Linde masterminds the Norway to Sweden LNG supply chain with mid-scale solutions

Maxim Schwarz, Linde Engineering Pullach, near Munich, Germany

LNG is fast becoming the fuel of choice for the generation of electricity. It is also increasingly being used as a fuel for transportation, which is crucial for tomorrow's markets.

It is now the favoured worldwide delivery method for natural gas because LNG can be produced at remote locations and distributed to end-users quickly and easily.

Not only have growing economies such as Brazil and China been increasingly using LNG to meet basic fuel needs, but also countries such as Norway and Sweden are now using LNG as a portable fuel.

The beauty of small to mid-scale LNG applications is the rapid response time between idea sharing and turn-key plant delivery.

New model

Response time is crucial in businesses where energy commodity prices are becoming even more volatile.

In such an uncertain market environment, energy production and distribution must be secured, but not by using old business models.

LNG began as frontier technology for plants and shipping in the 1960s and has been developing ever since in scale, location and customer base.

Regarding LNG supply, Norway seems to be the most suitable partner for small LNG costumers in Northern Europe.

The LNG infrastructure in Norway already exists and new liquefaction facilities like the small-scale Stavanger LNG plant started commercial operation only a short time ago.

Norway also hosts Europe's only baseload LNG plant at Hammerfest, which liquefies feed-gas delivered by pipeline from the Snohvit field in the Barents Sea.

The Stavanger LNG plant has operated by Skangass since 2010. The yearly production capacity is 300.000 tonnes per annum.

In the near future, a second liquefaction Train will be built to increase production to 600,000 tonnes per annum.

The Stavanger LNG plant is operated in base-load mode and employs intermediate storage of the LNG product in an insulated tank before it is loaded to road tankers or small LNG carriers.

The trucks then carry the LNG over long distances to satellite stations in various cities of Norway.

After vaporization of the LNG at these stations the natural gas is finally distributed to a variety of industrial and private consumers.

Standards

Small to mid-scale LNG plants do not compromise on safety, reliability, robustness or efficiency in comparison to world-scale LNG facilities, while execution risks and capital requirements are significantly lower.

The permitting standards themselves are world-class, especially in a country such as Norway, which is a hydrocarbons production world leader.

Linde Engineering successfully delivered to the client a fully operational LNG plant according to the demanding Norwegian/European Standard NS EN 1473.

Due to the nearby residential settlement the Stavanger LNG plant must fulfill the challenging noise requirement of 53 db at Battery Limit.

Beside the high permitting standard required in Norway, the Stavanger LNG project was facing further challenges, as it is located on an old refinery site within an industrial zone.

This resulted in limited available plot space of only 68m by 47m. Numerous residence reservations/objections had to be managed and overcome by Linde and the client.

Design

The plant consists of natural gas treatment and liquefaction, LNG storage tank, one LNG ship loading and one truck filling station.

The natural gas is cooled, liquefied and sub¬cooled in a coil-wound heat exchanger by a most highly efficient single mixed refrigerant cycle.

This cycle provides cold temperatures by Joule-Thomson expansion and liquid vaporization of the mixed refrigerant within the shell of the CWHE at different pressure levels.

The refrigerant cycle is recompressed in an electric motor-driven integrally geared turbo compressor.

The mid-scale LNG plant above, with 900 tonnes per day net liquefaction capacity, is located in Stavanger, Norway, and uses the Linde processing technology

The liquefaction process is based on Linde's robust single mixed refrigerant cycle, which contains the components nitrogen, ethylene, propane, butane, pentane and a portion of the compressed tank return gas (Linde patent).

Infrastructure

Plot space requirements of mid-scale LNG plants differ significantly from world-scale LNG projects.

A mid-scale LNG plant including buildings, flare, LNG tank and utilities requires a plot space in the magnitude of 50.000 square metres, while large base-load LNG plants require in excess of ten times more plot space.

Mid-scale LNG projects are fast-track projects compared with larger ventures. Securing off-take rights from existing natural gas pipeline systems prior to starting serious plant engineering activities takes comparatively little time.

All in all it may take around 15 months to properly prepare for a final investment decision from commencement of plant engineering activities.

Early

The Stavanger plant achieved the status "commissioning completed/ready for LNG production" in August 2010, one month ahead of schedule.

The construction phase was supported by the "Integrated Completion Management System (ICM)", a newly developed and customized software package which allowed the detailed follow- up and exact progress-measuring of all relevant construction activities.

