Sustainable mobility is already possible with natural gas

With the collaboration of
Gasnam and **Sedigas**

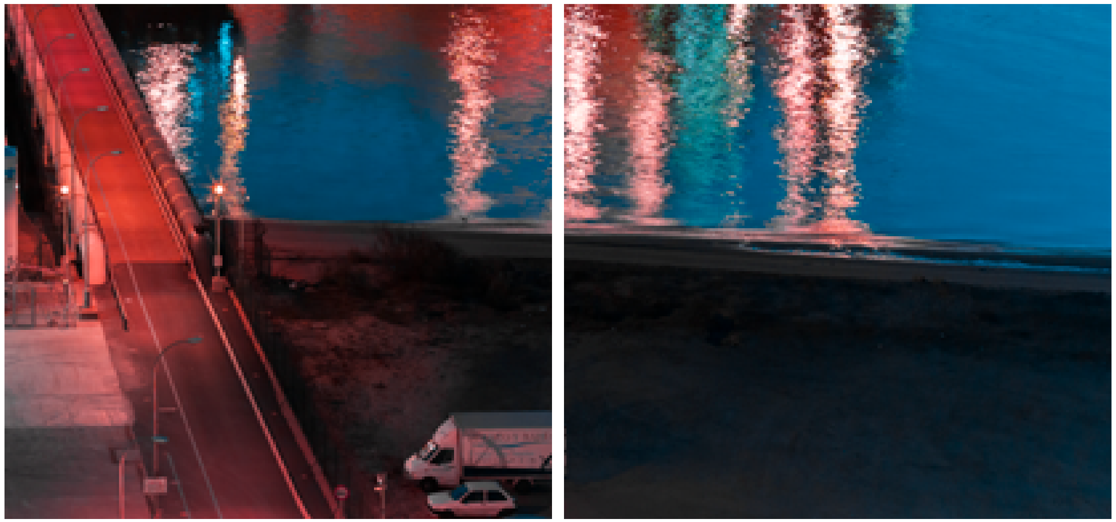


Photo: Balearia.

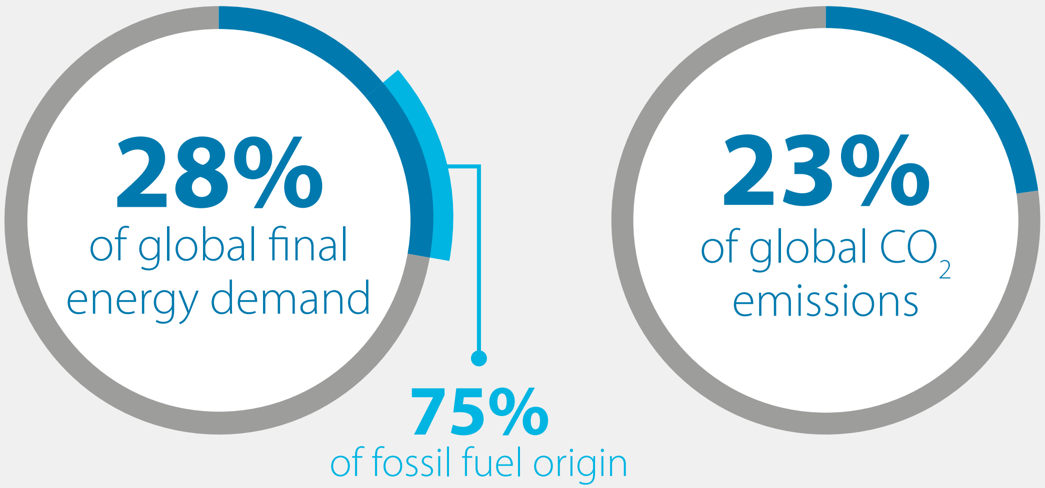
1 Context

2050 target: carbon neutrality

The European Union aims to achieve **carbon neutrality by 2050**. To meet this target, there are different sectoral plans that aim to reduce CO_2 emissions into the atmosphere.

