




All about

**LNG**

Liquified Natural Gas





Faced with climate issues and the evolution of technologies and uses, the road transportation sector is in a transformation phase; the energy transition starts with actions and measures that are aimed at reducing pollutant emissions and greenhouse gases.

In this context, Total group is now embarking on the construction of a network of stations that will distribute Natural Gas for Vehicles (NGV), which presents an alternative energy offer to our customers, especially for transportation professionals.

**“ There is not and will never be one single mobility solution, as each type of energy comes with its own advantages and disadvantages and will be used for the purpose it is best suited for. Among all energy types available today, NGV will play a crucial role in tomorrow’s mobility, and Total will be contributing to its development. Fossil fuels and alternative energies will be used alongside this. ”**



This document will help you gain a better understanding of what LNG is, what the challenges are for users and what offers Total is developing in the field.

Happy reading!



Research Marketing Strategy  
**Product Marketing**  
Total Marketing & Services

# Contents

## 1 ESSENTIALS

What is LNG? .....	p.4
LNG, a special type of fuel .....	p.5
Producing LNG .....	p.6
A LNG engine: how does it work? .....	p.7
A LNG vehicle: how does it work? .....	p.8

## 2 IN PRACTICE

Filling up with LNG .....	p.9
Precautions to take .....	p.11
The LNG market in Europe and its potential .....	p.12
Total's ambition for NGV .....	p.13

## 3 FIND OUT MORE

Diesel or LNG: which is best for my vehicle? .....	p.14
What is "Boil-off gas"? .....	p.15



## ESSENTIALS

# What is LNG?

Natural gas is a mix of light hydrocarbons mainly composed of methane. It is naturally found in some porous rocks.



*Natural gas,  
that rings  
a bell!*

### The different applications of natural gas

Natural gas is an energy source that has been used for a long time for many applications:

RESIDENTIAL  
(cooking, heating)



INDUSTRIAL  
(fuel)



PRODUCTION  
OF ELECTRICITY  
(gas power plant)



FUEL  
(truck, boat)



**LNG?** An acronym for **Liquified Natural Gas**, it's a natural gas that is cooled between  $-120^{\circ}\text{C}$  and  $-162^{\circ}\text{C}$ : once in its liquid form, **it takes up less space and can be easily transported.**



## ESSENTIALS

# LNG, a special type of fuel

### *The 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 in service station?**

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

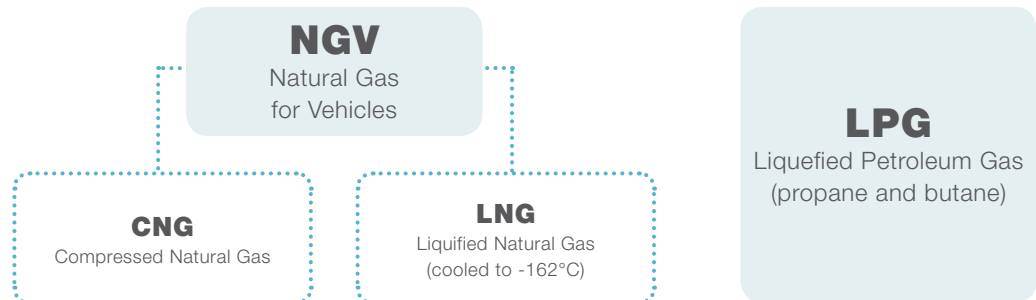
### **What vehicles run on LNG?**

On the road, LNG is used exclusively for trucks and coaches. It offers a range that can reach 1,500 km. So it's mainly intended for long-haul transport. 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.

