Enabling competitive and cleaner transport
Switching to cleaner-burning LNG is significantly reducing greenhouse gas emissions and air pollution in shipping.
SULPHUR REGULATION

A game changer for shipping
**SULPHUR REGULATION**

*A game changer for shipping*

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**Sulphur regulation - 2020 IMO global cap**

<table>
<thead>
<tr>
<th>Sulphur content</th>
<th>HSFO</th>
<th>ULSFO / Gasoil</th>
<th>VLSFO / Gasoil</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.5% max</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.5% max</td>
<td></td>
<td></td>
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<tr>
<td>0.1% max</td>
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</tbody>
</table>

**Today**

- **Worldwide**: Authorized sulphur content in fuel (%)
- **ECAs + EU Ports**

**2020**

- **Forbidden**: 0.5% max
- **Worldwide**: Authorized sulphur content in fuel (%)
- **ECAs + EU Ports + ECAs China**

*Forbidden unless used with scrubbers for SO₂ post-treatment*

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**Authorized sulphur content in fuel (%)**

- **Outside ECA zones**
- **ECA zones**

ECAs = The Channel, North Sea, Baltic Sea, North America, US Caribbean

Source: [IMO, TOTAL](#)
Tighter air quality regulations for shipping offer a chance to switch to LNG

LNG, Ultra Low Sulphur Fuel Oil and installing scrubbers are part of the solution for shippers to reduce dangerous emissions.

Currently 84% of global shipping uses heavy fuel oil that generates polluting Sulphur Dioxide. The International Maritime Organisation has ruled that marine fuels must be under 0.5% sulphur by 2020 to reduce this pollution.

LNG’s sulphur content LNG is negligible (5 ppm max), i.e. 1,000 times lower than the IMO 0.5% rule.

Timeline for IMO enforcement

Source: IMO
TIGHTER AIR QUALITY REGULATIONS FOR SHIPPING OFFER A CHANCE TO SWITCH TO LNG

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Source: OIES
LNG HAS SIGNIFICANTLY **LOWER CO₂ FOOTPRINT**

*LNG can help future proof ship owners against tighter CO₂ and other emissions regulations*

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**Maritime transport** emits around **1000 million tonnes** of CO₂ annually and is responsible for about **2.5%** of global greenhouse gas emissions (3rd IMO GHG study)

In **April 2018** the IMO adopted a vision to **reduce** the total greenhouse gas emissions by at least **50% by 2050**

**LNG as a marine fuel** can be **23% lower compared** to traditional fuels and save up to **80-92% on other emissions**

*Source: IGU, IMO*
ADVANTAGES OF LNG AS A MARINE FUEL

Environment

- Regulatory compliance & environmental performance
  - Totally compliant with 2020 IMO Global Cap
  - Beyond Sulphur regulations, IMO is studying other potential emissions restrictions on NOx, CO2, particulates
  - LNG would be compliant as well

Economics

- LNG competitiveness
  - $/t
  - GASOIL (0.1%)
  - ULSFO (0.1%)
  - VLSFO (0.5%)
  - HSFO (3.5%)
  - LNG

Growing market

- Long-term availability
  - LNG is a fast growing market evaluated at 345 mt in 2020 ~ 10% world gas consumption (+4-5%/y)

Source: TOTAL

LNG PLAYBOOK
**CMA CGM – 1st Mover for Large Container Ships**

Unlocking chicken and egg situation

**FAL 1** French Asia Line

9 x 22,000 TEU Newbuild vessels
- Investment around $1.2 Bn
- Built at Shanghai Waigaoqiao Shipbuilding & Hudong-Zhonghua Shipbuilding (CSSC Group)
- An 18,000 m³ GTT membrane tank and WinGD X-DF engine

**FAL 1** Focus Northern Europe

LNG supply deal
- 300 kt/year on 10 years from 2020

Bunker vessel
- Bunker vessel chartered to MOL: 18,600 m³
- Mark III membrane Containment system
- Bunker operations: mainly in Northern Europe

Tailor-made solution with one large bunker vessel operating in Europe to minimize:

- LNG bulk price (favorable European price)
- Logistics cost (loading at terminal + bunkering)
- Bunkering time

Source: TOTAL

LNG PLAYBOOK
A CLEANER, MORE AFFORDABLE AND AVAILABLE FUEL TO SUPPLY GLOBAL ROAD AND MARINE MARKET

1. LNG supply is available in key markets globally

2. The LNG road network is developing in EU & China

3. The marine segments are adopting LNG
   - Container
   - Tanker
   - Bulker
   - PCT
   - OSV
   - Ferry

4. Key downstream infrastructure is being developed

Source: Shell
**Carnival** is the **world’s largest operator of cruise ships**. These ships, which can host up to 6,000 guests and 2,000 crew members, require significant energy.