Transport is the segment of activity that presents the greatest trend increase for the 2050 horizon, x2 in passenger transport (passengers/km) and x3 in the transport of goods (T/km), which would raise current emission levels (WTW GHG) by 45%.

According to the International Energy Agency, transport represents:



Options for a sustainable mobility

Decarbonisation is heavily conditioned by the combination of power, autonomy and operating conditions of each means of transport.

For **light transport (urban)**, electric, hybrid and fuel cell engines offer a technological solution capable of ensuring their sustainability in the short, medium and long-term.

These solutions cannot be extrapolated, either in the short or medium-term, to **heavy transport**, which has the highest growth forecast for the 2050 horizon. There is therefore a risk that the 2050 targets for the transport sector will not be met.

Compressed natural gas and liquefied natural gas are currently the only real alternatives for reducing CO_2 in these segments, ensuring an air quality almost equivalent to a 100% renewable solution. They also allow for the provision of a medium and long-term solution through their hybridisation with renewable gases (biomethane, hydrogen and e-gas).

Compressed natural gas *(CNG) and* ***liquefied natural gas*** *(LNG) are the* ***only real alternatives*** *for reducing* CO_2 *and improving air quality*

50%

of heavy transport can only be decarbonised with **natural gas** and in the near future with renewable gases

2 Natural gas

General aspects

Natural gas properties

85-95% methane

Non-corrosive and non-toxic

Colourless and odourless

Differential energy density

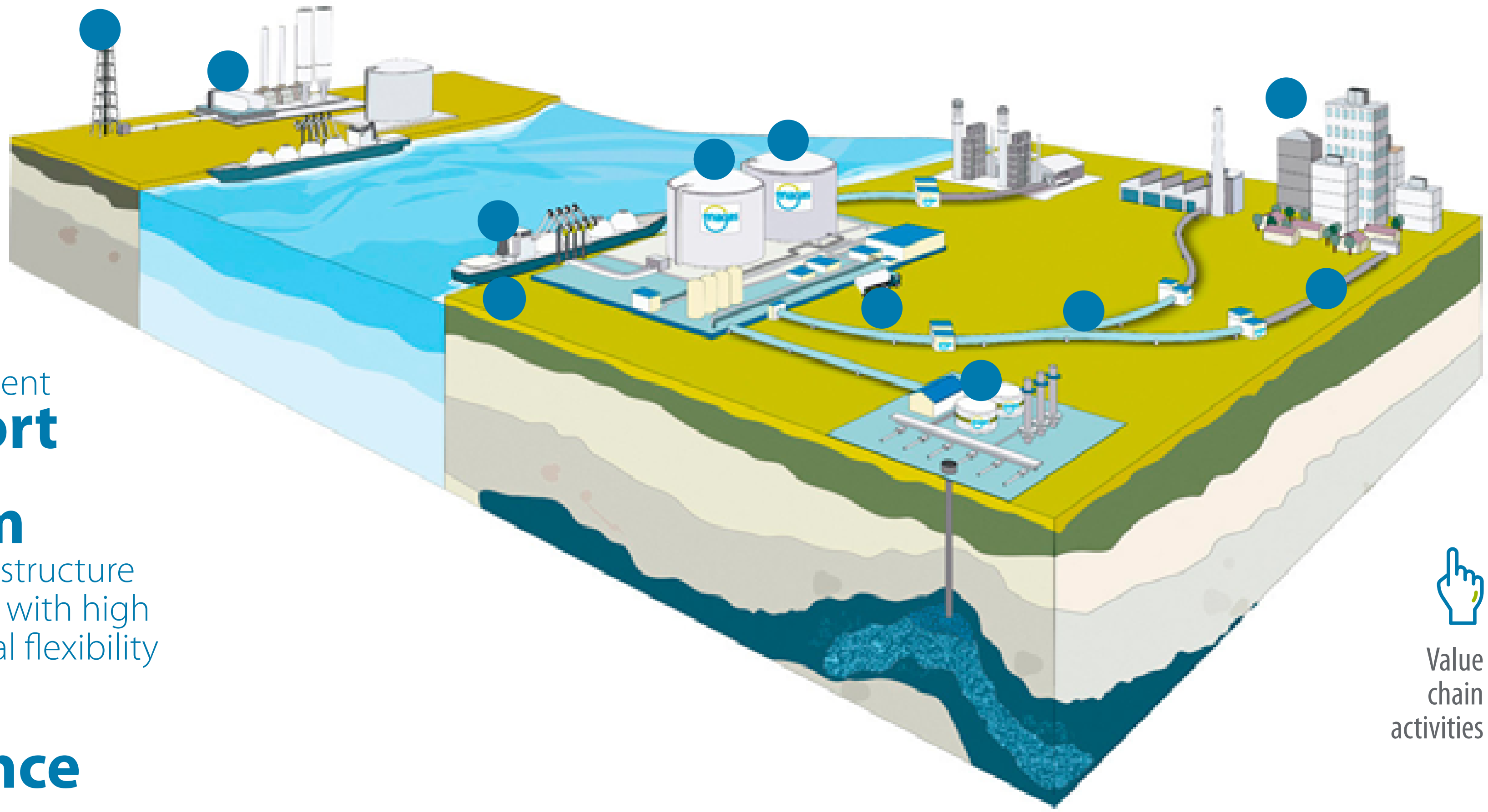
600x volume reduction in the conversion from NG to LNG

