

Making our world more productive



# StarLNG™

Leading standardised small- to mid-scale LNG plants.





# Meeting future energy challenges.

## Growing importance of natural gas

In the bid to find cleaner, more environmentally sound sources of energy, the spotlight is increasingly shining on natural gas. Burning methane, the principal component of natural gas, produces around 30% less carbon dioxide (CO<sub>2</sub>) than crude oil, and almost 45% less CO<sub>2</sub> than coal. When combusted, it also releases around 90% less sulfur oxide and 80% less nitrogen oxide than other fossil fuels, and it emits no heavy metals or soot particles. It is thus the ideal choice to meet stricter environmental regulations for pollutant emissions, especially in transport and shipping. Another factor that adds to the appeal of natural gas is the fact that reserves are set to last for the foreseeable future, and advanced extraction technologies are unlocking new deposits all the time, especially in shale reserves.

## Changing LNG landscape

Already today, natural gas meets more than 25% of the world's energy demand and this share is set to rise. Consequently, natural gas is moving beyond its niche market to serve a much broader application spectrum at local level. The trucking and marine transport industries are two good examples. This growing merchant market relies on state-of-the-art liquefaction and transport technologies, especially tankers, to deliver gas economically from remote deposits to the point of use. Reflecting this shift, Liquefied Petroleum Gas (LPG), Natural Gas Liquids (NGL) and Liquefied Natural Gas (LNG) have become much more important in the world's energy mix over the past two decades.

*“Our people, operational excellence and patented technologies empower us to deliver value to our customers.”*

Dr Marc Schier  
Natural Gas Processing Plants

## Mid-scale is scaling out

In the past, the LNG market typically differentiated between small- to mid-scale production facilities and world-scale plants. Whereas the small- to mid-scale segment usually produces up to 0.5 million tonnes per year (mtpa), world-class plants have liquefaction capacities of anywhere between 3.5 and almost 8 mtpa. According to our estimates, the small- to mid-scale sector currently accounts for around 10 to 15 percent of global liquefaction capacity. However, that may be about to change.

Recently, the market is seeing growing demand for a new class of LNG plant; namely “large” mid-scale facilities producing between one and two mtpa. Operators of these plants are looking to combine the benefits of large-scale plants (processing natural gas directly from the field and exporting the LNG to high-value markets in large “parcels”) with those of small- to mid-scale plants (processing of pre-treated feed gas from a pipeline).

Hence the market demands more flexible and cost-effective construction models for large mid-scale plants, offering fast time-to-solution – especially in remote areas or in environments where construction work is difficult or costly. Similar to the “smaller” mid-scale sector, the key to meeting these demands lies in standardised machines, equipment and instrumentation. Pre-fabricated modules can significantly reduce on-site construction effort and accelerate lead times from tendering to commercial production.

**40 years**  
of experience in the natural  
gas business.

## In-depth understanding of LNG market dynamics.

### Building on expertise

At Linde, we have over 40 years of experience in the natural gas business. Linde Engineering is the only company in the LNG business capable of offering customers Linde-developed plant modules in conjunction with a broad portfolio of liquefaction technologies, distribution infrastructures and services. In fact, we are the only equipment manufacturer to offer both coil-wound and plate-fin heat exchangers – equipment at the heart of most natural gas processing steps. Complementing this strong engineering portfolio, Linde Gas also has extensive process and operating expertise in the cryogenic industry, mainly for air separation but also for liquefaction of natural gas.

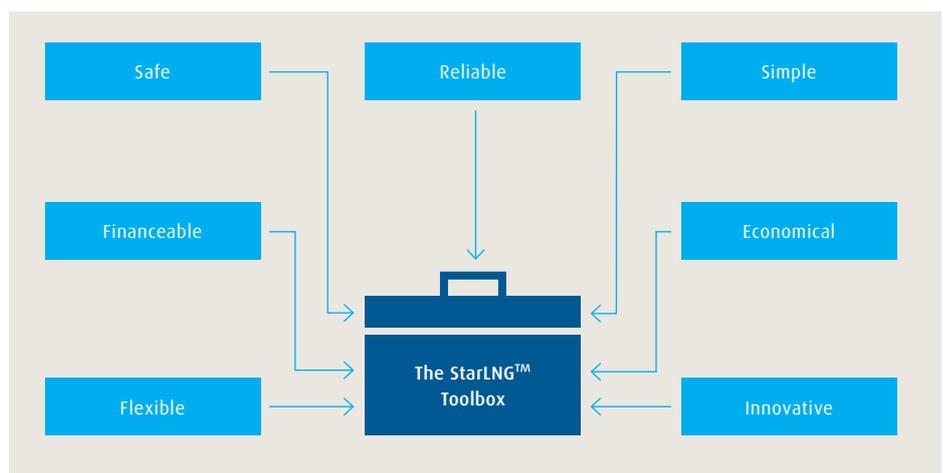
This know-how covers the entire LNG value chain – from extraction through purification and liquefaction to distribution and regasification. Building on this synergised expertise and our strong track record in the successful execution of world-class EPC (engineering, procurement, construction) projects on a lump-sum, turnkey basis, we have now developed a flexible and modularised plant concept specifically for the emerging small- to mid-scale LNG market. Linde's StarLNG™ plants leverage our standardisation and modularisation experience in air separation to meet growing demand for cost efficiency, short lead times and construction flexibility.

### A plant concept offering flexibility

StarLNG is designed as a process toolbox with configuration variations supporting about 90% of real-life LNG projects. In other words, the generic LNG plant design can be individually adapted to cope with most pipeline gas specifications as it covers a wide feed gas envelope and includes options for heavy hydrocarbon or nitrogen removal, for instance. It comes with modularised pre-treatment and process units, as well as main pipe racks. In addition, the StarLNG plant concept is adjustable within a wide liquefaction capacity range.

Our StarLNG concept offers a number of compelling benefits to our customers. First and foremost, all StarLNG units leverage the safety and operational experience we have gained building world-scale LNG plants and are designed to the same rigorous safety and reliability standards. This reduces execution risk and capital investment over a wide capacity range for our customers. Our excellent track record in safety performance is reflected in the fact that we have obtained construction permits for plants located close to urban developments in some of the world's most highly regulated geographies.

