

RECEPTION

The Isle of Grain terminal - The return of LNG to the UK

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The conversion of the Isle of Grain from a peak-shave LNG plant to an importation terminal is underway with a scheduled construction completion date of January 2005. The commissioning of this terminal signals a return of large scale LNG importation to the United Kingdom after a 20-year absence.

The first LNG shipments to the UK began in 1959 when the then Gas Council - later to become British Gas - imported LNG from Louisiana in the USA on the Methane Pioneer to Canvey Island, the first LNG import terminal in the world. The success of this venture led to large-scale trade from Algeria to the Canvey Island terminal in the 1960's and continued to the mid 1980's, when the increased production of North Sea Gas reduced the UK's need for LNG imports. Canvey Island finally closed as an LNG import terminal in the mid 1990's.

Despite the loss of LNG importation capability LNG continued to play an important role in the UK gas infrastructure, where Transco (formerly part of British Gas) owned and operated five peak-shave installations, all of which are strategically located at the extremities of the UK gas network in order to provide system support in times of high demand or supply shortfall (see Figure 1).

One of these sites, the Isle of Grain (see Figure 2) is located in the Thames Estuary, on the opposite side of the Thames from Canvey Island, a few miles further down

river. The Isle of Grain is afforded deep-water river access by the River Medway, which connects into the Thames. Both the Isle of Grain and the River Medway have a long marine history dating back to the Tudor warships built from 1547 at the Royal Docks in Chatham, up to the more recent petrochemical usages as the BP Kent Oil refinery.

It was upon the closure of the Kent refinery that the potential of the Isle of Grain for LNG importation was first recognized, with the whole of the refinery land being purchased by the then British Gas for a potential importation terminal. Subsequently, planning permission was obtained for a baseload import terminal alongside the now operational Peak shave LNG plant. This project faltered due to the over-supply of gas from the North Sea and the opening of the UK market to gas competition, and the planning permission lapsed in the early 1990's.

In 1997 the British gas industry embarked on a period of major structural change with the demerger of Centrica plc from British Gas plc, which was then renamed BG plc. As part of Transco, the



Figure 2 - The Isle of Grain Peak-Shave site

Isle of Grain peak-shave site remained with BG plc. This was followed by a further demerger in 2000 when Transco went on to become the major business of Lattice Group plc.

More recently the rapid decline of the North Sea as a supply base for the UK has led to the Isle of Grain once more becoming the preferred site for LNG importation into the UK. The site benefits from deep-water access on the river Medway, connections to the high-pressure gas network and a remote location, whilst only being 50 miles (80 km) away from central London and the associated high demand for gas.

It is estimated that additional supplies will be required from 2005, with up to 10% of UK supply being imported. By 2010 the UK is projected to import up to half of its gas demand and that by 2020 imports may be as high as 90% (see Figure 3).

It is recognised that with the country becoming increasingly dependent on imports it is likely that some of this demand will be met by pipeline supplies from new Norwegian gas fields and additional European inter-connectors attracting pipeline gas from Russia, Algeria and Egypt. However it is also widely predicted that a significant volume of gas will be provided in the form of LNG. Active LNG projects in the UK presently account for 35 mtpa (million tonne per annum) or 50% of the projected gas shortfall.

It is debatable whether all the LNG planned for the UK market will arrive; however it is certain that LNG is returning to the UK as the Isle of Grain is under construction and scheduled for commissioning in early 2005 at an initial rate of 3.3 mtpa.

National Grid Transco's role in the UK energy markets

National Grid Transco (NGT) was formed in 2002 as a result of the merger of National Grid Group plc and Lattice Group plc. The merger formed an international energy delivery business, whose principal activi-

The Market for LNG

The UK is Western Europe's largest gas market with annual consumption equivalent to 94 billion cubic meters of gas per year. This demand has been sustained by the attractiveness of the fuel to domestic users for space heating along with its environmental benefits over other alternative fuels. More recently, significant market growth has occurred due to the attractiveness of natural gas to power generators. Now, over 50% of all power used in the UK is generated from natural gas. The demand for natural gas in the UK is expected to remain strong for the foreseeable future.