### **LNG's false friends**

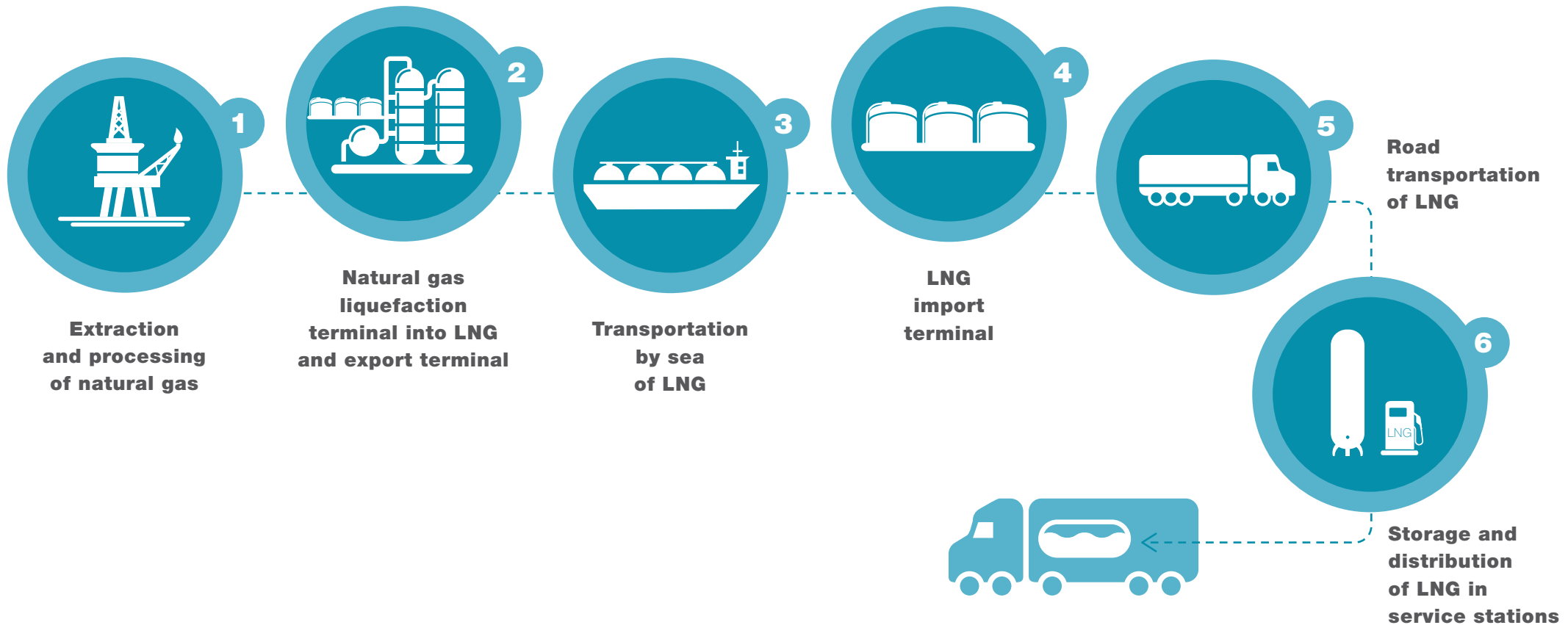




# ESSENTIALS

## Producing LNG

After extracting natural gas from underground reserves, it must be cleared of impurities so that it can be cooled, liquefied and become LNG. It then contains over 90% of methane. It is then transported in liquid form until it is dispensed at the service station.





## ESSENTIALS

# A LNG engine: how does it work?

Whether they run on Diesel or natural gas, combustion engines operate by burning a mix of air and fuel. For a Diesel engine, the air/diesel mix ignites by itself (autoignition) when the temperature and the pressure are high enough in the combustion chamber.

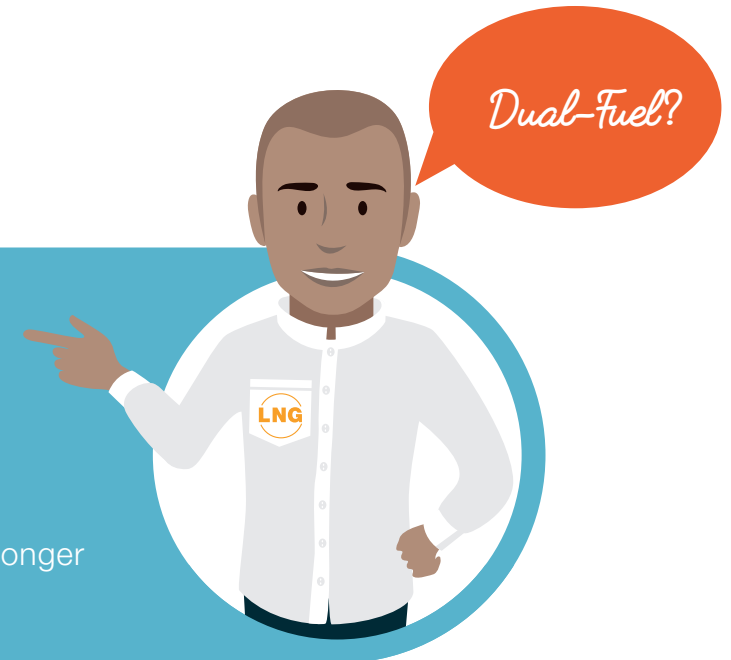
In a natural gas engine (one that runs on LNG or CNG), the mix of air and natural gas is ignited by the spark from the spark plug in the center of the combustion chamber... just like in a gasoline engine!