In addition, this advanced level of standardisation and modularisation, combined with well-referenced equipment sizes, means that we can draw on a large pool of





Mid-scale StarLNG plant with up to 0.8 mtpa liquefaction capacity in Bintulu, Malaysia.

vendors to offer customers more competitive pricing. Moreover, standard agreements with suppliers for long-lead items and design blueprints enable us to accelerate lead times from tendering to commercial production. Compared with world-scale projects in particular, this translates into huge time savings, not only for small-scale but also for mid-scale plants.

### StarLNG highlights at a glance

#### Safe, simple, robust and highly efficient process design (lowest OPEX)

- Our strong focus on health and safety makes our small- to mid-scale LNG plants as safe as our world-scale plants
- Process design validated in dynamic simulations
- High reliability, robust design and ease of operation due to high degree of automation; remote control possible

#### Fast-track EPC time schedule

- Pre-engineered toolkit for process and plant design, standard documentation and modularised plant layout for shortest delivery time with minimum on-site construction effort

#### Lowest CAPEX

- Toolkit approach supports customisation, while benefiting from standardisation and production cost efficiencies of best-cost countries

#### Pre-engineered standard documents

A set of generic standard documents has been prepared and validated. They include the following:

- Equipment specifications
- Plant CAD model
- Plot plan
- Start-up concept
- Automation philosophy
- Operation manual for process simulation models (OPTISIM)
- Process sketches and descriptions
- PFD template
- 100% piping and instrumentation diagrams (PID)
- Set of design concepts for all disciplines
- HAZOP report template
- Conceptual HAZAN for CWHE
- Value engineering for critical equipment
- 100% process data sheets completed
- Winterisation concept
- Execution strategy for LNG storage

Lowest **CAPEX** with plant solutions standardised for all climatic conditions.

**90%** of typical technical project requirements are covered by standard documents.

**+1,000**  
coil-wound heat exchangers  
manufactured.

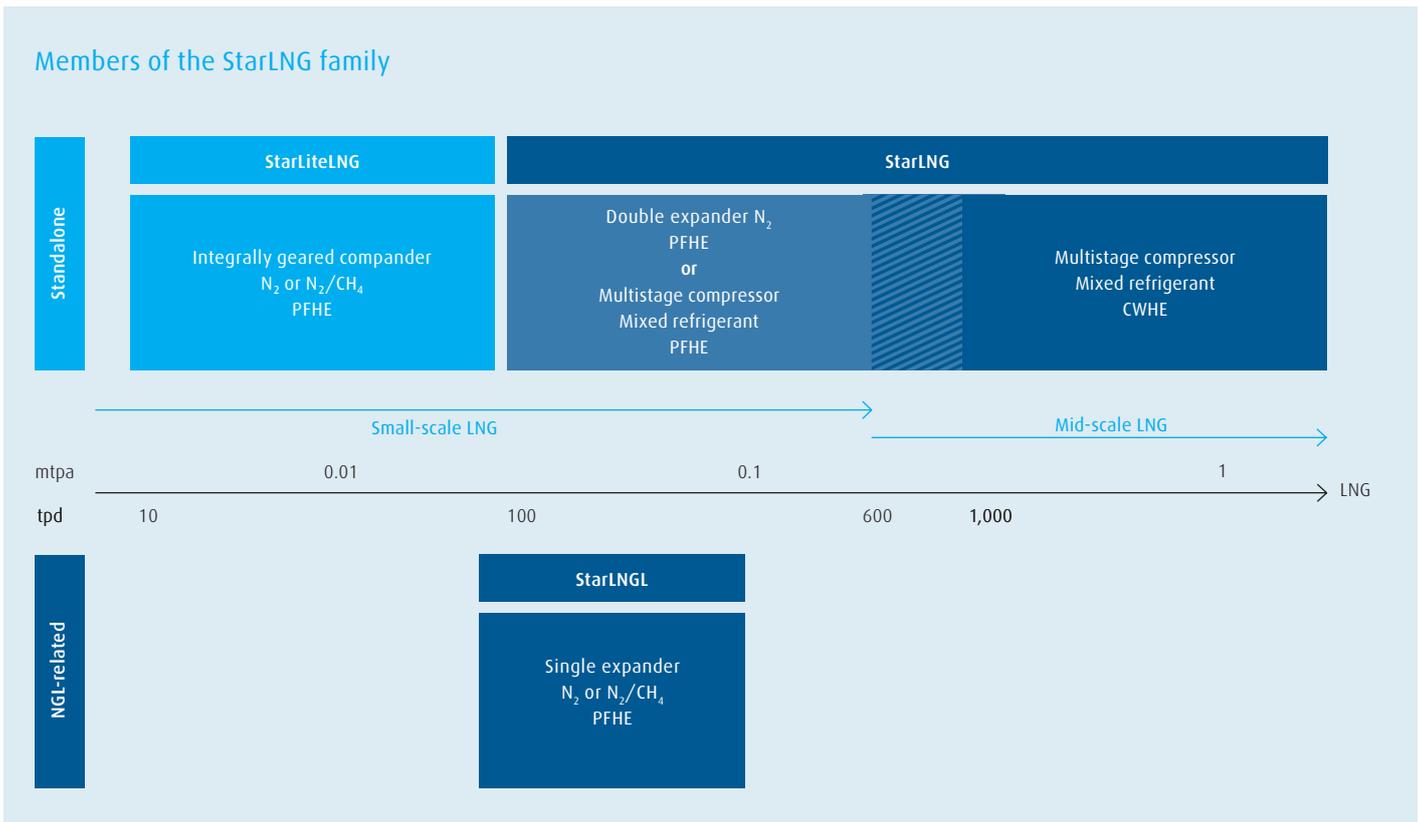
# The concept.