Energy **80x** higher than a lithium battery

Hydrogen, biomethane and synthetic natural gas are **100% renewable solutions**. They are sustainable alternatives in the short, medium and long-term on their own, or when combined with natural gas.

- **Green hydrogen** is a 100% clean and carbon-neutral energy source, which does not generate CO_2 in its production process. It is produced from the electrolysis of water.
- **Biogas-biomethane** is a renewable gas in a gaseous or liquid state, obtained from municipal solid waste, wastewater and other waste.
- **Synthetic natural gas** in a gaseous or liquid state is obtained by industrial processes through renewable sources.

Value chain



Safe and efficient
transport

System
with extensive infrastructure and technology and with high capacity and logistical flexibility

+50 years
Experience

Value chain activities

Technology

No specific engines are needed to use natural gas, so **the required power is not a limitation and it can be used immediately** in any segment of mobility. Natural gas refuelling stations also operate with mature and proven technology.

It is the only energy that, together with capture processes, is part of the alternative fuel chain of the future: hydrogen, methanol, NH_3. Developing these from natural gas or electrolysis processes, or a combination of both, and using natural gas infrastructure and logistics, would make it possible to have a more competitive "*time to market*" than those envisaged for these alternatives to date, and very much in line with the NECP (PNIEC) and the various road maps.

*It is the only energy that, together with capture processes, is part of the **alternative fuel chain of the future**: hydrogen, methanol, NH_3*

Advantages

Environmental

DECARBONISATION

-21%
CO_2 emissions

Up to **-40%**
CO_2 emissions as predicted by the IEA*

*on reducing CH_4 emissions over the whole life cycle by incorporating the use of renewable gases

CIRCULAR ECONOMY

Allows for transformations of existing vehicles, extending their life cycle and reducing the impact of both new construction and waste treatment of existing ones

IMPROVES AIR QUALITY

-100%
emissions of more polluting particles

-95%
NO_x

-100%
SO_x

Almost equivalent to a 100% renewable vehicle

Financial

Price
stable and competitive against the volatility of conventional fuels

30-50%
reduction in price compared to conventional fuels

Mature gas
economy with amortised investments

Capacity
to meet any demand

The low need for additional investment and the logistical capacity and flexibility mean that the cost for new uses does not increase, compared to other alternatives where the cost of infrastructure and logistics can account for up to 50% of the final price of energy.