This demand for natural gas has historically been supplied from the North Sea reserves, with excess gas being supplied to Continental Europe. However, more recently, both industry players and UK government predict that the UK is des-

Figure 1. Map showing UK LNG peak-shave terminals

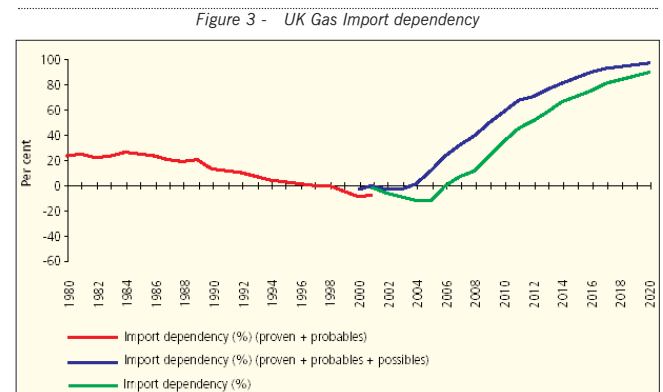
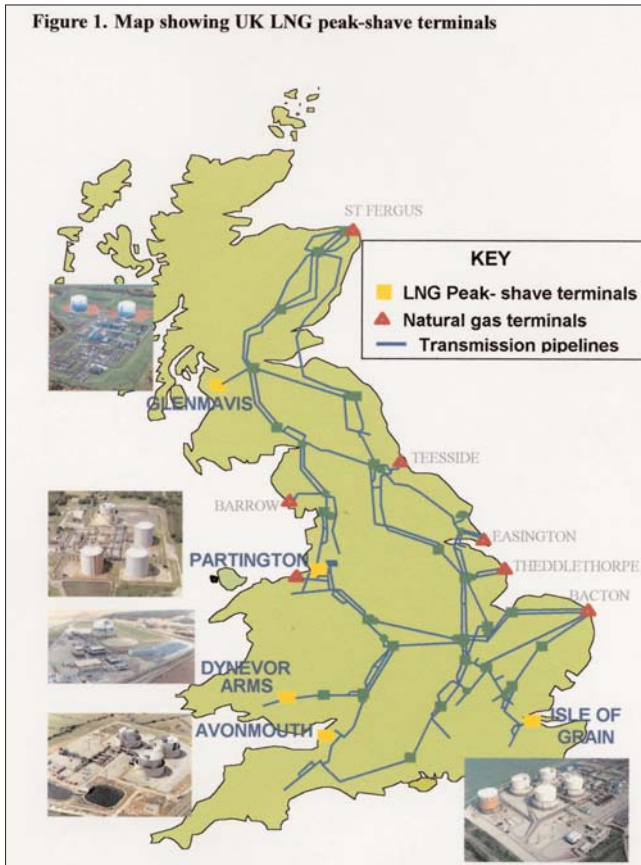


Figure 3 - UK Gas Import dependency

ties are in the regulated electricity and gas industries in the UK and USA. In the UK it owns and operates Britain's natural gas transmission and distribution system through its Transco subsidiary. NGT also owns and operates the high-voltage electricity transmission network in England and Wales, and is the largest electricity transmission and distribution network in the New England/New York region. The operation and ownership of primary energy infrastructure is viewed by NGT as core business.

Commercialisation and Development of Grain

The traditional length of time to bring an LNG project to market has been in excess of five years and in some cases over 10 years. The challenge in the UK was to convince the market that the Isle of Grain was in the ideal location and that LNG would once again be an economic means of supplying the UK. A further challenge was that Transco would continue to require some services from the new importation terminal to support the high-pressure gas transmission system in times of high demand or for support in an emergency.

The original concept for the project was that Grain LNG (a subsidiary of Lattice) would own capacity and trade LNG. However, following the merger of Lattice and National Grid, the role of owner/operator and allowing third parties to utilise the terminal was more aligned to the company's skill base. So the challenge was set for Grain to be the first LNG terminal in the UK for 20 years: it would need to compete with new pipeline projects and would need to convince third parties to underwrite the development.

An open process was launched to promote and sell capacity to approximately 25 companies in the LNG business. The delivery capacity offered to the market was 140 GWh/day (about 12 million m³(st)/day) along with the existing storage capacity. Through a series of presentations to the industry the major LNG players became convinced of the viability of the project and the market for LNG in the UK. Grain LNG received a large number of indications of interest for capacity based on the access terms.

