

# Liquefied Natural Gas.

The alternative vehicle fuel.



# LNG – the fuel for your vehicle fleet?

With steadily rising fuel costs and pressure to reduce emissions, the transport industry has been searching for alternative fuels that will address these two concerns. LNG – or Liquefied Natural Gas – is now establishing itself as the low carbon fuel of choice for heavy goods vehicles.

## The cost of fuel

Fuel prices continue to rise, impacting on the profitability of the transport industry. At the same time, customers are increasingly resistant to accepting higher supplier prices, so fleet operators find their margins being inexorably squeezed.

The price of conventional fuels such as diesel has been rising continuously for a number of years. In 2011, crude oil reached an all-time high of around \$120 per barrel. It has not fallen significantly since then. Even the economic slowdown in the Western economies has done nothing to reverse this trend and the developing nations such as China and India are more than making up for any shortfall in Western demand. And there is little likelihood of any turnaround in that situation. Indeed, with sectors like shipping looking to move away from Heavy Fuel Oil (HFO) to lighter fractions such as diesel, pressure on supply – and consequently price – is set to increase further.

## Environmental impact

According to the Department for Energy and Climate Change (DECC), the transport sector accounts for 22% of total UK greenhouse gas emissions. In addition, fuels like diesel result in the release of other pollutants such as particulates and oxides of nitrogen.

The Government is committed to reducing greenhouse emissions. Some urban areas – including London – are already looking at measures to reduce the amount of pollution in their streets through the introduction of low emissions zones and other regulations.

So improving environmental performance and reducing carbon emissions is increasingly a key priority for many companies

Many fleet operators and their customers have been set tough carbon reduction targets. In response, a variety of initiatives to reduce carbon footprints and achieve a better environmental performance as well as a better financial return.

With diesel prices set to remain high and increasingly stringent carbon reduction goals, a switch to low carbon vehicle fuels can help achieve cost reductions and lower emissions.

# Natural Gas.

## Cheaper than diesel

Natural Gas is increasingly seen as a low-cost, alternative energy source to more conventional oil-based products. While oil production is in decline, global gas reserves have nearly tripled in the last 30 years and availability is set to grow with more production and import facilities coming on stream. It is estimated that our gas reserves could last around 200 years, in contrast with just 40 years for oil. This results in an attractive difference between the prices of diesel and gas exists – and this differential is expected to continue. LNG is currently around half the price of diesel.

## Cleaner than diesel

Natural gas emits less CO<sub>2</sub> on combustion than either coal or oil. Compared with oil, it creates around 90 percent less sulphur oxide, 80 percent less nitrogen oxide and no heavy metals or soot particles. Burning natural gas produces around 30 percent less CO<sub>2</sub> than crude oil. As well as a significant reduction in air pollution, noise pollution is also reduced, since gas-fuelled engines are quieter.

# LNG as a transport fuel.

For transport applications, the most economic method of storage for natural gas is as a liquid. The gas is cooled to temperatures as low as -164°Celsius, compressing it to 1/600th of its original volume. The result – Liquefied Natural Gas or LNG – has a much greater energy density than its compressed gaseous equivalent, Compressed Natural Gas or CNG.

This means a much greater range is achieved with LNG, which makes it a very attractive fuel for vehicles, especially for operators of heavy duty vehicles with high mileage. It is here that the greatest environmental and economic benefits can be gained.

Fleet operators now have the option to run vehicles on dual-fuel technology and manufacturers such as Volvo and Mercedes are starting to offer fully-supported products in the European and UK market.

Because LNG has a greater energy density, onboard storage tanks can be fitted to both 6 x 2 and 4 x 2 tractors – a similar stored volume of CNG would be much more difficult and cannot in fact be achieved on a 6 x 2 tractor unit.

LNG has a good safety record and is used widely across industry. It has a high ignition temperature, so it is harder to set fire to than diesel and many other common fuels. On release, LNG vaporises into a lighter-than-air gas which quickly disperses into the atmosphere. LNG is non-toxic and non-corrosive: it will not pollute land or water resources in the event of a leak into the environment.

