

Introduction to Small Scale LNG

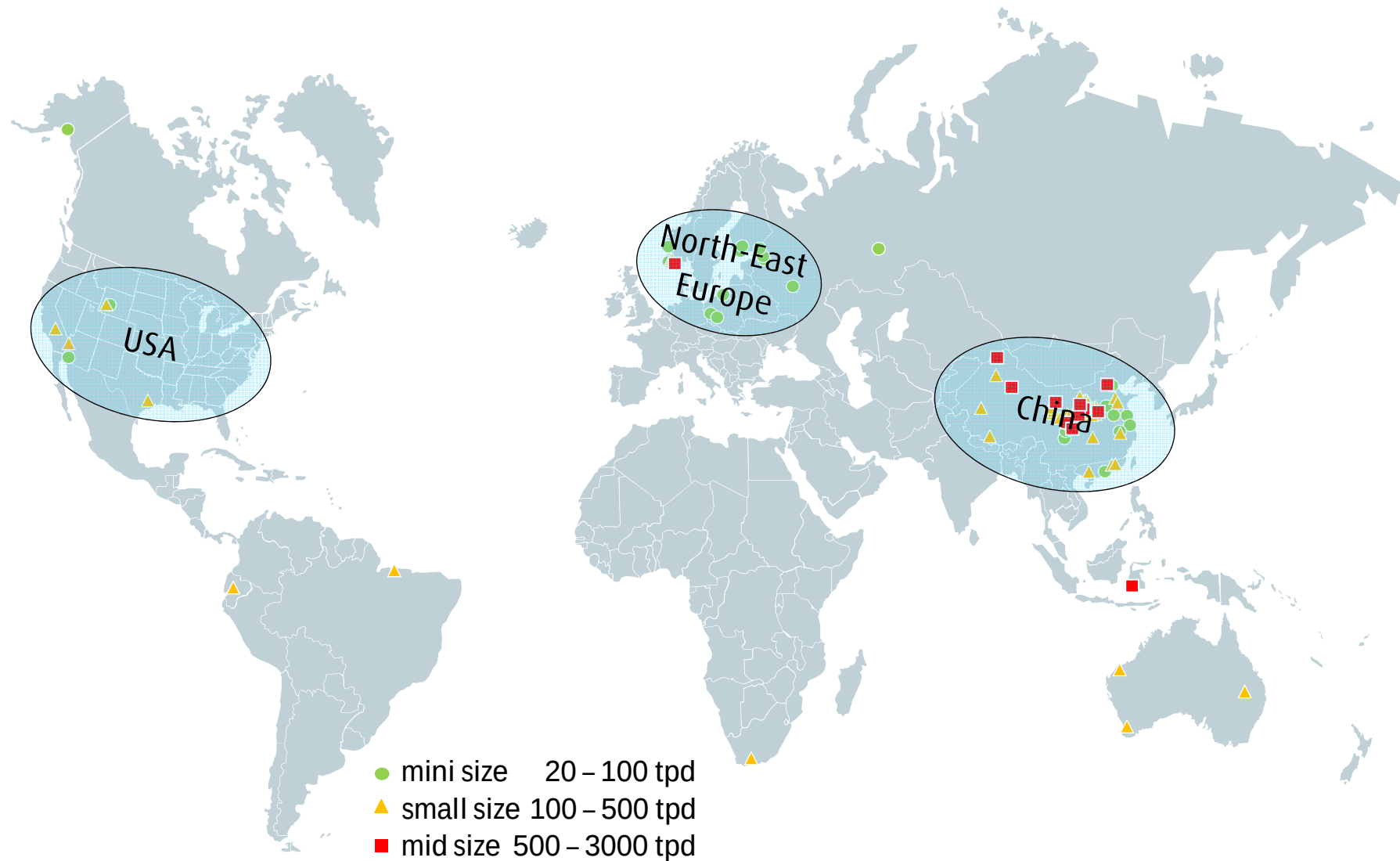
Dr. Thilo Schiewe

October 2012

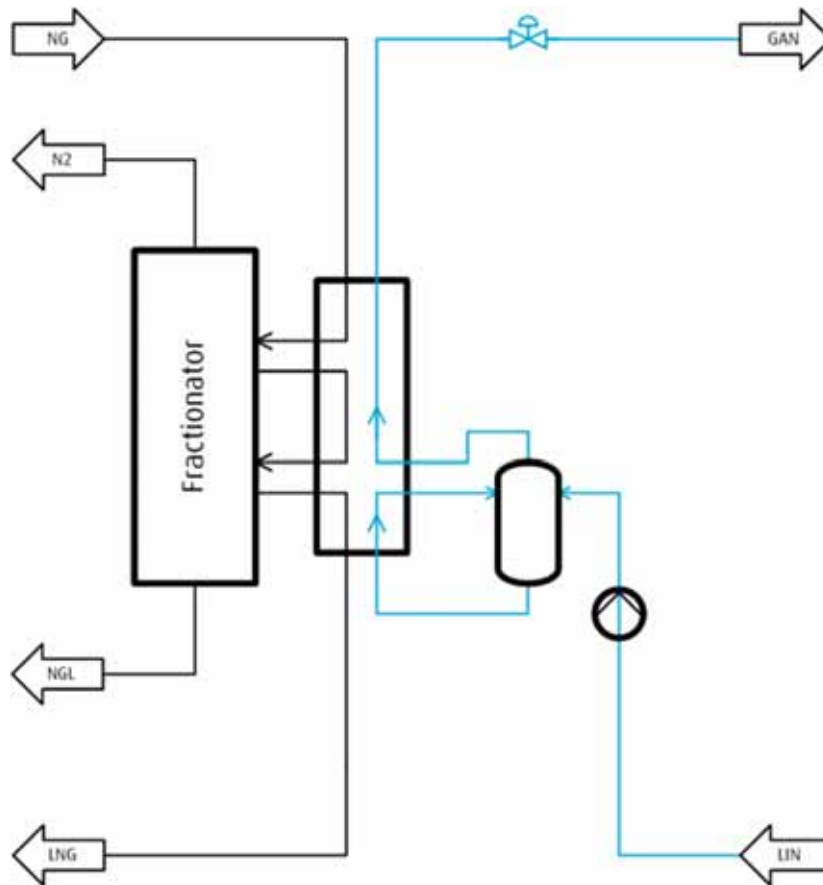
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Liquefaction Plants with < 1 mtpa LNG capacity

