



All you need
to know about

LNG

Liquefied Natural Gas



TOTAL

COMMITTED TO BETTER ENERGY

Today's energy environment poses a large number of major challenges: sweeping changes in the global energy supply, issues related to global warming and reducing our energy footprint, tighter regulations designed to bring about the energy transition. It's therefore essential that we investigate, explore and test new forms of energy.



“ Various initiatives and tests are currently underway, worldwide and at numerous Group subsidiaries, in the field of alternative energy: first-, second- and (soon) third-generation biofuels; hydrogen; liquefied natural gas (LNG) and compressed natural gas (CNG); even electromobility. ”



Currently, conventional fuels still account for a significant share of the transport energy mix and will continue to do so over the medium term. However, it is clear that **the percentage of alternative fuels used in new vehicles will keep rising at a steady pace.**

With that in mind, **we decided it was essential to offer some simple, practical and comprehensive information** about these energies and markets of the future.

“LNG: All you need to know” provides the information and data you need in order to gain a thorough understanding of LNG technology and explain it to others.

Enjoy your read!



Strategy Marketing Research
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ESSENTIALS

What is LNG?

Natural gas is a blend of light hydrocarbons consisting primarily of methane. It is naturally present in certain porous rock.



*Natural gas,
that rings a bell!*

The various applications for natural gas

Natural gas is an energy source that has long been used for various purposes:

RESIDENTIAL
(cooking, heating)



INDUSTRIAL
(fuel)



POWER
GENERATION
(gas power plant)



FUEL
(boats, lorries)



LNG is an acronym for **Liquefied Natural Gas**, which is natural gas cooled to -162°C so that it can be stored in liquid form. As a result, **it takes up less room and is easy to transport.**



ESSENTIALS

LNG, a special type of fuel

States of natural gas

METHANE IN AIR

20°C / 1 bar

1L of diesel fuel = 900L of methane

CNG

20°C / 200 bar

1L of diesel fuel = 5L of CNG

LNG

-120°C / 10 bar

-162°C / 1 bar

1L of diesel fuel = 1.8L of LNG

? **How is LNG stored?**

LNG is stored in cryogenic tanks that keep it in a liquid state at a very low temperature (between -120°C and -160°C).

? **What vehicles run on LNG?**

On the road, LNG is used exclusively for lorries. It is also a fuel used by some boats.

? **Are there different grades of LNG?**

No. All pump-dispensed LNG is the same and is good for your engine.

