LNG FOR TRANSPORT: THE STATE OF THE ART OF TECHNOLOGIES THAT USE LNG IN TRUCKS AND SHIPS AND ITS APPLICATION IN BRAZIL

Rio Pipeline 2019 – EPE Stand

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Agenda

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- ✓ Natural Gas for Ship
- ✓ Natural Gas for Trucks
- ✓ Conclusions

Introduction

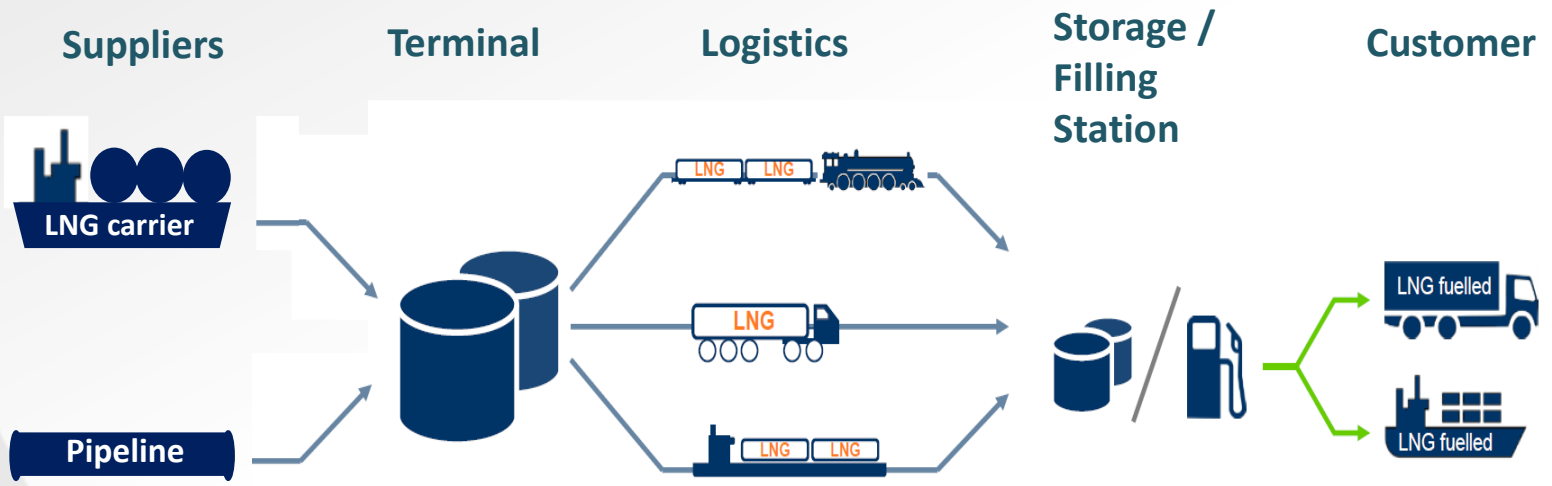
- Transport Sector:
  - 56% of sectoral energy consumption in the world;
  - 32,7% of sectoral energy consumption in the Brazil;
  - The fuels used are of fossil origin and are highly polluting like diesel, gasoline and maritime oil bunker;
- Transport sector emissions in 2015:
  - Half of the world's NOx emissions;
  - 12% of SO_2 emissions;
  - 7% of particulate emissions ($PM_{2.5}$).

Source: IEA, 2017 ; EPE, 2018.

Introduction

- Many countries have been active in limiting pollutant emissions from heavy vehicles as well as light vehicles and shipping;

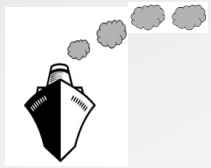
- Natural gas, mainly in the form of LNG will be a strategy.