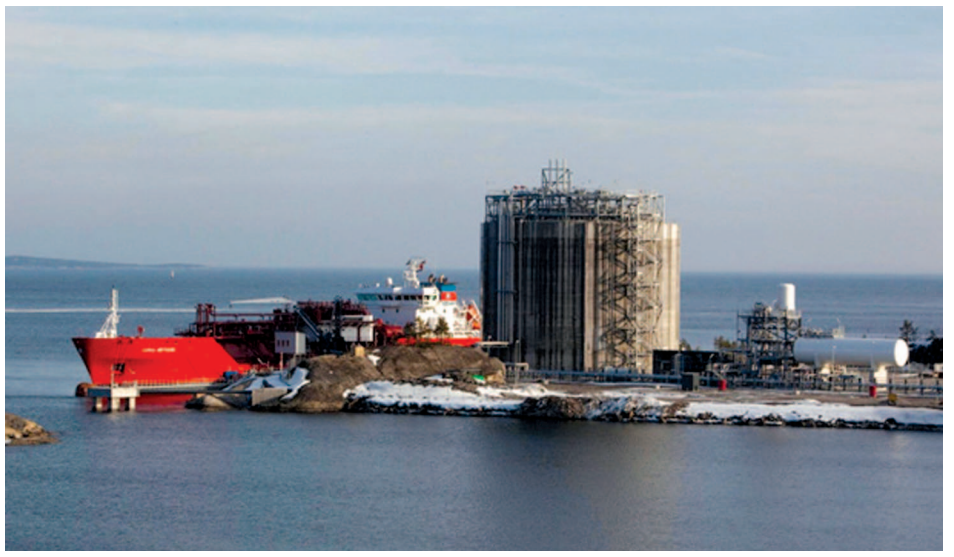
Module sizes and weights are obviously considerably smaller for mid-scale LNG plants where even the tallest modules would not exceed a footprint of 20m x 20m and weights would not exceed 1,000 metric tons.

Such sizes and weights can be easily lifted without being limited to only a few available special cranes, as would be the case for bigger modules being applied for the larger plants.

Standardization

Linde has standardized its project execution concept by applying the following measures:

- Safety as for world-scale LNG: QRA, HAZOP, same codes & standards
- Efficient process with low investment and operational cost (Coldbox/PFHE)
- Modularized units for pre-treatment, process and main pipe racks
- Toolbox concept with many options (MR-compressor and driver selection, etc.)



The small LNG carrier 'Coral Methane' is owned by Norway-based I.M. Skaugen and is playing its part in linking the value chain from Norway to Sweden

- Dynamic simulation of MR cycle process
- High degree of automation incl. remote control
- Frame agreements with sub-suppliers for main rotating equipment
- Procurement and manufacturing in best-cost countries

The transport of the sales gas to the costumer is done to a large amount by multigas LNG carriers of Norway-based I.M. Skaugen.

Delivery

The LNG storage capacity of the two ships is 10,000 and 12,000 cubic metres. The capital-efficient ships were available from 2009 and the supply chain required much lower infrastructure costs compared with large-scale LNG applications.

Especially the possibility to adjust the infrastructure to the demand quickly is an advantage compared with gas supply from pipelines.

Depending on the distance one 10,000 cubic metres capacity carrier can move up to 500,000 tonnes per annum.

Adding additional vessels to the supply chain is relatively easy. In an increasing market for gas the small to mid-scale LNG concept is an option for customers far from pipeline connections.

Fuel

Additionally, it is a concept to monetize stranded gas on the production side which enables the exploitation of gas fields which are too small for traditional large-scale LNG carriers.

Today LNG carriers can use high-efficiency gas engines. This development enabled the introduction of LNG as ship fuel.

Linde's subsidiary, Cryo AB of Gothenburg, Sweden, recently built a mid-scale LNG import terminal at Nynäshamn in Sweden with a 20,000 cubic metres capacity full-containment LNG storage tank. The facility receives the Norwegian LNG.

The Swedish facility is located 60 kilometres south of the capital Stockholm and is the nation's only terminal.

Linde's sister company, AGA Sweden, is the owner and operator of this small terminal.

AGA is engaged in the whole value chain of small-scale LNG, in terms of producing and shipping it to the terminal, before distributing it by truck to the customers.

These are the main benefits for building an LNG plant of a small or mid-scale size:

Fast-track EPC schedule

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

Lowest Capex

- Standardization with toolbox approach allows for customizing plants, while maintaining standardization benefits
- Global organization offers engineering and procurement capabilities in best-cost countries
- Proven competence in EPC projects and operator experience

Lowest Opex

- Focusing on HSE to make small/mid-scale LNG as safe as for world-scale plants
- Ability to execute plants in most challenging HSE-environment, thereby enabling our clients to use most cost-efficient plant location
- Simple and robust to operate mixed refrigerant technology with highest energy efficiency

Small and mid-scale LNG is flexible, can cover widely dispersed demand at modest investment cost, is suitable for relatively small volumes of gas, and allows for competition.

It can work either as a market-opener to be replaced with pipeline supplies when the appropriate level of demand has been reached, or as a long-term but adaptable solution for supplying gas.

Conclusions

The technology will enable industrial users, such as refineries and power plants, in stranded markets to switch to cost-efficient and environmentally-friendly gas.

The use of LNG is also moving into new markets like marine fuels, where its unsurpassed environmental benefits can significantly reduce emissions.

The demand for natural gas in Norway and Sweden is projected to increase in the near future. The Stavanger LNG plant connecting with the Nynäshamn LNG receiving terminal has opened a new era in meeting the increasing demand in this area.

Mid-scale LNG plants are an economically interesting alternative to the large-scale plants. While export projects appear to require plant capacities above 500,000 tonnes per annum, merchant LNG projects are economically attractive.

With the introduction of such plants, combined with the respective transport infrastructure, natural gas markets can be dynamically introduced and developed.

LNG is now in a phase of strong growth in many parts of the world. More and more of the "stranded" customers are now getting access to gas or LNG in places not covered by traditional supply chains. ■