! **Products not to be confused with LNG**

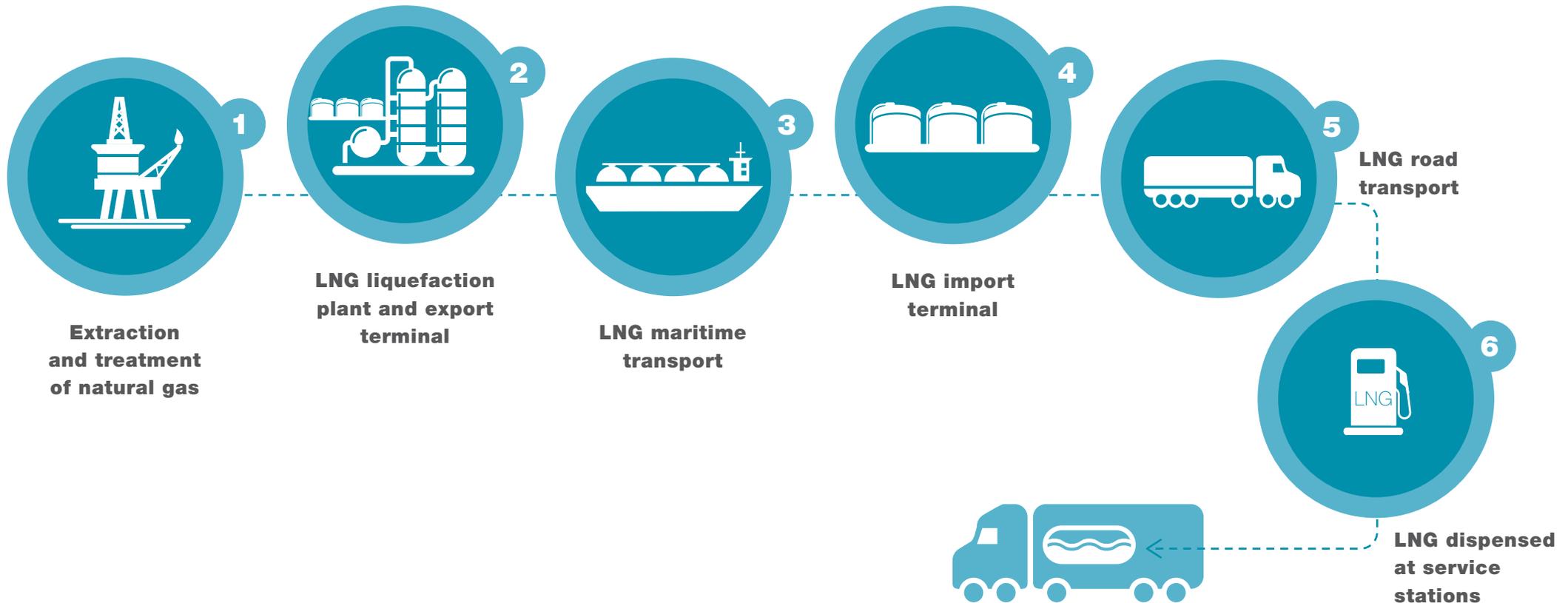
- **LPG:** Liquefied Petroleum Gas - composed of different chemicals (propane and butane)
- **CNG:** Compressed Natural Gas - same composition as LNG, but not liquid as it is stored in gaseous form at high pressure (between 200 and 250 bars)
- **NGV:** Natural Gas for Vehicles - a term that encompasses all natural-gas fuels: CNG and LNG



ESSENTIALS

Producing LNG

Once extracted from underground reserves, natural gas needs to be purified before it can be cooled and turned into Liquefied Natural Gas, which comprises more than 95% methane. It is then transported in liquid form to be dispensed at service stations.





ESSENTIALS

Diesel or LNG: which is best for my vehicle?

Each technology has its advantages and drawbacks in terms of cost, noise, pollutant emissions and so on. It is therefore up to customers to choose, based on their needs and preferences.



Cost

A vehicle that runs on LNG is more expensive to purchase but can prove more cost-efficient than its diesel or gasoline equivalent, depending on the price of fuel, the number of kilometres covered annually, and prevailing tax laws.



Noise

The engine technology for natural gas reduces noise levels in LNG vehicles quite substantially compared to diesel lorries. This is a real advantage for urban or night transport.



Driving range

LNG-powered lorries have a driving range comparable to that of diesel lorries (between 700 km and 1,000 depending on use).



CO₂ emissions

It's difficult to distinguish LNG vehicles from other vehicles, since CO₂ emissions vary significantly based on each vehicle and its use. But like biodiesel and bioethanol, any use of biogas in LNG reduces the vehicle's impact on the environment.



Pollutant emissions

Both diesel and LNG lorries comply with the European Union's EURO VI standard. That standard, which took effect on 1 January 2014, defines permissible pollutant emission levels for heavy-duty vehicles. One big difference: LNG engines meet EURO VI standards without the need for particulate filters or Selective Catalytic Reduction (SCR) systems, which require AdBlue®.



ESSENTIALS

LNG engine: how does it work?

Whether they run on diesel or natural gas, combustion engines operate by burning a mixture of air and fuel. For a diesel engine, the air/diesel mix ignites by itself (auto-ignition) when the temperature and pressure are sufficiently high within the combustion chamber.

In a natural gas engine (one that runs on LNG or CNG), the blend of air and natural gas is ignited by the spark produced by the spark plug in the centre of the combustion chamber... just like in a gasoline engine!

Did you know?

