# Techniques used in LNG production plants continue to develop and adapt

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The liquefaction process for LNG has been a key area that has constantly required continued development to save costs and increase LNG plant capacity.

This review cover the current LNG technology and how it is being further developed. It was expected that by the end of 2012, there will be 100 liquefaction Trains on stream worldwide with total capacity of 297.2 million tonnes per annum.

The majority of these Trains use either APCI or Cascade technology for the liquefaction process.

The other processes, used in a small minority of some liquefaction plants include Shell's DMR technology and the Linde technology.

## Most used

APCI technology is the most used liquefaction process in LNG plants: out of 100 liquefaction Trains on-stream or under-construction, 86 trains, with a total capacity of 243 MTPA have been designed based on the APCI process: the second most used is the ConocoPhillips Cascade process which is used in 10 Trains with a total capacity of 36.16 MTPA.

The Shell DMR process has been used in 3 Trains with total capacity of 13.9 MTPA; and, finally, the Linde/Statoil process is used only in the Snohvit plant in Norway with 4.2 MTPA from a single train.

There is still high demand for LNG as the source of fuel to generate electricity and demand is expected to increase annually.

In order to meet this demand, LNG producers look for better options to maximize their production by optimizing their current plants. However, they need to consider several other factors for this option such that they shouldn't be subject to extra expenditure for increasing their plant's capacity.

## Five links

An LNG project represents a chain of capital-intensive investments, consisting of five links - field development, pipeline to on-shore, liquefaction facility, tanker transportation and the receipt/regasification terminal.

The liquefaction unit process has been accounting for up to 50 percent of total project cost of a liquefaction plant as shown in Figure 1.

One of the criteria for the selection of a liquefaction process is the capacity requirements. Designing a large plant and running it far below the capacity rates is a waste of investments and potentially could result in greater maintenance issues.

Economy of scale means maximizing profit based on fixed capital investment. Hence in order to fully take advantage of economies of scale, production must be maintained near capacity.

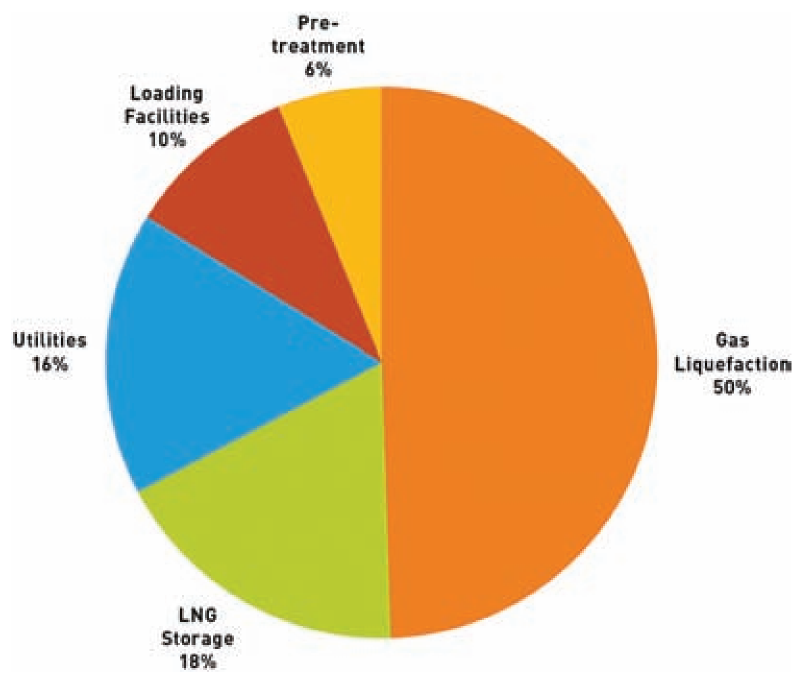


**Figure 1: Typical breakdown of liquefaction plant capital costs**

Since the production level is based on what the market will support, if the demand goes down, so would production.