In 2016 Carnival agreed to build **two LNG fueled cruise ships** to help lower emissions, **reduce CO₂ footprint** and **improve the customer experience**.

**By switching to LNG**, the cruise ships will be able to **operate in low emissions areas** and will be future proof to future tightening of emissions standards for SO₂.

*Source: Shell, IGU, Guardian*
LNG AS A **PORTSIDE FUEL**

*Helping reduce emissions in busy ports*

On average, **AIDA ships spend 40% of their operating time in port**. They must also have a power supply there to ensure onboard operations can continue.

In Hamburg, AIDA’s ships are supplied with power supplied via a **hybrid LNG barge**, allowing operations on the ship to continue without using higher polluting fuels & long connection times.

The barge supplies **power to cruise ships** during the summer season and is able to operate as a **floating power and heat plant in the winter**.

When combining **fuel savings and port discounts**, cost savings for each stay in the port of Hamburg can be substantial.

Source: [AIDA](https://www.golng.eu)
By May 2018, there were about 280 LNG-fueled vessels in China and 18 LNG bunkering stations have been built.

ENN has built an LNG bunkering terminal in China’s coastal Zhoushan city, providing fuel supply to international vessels.

ENN’s 8,500m³ bunkering vessel that is under construction.
FLEET OF **LNG-FUELED VESSELS** IS GROWING RAPIDLY

- Currently **159 LNG-fueled vessels** operating globally* with **145 more in the order book**
- More than 100 'LNG ready' vessels in operation

**Operating area of LNG-fueled ships, existing+ordered**
- **Global**: 82
- **Europe excl Norway**: 91
- **Norway**: 82
- **America**: 29
- **Oceania**: 4
- **Middle East**: 1

Source: DNV-GL Alternative Fuels Insight, May 2019

*Excluding LNG carriers
ADDITIONAL LNG BUNKERING INFRASTRUCTURE IS BEING DEVELOPED GLOBALLY

Unique projects worldwide

Project status by region

- **Europe**: 37 in operation, 21 decided, 27 planned
- **Norway**: 16 in operation, 1 decided, 6 planned
- **Asia Pacific**: 20 in operation, 15 decided, 4 planned
- **America**: 8 in operation, 4 decided, 2 planned
- **Oceania**: 4 in operation, 1 decided, 2 planned
- **Middle East**: 4 in operation, 1 decided, 1 planned

Facilities worldwide by type

- **Local Storage**: 54 in operation, 24 decided, 19 planned
- **Truck Loading**: 48 in operation, 14 decided, 10 planned
- **Tank to Ship**: 33 in operation, 15 decided, 6 planned
- **Bunker Ship**: 17 in operation, 13 decided, 3 planned
- **Other Bunkering**: 3 in operation, 3 decided, 1 planned

Source: DNV-GL Alternative Fuels Insight, May 2019
LNG IN TRANSPORT **SAVES COSTS, IMPROVES AIR QUALITY AND INCREASES EFFICIENCY**

*Clear CO2 emissions benefits from LNG trucking, with negligible SOx and Particulate Matter emissions from LNG*

Heavy duty vehicles are a major source of CO2, poor urban air quality and noise.

While only 4% of vehicles on the road are trucks, they account for 17% of global pollution.

LNG and bioLNG can affordably and sustainably be used to transport food, goods and material to customers.

LNG as a road fuel reduces CO2 by 15% (28% if bioLNG), Nox by 50%, PM 2.5 by up to 90%.

Gas engines have lower noise emissions, allowing operators to deliver in residential areas at night.

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**Green house gas emissions in heavy duty vehicles (g CO2 eq/ km)**

- **bioLNG**
- **LNG (HPDI)**
- **LNG (SI)**
- **Diesel (FQD)**

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**Source:** NGVA
LNG IN TRANSPORT SAVES COSTS

Truckers can save around 25% on fuel costs compared to traditional liquid fuels in India

Transport is essential to modern living

It drives economic growth, allowing countries to trade goods and communities to connect with one another

In Gujarat, India, truckers save around 25% on fuel costs by switching to LNG

The IEA estimates that use of natural gas for transportation could grow by as much as 14% between 2016 and 2022