The release of greenhouse gases such as carbon dioxide (CO<sub>2</sub>) cannot be stopped overnight. However, by switching from diesel to natural gas, we can already achieve significant reductions in emissions as well as attractive financial savings.



## BOC – a leader in gas technologies.

BOC is a member of The Linde Group, a multi-billion pound global engineering and technology business. With over 100 years experience in dealing with all types of gases, we have the expertise and financial strength to create a safe and sustainable platform for truck operators to access. We are investing in innovative zero-loss refuelling solutions, the development of new LNG production and storage facilities, as well as taking a leading part in the development of safety and operating standards.

We aim to be the leading provider of LNG transport fuels in the UK, reflecting the position already achieved by other parts of The Linde Group across the globe. We do this by offering our customers a comprehensive package of solutions built on our extensive knowledge of gases and related engineering applications.

With BOC, you have a reliable and experienced partner who will work with you to achieve a smooth transition to a new technology, enabling you to access all the benefits of running your vehicles on LNG.

### Cryogenic experience

LNG storage and refuelling rely on cryogenics. BOC have been an expert in cryogenics – the science of low temperature physics – for over 100 years. In the UK, BOC has over 4,000 bulk liquid cryogenic systems installed on customer sites. We have a national engineering resource focused on the design and installation of these systems. This in-depth expertise has been applied to the design and installation of LNG systems for the UK market.

Our LNG activities form a worldwide business and we have a global team of engineers who can deploy technological and operational best practice from a number of different countries. We have installed LNG refuelling solutions in Australia, Sweden and the USA. We have applied our own experience to improve the design of both pumped and pressure-decant facilities.

### Health and safety

As a leading industrial gases company, we operate to the highest standards of safety, employing best practice from across the globe to ensure the protection of our own staff, our customers and the public. And we believe that similar robust safety practices must be the basis of industry codes of practice for small scale LNG installations if the industry is to gain the approval of key stakeholders such as the Health & Safety Executive, local fire brigades and local planning authorities.

### Superior customer service

With LNG integrated in our existing bulk cryogenics infrastructure, we offer the full range of customer solutions expected of the market leader and enjoyed by over 4,000 cryogenics customers. These include:

- Full turnkey solution for the supply, installation, ongoing maintenance and support of innovative storage and refuelling solutions
- Additional support for the development of permitting and safety cases in back-to-base station projects
- 24/7 bulk LNG logistics/scheduling, utilising latest telemetry solutions
- 24/7 customer engineering centre and nationwide field-based engineering teams
- 24/7 customer service support from our national customer service centre.

## Enhanced refuelling solutions.

BOC can offer a better refuelling experience with zero onsite emissions, fast fuelling times, ease of operation and an inherently safe system design and installation. These factors all help to reduce the cost of ownership compared to other existing solutions.

### Zero-loss technology

BOC has designed both pressure-decant and pumped refuelling systems which eliminate methane losses that might otherwise be vented from various points within the system, including the vehicle onboard storage tank. Methane loss can typically cause:

- additional fuel expenditure
- increased onsite emissions

- increased health and safety risk
- longer refuelling times
- reduced savings through wastage

Our innovative system actually conditions the LNG within the storage tank so it is always at the optimum temperature and pressure ready for the refuelling process.



# What are the benefits of a BOC system?

BOC provides temperature-controlled cryogenic systems across many industries. We have adapted these techniques to the LNG refuelling operation in order to deliver a best-in-class solution.

## Lower fuel spend

Conventional pressure-decant and pumped technologies available on the market can result in methane losses of on average of 20% – and sometimes as much as 40%. A large proportion of these emissions result from venting of the vehicle’s storage tank which means the user has to foot the bill.

Selecting BOC’s zero-emissions solution will result in a significant reduction in fuel expenditure.

## Reduced onsite emissions

Compared to carbon dioxide, methane is 23 times as powerful as a greenhouse gas. Each tonne of methane released into the atmosphere will result in a significant increase in your carbon footprint and impair the environment performance of your operation. Selecting a BOC refuelling solution will minimise losses and enhance the environmental performance of your LNG vehicle project.