Other advantages

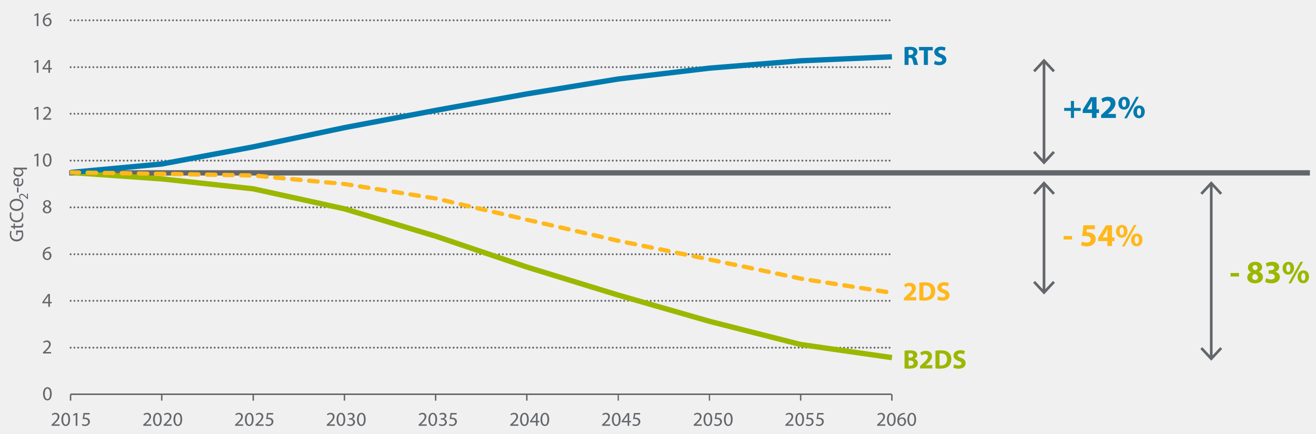
-50%
noise compared to conventional fuels

Security
in product handling and over 50 years' experience

3 Towards decarbonisation with natural gas

The challenge of decarbonisation in transport

2060 vs. 2015 emissions according to the International Energy Agency



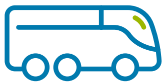
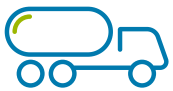
RTS *Reference Technology Scenario*, BaU (*Business as Usual)*.

2DS *2 degrees*, global targets agreed to maintain the two-degree reduction.

B2DS *Beyond 2 degrees*, global targets to reduce by more than two degrees.

Source: IEA (2017), Mobility Model, March 2017 version, database and simulation model, www.iea.org/etp/etpmodel/transport/.

The **estimates for potential natural gas penetration** in the different mobility segments are directly proportional to the power of the motorisation required.

	Power CV	Natural gas penetration
	0-300	15%
	200-400	20%
	250-600	40%
	1000-40000	80%

Natural gas is the energy vector with the greatest global capacity to influence emissions, capable of reducing emissions by 50%:

Up to **30%** of **direct emissions***

Up to **20%** of **indirect emissions****

* For the cumulative effect in the event of achieving the established penetration levels.

** For improving segments where the use of natural gas allows for an increase in modal share, such as railways, to the detriment of segments such as road transport which are up to 12 times less efficient.

A key factor in achieving emission reduction targets is **modal switch**.

It involves **changing the mode of transport in which inland freight and passenger traffic is moved to other, more efficient types of transport**.

In this regard, rail transport stands out from the rest.

By using the train, emissions are reduced, both per tonne transported and per passenger. Furthermore, using natural gas on non-electrified tracks leads to a further reduction in emissions.

A key factor in achieving emission reduction targets is ***modal switch****, which accounts for 20% of total emissions for 2050 according to the IEA*

Road mobility

Activity report

Natural gas is a fuel used for short and long-distance cars, vans, buses and trucks

IN EUROPE

≈ 2 million
natural gas vehicles

IN SPAIN

The number of natural gas vehicles in 2019 has grown twice as much as the number of electric vehicles

Refuelling stations

- There are **two types of gas stations**: **CNG** for light vehicles, vans and short-distance trucks and **LNG** for medium and long-distance trucks and buses.
- The **refuelling station has proven technology**.
- Natural gas has the **capacity and logistics** to meet demand at any refuelling station.
- Natural gas vehicles can be **refuelled** in **1-2 minutes** (fast charge).
- To see the refuelling stations, visit the Gasnam website: gasnam.es/terrestre/mapa-de-estaciones-de-gas-natural.