The access term and agreement structure is based upon a multi-user format for the terminal. The user receives a

right to berth a LNG carrier, unload, have LNG stored and gas redelivered at the outlet of the terminal, with the operator having incentives to perform. It is the user's role to make arrangements with the Port Authority for access for the LNG carriers and with Transco for entry capacity into the UK system.

Through a process of bidding stages for

capacity, Grain LNG now has its first customer. A joint venture between Sonatrach and BP secured the initial capacity of 140 GWh/day (3.3 mtpa) at the terminal for the next 20 years. This signals the return of LNG from Algeria to the UK market after a 20-year absence.

The project has taken around two and a half years from inception to closure - an

impressive achievement during which a number of industry commentators predicted that the UK market was not ready for LNG in this timeframe.

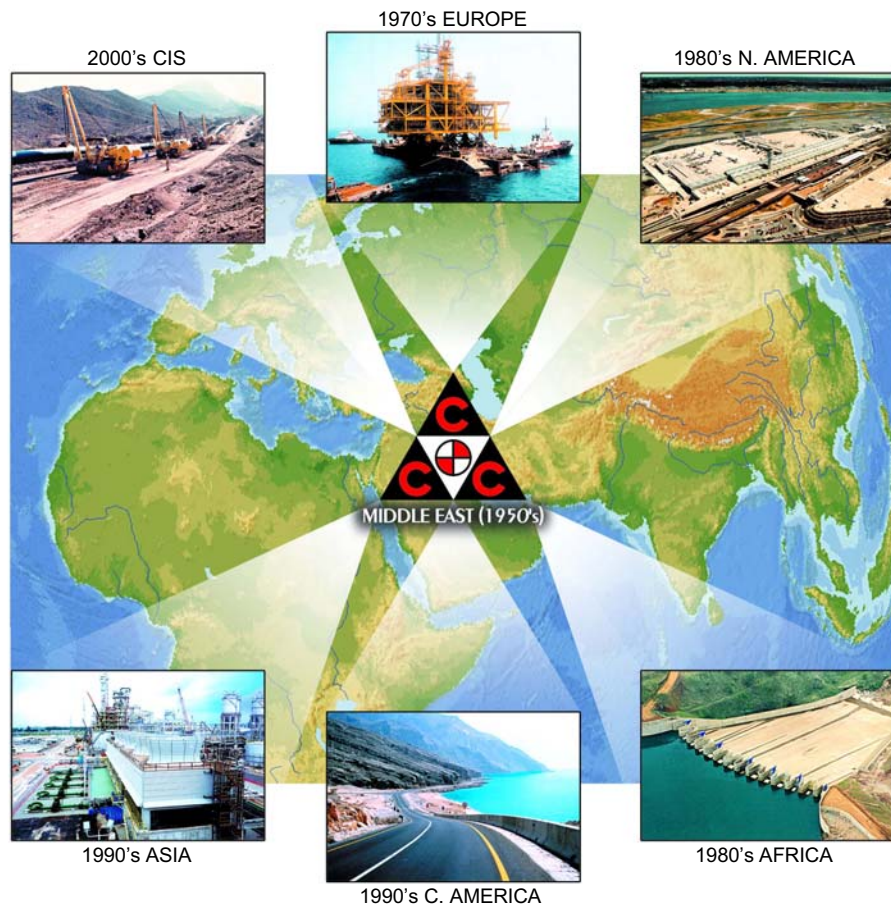
The Existing Peak-shave Plant

The Isle of Grain peak-shaving plant was commissioned in 1981 and has 200,000 m³

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RECEPTION

of LNG storage in four 9% nickel-steel double-containment tanks. The send out capacity is comparable in scale to many of the world's import terminals with a peak send out of 780 million std. ft³/day (22 million m³(st)/day). The LNG is produced on site by liquefying the pipeline gas in two small-scale liquefaction plants: an open-loop gas expander, taking advan-

tage of London's high demand for low pressure gas, and a closed-loop nitrogen expander plant which gives the plant an all-year ability to liquefy gas. The installation has a typical peak-shave configuration of slow fill with high send out capacity, taking 270 days to fill and only 5 days to empty the LNG storage.