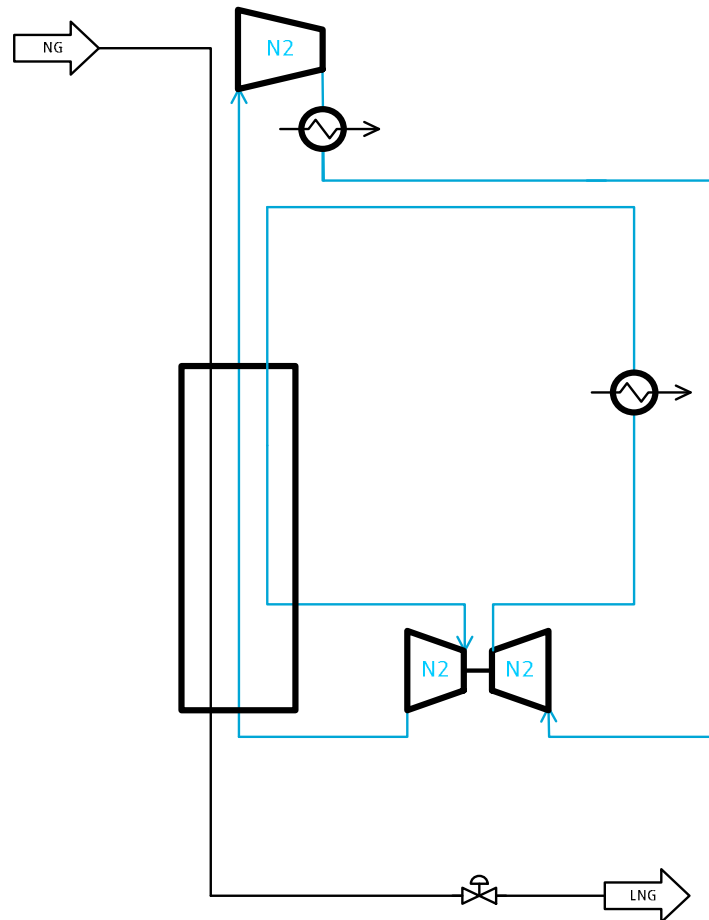


Liquid N₂ (LIN) Refrigerant

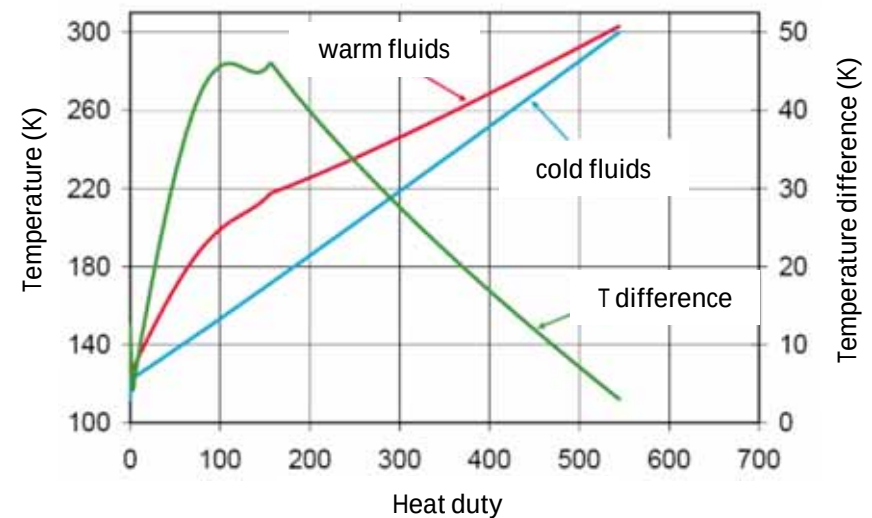


- 1000 kWh/t_{LNG}
- Utilizes surplus LIN from ASU
- Efficient batch mode
- for mini scale or demonstration purposes only

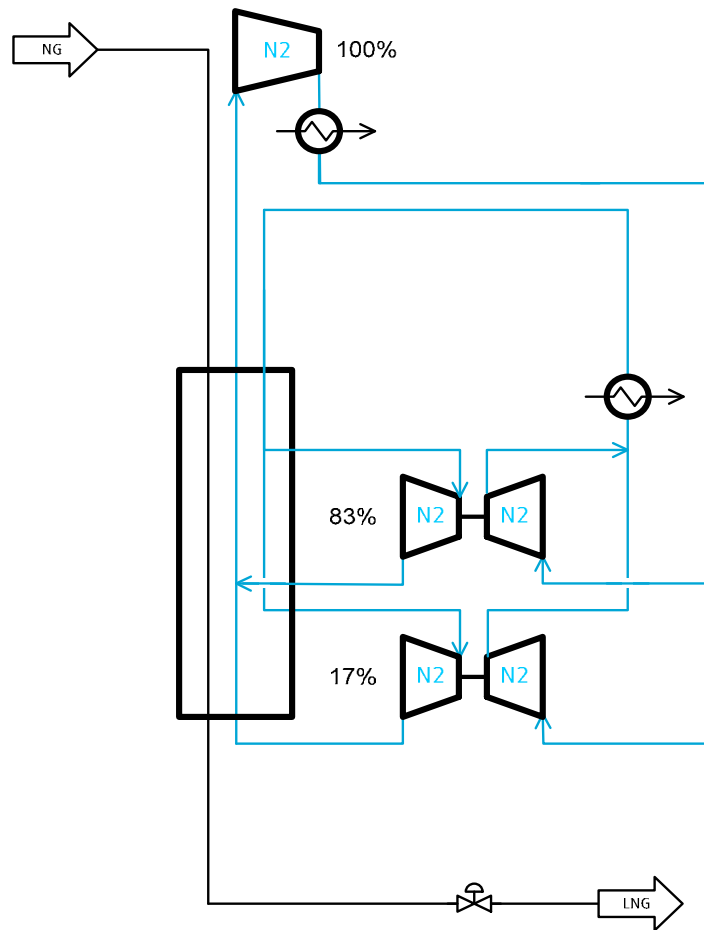
Single N₂ expander process



Specific energy consumption
(normalised conditions)
 $770 \text{ kWh} / t_{\text{LNG}}$