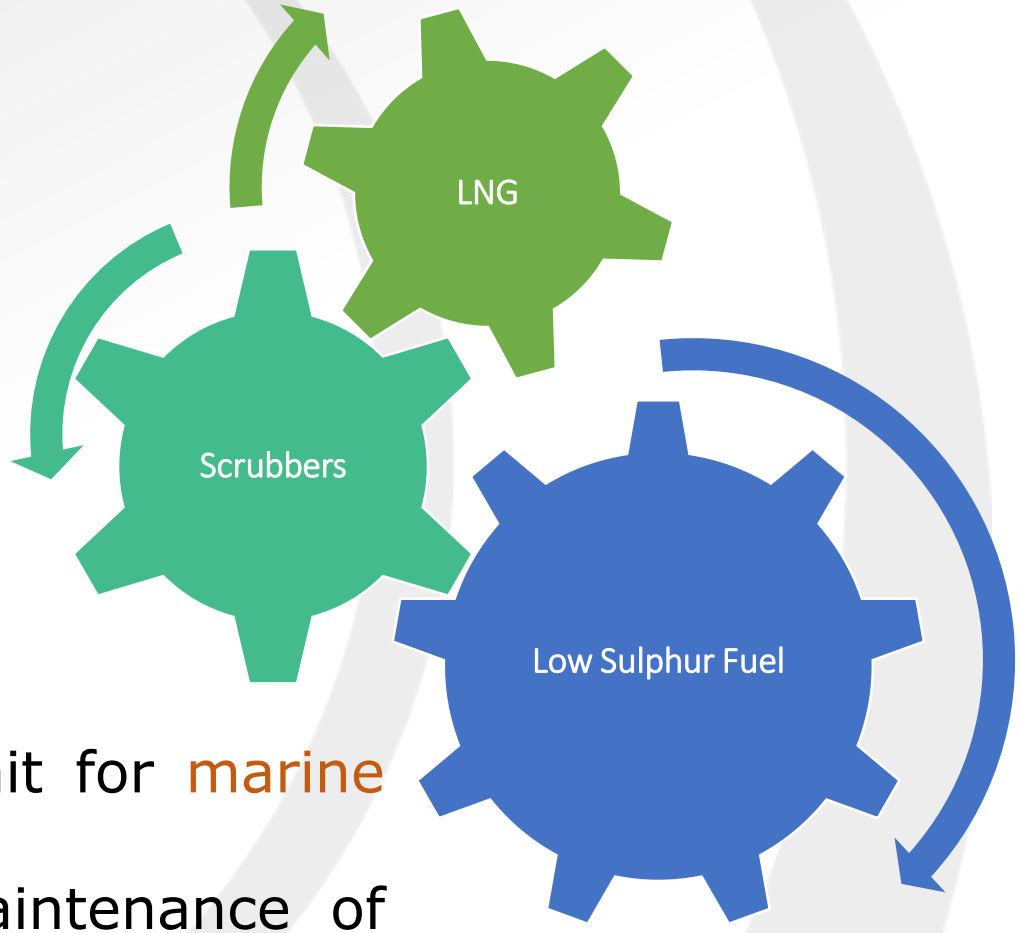
Source: Adapted from GABL, 2017.

Natural Gas for Ship

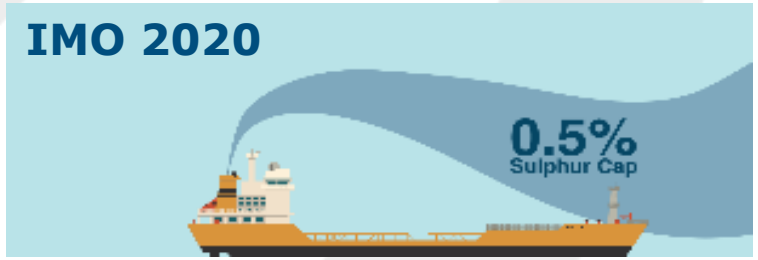
Participation of shipping in the international trade. Typically, the fuel used like marine fuel is Heavy Fuel Oil (HFO).



The global pollution from maritime transport represented 2.6% in 2015.



- IMO 2020 - reduction of the global sulphur limit for marine fuels;
  - 3.5% to 0.5% from January 2020 and maintenance of 0.1% for ECA.