## Introducing the StarLNG family

The StarLNG concept was originally developed for the typical small-scale capacity range of 100 to 600 tpd and was based on Linde’s proprietary single mixed refrigerant liquefaction process (LIMUM®1) using plate-fin heat exchangers (PFHE). During concept development, Linde engineers recognised that many of the standardised design solutions and features can also be applied to LNG plants using other liquefaction technologies. Therefore, the concept was extended to larger-scale plants with up to 1 mtpa liquefaction capacity per train using the LIMUM3 process based on Linde’s proprietary coil-wound heat exchanger (CWHE).

Building on the success of this extended portfolio, we then rounded out the StarLNG family by adding plant concepts using packaged proprietary nitrogen expander-based liquefaction processes, either for small-scale, highly modularised standalone LNG units or for integration into existing or new NGL extraction facilities.

The following figure gives an overview of the different members of the StarLNG family together with the applied liquefaction processes, refrigerants, compressor types and main cryogenic heat exchangers. On the following pages, the various StarLNG family members are presented in more detail.





Small-scale StarLNG plant with 175 tpd liquefaction capacity in Kwinana, Australia.

# StarLNG family members.

Our small- to mid-scale LNG plants match the safety, reliability, robustness and efficiency performance of world-scale LNG facilities.

## StarLiteLNG™

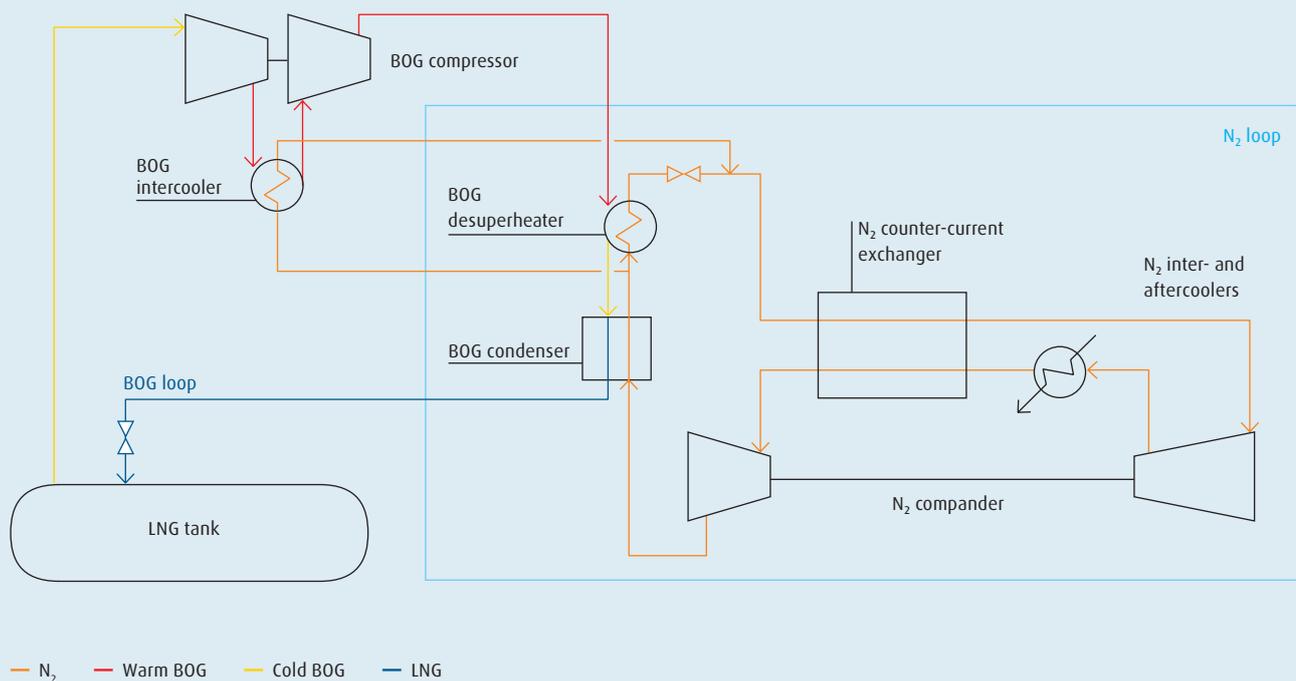
StarLiteLNG refers to compressor units (packaged compressors and expander) designed and manufactured by Linde's fully owned subsidiary Cryostar. Ideal for the lower end of the liquefaction capacity spectrum, these plants support volumes between 28 and 200 tpd. StarLiteLNG packaged units are based on Linde's proprietary EcoRel system, used for on-board reliquefaction of boil-off gas (BOG) on LNG carriers such as the Q-Max (which transports world-scale LNG cargo from Qatar to the Far East).

At the heart of the StarLiteLNG refrigeration unit is the compressor, with its integrally geared design driving a single nitrogen refrigeration cycle.

### Key highlights

- Minimised equipment count for ease of operation and low capital cost
- Broad portfolio of standard compressor sizes covering wide range of liquefaction capacities
- Skid-mounted modules to minimise on-site construction effort
- Machinery designed, manufactured, assembled and tested in-house for reliable operation
- Proven and reliable PFHEs manufactured by Linde Engineering