Financial aspects

Using natural gas in the transport of goods makes it possible to reduce OPEX by up to 20-30% compared to diesel, thanks to the competitiveness of the price of natural gas, rapidly reducing the period of the initial return on investment due to the increase in the cost of vehicles compared to diesel.

Unlike other types of sustainable mobility (electric, hybrid, etc.), natural gas **is developed in the field of production, supply and use**. It is also **financially viable**.

Environmental aspects

Using natural gas to transport goods by road, in the short to medium term, **contributes to improving air quality and reducing CO_2 emissions** (-16% compared to a diesel equivalent vehicle). The hybridisation of **natural gas with biomethane and/or hydrogen blending** will also enable emissions to be reduced by up to 100%. In this way, natural gas together with renewable gases will replace traditional fuels.

Rail mobility

Railways are the most efficient means of transport (between 7 and 9% compared to other land transport).

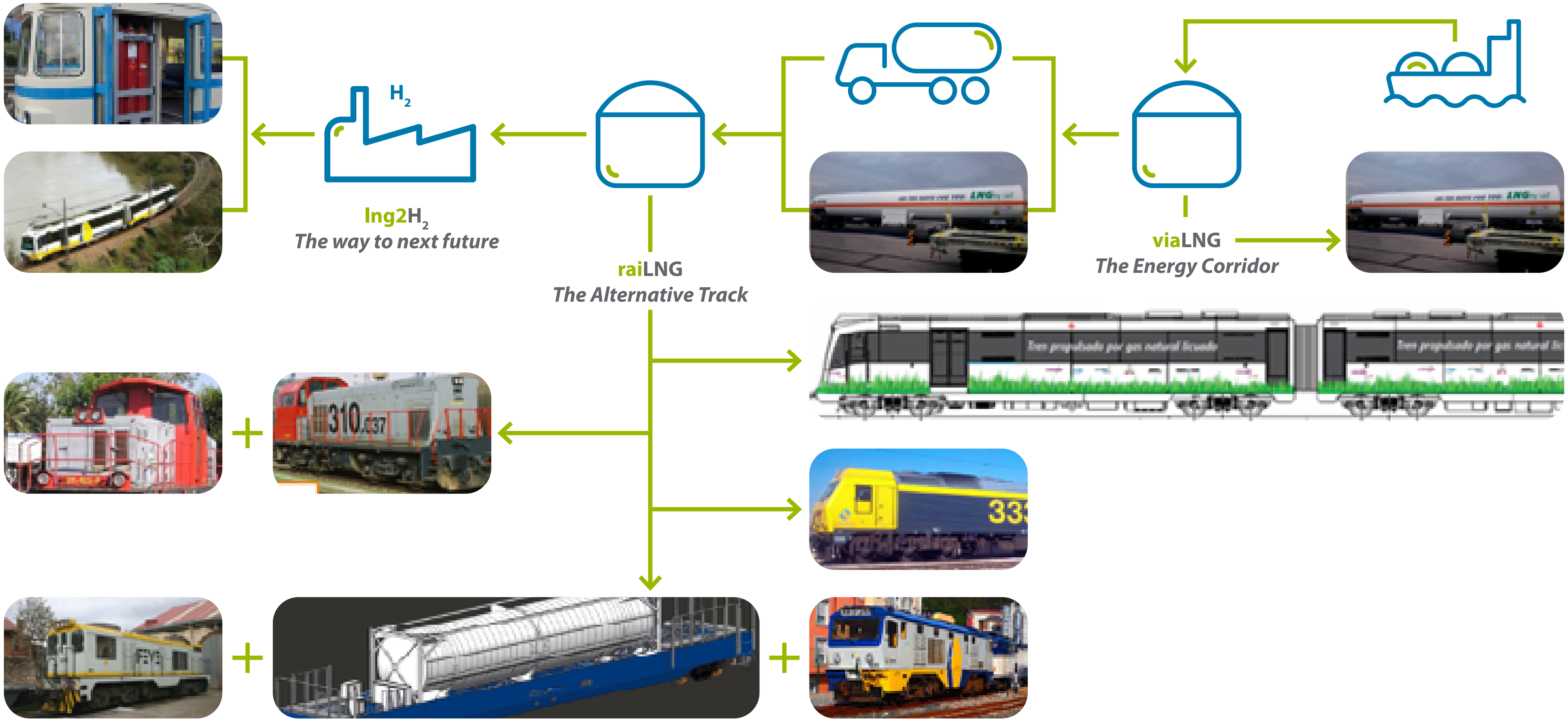
The current average level of electrification of the railway worldwide is 33% and its sustainability depends on the energy mix of each country. Its annual growth (between 1-2%) is prioritised on high occupation density lines (high speed and main freight corridors), but it is insufficient to ensure both the objective sustainability and the increase of *modal share* required to mitigate the effects of road transport.

