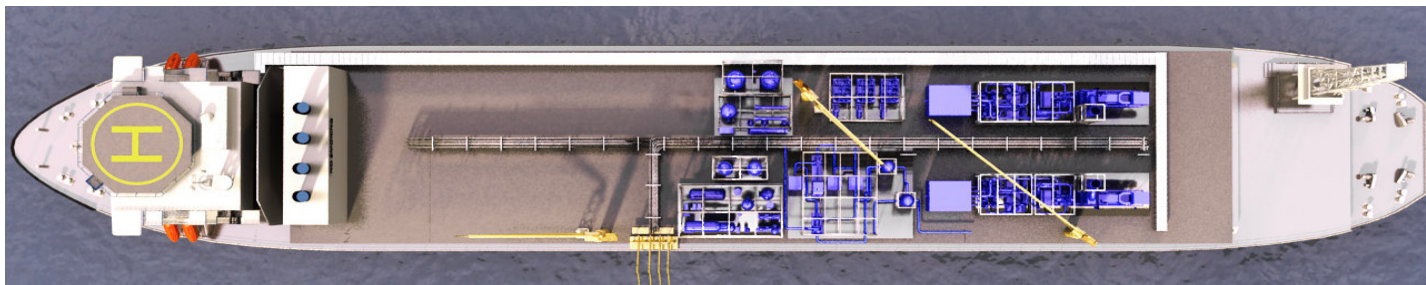
- Non-combustible and non-toxic cooling medium locally generated
- Robustness; single phase, single component, few or no splitting of streams
- Can be ramped quickly up and down in capacity, also fully automatic
- Can operate on optimum design point over a wide range of feed gas properties



Well proven process and equipment from onshore and marine LNG applications!

# New and efficient LNG production

- Novel and improved Brayton technology
  - Based on proven technology
  - Patent pending
  - Low specific energy consumption:  $\sim 0.35$  kWh/kg LNG
  - Adaptable to varying gas compositions
  - Compact system – small footprint
  - Capacities increased to 1.0 MTPA per train
  - Waste heat recovery feasible => energy consumption further reduced
  - Successful offshore engineering studies for varying capacities carried out – to be followed by contract

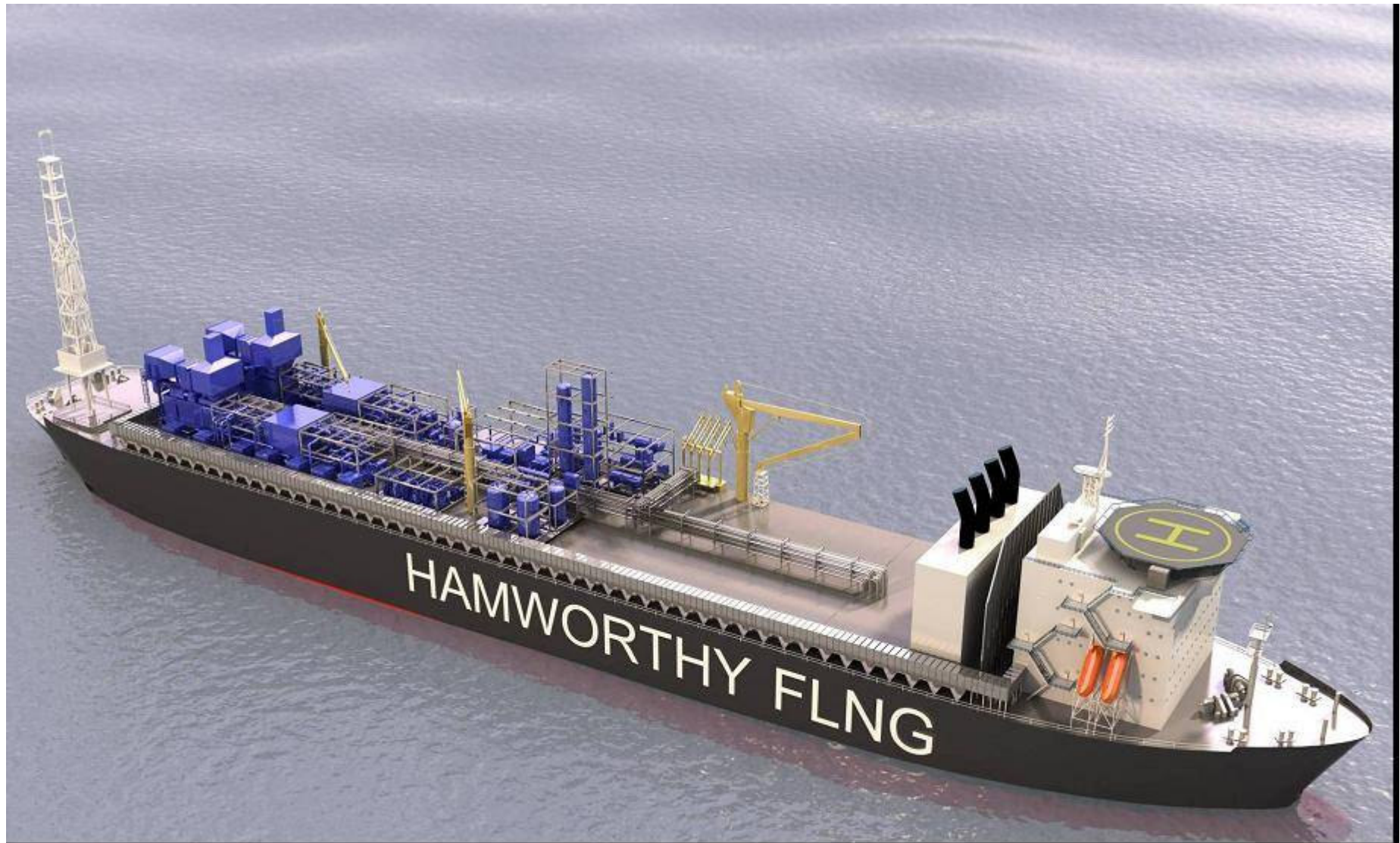




# 3D model 26.000 TPA



# 3D model FLNG 2 MTPA



# Concluding Remarks

- Efficient LNG technology for hydrocarbon gas recovery available today
- Unique MiniLNG™ technology for biogas, landfill gas and coal mine methane – up to 5.500 TPA
- Novel and compact nitrogen Brayton technology developed for onshore and offshore flare gas recovery – 1.000.000 TPA

“Hamworthy wants to work with you to understand your needs and customize your solution”