## StarLiteLNG process with nitrogen single expansion cycle and PFHE (coldbox)



## Small-scale StarLNG

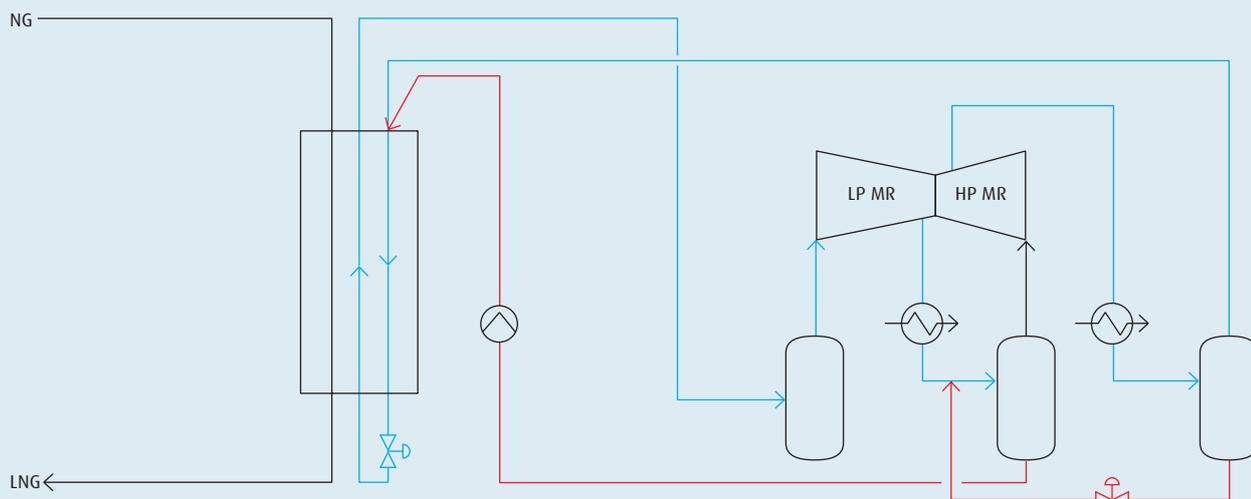
The StarLNG concept originally targeted small-scale LNG liquefaction capacities ranging between 100 and 600 tpd. Such plants typically consist of natural gas treatment (sour gas removal and dehydration) and liquefaction units, an LNG storage tank and an LNG truck filling station. The natural gas is cooled, liquefied and sub-cooled in a PFHE mounted in a coldbox using Linde's highly efficient single mixed refrigerant cycle process, LIMUM1. This mixed refrigerant cycle uses four refrigerants: nitrogen, methane, ethylene or ethane (depending on availability) and butane. For small-scale StarLNG plants alternatively to the LIMUM1 process described above, Linde can also offer a

well-proven nitrogen double expander cycle process, which offers particular advantages if the mixed refrigerants required for LIMUM1 are not available.

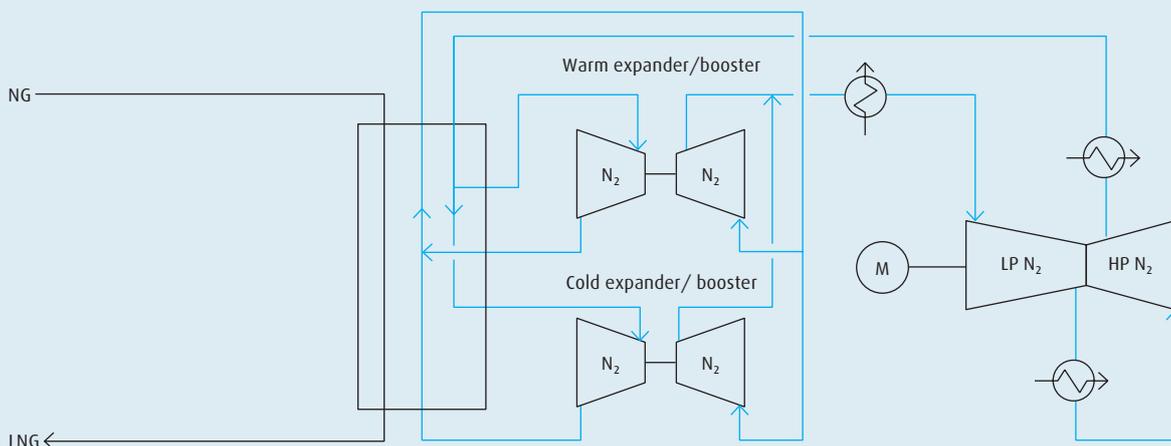
### Key highlights

- Proven PFHEs manufactured by Linde Engineering
- Once-through liquefaction of pre-treated (dry and sweet) natural gas
- Alternative process technology based on a double nitrogen expander cycle also available
- Compact modular design

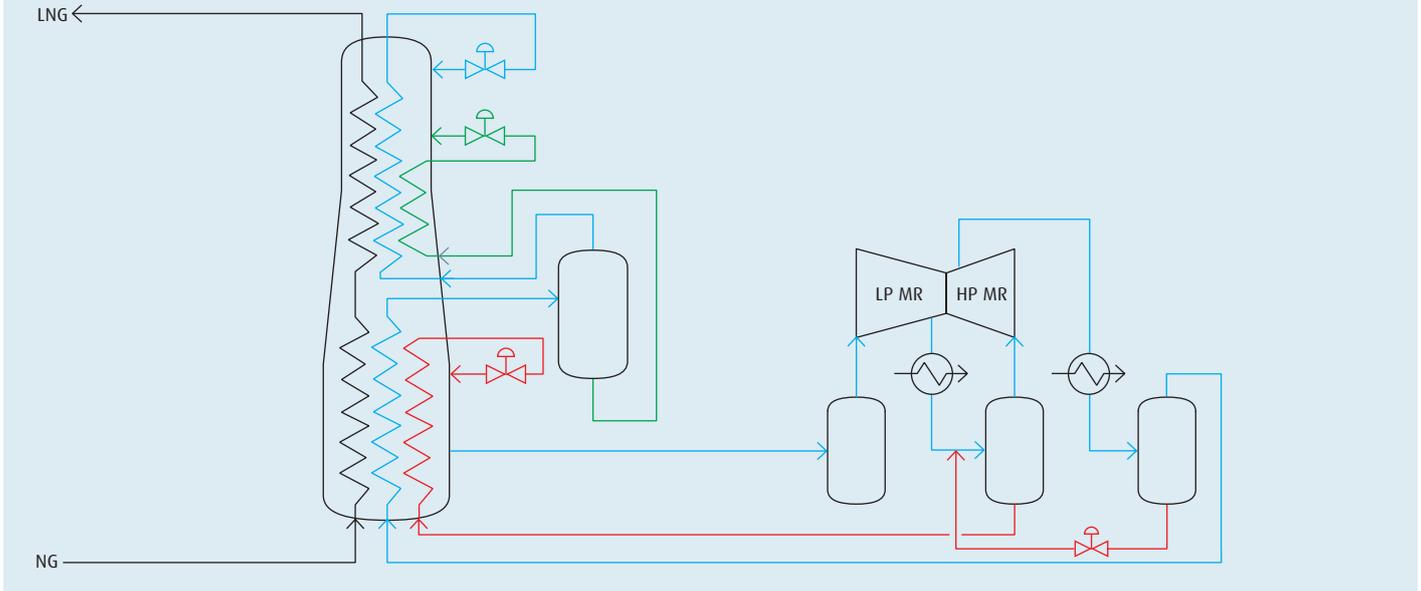
### Small-scale StarLNG process with single mixed refrigerant cycle LIMUM and PFHE (coldbox)