Therefore, it is essential to **introduce alternative fuels**, especially in the segments that support the efficiency of railways from the main corridors for both passengers and freight.

Despite the fact that countries such as Spain have high levels of rail electrification, 54% of the energy consumed worldwide is of fossil fuel origin.

*54% of the energy directly consumed by railways is of **fossil fuel origin***

Since 2014, Spain has been leading the road map in **alternative solutions** for railways with projects in the commercialisation phase in all traction segments.



Activity report

- Easily adaptable infrastructure from existing commercial solutions for the road mobility segment.
- **Sufficient technological maturity** to ensure its application to any traction segment, **totally miscible with biomethane**. In conventional engines it enables blending with up to 30% hydrogen. This solution would make it possible to speed up the introduction of hydrogen in the heavy traction segments and is more viable in the short-term than the solution linked to the evolution of fuel cells, which would require a revolution in their energy intensity (kWh/kg) for that segment.

A proven technology

- The first experiences date back to the 1930s, but it was from the 1980s onwards that the use of LNG as a railway fuel was promoted in the USA and Canada. Since then, approximately fifty units have been used for commercial service in various parts of the world (North America, Peru, India, Russia) and another hundred are in the test and/or project phase in countries such as Spain, Russia, the United Kingdom and Italy.
- In Spain **a railway road map is being developed** between Renfe, Enagás and other agents in the sector for the transformation of all traction segments to LNG and associated supply points.

Financial aspects

Very competitive returns on investment reduce the life cycle cost for the operator by more than 50% according to the traction segment and alternative technology (state-of-the-art **diesel solutions** and/or **100% renewable H_2 solutions**).

Environmental aspects

Externalities equivalent to those of 100% renewable solutions and up to 95% lower than those of a state-of-the-art diesel solution.

Maritime mobility

The IMO's target is to reduce CO_2 emissions from maritime transport by 70% by 2050 compared to 2008.

To achieve the decarbonisation targets in maritime transport, **69% of emission reductions depend on the efficiency of ships and their operational profiles**.

Meeting CH_4 emission reduction targets, together with hybridisation with renewable gases and hydrogen, will make natural gas the technology with the greatest sectoral impact, with a reduction in CH_4 emissions of up to 40%.

Natural gas is the only viable option in the short to medium-term if we consider both the post-COVID economic situation, with its effect on measures based on replacing the fleet with more efficient ships, and the lack of technological viability of any other alternative by 2035.