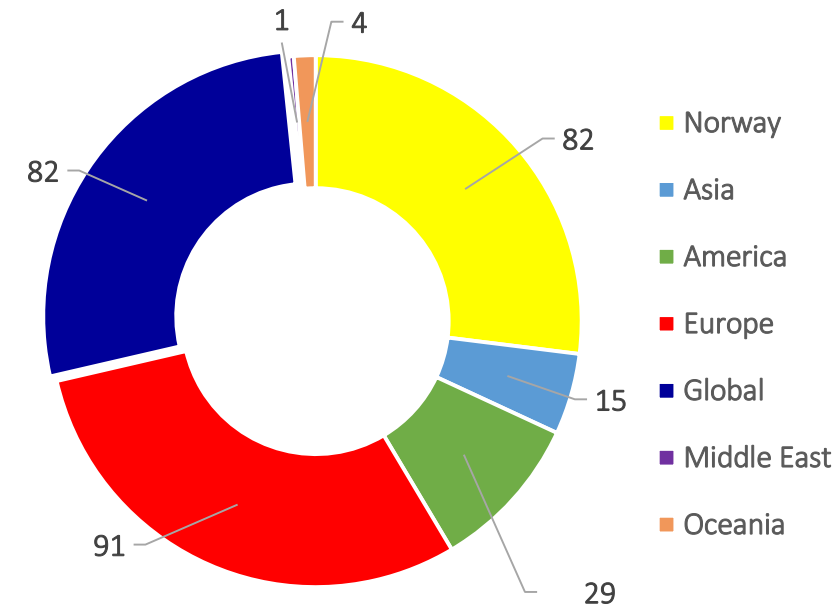


Source: Shell, 2019.

Natural Gas for Ship

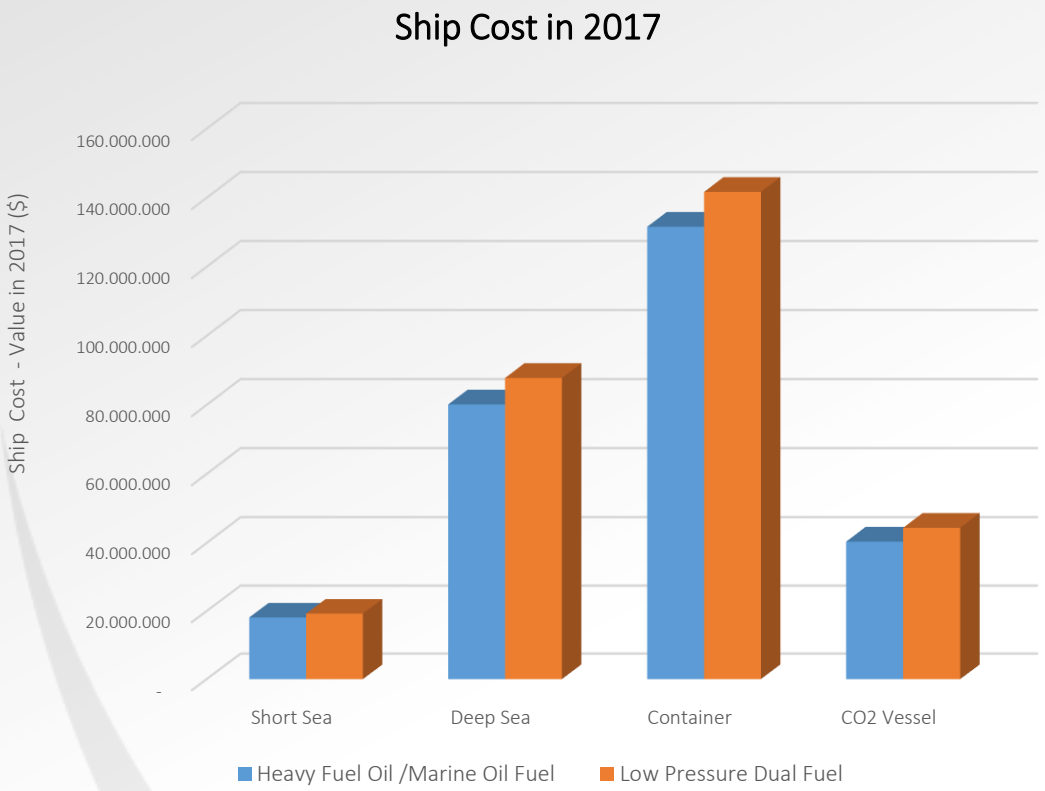
- Natural gas is considered one solution mainly in ECA regions;
- 2% of the marine fuel used today correspond to LNG;
- The current fleet is 159 vessels in operation and 145 already commissioned;
- European shipping area is predominantly, most notably in Norway;
- Natural gas can reduces or even extinguishes SO_x, NO_x and particulate emissions.

Number of vessels that use LNG by region



Source: DNVi, 2019.

Natural Gas for Ship



Source: Speirs et al, 2019; Yoo, 2017.