### Small-scale StarLNG process with nitrogen double expansion cycle and PFHE (coldbox)



## Mid-scale StarLNG process with LIMUM3 liquefaction process using CWHE



### Mid-scale StarLNG

Building on the StarLNG concept, the mid-scale LNG designs support capacities ranging from 600 to 3000 tpd (equivalent to approx. 1 mtpa). Here we use our LIMUM3 liquefaction process based on our proprietary coil-wound heat exchangers (CWHEs). This avoids multiple parallel blocks of PFHEs, which can result in complex piping arrangements, higher plot space requirements and flow distribution issues.

#### Key highlights

- CWHEs offering extremely robust design and ease of operation
- Same exchangers as those used for most world-scale plants
- Extended for liquefaction capacities >1 mtpa per train
- Three separate refrigerant fractions provide refrigeration power separately for the pre-cooling, liquefaction and sub-cooling cycles
- Part load capability of less than 31%

### Extended mid-scale StarLNG

Based on its mid-scale StarLNG plants, Linde has developed a concept for a new class of mid-scale LNG production plants with 1–2 million tpa liquefaction capacity. These plants are becoming increasingly attractive for the international LNG market as they combine the strengths of both mid-scale and world-scale plant types and markets. The concept offers economies of scale relative to smaller LNG plants while still benefiting from components of well-proven sizes that do not stretch technical limits. Furthermore, it has the potential to reduce construction costs especially in remote areas or high-cost countries by applying a fully modularised approach.

#### Highlights

- Reduced processing effort for pre-treated feed gas
- Economies of scale relative to small-scale LNG plants, with reduced construction costs
- Proven components and dimensioning without stretching technical limits
- Multiple sourcing flexibility with no supplier lock-in or cost component qualification programmes
- Significant reduction in overall project risk and complexity compared with world-scale projects
- Compact modular design

**Extended class**  
of mid-scale LNG plants with  
1–2 mtpa liquefaction capacity.



Mid-scale StarLNG plant with 1,200 tpd liquefaction capacity in Jimunai, China.

## StarLNGL

Around the world, Linde Engineering customers secure valuable revenue streams by recovering ethane and propane from natural gas liquids (NGL). With StarLNGL, Linde has developed a process that integrates LNG production into NGL recovery plants. The StarLNGL concept takes advantage of the existing cryogenic conditions in an NGL plant, allowing customers to efficiently generate LNG while simultaneously increasing NGL production rates. Building on our proven StarLNG modularisation concept, StarLNGL is an integrated NGL and LNG technology ideal for existing or new NGL recovery plants.

Offering a very short payback period, StarLNGL liquefaction facilities enable NGL customers to generate additional revenue from valuable LNG feedstocks.

## Highlights of StarLNGL

- Lower capital expenditure relative to standalone LNG unit
- Elimination of redundant infrastructure
- Integration into new or existing NGL plants
- Seamless integration with NGL technologies such as CRYO-PLUS™, GSP and RSV\*
- Zero impact on availability and reliability of the NGL plant
- Higher ethane and propane recovery with increased plant throughput
- Compact modular design

\* Gas Subcooled Process and Recycle Split Vapour

# References.

## Natural gas liquefaction plant in Bergen (Norway)

Client	Naturgass Vest
Process	LIMUM closed mixed refrigerant cycle process with plate-fin heat exchanger
Capacity	120 tpd
Scope of work	Engineering, procurement, construction, start-up supervision
Start-up	2003



## Natural gas liquefaction plant in Kwinana (Australia)

Client	Wesfarmers Gas Limited
Process	LIMUM closed mixed refrigerant cycle process with plate-fin heat exchanger
Capacity	175 tpd
Scope of work	Engineering, procurement, construction, start-up supervision
Start-up	2008



## Natural gas liquefaction plant in Montreal (Canada)

Client	GazMetro
Process	N <sub>2</sub> expander with coldbox
Production capacity	390 tpd
Scope of work	Basic engineering, detail engineering, procurement, module construction, start-up assistance
Start-up	2017



## Natural gas liquefaction plant in Shanshan (China)

Client	Xinjiang Guanghui LNG Development Co. Ltd.
Process	LIMUM closed mixed refrigerant cycle process with coil-wound heat exchanger and gas turbine to drive MRC compressor
Capacity	1,300 tpd (430,000 tpa)
Scope of work	Engineering, procurement of main equipment, construction supervision, start-up supervision
Start-up	2004



### Natural gas liquefaction plant in Jimunai (China)

Client	Xinjiang Jimunai Guanghui LNG Development Co. Ltd.
Process	LIMUM closed mixed refrigerant cycle process with coil-wound heat exchanger and electric motor to drive MRC compressor with integrated nitrogen rejection unit
Capacity	1,200 tpd (400,000 tpa)
Scope of work	Engineering, procurement of main equipment, construction supervision, start-up supervision
Start-up	2013



### Natural gas liquefaction plant in Beiniuchuan (China)

Client	Inner Mongolia Huineng Coal Chemical Co. Ltd.
Process	LIMUM closed mixed refrigerant cycle process with coil-wound heat exchanger and steam turbine to drive MRC compressor
Capacity	810 tpd (276,000 tpa)
Scope of work	Engineering, procurement of main equipment, construction supervision, start-up supervision
Start-up	2015



### Natural gas liquefaction plant in Bazhong (China)

Client	Sichuan Tongkai Energy Science & Technology Co. Ltd.
Process	LIMUM closed mixed refrigerant cycle process with coil-wound heat exchanger and electric motor to drive MRC compressor
Capacity	960 tpd (320,000 tpa)
Scope of work	Engineering, procurement of main equipment, construction supervision, start-up supervision
Start-up	2015