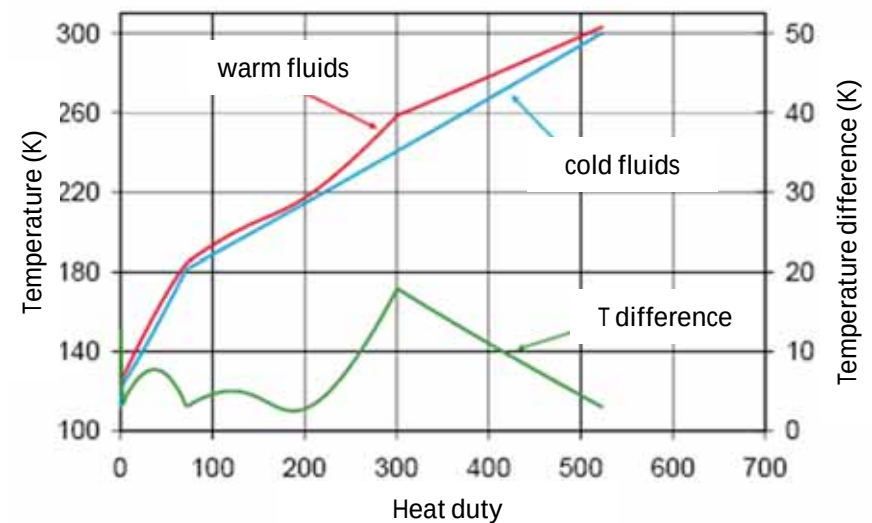
Double N₂ expander process (cLNG)



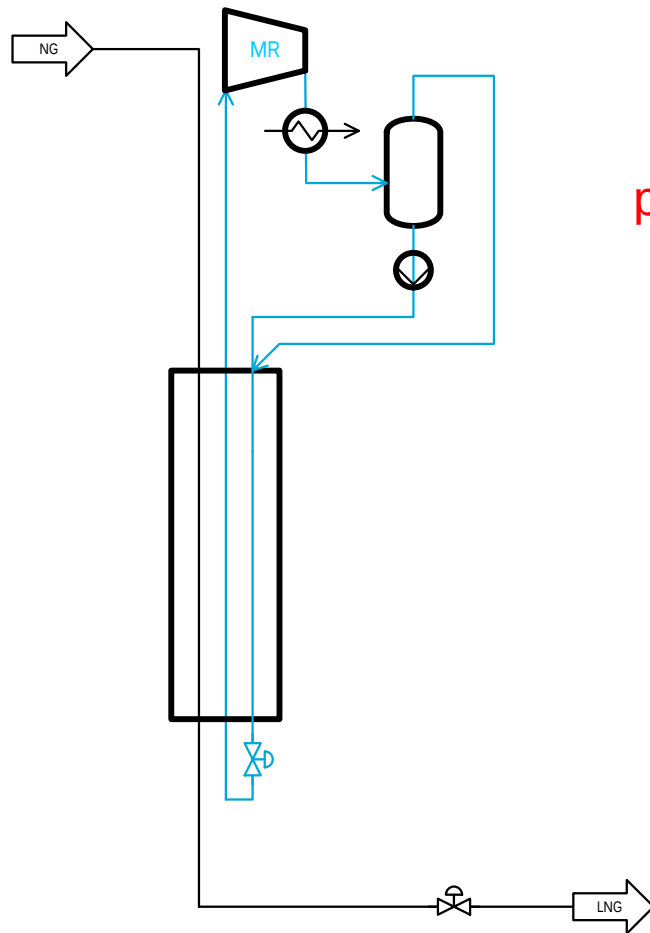
Specific energy consumption
(normalised conditions)

$$500 \text{ kWh} / t_{\text{LNG}}$$

- Non flammable
- Complex equipment



Single Mixed Refrigerant (SMR) process (PRICO)