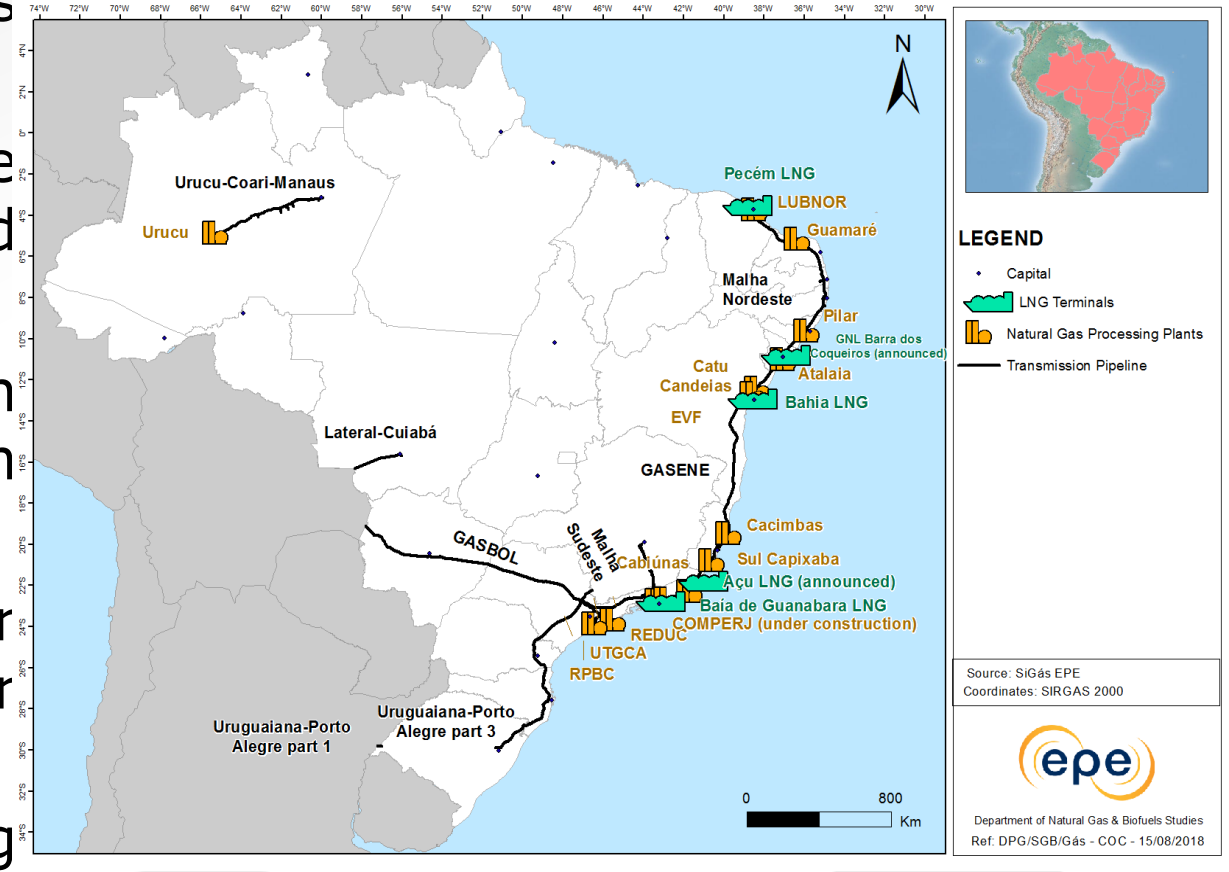
- Recently the cost of LNG vessel have been substantially lower;

- This reduction in costs is due:
  - Experience gained in new built ships;
  - Improved technologies and efficiency acquired by shipyards;
  - Favorable market conditions for both buyers and builders;

- The costs of LNG ships are 6% to 10% higher than ships that use other fuels.

Natural Gas for Ship - Brazil Scenario

- Forecast of significant increase in gas supply in the coming years;
- "**Novo Mercado de Gás**" – To make the gas market open, dynamic and competitive;
- ANP recently launched the Resolution 789/2019, which reduces the maximum sulfur percentage of marine fuel oils;
- Challenges for implementation mainly for the capacity of Petrobras to offer oil bunker with low percentage of sulphur;
- Opportunity for ships that carry out long distances routes, especially for ECA regions.



Natural Gas for Trucks

It represents the growth of energy consumption in the freight sector in the last decades;

About half of global diesel demand is in the cargo transportation sector;

The main motivation: emissions reductions and issues related to energy supply security.