Source: Petronet
POTENTIAL LNG DEMAND ON 5 IDENTIFIED HIGHWAYS IN INDIA IS SIGNIFICANT

<table>
<thead>
<tr>
<th>Highway</th>
<th>Length (Km)</th>
<th>Estimated LNG demand- Low case (MTPA)</th>
<th>Estimated LNG demand- High case (MTPA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delhi-Mumbai</td>
<td>1,375</td>
<td>1.10</td>
<td>1.45</td>
</tr>
<tr>
<td>Mundra-Ahmedabad</td>
<td>344</td>
<td>0.10</td>
<td>0.20</td>
</tr>
<tr>
<td>Mangalore-Thiruvananthapuram</td>
<td>609</td>
<td>0.20</td>
<td>0.26</td>
</tr>
<tr>
<td>Mangalore-Bangalore</td>
<td>352</td>
<td>0.78</td>
<td>0.94</td>
</tr>
<tr>
<td>Mumbai-Chennai</td>
<td>1,344</td>
<td>0.12</td>
<td>0.13</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>4,024</strong></td>
<td><strong>2.29</strong></td>
<td><strong>2.99</strong></td>
</tr>
</tbody>
</table>

Source: Petronet
**BENEFITS FOR DIFFERENT STAKEHOLDERS**

- **Government:** Additional penetration of gas to achieve target of 15% of gas share in the energy basket. Achieving COP 21 Goals. Conversion of around 250,000 vehicles has a potential to increase the gas consumption share by 1.5%, i.e. from 6.5% to 8% in a period of 5 years. Stakeholders together will invest $215 million from their own funds to create a green environment in first two years.

- **LNG Provider (Petronet LNG):** Cost for setting and supplying LNG to filling stations and infrastructure is $36 Million for 10,000 vehicles, 40 stations.

- **Fleet Owners:** Assuming 10,000 fleet owners convert to LNG in 2 years, additional investment at $13,500 per truck, incremental cost is $132 million and savings of $44 million per annum for 10,000 trucks.

- **Original Equipment Manufacturers (OEM):** New business opportunity and business case with 10,000 trucks in 2 years.

- **Oil Marketing Companies:** Reduces risk as government is promoting alternate fuels. Acquiring technical competency. Earning of around $8.8 million per annum, for 10,000 trucks.

- **LNG Transport Trucks:**

**Total Investment** amount for the joint venture consists of cash investments by all stakeholders as well as funding the initial incremental cost for the fleet owners and managing the total infrastructure for assured fuel supply.

*Source: Petronet LNG PLAYBOOK*
LNG CAN OFFER A **COMPELLING VALUE PROPOSITION** TO LOGISTICS FIRMS

**1. Cost competitive fuel**
- Can contribute to lower local exhaust emissions and global greenhouse gas emissions

**2. Cleaner burning fuel**
- Can contribute to lower local exhaust emissions and global greenhouse gas emissions

**3. Proven & reliable LNG engine technology availability**
- Limited to SI engines with sound intensity measured in watts / m² at peak load & idle conditions

**4. Reduced engine noise**
- Limited to SI engines with sound intensity measured in watts / m² at peak load & idle conditions

**5. LNG Availability, Safe and reliable supply chain**

Source: Shell
CUSTOMER DEMAND FOR LNG **DRIVEN BY SHIPPERS AND SUSTAINABILITY PROGRAMMES**

*LNG can be accessed by consumers via sea, rail or road*

**Retailers**
- Food products & consumer goods
  - Current LNG users: Nisa, Whitbread, Sainsbury's, Asda, BBC, Argos
  - Customers: Tesco, Sainsbury's, Coca-Cola, John Lewis Partnership, B&Q, Argos

**Parcel couriers**
- Post & mail express services
  - Current LNG users: DHL, UPS, DHL FastWay, Yodel, Confort
  - Customers: (Global) Freight Forwarders, General Cargo, Multiple

*Source: Shell*
Improved economics of LNG vs diesel and restrictions to use trucks in cities are boosting LNG-fueled truck development

**CHINA LNG ROAD DEVELOPMENT**

- **2,500+** LNG stations
- **70,000+** New LNG engines in 2017

Source: ENN
LNG AS TRANSPORTATION FUEL IN CHINA

Over 2,500 LNG filling stations in China. 70,000 new engines added in 2017

Sales of LNG buses and trucks in China

Volume of LNG sales

Number of filling stations in China

Source: ENN
China uses LNG trucking as an effective way of building a strong LNG supply system to supply gas to towns and cities without pipelines. LNG from onshore factories and coastal receiving terminals is distributed to industrial factories, city gate stations and refilling stations by truck-carried tankers.