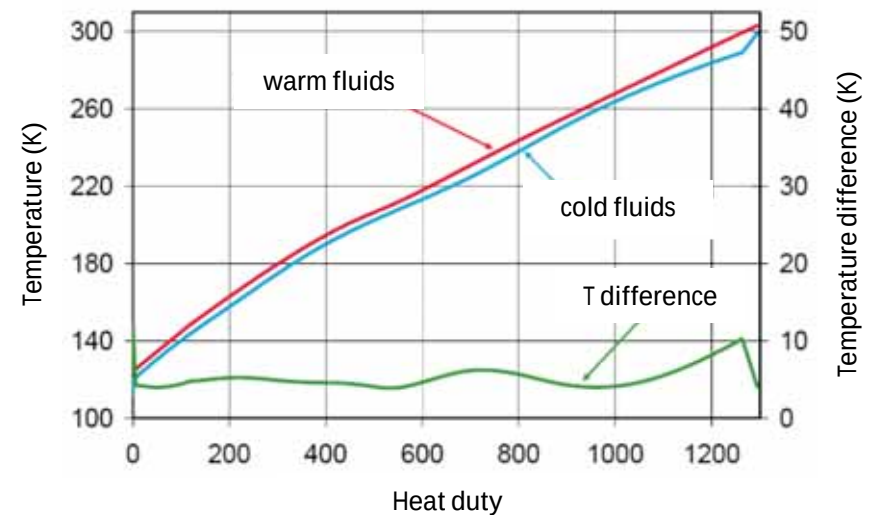


public domain
since 1996

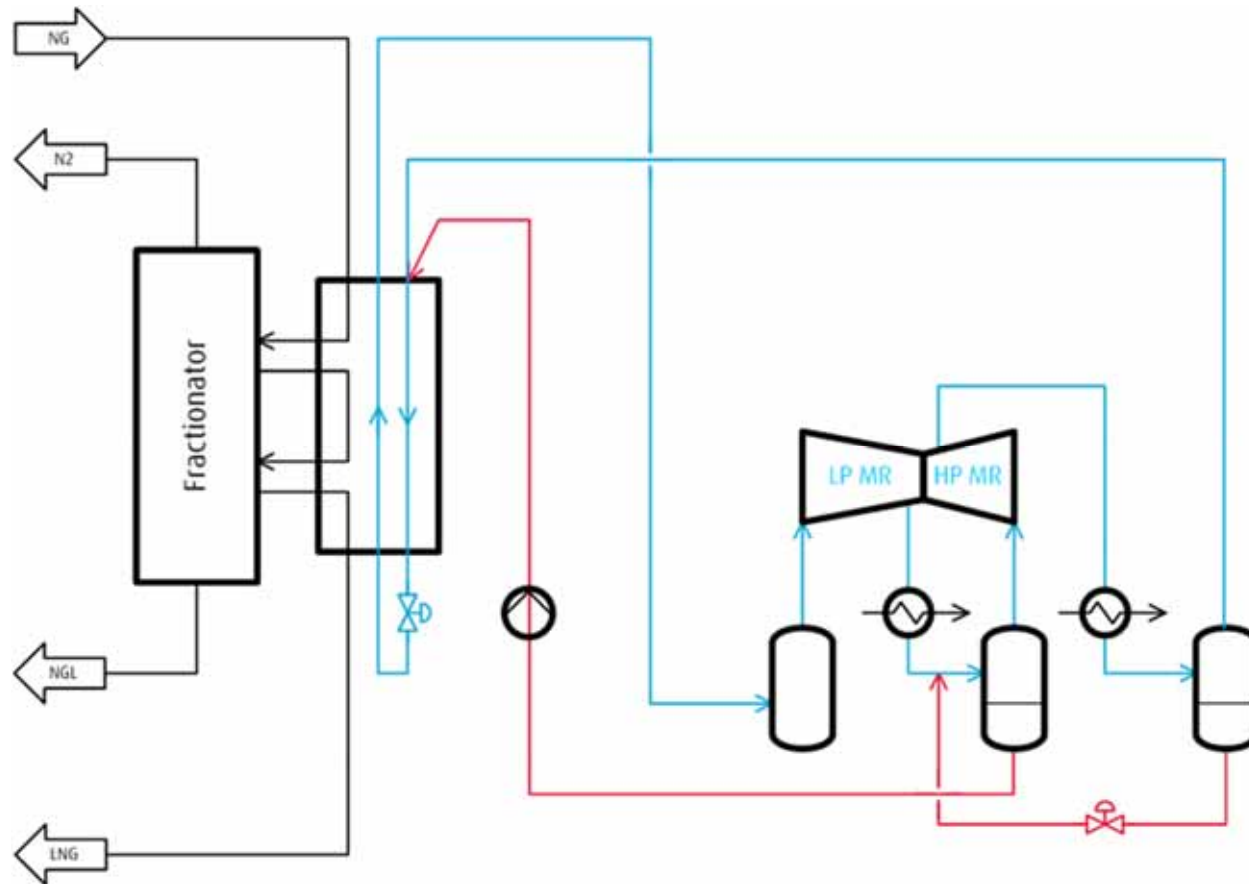
Specific energy consumption
(normalised conditions)