## Consistent fast-fill experience

The emissions created in existing refuelling solutions have the effect of slowing the refuelling. Filling times fluctuate and system utilisation can go down. This can erode driver confidence in using the system and have a negative impact on the financial benefits of using LNG.

The BOC system conditions the LNG at optimum temperature and pressure. This means that there is no delay in refuelling. In other systems, warm gas has to be vented off from the vehicle onboard storage tank by the operator before cryogenic refuelling can commence, wasting valuable fuel and slowing the fill time.

## BOC Safety standards

The Linde Group, of which BOC is a member, has developed a set of global LNG standards. It has considerable experience of operating in LNG markets: in Sweden we have run an LNG business for over 10 years and were involved with the government and other stakeholders to establish industry standards.

As you would expect from a leading industrial gases company we apply the highest safety standards to our activities, in order to ensure a sustainable environment for the use of LNG as a vehicle fuel.

As the use of LNG grows we can expect see more industry-specific legislation and codes of practice. We believe that our approach to system design and the installation standards we use will satisfy industry stakeholders such as the Health and Safety Executive (HSE), local fire brigade and local planning authorities.

So with BOC as your supply partner, you have a greater level of support on LNG projects. We can help to create the site safety case, liaise with local stakeholders (such as the fire brigade and HSE) and help to ensure that the LNG installation meets current legislation, as well as safety and operational standards.

And that leaves you free to focus on your core business.



# Your road to LNG. BOC supports you from start to finish.

## Step 1: Why LNG is worth your while

We will help you to understand how LNG fuel can impact your bottom line. Our sales specialists have a thorough understanding of local markets and we work closely with most heavy truck OEMs and selected retailer chains.

## Step 2: Analysis and preparation

Our starting point is a joint analysis of your operation and fuelling process. Based on this analysis, we will create a profile of your fleet (including driving patterns etc.) in order to quantify opportunities, potential benefits and required fuelling solutions. In addition, we will develop a plan for how you can introduce LNG in your company. BOC covers the entire technology chain for LNG fuel – from LNG supply to on-site fuelling solutions. We also offer solutions for fuelling CNG from LNG, so-called LCNG, for vehicles driving shorter distances, in which case the gas is compressed before being stored in the vehicle.