Source: Galileo, 2019.

Natural Gas for Trucks

Some measurements around the world:

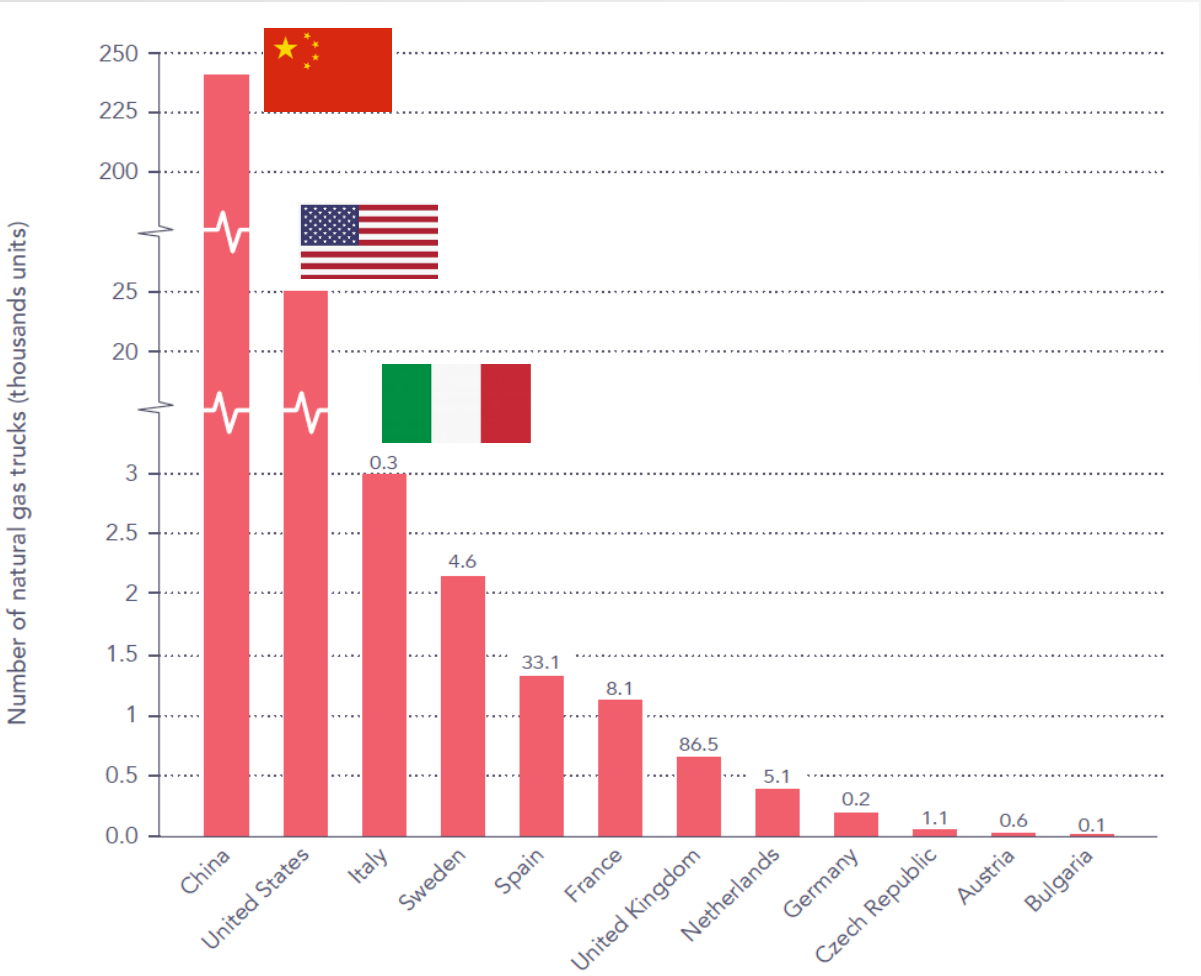
To propose a 15% reduction in emissions by 2025 and a 30% reduction by 2030 when compared to the emissions of 2019;

National Heavy Vehicle Program – to propose the emission reductions of 8% to 14% compared to 2017 emissions for some subcategories of heavy vehicles;

LNG BLUE CORRIDORS

Blue Corridor was created with the objective of endorsing LNG as an alternative for medium and long distances.