$$350 \text{ kWh} / t_{\text{LNG}}$$

- Easy operation
- Simple equipment



SMR with N₂ and Light Hydrocarbons Refrigerant

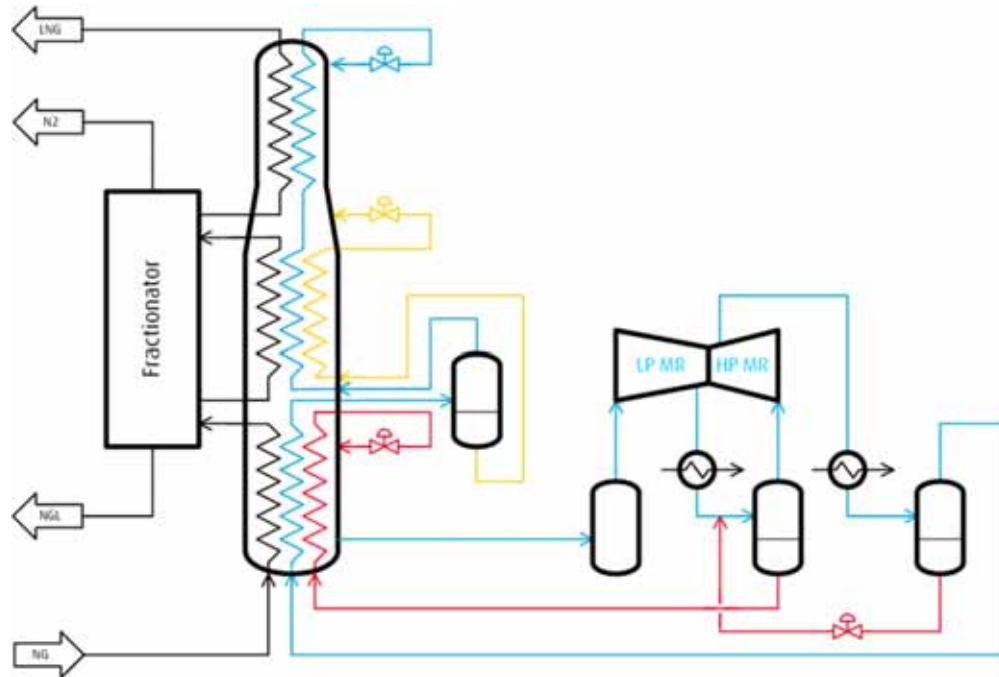


SMR + PFHE

- 300 kWh / t_{LNG}
- Easy operation
- Simple equipment

Linde
Multi Stage
Mixed Refrigerant
Cycle
LIMUM®

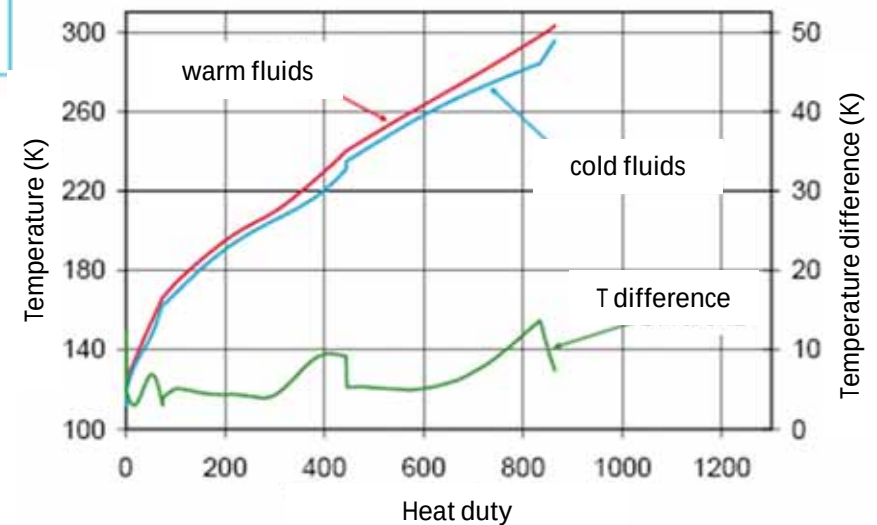
SMR with N₂ and Light Hydrocarbons Refrigerant



Linde
Multi Stage
Mixed Refrigerant Cycle
LIMUM®

SMR + CWHE

- 300 kWh/t_{LNG}
- Large plant capacity
- Robust equipment



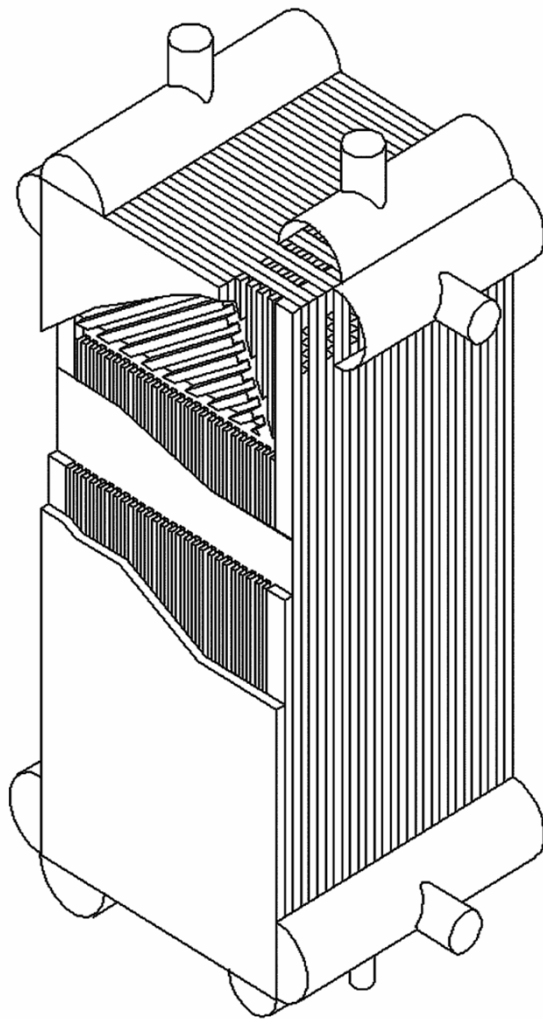
Single Mixed Refrigerant (SMR) process (LIMUM®)



Fractionator design alternatives:

- Simple KO drum to remove heavy hydrocarbons (avoid risk of freezing in LNG)
- C_{2plus} extraction to meet the required methane number / Wobbe index of the LNG
- N₂ rejection, in case of N₂ rich feed gas and missing sink for N₂ rich end flash gas (e.g. gas turbine fuel is not required, as an electric motor is used)

Plate Fin Heat Exchangers



- 😊 low cost per unit area
- 😊 complex stream arrangement possible
- 😊 readily available from many qualified suppliers
- 😞 expensive manifolding for larger plant capacities
- 😞 limited acceptable temperature gradients

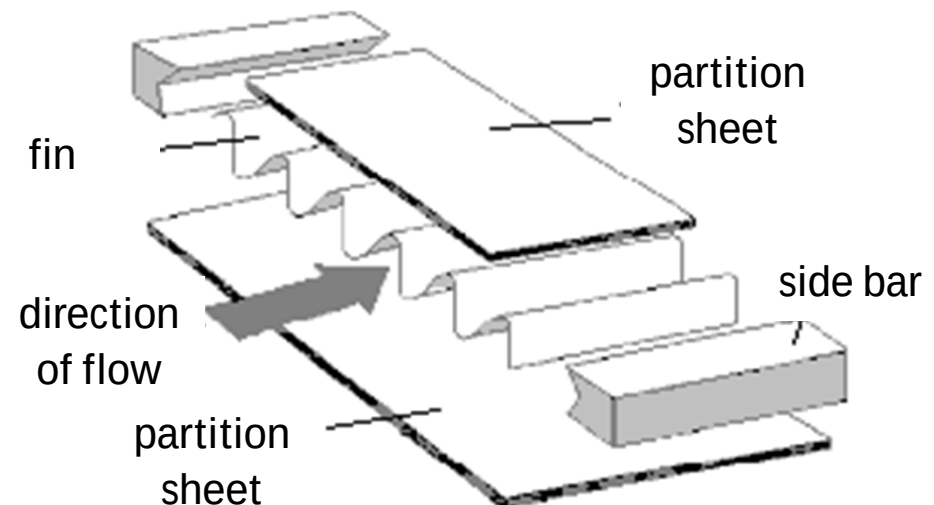


Plate Fin Heat Exchangers



Plate-fin heat exchangers are used for a wide range of applications, especially for low temperature services and treatment of clean fluids.