### Did you know?

Older generations of so-called Dual-Fuel engines were able to run on 100% diesel or on a diesel/natural gas mix, but did not meet EURO VI standards.

Recently, a new generation of EURO VI engines has emerged with the HPDI technology in which a mix of natural gas (LNG) and diesel is used, but it no longer possible to use 100% diesel or 100% natural gas.





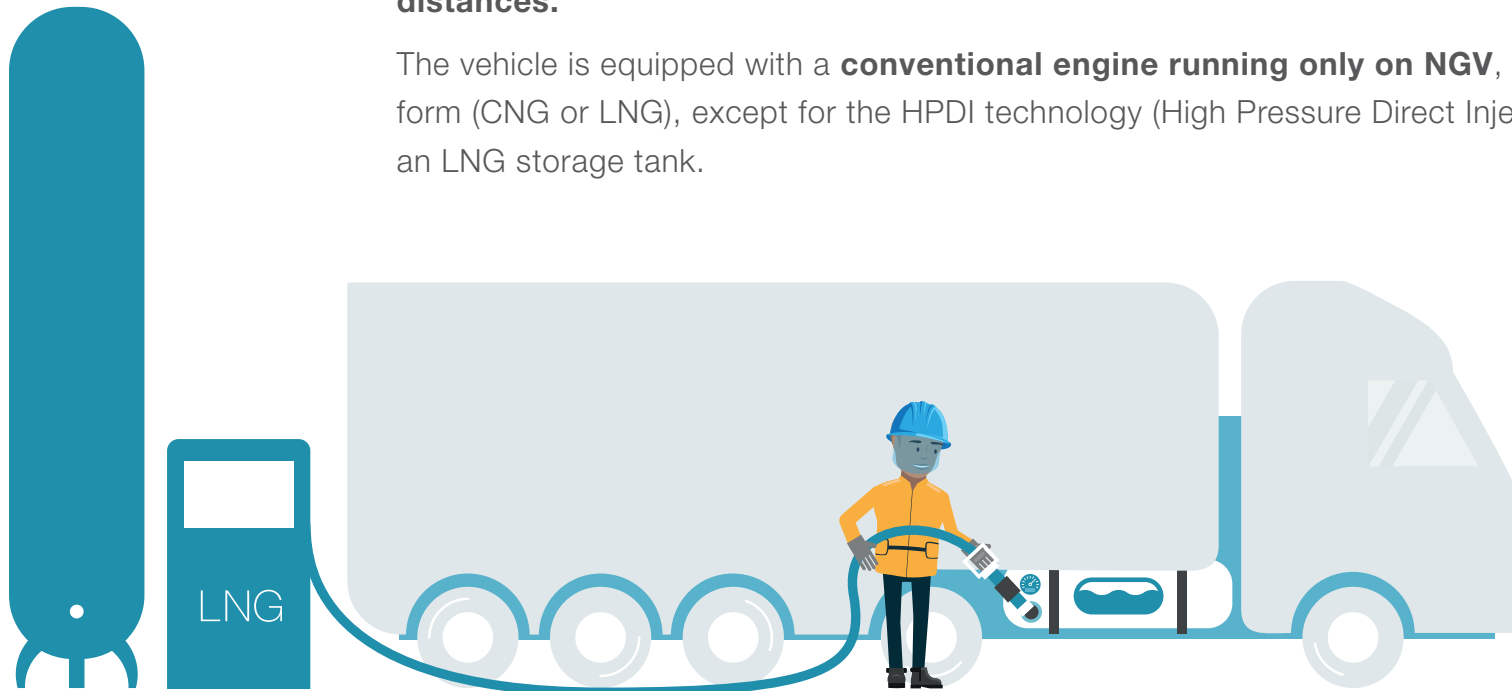
## ESSENTIALS

# A LNG vehicle: how does it work?

This type of vehicle contains a **cryogenic tank** that enables **to maintain natural gas in a liquid state, from -120°C to -162°C** (depending on the liquid-gas equilibrium determined by the pressure and temperature of the tank). The natural gas from the cryogenic tank is then **gasified to be introduced into the engine**.

Be aware! It is necessary to **quickly consume the LNG to avoid the boil-off phenomena** (see page 15). Thus, this technology is particularly suitable **for Heavy-Duty vehicles and coaches traveling long-haul distances**.