Activity report

294
LNG-powered ships (including *LNG ready*)

61 ships
2020 portfolio

134
2021 total portfolio

145
2022 total portfolio

IN SPAIN

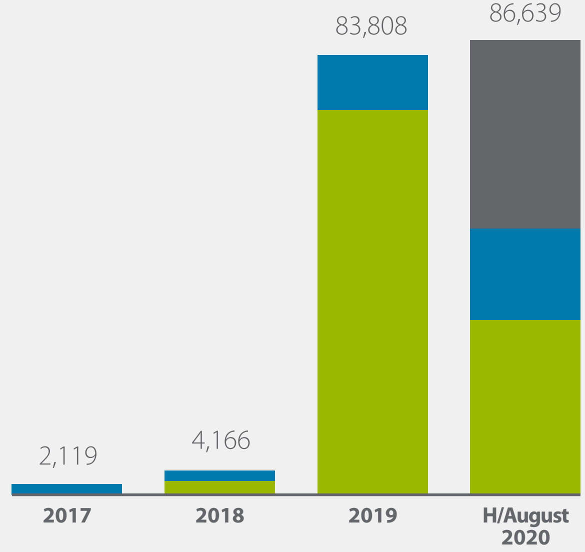
6 ships
(4 ferries and 2 cruise ships) LNG-powered

5 new ships
planned in two years

478 bunkering operations
up to August 2020 x4 vs. the same period in 2019

86,639 m³
volume supplied up to August 2020 (almost x2 vs. the same period in 2019)

Gas supplied as maritime fuel (m³)

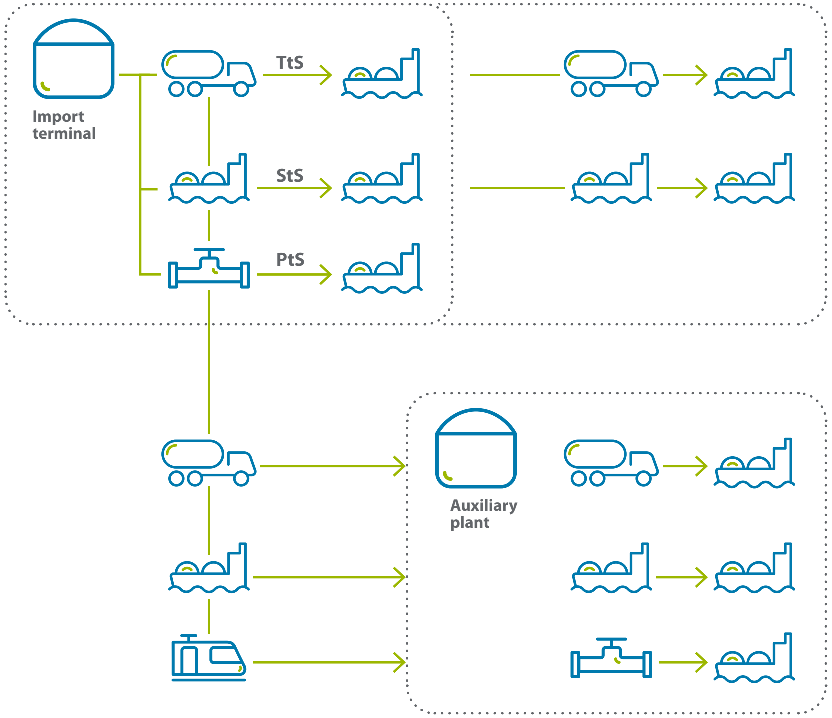


	2017	2018	2019	H/August 2020
MTtS			125	36,093
TtS	1,749	1,831	10,433	17,596
StS		2,335	73,250	32,950

Source: DNVGL AFI.

MTtS: Multi Truck to Ship. **TtS:** Truck to Ship. **StS:** Ship to Ship.

The progress made in maritime mobility has made it possible to develop a **mature market with logistical capacity and flexibility** and to contribute to the growth of LNG bunkering in the Iberian Peninsula, without needing to undertake major investments in the coming years.



Infrastructure prepared for supply

- Availability and use through **logistic solutions adapted to the volume and distance** to which the energy must be transported.
- **Availability of supply** by tanker truck (TtS - *Truck to Ship*) at all ports.
- No need for investment in the next 15 years.
- **Adaptation of all existing LNG terminals** to provide small-scale services and *bunkering* (*Pipe to Ship*, PtS).
- **Under development:** ship-to-ship LNG bunkering projects (StS).