Main applications

- Petrochemical plants
- Gas treatment plants
- Natural gas liquefaction plants
- Air separation plants
- He- and H₂ liquefaction plants



Plate Fin Heat Exchangers

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Plate Fin Heat Exchangers – assembly in Cold Boxes

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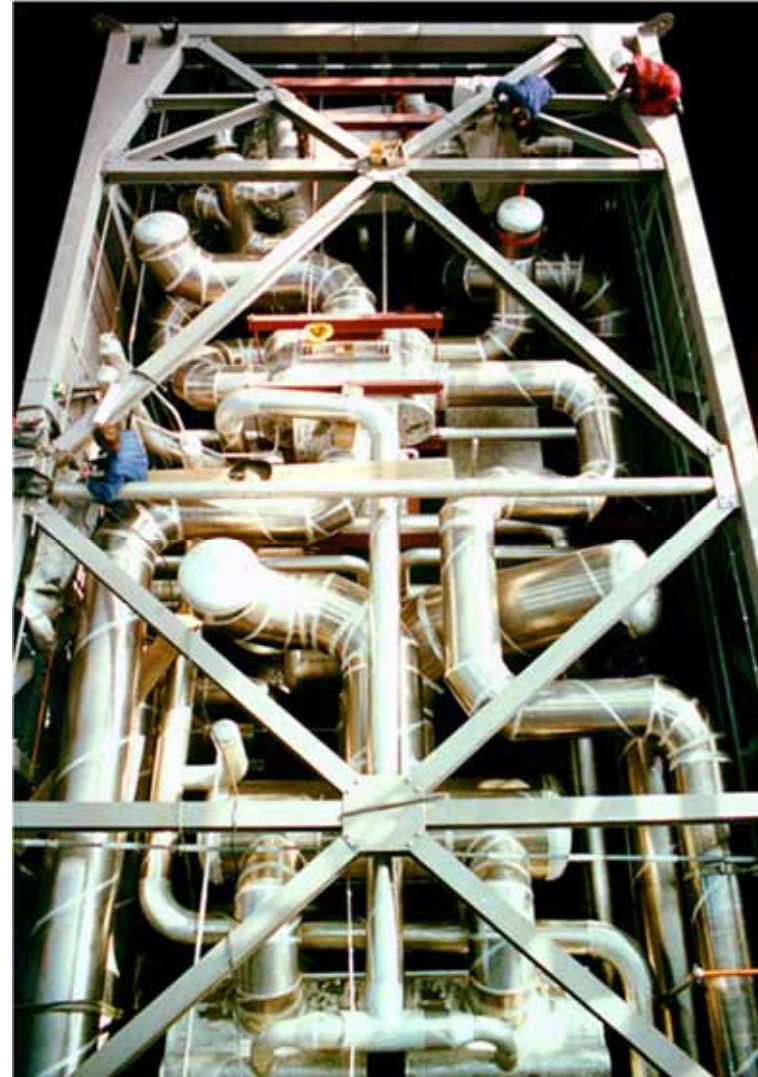


Plate Fin Heat Exchangers - assembly in Cold Boxes

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Coil Wound Heat Exchangers



- 😊 large heating surface per shell
- 😊 tolerant against thermal shocks
- 😊 good part load behaviour
- 😊 fixing of single tube leakages within moderate down time
- 😞 proprietary equipment
- 😞 only one shell side stream possible

Coil Wound Heat Exchangers

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Oxygen Plant No. 14
manufactured 1910



Coil Wound Heat Exchangers



Coil wound heat exchangers are used for clean media with broad temperature and pressure ranges.

They are especially suitable for large heat loads at small temperature differences and for heat exchange among several fluids.



Coil Wound Heat Exchangers

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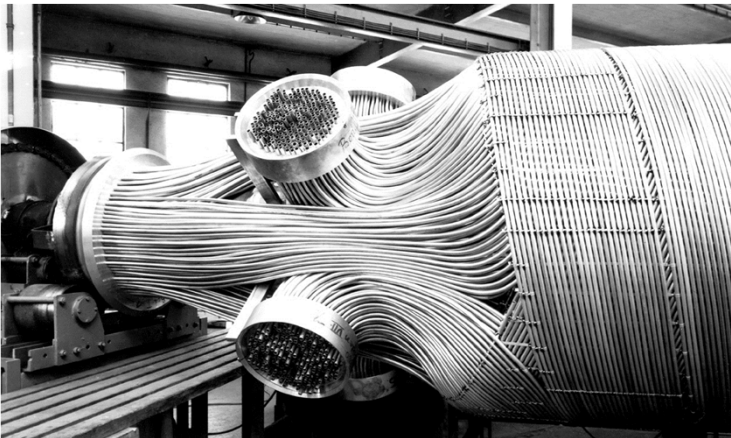
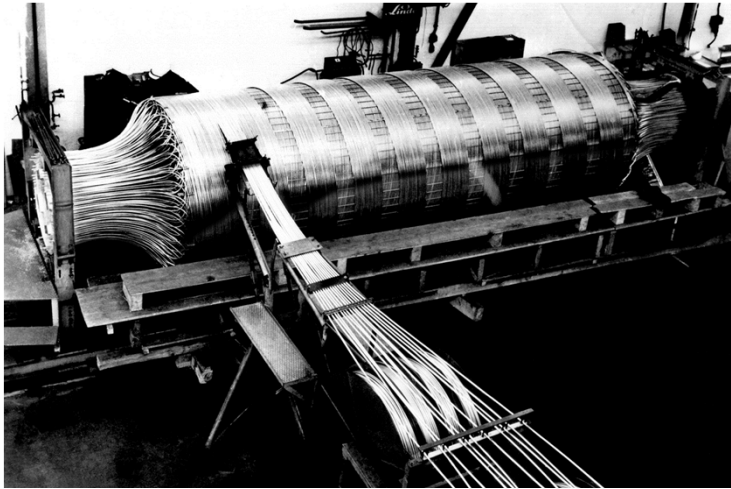
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Coil Wound Heat Exchangers

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Coil Wound Heat Exchangers

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Coil Wound Heat Exchangers, Shipping