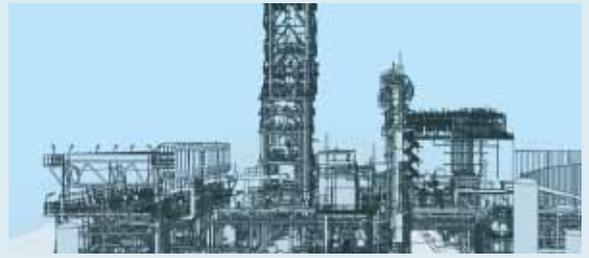
### Natural gas liquefaction plant in Jincheng (China)

Client	Jincheng Huagang Gas Co. Ltd.
Process	LIMUM closed mixed refrigerant cycle process with coil-wound heat exchanger and electric motor to drive MRC compressor
Capacity	1,340 tpd (446,000 tpa)
Scope of work	Engineering, procurement of main equipment, construction supervision, start-up supervision
Start-up	2015



### Natural gas liquefaction plant in Xinghe (China)

Client	Inner Mongolia Xingjie Natural Gas Co. Ltd.
Process	LIMUM closed mixed refrigerant cycle process with coil-wound heat exchanger and electric motor to drive MRC compressor
Capacity	1,360 tpd (447,000 tpa)
Scope of work	Engineering, procurement of main equipment, construction supervision, start-up supervision
Start-up	expected 2018



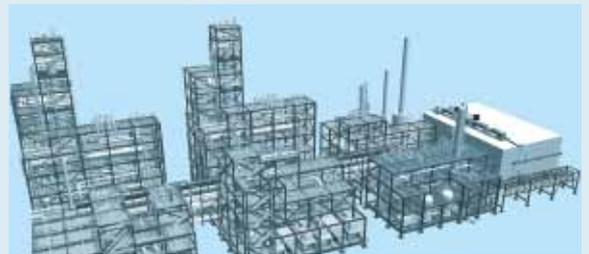
### Natural gas liquefaction plant in Stavanger (Norway)

Client	Lyse Gass AS
Process	LIMUM closed mixed refrigerant cycle process with coil-wound heat exchanger
Capacity	900 tpd
Scope of work	Engineering, procurement, construction, start-up supervision
Start-up	2010



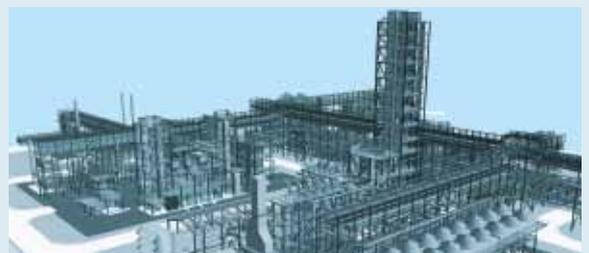
### Natural gas liquefaction plant in British Columbia, Canada

Client	Pacific Oil & Gas
Process	LIMUM closed mixed refrigerant cycle process with coil-wound heat exchanger
Capacity	2.1 mtpa
Scope of work	Engineering, procurement, construction, start-up supervision
Start-up	expected 2019



### Natural gas liquefaction plant in Portovaya, Russia

Client	Gazprom
Process	LIMUM3 with coil-wound heat exchanger
Capacity	1.5 mtpa
Scope of work	Engineering, procurement, start-up supervision
Start-up	expected 2019





Mid-scale LNG plant with up to 0.8 mtpa liquefaction capacity located in Bintulu, Malaysia, on stream since 2015 and featuring Linde's LIMUM closed mixed refrigerant cycle process with coil-wound heat exchanger.

## Monetising flare gas through the reliquefaction of boil-off gas.

At the end of 2012, Malaysia LNG Sdn Bhd (MLNG), a subsidiary of Malaysian oil and gas company Petronas, placed an engineering, procurement, construction and commissioning (EPC) contract with Linde Engineering for the world's largest boil-off gas (BOG) reliquefaction plant, adding up to a maximum of 0.8 mtpa of LNG capacity to the existing Bintulu LNG complex.

The Petronas LNG complex in Bintulu, Sarawak, comprises three LNG plants owned and operated by Petronas' joint venture (JV) companies. With a total of nine production trains and a combined capacity of more than

24 mtpa, the complex is one of the world's largest LNG production facilities.

This BOG concept helps to improve LNG plant efficiency and productivity overall by capturing BOG that evaporates from LNG storage tanks, reliquefying it and routing it back to storage. In addition, this reliquefaction concept helps improve the carbon footprint of LNG complexes by minimising greenhouse gas (GHG) emissions.

Working on site, an integrated commissioning team comprising MLNG operating staff and Linde Engineering personnel successfully

started up the plant and ensured stable, controllable and profitable operation.

### Highlights

- Capacity between 0.3 mtpa and 0.8 mtpa (similar to a mid-scale LNG plant)
- Single mixed refrigerant (SMR) cycle
- Good efficiency levels (typically 350 kWh/t)
- Minimum rotating part count
- Excellent safety records



Mid-scale StarLNG plant with 813 tpd liquefaction capacity in Beiniuchuan, China.

# StarLNG – a closer look.

## StarLNG feed gas design envelope

In order to cover a wide range of real-life LNG projects and cope with most pipeline gas specifications, a wide feed gas envelope was created as the design basis for the StarLNG concept. The feed gas compositions were selected to cover almost all known pipeline gas compositions. Pipeline gas was used (dew point controlled, limited heavy hydrocarbon content (HHC), etc.) because the major technical effort required to pre-treat well gases (as is done in world-scale LNG plants) is often not deemed economically viable for small- to mid-scale LNG projects.

- Feed gas variations between 0.8 and 20 vol% N<sub>2</sub>
- Feed gas pressure varied between 30 and 60 bar (abs)
- Feed gas compression for lower pressures, let-down station for higher pressures
- Feed gas temperature varied between 0 and 50°C

Generic feed gas conditions are selected to cover almost all known pipeline gas compositions.