LNG and diesel technology can be combined within a single engine. These so-called **Dual-Fuel** engines can operate on 100% diesel or a mixture of diesel and natural gas. However, Dual-Fuel engines do not yet comply with the EURO VI standard. Stay tuned...





ESSENTIALS

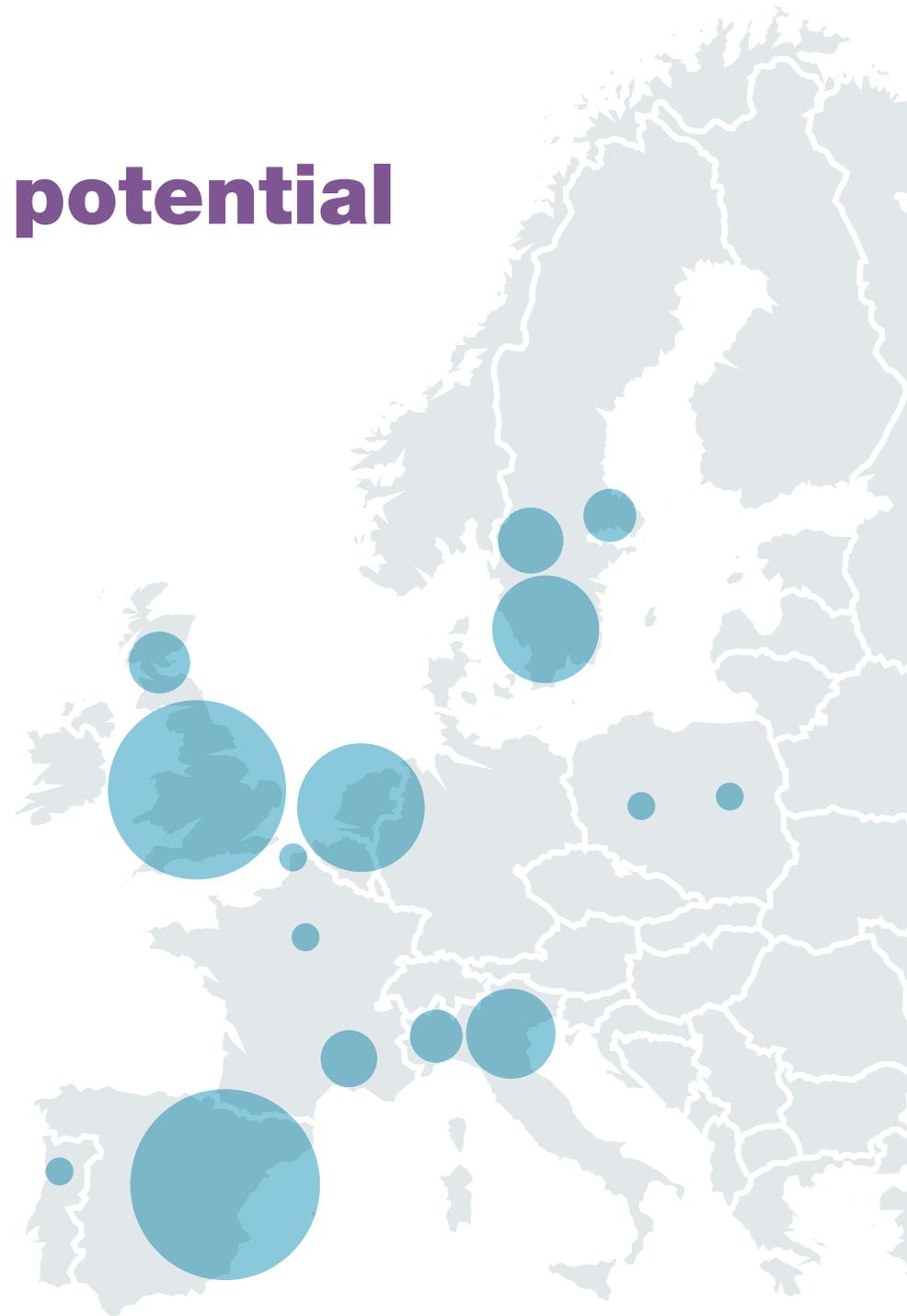
The current and potential market for LNG

LNG is only in its early stages in Europe.