The vehicle is equipped with a **conventional engine running only on NGV**, regardless of its storage form (CNG or LNG), except for the HPDI technology (High Pressure Direct Injection) which requires an LNG storage tank.



The embedded energy density of LNG combined with one or more tanks offers **a significant range that can reach 1500 km**.





## IN PRACTICE

# Filling up with LNG

### The 9 essential steps



- 1 Visit an LNG station.** These stations use special equipment with customized distributors and couplings.
- 2 Get ready to fill up:**
  - **Turn off your engine** and mobile phone. Do not smoke.
  - **Locate the station's equipment emergency shut-off button** to make sure you can act quickly if necessary.
  - **Every station is different:** read the sign explaining how your particular station works.
  - **Put on 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's equipment cooling system** by following the specific on-site instructions: this step is necessary to optimize the filling process.

### **Important**

If the station's equipment is at a low temperature, the connectors and hoses may be covered with frost: do not touch them, they could burn you!





## IN PRACTICE

# Filling up with LNG

- 5 Use the compressed air blower** on both the station-side and truck-side connectors to remove any remaining traces of frost: this helps to improve the lifespan of the equipment and reduces the risk of leaks.
- 6 Connect and lock the LNG hose to your tank**, along with the vapor recovery hose, if your tank is equipped with a coupling to do so.
- 7 Identify yourself** using the LNG station's electronic control system to authorize the filling of the tank.
- 8 Start filling up your tank** by pressing the start button: the pump automatically stops 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, use the compressed air blower again to remove any surface frost...

... and drive!



### Where can I find a LNG station?

NGVA Europe, which regularly updates the stations that are available in Europe:  
<http://www.ngvaeurope.eu>

### Is driving any different?

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



## IN PRACTICE

# Precautions to take



### When filling up



#### Use a face protector (visor), gloves

to prevent cold burns, long-sleeved clothing and protective footwear 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, follow the same safety instructions as you would for gasoline:



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



- **Do not use your phone**

Finally, if the hose does not fit the coupling on the truck, never use an adapter.



### When parking

Never park in a confined space for several days in a row. Indeed, an atmosphere of flammable gas could be created through the evaporation of methane from the tank (see “Find out more” for more 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 (risk of burns or inflammation from a heat source), evacuate the area and notify the fire brigade and onsite safety personnel.

In most cases, let the tank empty completely.



IN PRACTICE

# The LNG market in Europe and its potential

Because it offers vehicles the greatest range (up to 1,500 km depending on the configurations and uses of the vehicles), LNG technology is primarily intended for long-haul transportation.

Still in full development today, the network of LNG service stations is progressively spreading, in particular on major European routes.



Density of LNG stations in Europe

Source: NGVA 2018

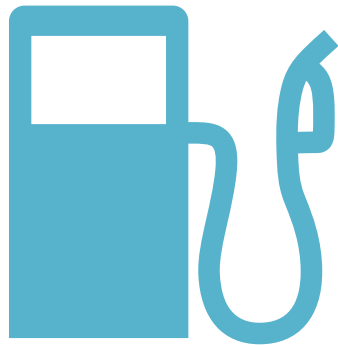


IN PRACTICE

## Total's ambition for NGV

Total is expanding rapidly in the NGV sector, aiming to become the European leader. To help achieve that, it acquired **PITPOINT**, Europe's third-largest operator.

More recently, Total has made an equity investment in Clean Energy, a leading NGV supplier in the North American market.



2022 target: 350 NGV stations  
in our European networks



### Did you know?

Total already has NGV stations in Europe, but also in Egypt and Pakistan.



FIND OUT MORE

# Diesel or LNG: which is best for my vehicle?

Each technology has its advantages and drawbacks, whether in terms of cost, noise, pollutant emissions and so on. Choose depending on your needs and preferences.



## Cost

A vehicle that runs on LNG can prove more cost-efficient than its Diesel or gasoline equivalent, depending on the price of fuel, the distance covered annually, and prevailing tax laws, even if it is more expensive to purchase.



## Noise

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



## Range

Trucks running on LNG have a range that can reach 1,500 km depending on how the vehicles are used and configured.