CORE LNGas hive
LNG hive2
Cofinanciado por la Unión Europea
Mecanismo «Conectar Europa»

Financial aspects

A study of Gasnam and DNV GL business cases shows that, despite the initial payment, **investments in the retrofitting of different types of ships* or a new construction for the LNG solution would be recovered in the short-term** (between 3 and 8 years).

Although it depends on the type of ship, this figure is much lower in all cases than the life span of the ship, compared to other alternative fuels that are not sufficiently developed at present.

As a result, **using LNG and its infrastructure in the short-term ensures that targets for reducing emissions at sea and improving air quality in ports are achievable** in the medium and long-term at the lowest possible cost.

The contribution of LNG and renewable gases, according to a study by CE Delft for SEALNG**, will help to further decarbonise the transport sector by using liquid biomethane (LBM) and liquid synthetic methane (LSM).

These energies offer almost a 100% reduction in greenhouse gas emissions and contribute to achieving net-zero emissions. They are also scalable solutions for the maritime sector and could become competitive versus other low-carbon fuels.

*Nine types of ships: Ferries, cruise ships, tugs, bunkering ships, cargo ships, fishing vessels, containers, such as Ro-Ro, Ropax.

**CE Delft Study for SEALNG: Availability and costs of liquefied bio and synthetic methane, the maritime shipping perspective (March 2020).

Environmental aspects

LNG as a maritime fuel already reduces CO_2 emissions by at least 21%*, and its abatement potential up to 40% due to the combined effect of the use of renewable gases and the reduction in fugitive emissions*

According to LNG demand forecasts, the Iberian Peninsula will save 7.2 million tonnes of CO_2 in an average demand scenario for 2050, equivalent to the annual emissions of 4 million vehicles.

4 Conclusions

Infrastructure development must follow a strategic line where the main axis is the volume of demand for each technology by sector (maritime, rail and road), paying special attention to those where electrification or other technologies are not technically possible or profitable.

In this regard, **using LNG makes it possible to evenly cover demand in all sectors** as its large-scale capacity and logistics provide the framework for taking advantage of intermodality centres (ports, railway nodes) to install supply points. This makes it possible to share infrastructure costs between the different sectors and avoid the constraints of other alternative fuel technologies.

According to the IEA*, the "transformation of the energy sector can happen without the oil and gas industry, but it would be more difficult and more expensive"*

- **Natural gas is the only solution** that can provide short-term impact capacity to all sectors.
- **It has mature and developed infrastructure that is readily available and has the capacity** to meet all demand in the mobility sector.
- **It is also essential to the energy transition** in segments where electrification is not viable.
- **It is the vector towards the development of renewable gases**.
- **It is a clean fuel** for all types of transportation.

IEA: International Energy Agency.

2DS: 2 degrees, agreed global targets to maintain the two-degree reduction.

B2DS: Beyond 2 degrees, global targets to reduce by more than two degrees.

BaU: Business as Usual.

CNG: Compressed natural gas.

***MODAL SHARE*:** percentage of passengers or goods that use a particular type of transport.

MGO: Marine gasoil.

ULSFO: Ultra Low Sulphur Fuel Oil.

VLSFO: Very Low Sulphur Fuel Oil.

IMO: International Maritime Organization.

NECP: National Energy and Climate Plan.

GHG: Greenhouse gases.

WtW: Well to Wheel for land, o Well to Wake for maritime.

GWP: Global Warming Potential.

MTTS: Multi Truck to Ship.

TTS: Truck-to-Ship.

STS: Ship-to-Ship.

Study "*Life Cycle GHG Emission Study on the Use of LNG as Marine Fuel*" (April 2019)

International Energy Agency - *Energy Technology Perspectives 2017*

DNVGL, Maritime Forecast to 2050. Energy Transition Outlook 2019

CE Delft Study for SEALNG: *Availability and costs of liquefied bio and synthetic methane, the maritime shipping perspective* (March 2020)

5 Acronyms, abbreviations and bibliography

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