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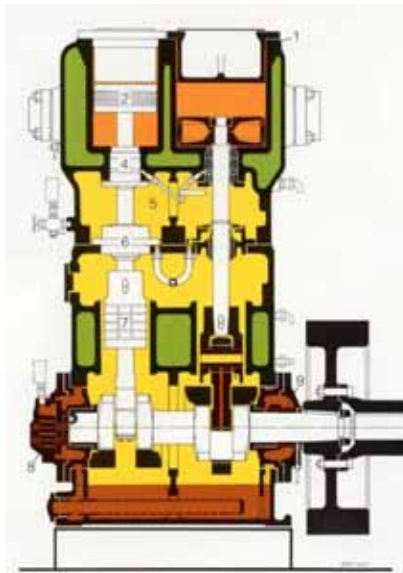


Process Design Options for Refrigerant & Heat Exchanger



PLANT LNG CAPACITY (t/d) (Nm ³ /d)	< 20 < 25.000	20 - 100 25.000 - 125.000	100 - 400 125.000 - 500.000	400 - 3000 500.000 - 4.000.000
Refrigerant				
liquid nitrogen	😊	😞	😞	😞
nitrogen gas	😞	😊		😞
single mixed refrigerant	😞		😊	😊
Cryogenic Heat Exchanger				
plate-fin heat exchanger	😊	😊	😊	- 800 (1.000.000)
coil wound heat exchanger	😞	😞		😊

Cycle Compressor Type Alternatives



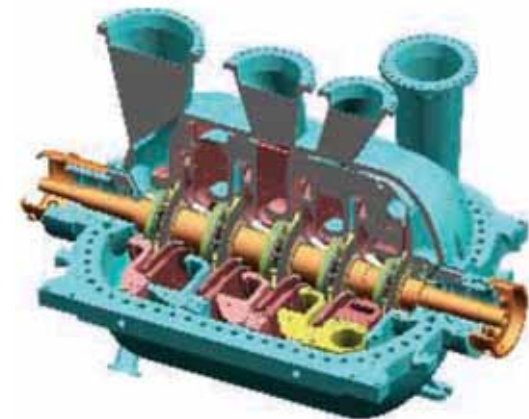
Reciprocating

- Inexpensive
- Small capacity
- Reduced availability



Screw type

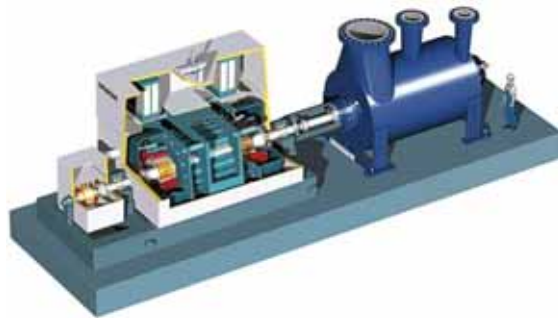
- Insensitive to composition
- Medium capacity
- High reliability



Centrifugal

- Optionally integrally geared
- Medium to large capacity
- High reliability

Cycle Compressor Driver Alternatives



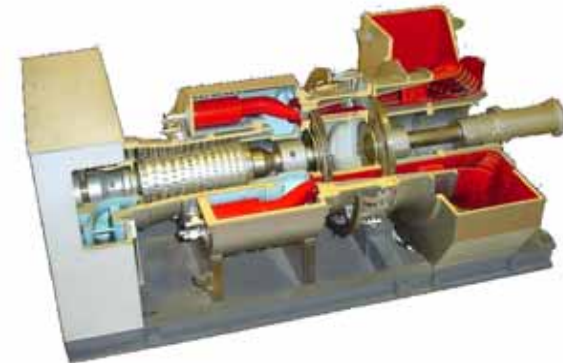
Electric motor

- Requires stable grid
- May require NRU
- High availability



Steam turbine

- Good match in (coal) chemical plants with HRSGs
- May require NRU
- High availability



Gas turbine

- First choice in remote areas
- Sink for N₂ rich fuel (max. 20-30 vol-% N₂)
- Reduced on-stream time (maintenance)

Process Design Options for Compressor & Driver



PLANT LNG CAPACITY (t/d) (Nm ³ /d)	< 20 < 25.000	20 - 100 25.000 - 125.000	100 - 400 125.000 - 500.000	400 - 3000 500.000 - 4.000.000
Compressor				
reciprocating	😊	🟡	😞	😞
screw type	🟡	😊	😞	😞
centrifugal	😞	😊	😊	😊
Driver				
electric motor	😊	😊	😊	😊
steam turbine	😞	🟡	😊	😊
gas turbine	😞	😞	🟡	😊

LNG Project References – Mid Scale Liquefaction Plant

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Customer:

Xinjiang Guanghui LNG
Development Co., Ltd.

Capacity:

432,000 TPA LNG

Scope of Work:

Basic Eng., Key Equipment
Supply, Detailed Eng.,
Construction, Start-up
Supervision

Start-Up:

2004

Process:

LIMUM® - CWHE Process
(gas turbine drive)

LNG market development in China: LNG Production und Road Transport



LNG Project References – Mid Scale Liquefaction Plant

**Customer:**

Xinjiang Guanghui LNG
Development Co., Ltd.

Capacity:

400,000 TPA LNG

Scope of Work:

Basic Eng., Key Equipment
Supply, Detailed Eng.,
Construction, Start-up
Supervision