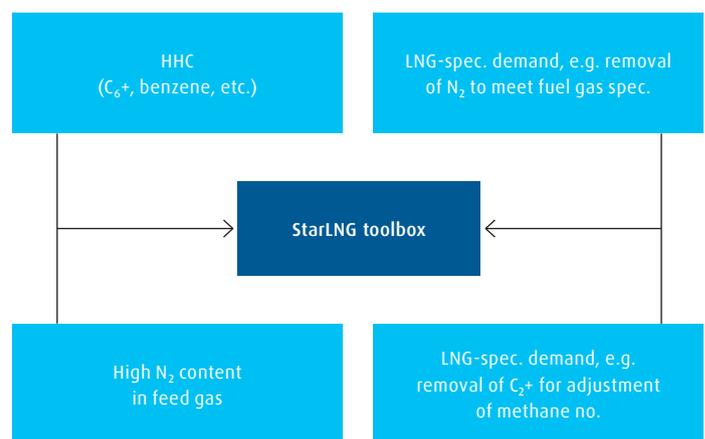
## Toolbox approach for different feed gas qualities

If a feed gas contains heavier hydrocarbons (pentanes and heavier) and aromatic material (BTX), the gas will freeze unless the concentration of these components has been lowered sufficiently. The simplest way to achieve this is with a separator (HHC KO drum) in the feed path of the main cryogenic heat exchanger. Alternatively, a separation column (demethaniser) can be installed to remove heavy hydrocarbons.

Both alternatives are part of the StarLNG toolbox, and are readily available for deployment. StarLNG plant components and toolbox options also include nitrogen rejection for high N<sub>2</sub> content depending on availability/capability of a flash gas sink (e.g. gas turbine). This highly flexible, simple toolbox concept with its wide feed gas envelope and choice of settings enables small- to mid-scale, adaptable LNG plant designs supporting over 90% of real-life projects.

## Toolbox matrix for different feed gas qualities

Having extensively screened all relevant feed gas conditions, Linde engineers developed a versatile but simple standard to support a wide envelope of operating parameters.



## StarLNG™ design envelope with generic feed gas compositions

vol%	Base case	N <sub>2</sub> -rich	HHC-rich
N <sub>2</sub>	0.85	5.00	0.80
CO <sub>2</sub>	4.80	2.00	2.00
CH <sub>4</sub>	88.71	90.87	89.13
C <sub>2</sub> H <sub>6</sub>	5.25	1.86	4.86
C <sub>3</sub> H <sub>8</sub>	0.36	0.23	1.94
C <sub>4</sub> H <sub>10</sub>	0.02	0.04	0.78
C <sub>5</sub> H <sub>12</sub>	0.00	0.00	0.31
C <sub>6</sub> <sup>+</sup>	0.01	0.00	0.18
<b>Total</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>





Gas turbine driver for MRC compressor.

### Liquefaction and storage pressure

Unlike the large-scale LNG business with its downstream LNG distribution chain at atmospheric pressure using LNG carriers, the small-scale LNG business may require pressurised storage facilities for a number of reasons:

- Economical pressurised storage tanks can be designed for low storage capacity needs
- Downstream LNG distribution (by ship/truck) to end consumers is typically based on pressurised gas

### Drive concept for main refrigerant compressors

In principle, the small- to mid-scale StarLNG concept supports both electric motor drives for the main refrigerant compressor(s) and gas turbine drives.

However, for smaller LNG plant capacities, gas turbines are only available in a limited number of discrete sizes, whereas electric motors offer higher design flexibility with regard to liquefaction capacity. Other advantages of an electric motor drive include:

- Higher plant efficiency
- Shorter delivery times than gas turbine drives
- Less impact on LNG production capacity from ambient temperature swings
- Less plant maintenance and fewer turnarounds
- More profitable and environmentally friendly plant operation if low-cost, reliable electricity is available – for instance from a nearby hydroelectric facility

**20%** of energy savings can be achieved by using pressurised storage tanks.



LNG storage tank at LNG terminal in Nynäshamn, Stockholm, Sweden.

## LNG storage concepts

Linde is one of the very few companies in the world that can offer all LNG storage tank technologies typically applicable for small- and mid-scale LNG plants. Our engineers are happy to advise you on the best fit for your needs depending on your:

- Storage volume
- Storage pressure
- Safety requirements
- Downstream distribution chain
- Plant operating conditions

Storage options include the following:

- Flat-bottom tank (larger capacities are feasible) 2,000–40,000 m<sup>3</sup>
- Spherical tank 1,000–8,000 m<sup>3</sup>
- Bullet tank 100–1,000 m<sup>3</sup>

For small- to mid-scale LNG plants, the storage tank is typically designed to hold a 3- to 10-day production volume in order to have adequate buffer and flexibility for the downstream supply chain.

Depending on storage pressure, the following tank types are recommended:

- Atmospheric pressure → flat-bottom tank
- Pressurised → sphere/bullet tank

Rising transport volumes mean the safety of LNG storage tanks has become a top priority worldwide. Double integrity or – as is more common nowadays – even full integrity LNG storage tanks have become the global standard. Depending on the safety features of an LNG tank, the following scenarios are conceivable in the unlikely event of a tank rupture:

- Single integrity tanks → uncontrolled LNG spill to ambient air
- Double integrity tanks → LNG spill into secondary containment (dike, pit), but uncontrolled vapour release to ambient air
- Full integrity (containment) tanks → no LNG spill to ambient air, only controlled gas release (recommended for plants located in densely populated areas)

## Truck loading

The small-scale StarLNG concept comprises truck loading facilities for delivering LNG to the merchant market by specialised trucks. The concept is based on the following:

- Simultaneous and independent loading of two trucks at two loading bays
- 50 m<sup>3</sup>/h loading flow rate per bay
- 50 m<sup>3</sup> typical LNG truck working volume
- 6–10 kPa(g) typical LNG truck mechanical design pressure
- Expandable for more loading bays, if needed
- Alternatives for LNG ship loading and regasification for export by pipeline (peak shaver)

Linde delivers LNG storage tank installations tailored to **individual** customer requirements.