## Waste

Likewise, if production of LNG is greater than demand, the sale price will weaken and production rates must be decreased which leads to further waste of capital investment.

Therefore, the selection of process technology is not only concerned with capacity and stability but also with maximizing profit based on market demand.

The refrigeration and liquefaction section is the key element of an LNG plant where it typically accounts for 30-40 percent of the capital cost of the overall plant.

Liquefaction of natural gas involves the transfer of energy from hot stream of natural gas to cold stream of the refrigerant via LNG heat exchangers.

During this process, the phase of natural gas changes from vapour to liquid. The basic principle of using refrigerant to liquefy the gas to cryogenic temperature of approximately (-160°C) is to match the cooling/heating curves of the process gas and refrigerant as closely as possible.

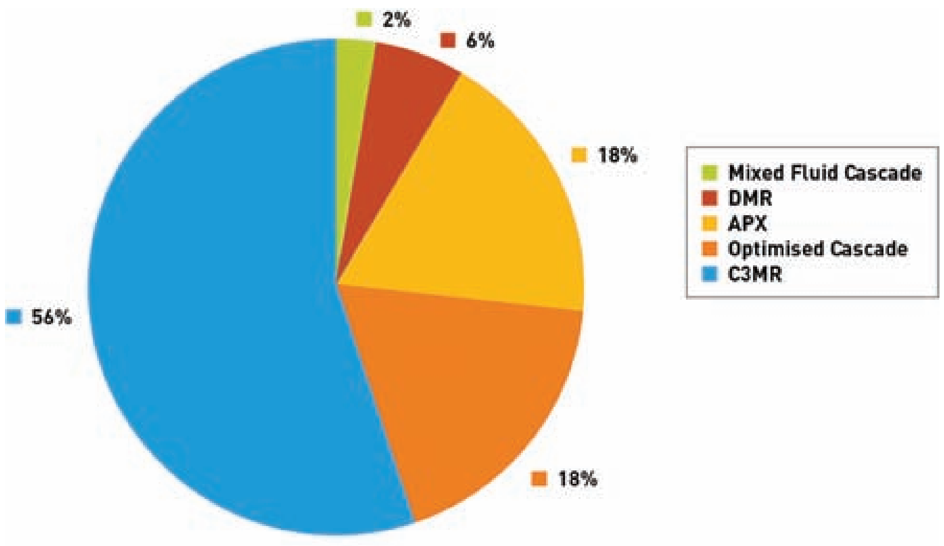


**Figure 2: The Evolution of LNG technologies worldwide applied natural gas liquefaction technologies**

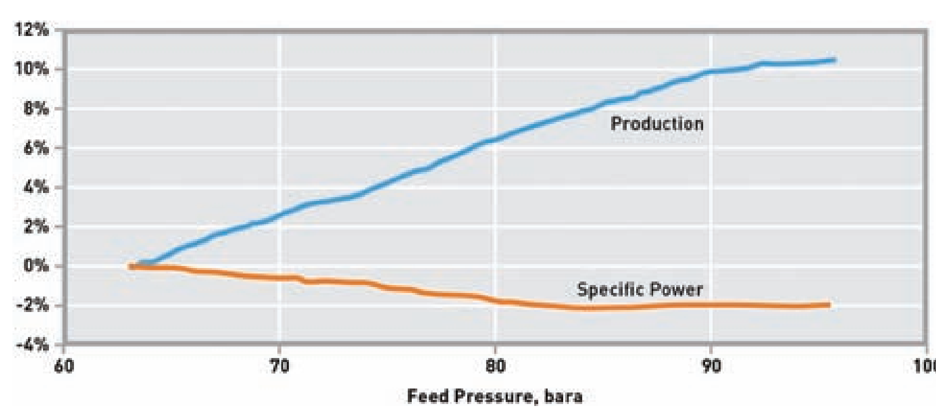


**Figure 3: The natural gas refrigerant cooling curve**