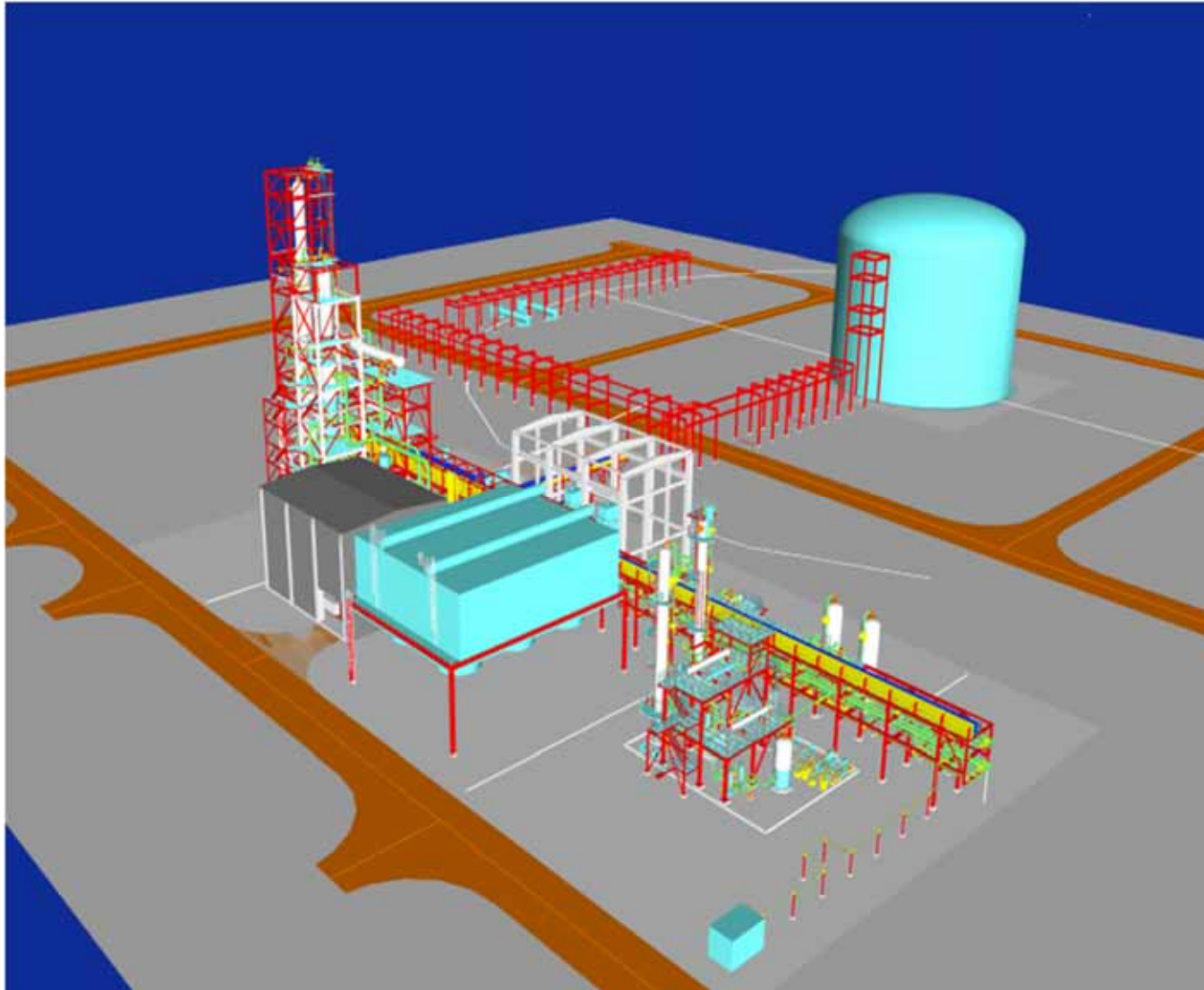
Start-Up:

2012

Process:

LIMUM® - CWHE Process with
integrated NRU (electrical
drive)

LNG Project References – Mid Scale Liquefaction Plant

**Customer:**

Inner Mongolia Huineng Coal
Chemical Co., Ltd.

Capacity:

280,000 TPA LNG

Scope of Work:

Basic Eng., Key Equipment
Supply, Detailed Eng.,
Construction, Start-up
Supervision

Start-Up:

2013

Process:

LIMUM® - CWHE Process
(steam turbine drive)

LNG Project References – Mid Scale Liquefaction Plant

**Customer:**

Skangass

Capacity:

300,000 TPA LNG

Scope of Work:

TKLS

Start-Up:

2010

Process:

LIMUM® - CWHE with 3D
temperature monitoring
(electrical motor drive)

LNG Project References – Mid Scale Liquefaction Plant

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LNG Project References – Mid Scale Receiving Terminal

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Customer:

Linde (AGA)

Capacity:

0.225 mtpa
20,000 m³ (tank)

Scope of Work:

EPC

Start-Up:

2011

Features:

accommodates LNG carriers up to 15,000 m³



LNG Project References – Small Scale Liquefaction Plant



LNG Plant, Bergen, Norway

**Customer:**

Naturgass Vest,
now Gasnor

Capacity:

40,000 TPA LNG

Scope of Work:

General Contractor (TKLS)

Start-Up:

2004

Process:

LIMUM® - PFHE Process

LNG Project References – Small Scale Liquefaction Plant



LNG Plant, Kwinana, Australia



Customer:
Wesfarmers LPG Ltd.

Capacity:
61,250 TPA LNG

Scope of Work:
General Contractor (TKLS)

Start-Up:
2008

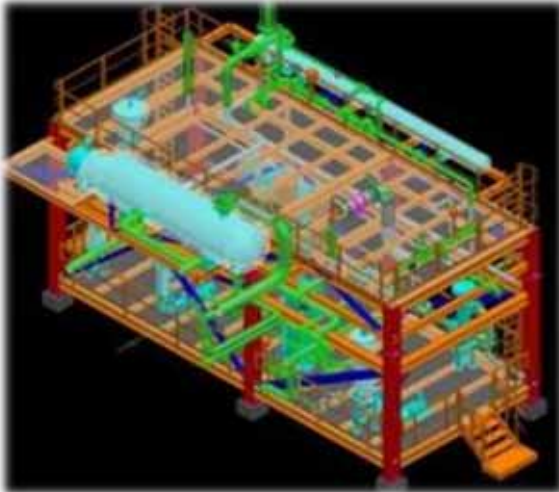
Process:
LIMUM® - PFHE Process

StarLNG™

Ship and Road-transportable Generic Module Concept

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CAD model prepared for:

- Core process units
- Coldbox
- Main pipe racks
- LNG truck loading



**Off-Site module pre-fabrication in best cost countries
reduces project budget in a high cost labour environment**

**Thank you
for your attention.**

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