Key markets currently include:

- **Spain**
- **Netherlands**
- **United Kingdom**

As a result, the network of service stations is still sparse and mainly found on major European roads.



Density of LNG stations in Europe

Source: LNG Blue Corridors (2015)



LNG IN PRACTICE

Filling up with LNG

The 9 essential steps

- 1 Visit an LNG station.** These stations use special equipment, with customised dispensers and couplings.
- 2** Get ready to fill up:
 - **Turn off your engine** and mobile phone. Do not smoke.
 - **Locate the emergency shut-off button** for the station equipment to ensure you can act quickly if necessary.
 - **Every station is different:** read the sign explaining how your particular station works.
 - **Use your personal protective equipment:** safety visor, cryogenic gloves, long-sleeved clothing and protective footwear.
- 3 Connect the station grounding cable** to a metal part of your tank: this eliminates the risk of sparks caused by static electricity.
- 4** If necessary, **activate the station equipment cooling system** by following the specific on-site instructions: this is a necessary step to optimise the filling process.

Important

If the station equipment is at a low temperature, the connectors and hoses may be covered with frost: do not touch them with bare hands as this could result in burns!





LNG IN PRACTICE

Filling up with LNG

- 5 Use the air hose** on both the station-side and lorry-side connectors to remove any remaining traces of frost: this helps to improve the lifespan of equipment and reduces the risk of leaks.
- 6 Connect and lock the LNG hose** to your tank, along with the vapour recovery hose, if your tank is equipped with the relevant coupling.
- 7 Identify yourself** using the LNG station electronic control system to authorise tank filling.
- 8 Fill your tank** by pressing the start button: the pump stops automatically when the tank is full. Bear in mind that LNG is dispensed by the kilogram, and filling the tank takes less than 10 minutes.
- 9 Disconnect** the hose and grounding cable then use the air hose again to remove any surface frost...

...and drive!



Where can I find a LNG station?

Currently, the network of service stations in Europe is sparse.

The following website regularly updates its list of stations currently operating in Europe:

LNG Blue Corridors <http://lngbc.eu/>

Is driving any different?

Given the same size engine, driving a vehicle that's running on LNG is no different from driving a diesel vehicle.



LNG IN PRACTICE

Precautions to take



When filling the tank

Use a face protector (visor), gloves to prevent cold burns and long-sleeved clothing when filling up with LNG.

Always check the condition of the equipment used to dispense the fuel (ensuring there are no signs of leaks) to prevent any risk of cold burns caused by the extremely low temperature of LNG and any risk of fire (gas cloud).

At the service station, you should follow the same safety guidelines as you would for gasoline:

- **Do not smoke** and do not bring a heat source near the vehicle
- **Do not use your phone**

If the hose does not fit the coupling on the lorry, under no circumstances should you use an adapter.



When parking

Never park in a confined space for several days in a row. Flammable gas could be released into the atmosphere through the evaporation of methane from the tank (see «Find out more» for details).



If you detect a leak

LNG leaks create a small cloud of white frost. If this happens, define a safety perimeter around the leak (because of the risk of burns or inflammation from a heat source), evacuate the area and notify the fire brigade and onsite safety personnel.

In most cases, the tank should be allowed to empty completely.



LNG IN PRACTICE

Summary of maintenance tasks



I drive a lorry

EURO VI Diesel

- Fill the AdBlue® tank on a regular basis
- Perform regular maintenance on the AdBlue® (SCR) system
- Inspect the particulate filter and SCR systems

EURO VI LNG

- Replace spark plugs
- Regularly inspect the special parts in the LNG engine
- Verify that the gas circuit and LNG tank are airtight

! Important

Maintenance must be performed by an authorised garage that is certified by your LNG vehicle's manufacturer.

Did you know?