## CO<sub>2</sub> emissions

It's difficult to distinguish LNG vehicles from other vehicles, since CO<sub>2</sub> 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

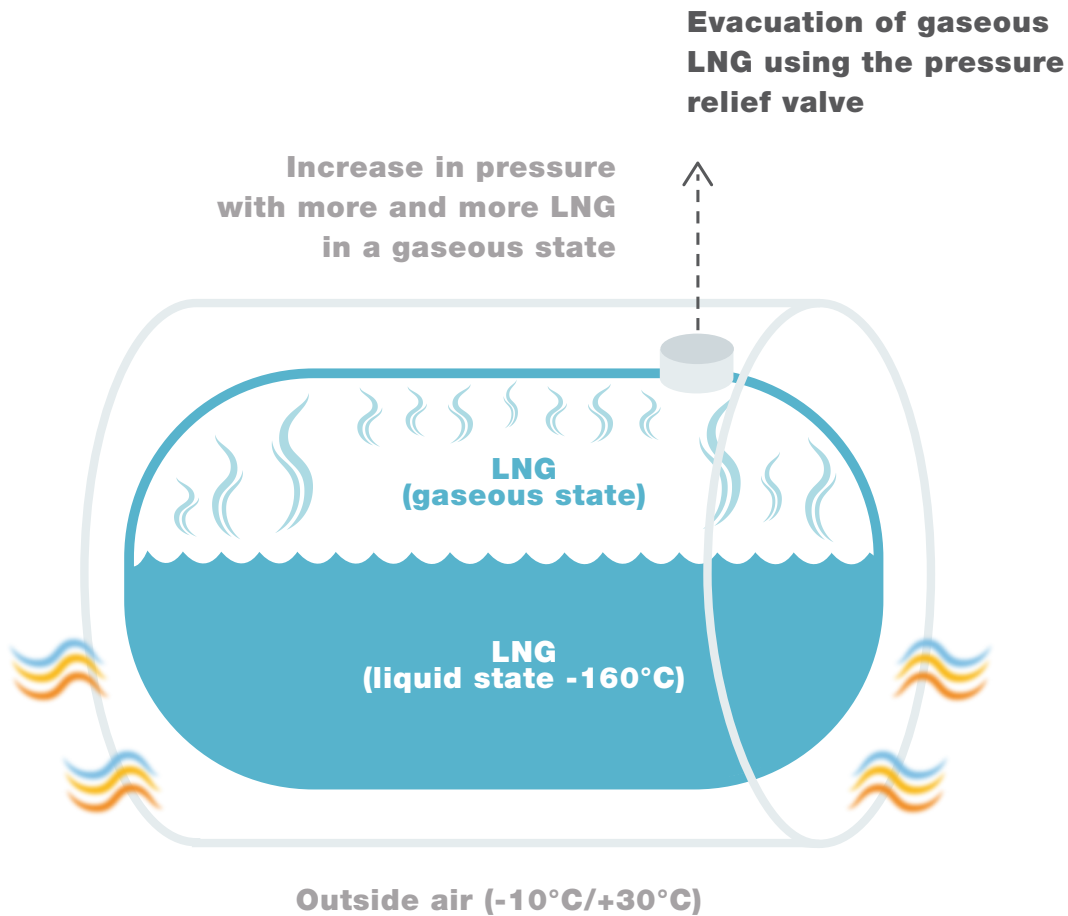
Both Diesel and LNG trucks comply with the European Union's EURO VI standard. That standard, which took effect on January 1, 2014, defines permissible pollutant emission levels for trucks. One big difference: LNG engines meet EURO VI standards without the need for particle filters or Selective Catalytic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

AdBlue® is a registered trademark of the German Association of the Automotive Industry (VDA).  
\*With the exception of HPDI technology (High Pressure Direct Injection).



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  $-160^{\circ}\text{C}$ , your LNG tank is made of highly effective insulating materials that keep out heat.

However, just as a thermos 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 do not fill up for a few days (i.e. without cooling the remaining fuel with LNG at  $-160^{\circ}\text{C}$ ), your tank will let out small amounts 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 (such as a parking garage) for several days in a row to avoid creating an atmosphere of flammable gas!

[total.com](http://total.com)



Total is a major energy player committed to supplying affordable energy to a growing population, addressing climate change and meeting new customer expectations.

Those commitments guide what we do. With operations in more than 130 countries, we are a global integrated energy producer and provider, a leading international oil and gas company, and a major player in low-carbon energies. We explore for, produce, transform, market and distribute energy in a variety of forms, to serve the end customer.

Our 98,000 employees are committed to better energy that is safer, cleaner, more efficient, more innovative and accessible to as many people as possible. As a responsible corporate citizen, we focus on ensuring that our operations worldwide consistently deliver economic, social and environmental benefits.

Our ambition is to become the responsible energy major.



TOTAL MARKETING SERVICES  
SA au capital de 324 158 696 euros  
542 034 921 RCS Nanterre  
Siège Social : 24, cours Michelet 92800 Puteaux - France