Natural Gas for Trucks



China compared to the other countries is the one with the largest fleet currently, followed by the United States and Italy.

Source: Speirs et al, 2019.

Natural Gas for Trucks

- LNG trucks have shown a recent increasing of the autonomy;
- Models such as New Stratis NP from Iveco have autonomy of up to 1,600 km;
- LNG-Powered Scania Trucks, also features autonomy of about 1,100 km without the need for refueling.

- LNG trucks have the advantage of using a fuel at a lower price;
- The price of the truck is usually higher, around 20,000 to 30,000 euros.

Natural Gas for Trucks – Brazil Scenario

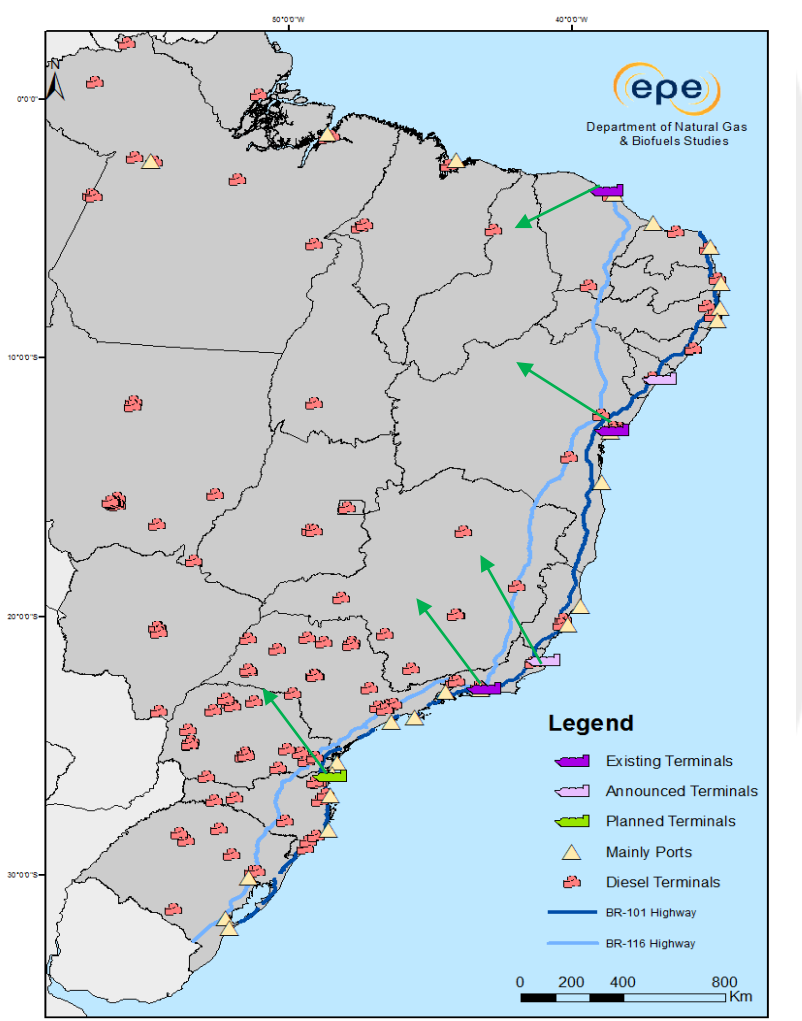
Opportunities:

- The high price of diesel is a key factor to stimulate the use of LNG;
- Brazil imported 34,000 m³/day of diesel oil, about 23% of the consumption in the country.;
- Some companies are trying to introduce this mode, for example, Golar is bringing 4 LNG-powered trucks to Brazil in the coming months.

Natural Gas for Trucks – Brazil Scenario

Challenges :

- Lack of infrastructure;
- Need for high investments: estimated that the cost of each refueling facility for trucks would cost anywhere from $ 470,000 to $ 1,150,000 depending on the technology;
- Need to be approval in Brazilian organizations (Inmetro, ANP…);
- Uncertainty about the price these trucks will be available to the market.



Conclusions

- The use of LNG as fuel has been discussed worldwide;
- There is a potential market for its development, mainly due to gaps that have arisen due to the new regulations. Internationally, in the United States, Europe and China, this market is already at an advanced stage of maturity;
- In Brazil, the discussions are still in an initial state;
- Some challenges still need to be overcome, including the additional cost of transportation facilities, the storage infrastructure and refueling stations, for example.

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