## Step 3: Test

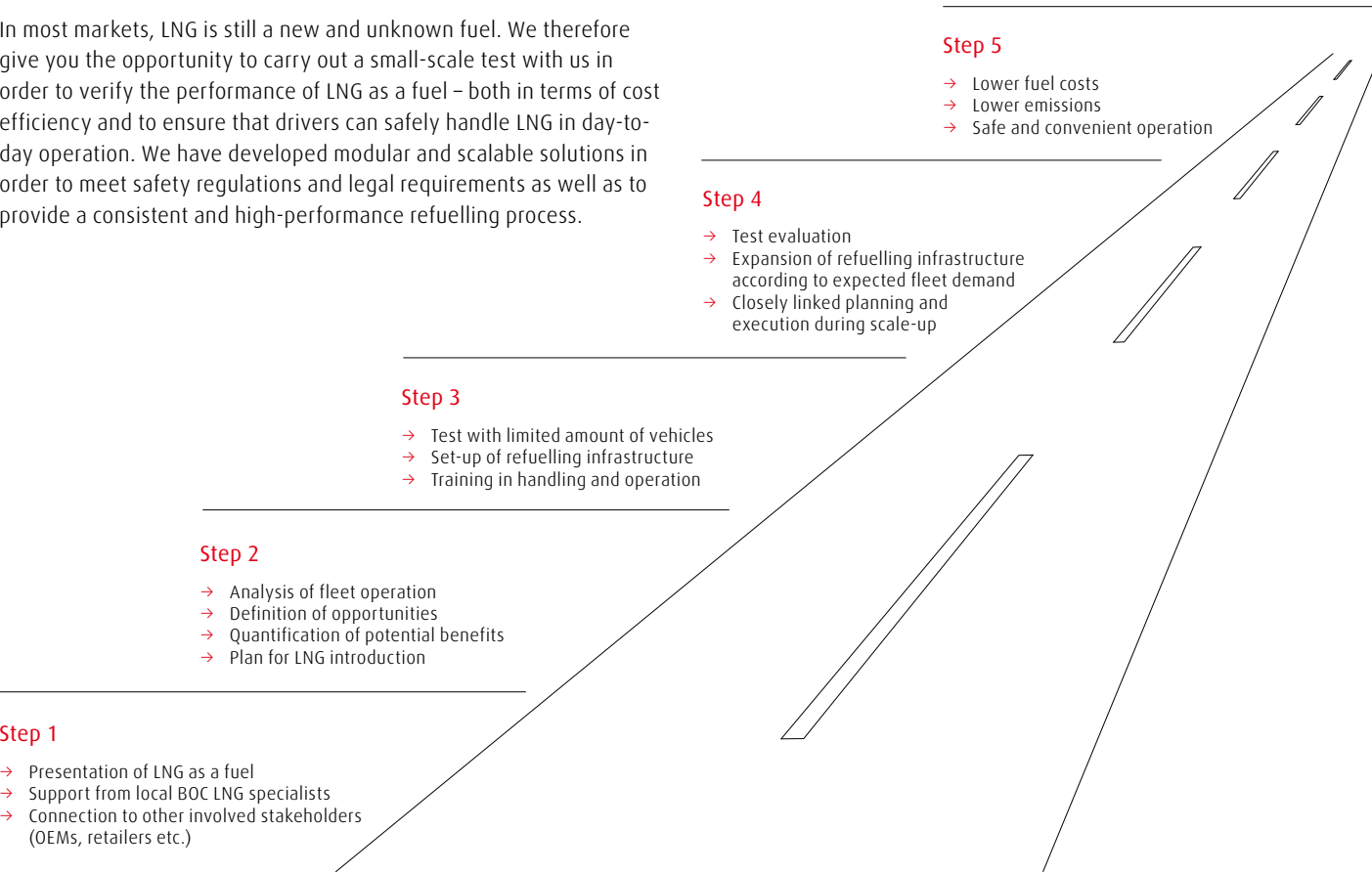
In most markets, LNG is still a new and unknown fuel. We therefore give you the opportunity to carry out a small-scale test with us in order to verify the performance of LNG as a fuel – both in terms of cost efficiency and to ensure that drivers can safely handle LNG in day-to-day operation. We have developed modular and scalable solutions in order to meet safety regulations and legal requirements as well as to provide a consistent and high-performance refuelling process.

## Step 4: Scale-up

After the evaluation of the test, we will meet with you to make a plan for the continued conversion of your vehicles and refuelling infrastructure. Typically, this plan identifies how many refuelling locations are required and ensures that the new infrastructure meets the demands of the new vehicles and routes.

## Step 5: LNG for the future

Looking ten years into the future, it is our strong belief that LNG will conquer many markets, where it will commonly be used as an on-board fuel, specifically for heavy trucks in point-to-point and back-to-back operation. Moreover, an LNG fuelling infrastructure will be broadly available along both larger and smaller transport corridors. As an early mover, you now have the chance to create significant value by converting your fleet to LNG, while lowering emissions at the same time.



# BOC – turning ideas into solutions.

BOC is a member of The Linde Group, the leading global gases and engineering company. BOC is the UK's largest provider of industrial, specialist and medical gases, as well as related products and services. As a leader in the application of technology, we are constantly looking for new ways to provide our customers with high quality products and innovative solutions.

At BOC we help our customers to create added value, clearly discernible competitive advantage and hence greater profitability. To achieve this we have a comprehensive range of products and services, and technical support which can be customised to meet the individual requirements of our clients.

To keep ahead of the competition in today's market, you need a partner for whom quality, service, process and productivity optimisation are an integral part of customer support. We are there for you and with you, helping to build your success.

BOC's reputation has been forged through partnerships – with customers, with relevant regulatory authorities and with key suppliers. In this way, we deliver comprehensive and consistent benefits to you.

**BOC – world-leading knowledge and resources adapted to local requirements.**

For more information on how BOC can help you enjoy the benefits of LNG as a vehicle fuel please contact:

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