*“Understanding our customers’ needs, offering a value-creating solution and executing are key capabilities at Linde Engineering.”*

Jürgen Nowicki  
Managing Director & Member of the Board of Directors, Linde Engineering Division

**80%**  
of piping work already  
completed in module assembly.

## Construction strategy.

### Modularised construction approach

Especially in remote areas or environments with high construction costs, our strategy is to reduce on-site construction work by supplying largely pre-fabricated assemblies to the site.

The larger and more complete the module, the lower the on-site hook-up cost. However, transport costs rise with module sizes and at a certain point – depending on local limitations – transportation becomes simply impractical.

Unlike some of our competitors, we assume responsibility for the entire EPC scope and thus not only optimise module fabrication cost, but also overall EPC cost. Our modularised construction approach

is adaptable to support project-specific conditions such as:

- Cost and availability of on-site labour
- Geographically suitable and best-cost workshop alternatives

### Road-transportable module concept

StarLNG includes a fully modular design of the base case plant. The module size has been chosen to enable road transportation (possibly involving escorts or extra permits) in many places, while also aiming for minimum hook-up work on site and moderate crane capacity requirements.



Linde manufactures PFHEs at its sites in Germany and China.

# Execution excellence – every step of the way.

## Plant safety

At Linde, we have a strong focus on and excellent track record in quality, health, safety and environmental (QSHE) protection. This has always been a top priority when planning and building our plants all over the world.

### Safety standards

- Same rigorous safety standards as world-scale LNG plants (codes, standards, safety practices)
- Generic piping and instrumentation diagrams validated in HAZOP (Hazard and Operability Study)
- Generic plant layout validated in QRA (Quantitative Risk Assessment)
- Various LNG storage alternatives validated in generic QRA
- Hazardous area classification
- Depressurisation concept
- Fire protection concept

## Long-standing experience in cryogenic plant design

We have a large engineering and project execution workforce for the implementation of engineering, procurement and construction (EPC) projects worldwide. Project managers with extensive experience in complex multi-national/multi-partner projects supported by advanced tools and methods for project control are the best way to ensure the success of your project.

We have gained vast experience with modularisation concepts during the many EPC turnkey, lump-sum contracts we have successfully executed, including Snøhvit and Kwinana.

## Manufacturing excellence – made in-house

We design and manufacture all key and proprietary cryogenic components required for LNG plants in our own fabrication workshops. The fact that the plant and process engineering as well as the

manufacturing team are integral parts of one company ensures your project is seamlessly executed.

## Commissioning, training and customer service

Skilled commissioning teams on site ensure smooth start-up and hand-over of the plant to your team. And our support does not stop when your plant goes on stream. Our service specialists covering every engineering discipline will readily answer any requests you may have. They also support plant modifications and revamps, maintenance and repair, spare parts, operational support such as troubleshooting, immediate repairs, expert reviews for plants as well as operator training over the entire lifecycle.

## Global sourcing and localisation

Worldwide staffing and training, global procurement and fabrication capabilities and a broad partner ecosystem bring maximum flexibility to your project.

## How to get your Star

Please contact our Linde Engineering head office or your local representative office for more information about StarLNG or to get a quote for your individual small- to mid-scale LNG project. To achieve maximum benefit from our pre-engineered StarLNG toolbox, we recommend completing a final Basis of Design (BoD) document at an early stage during the bidding phase. This document is required to develop a Process Design Package (PDP), including a Process Flow Diagram (PFD), heat and material balance and process datasheets, before the contract award phase. This enables us to order long-lead equipment like compressors and cryogenic heat exchangers as soon as you place your order.

You can rely on our long-standing experience in constructing and operating cryogenic plants to protect your investment.

**100%** of our time is focused on plant safety.

Great service is all about three things – true understanding of our customers and their business, creative solutions and the dedication and hard work to deliver.

# Your partner for the production and processing of gases

## Delivering reliable process plants for maximum capital efficiency

Linde has been optimizing gas processing technologies for 140 years, successfully delivering more than 4,000 plant engineering projects around the globe. Favoring trusted, lasting business relationships, the company collaborates closely with customers to enhance plant lifecycle productivity and innovate process flows. The company's proven gas processing expertise plays an indispensable role in the success of customers across multiple industries – from natural gas and oil refining through petrochemicals and fertilizers to electronics and metal processing.

## Operational excellence along the entire plant lifecycle

We work closely with our customers to gain an in-depth understanding of individual needs. Building on the unique synergies of Linde as an integrated plant operator and engineering company, Linde offers innovative process technologies and services to exceed our customers' reliability and profitability expectations. This commitment to innovation extends along the entire plant lifecycle. The LINDE PLANTSERV® service team supports customers every step of the way – from maintenance and repairs to full revamps. Leveraging the latest digital technologies to offer on-site and remote operational and support services, we consistently take asset performance to the next level.

## Making the impossible possible

From the desert to the Arctic, from small- to world-scale, from standardized to customized designs, Linde's engineering specialists develop solutions that operate under all conditions. The company covers every step in the design, project management and construction of gas processing plants and components. Customers can always rely on Linde to deliver the plants, components and services that fit their needs best – anywhere in the world.

## Discover how we can contribute to your success at [www.linde-engineering.com](http://www.linde-engineering.com)

Get in touch with our natural gas plant team:

Phone +49 89 7445-3434, inquiry: [www.linde-engineering.com/contact](http://www.linde-engineering.com/contact)

## Core competencies at a glance

### Plant engineering

- Air separation plants
- LNG and natural gas processing plants
- Petrochemical plants
- Hydrogen and synthesis gas plants
- Adsorption plants
- Cryogenic plants
- Carbon capture and utilization plants
- Furnaces, fired heaters, incinerators

### Component manufacturing

- Coldboxes and modules
- Coil-wound heat exchangers
- Plate-fin heat exchangers
- Cryogenic columns
- Cryogenic storage tanks
- Liquefied helium tanks and containers
- Air-heated vaporizers
- Water bath vaporizers
- Spiral-welded aluminum pipes

### Services

- Revamps and plant modifications
- Plant relocations
- Spare parts
- Operational support, troubleshooting and immediate repairs
- Long-term service contracts
- Expert reviews for plants, operations and spare part inventory
- Operator training