The site has been continually opera-

tional since it came into service in 1981, providing services to both Transco as the system operator and to the gas shippers (suppliers) in the UK. Due to the strategic location of the site, even after importation commences the Isle of Grain will still provide an important role in the safety integrity of the UK pipeline systems. During conversion the site is remaining opera-

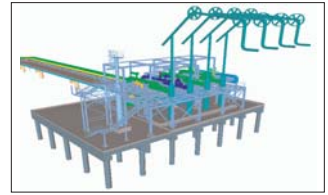


Figure 4 - 3-D schematic of Jetty

Faced with time-consuming on-site insulation after installing LNG pipes?

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Insulating pipes on-site is traditionally a time consuming and expensive process and maintenance costs are often significant. Pre-insulated pipes from Logstor are insulated in a factory environment ensuring unique and uniform insulation properties. Installation is extremely fast and the entire system needs no maintenance once installed. Such cost-effective systems have been the preferred alternative for many onshore and offshore projects all over the world for several years. Recently Logstor has further developed the technology to withstand the extreme requirements of LNG/LEG/ LPG applications. Numerous tests have confirmed that the pre-insulated pipe systems are capable of sustaining the stress and strain caused by the thermal expansion and contraction of the inner steel pipe, making them the ideal choice not only for terminals but also for carriers and other offshore LNG / LEG / LPG applications.

There are many advantages of pre-insulation over traditional post-insulation methods. The insulation is a 100% watertight bonded system, where the highly flexible PUR foam used as insulation material is so strong that it can transmit the forces induced by thermal expansion and contraction of the steel inner pipe to the casing made of HDPE (high density polyethylene). As a consequence the casing will follow the inner pipe expansion and there is no movement of the carrier pipe within the insulation. The insulation density is uniform throughout the system and pipe supports are positioned directly on to the casing. The uniform density eliminates the risk of thermal bridges at the pipe supports.



The on-site insulation is limited to installation of a relatively small number of heat shrinkable field joints. The installation process is fast and simple and Logstor offers the training of fitters as an integral part of a project, thus enabling the use of local labour. Depending on the nature and size of the individual projects, the pre-insulation process may also take place in a purpose built prefabrication facility on-site, reducing transportation time and costs to a minimum.

tional allowing only two of the four tanks to be converted at a time. Following the commissioning of the importation terminal the existing liquefaction facilities will be fully decommissioned.

Conversion to an Import Terminal

The present project was initiated in December 2000, as a response to the declining gas supply in the UK, and involves the conversion and extension of the existing peak-shaving equipment. The philosophy for the design is to re-use, where possible, existing equipment thus minimising the cost of the project and the lead time, whilst ensuring the project remains viable for the next 25 years. This has ensured that the plant will be ready to meet the predicted shortfall of gas in the winter of 2005.

The design concept is to connect the existing LNG plant to a new jetty (see Figure 4, showing a 3-D schematic of the jetty), via an above-ground unloading line; convert the existing LNG storage tanks from peak-shave duty to accept LNG from ships at far higher flows; and to install new more efficient vaporisation and larger boil-off gas compression to dispose of the flash gas accompanying the ship offloading.

The major challenges of the project to date have been the rapid decommissioning and conversion of the LNG tanks and the design of the unusually long unloading line connecting the jetty to the tanks, some 4.2 km in length.

Decommissioning and Modification of the Storage Tanks

Two of the storage tanks were decommissioned in 2003 for modification. These were cooled down, re-commissioned and filled with LNG in December 2003 in time for a return to peak-shave service for this winter. The remaining tanks are now empty and are awaiting decommissioning and modi-

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fication in 2004, to allow baseload operation to commence in January 2005.

During the modification the tanks have been fitted with new fill and boil-off lines, to allow for the greater LNG and flash-gas flow from importation, new pressure relief systems and new level, temperature and pressure instrumentation appropriate to importation duty. While out of service the tanks have been inspected and revalidated for a further 25 years of service.

In order to meet the timescales of the project, a number of methods of reducing the time frame for tank modifications were examined. Two areas of large savings were examined in detail, namely reducing the warm up times of the tank by supplying additional heat input, and reducing the boil-off times by insertion of a temporary pump to reduce the level of LNG following pump out to a minimum (heel removal). It was estimated that the heel of the tank would take up to six months to evaporate, thus jeopardizing the conversion programme. The removal of the heel via an inserted pump was deemed to be the most effective method to meet the schedule requirement.