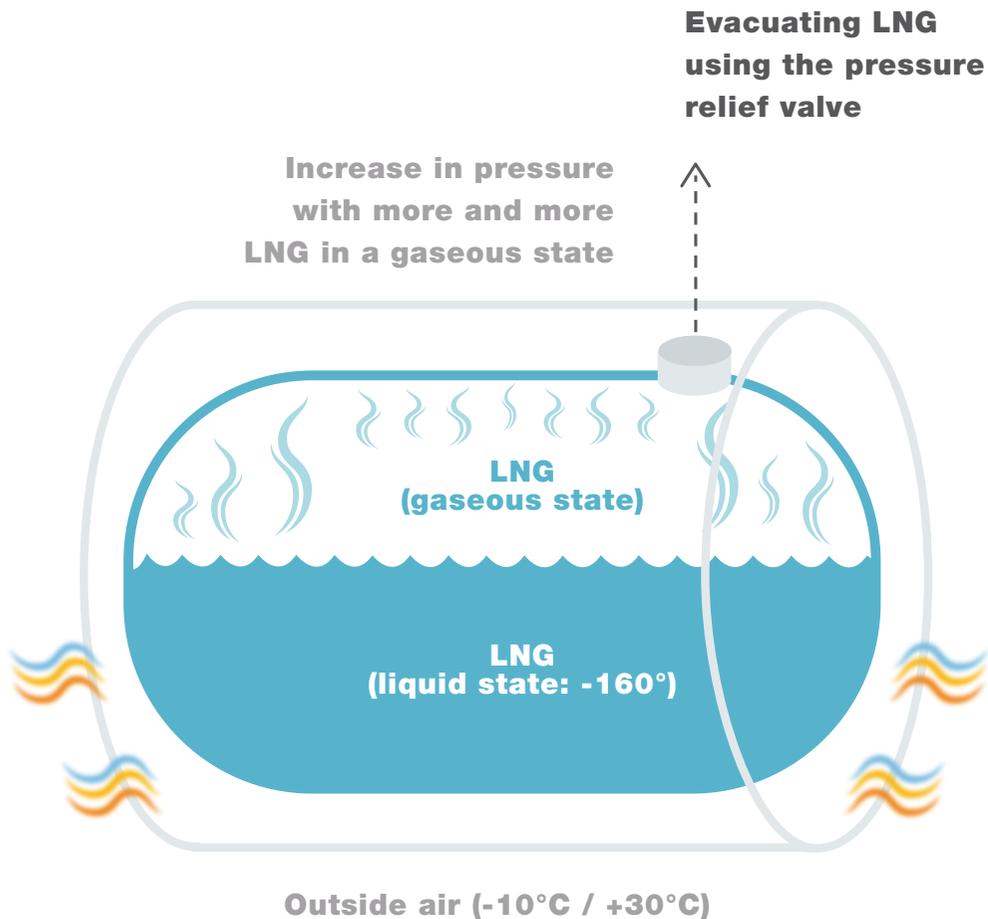
For most heavy-vehicle manufacturers, the lubricants used in LNG lorries are currently the same as those used with diesel engines.

The oil change intervals are very similar or even identical to those for diesel vehicles. Certain uses (such as urban trips) will require shorter oil change intervals.



FIND OUT MORE

What is «Boil-off gas»?



An extremely sophisticated container!

In order to store the natural gas safely and maintain a temperature of around -160°C , your LNG tank is made of highly effective insulating materials that keep out heat. However, just as a vacuum flask cannot keep coffee at the same temperature indefinitely, LNG is bound to warm up eventually, causing part of the LNG to return to a gaseous state, which gradually increases the pressure in the tank.

If you don't fill up for a few days (i.e. without cooling the remaining fuel with LNG at -160°C), your tank will let out fractions of gas as soon as the internal pressure gets too high.

That is why you are strongly advised not to park in a confined space (e.g. parking garage) for several days in a row to avoid creating an atmosphere of flammable gas!



All you need
to know about
LNG



I'm all clued in!

Energy is our future,
save it!



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