Decommissioning of the first tank was initiated in December 2002, with the tank level reduced to 380 mm via the in-tank pumps. A temporary pump was inserted into the tank in January 2003, when the level was reduced to below 35 mm. The removal of the heel saved one month per 100 mm of heel removed, thus saving three and half months from the programme for each tank. This procedure was completed within two weeks with no technical or health and safety issues.

It has taken approximately 7 months from removing the tank from service to completion of the tanks ready for re-commissioning, of which 4 months were the actual modification and revalidation works. This has enabled the tank modification works to be removed from the critical path of the project.

The Unloading Line

The configuration of the unloading line was the critical element of the design. The

selection of the line size not only impacted upon the direct cost of the construction but had significant impact upon the flash gas compression requirement and the potential to offload without the need for booster pumps.

A total of eight configurations were examined in detail ranging from the use of dual 24 inch lines with booster pumps to a single 42 inch line. The optimum solution was that of a single 36 inch line with a 14 inch LNG re-circulation line also used for offloading. These lines are 4.2 km long, once consideration is given to the expansion loops. They sit above ground on piled concrete sleepers contained within secure concrete walls, which provides enhanced safety and security. This design gave the best balance between safety and economics with the provision of expansion loops but the removal of the need for booster pumps and excessive flash gas compression.

The unloading system is presently being constructed with the civil works nearing completion. The first 1.2 km of pipework for the unloading line arrived on site pre-insulated at the end of 2003 in readiness for fabrication to commence in the new year.

Construction status

The construction contracts for the entire works were awarded to the Skanska group of companies, with Whessoe International Skanska Ltd. responsible for the LNG tank conversion and Skanska Whessoe Ltd. for the main works. Construction is underway with the civil works nearing completion and all main equipment items procured and under fabrication. The tank modification works are around 45% complete and the unloading line, jetty and associated works are presently 15% complete. The plant is on target for completion at the end of 2004 and is due for commercial operation in the first quarter of 2005.

Expansion

The present works at the Isle of Grain will enable the terminal to accept 3.3 mtpa of LNG. This does not however meet the expected market demand for LNG

or utilise the installed assets to their optimum. Therefore a further expansion is being planned for the terminal.

Permit applications for an additional three large LNG tanks of 190,000 m³ capacity each, additional vaporisation and associated plant have been submitted. These applications are being evaluated and permits are expected to be granted towards the end of 2003. This expansion will increase the capacity of the terminal to 10.5 mtpa and could be operational for the winter of 2007. Figure 5 is an aerial view of the site, showing the route of the unloading line between the jetty (under construction in right foreground), the existing storage tanks (background), and the proposed location of additional tanks (shaded area, centre)

Conclusions

The conversion of the Isle of Grain terminal is underway with full commercial operation on schedule for the first quarter of 2005. The pre-investment by NGT in the Isle of Grain terminal before securing a commercial owner has ensured that key infrastructure will be in place to meet the forecast shortfall of gas in the UK market in 2005. The Grain LNG team has ensured the return of large-scale LNG imports to the UK after a 20-year absence.

The scale of the UK market and the speed of depletion of indigenous gas supplies from the North Sea reserves indicate that LNG will play an important role in the country's future primary energy mix. The Isle of Grain terminal is well positioned to take advantage of this market both today and in the future.

Ian Belmore is the Technical Director of Grain LNG. He graduated from Birmingham University with a degree in Chemical Engineering and more recently with a Master of Business Administration from Imperial College, London. He joined British Gas in 1989 and rapidly moved into LNG operations working at two other peak-shave LNG plants before moving to the Isle of Grain. Presently he is responsible for the daily operations of the Isle of Grain LNG installation as well as the conversion to an import terminal.



David Fuller acted as the Commercial Director for Grain LNG and has worked in the gas business for over 20 years. A Chartered Engineer by training, he has been involved in a number of high profile international energy projects. He has worked on a number of commercial roles such as the UK Gas Interconnector, upstream and downstream projects in Egypt and in both Europe and South America. In his latest role he has taken the development of the Isle of Grain project from conception to final agreement with BP and Sonatrach.



Figure 5 - Aerial view of Isle of Grain Construction





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