



## International Symposium on Marine Design and Construction 2019 (SMDC 2019)



### LIQUEFIED NATURAL GAS AS ALTERNATIVE BUNKER FOR IMO 2020

Dr. T Bangar Raju<sup>a</sup>, Purbesh Pande<sup>b</sup>, Dr. B.V. Ramalingeswara Rao<sup>c</sup>,

Bhavana Anirudh<sup>d</sup>,

a Professor, School of Business, University of Petroleum and Energy Studies, India.

b, Student, MBA Port and Shipping Management,

c, Faculty, Indian Maritime University, Vishakhapatnam.

s, Student GITAM university

Keywords: IMO, LNG Bunkering, LSFO,

#### Abstract:

*With IMO 2020 deadline approaching nearer the vessel owners are looking for cleaner fuel or better options to meet the new emissions norms. The first option is going for cleaner low sulphur oil which more pressure on refineries and costs could be an issue. The scrubbers could be a short-term solution but costs of the same may be too high for the vessel owner. LNG fuel could be good option with zero emissions of sulphur and easy availability. The paper discusses the merits and demerits of LNG as alternative bunker. It also analysis the relationship between prices of LNG with Brent crude and MGO. The results show that LNG prices are not correlated with the prices of Brent crude and MGO prices.*

Keywords: IMO, LNG Bunkering, LSFO,

#### INTRODUCTION

In 2016, it was announced by the International Maritime Organization (IMO) that the date for implementation of the reduction of marine fuel Sulphur to permissible limits will be on 1<sup>st</sup> January 2020. To reduce global greenhouse emissions ships will have to use marine fuels or alternate fuels as per a new global Sulphur cap. The Sulphur content will be limited to not more than 0.5% Sulphur which is much lower than the present limit of 3.5% Sulphur. The date of implementation of IMO 2020 was set in the MARPOL treaty. The date of 1 January 2020 was decided in the MEPC

meeting held by the IMO in 2008. The impact of this transition represents approximately 75% of global marine fuel needs. Ship owners will be forced to decide if they want to continue using high Sulphur fuel oil, to do

so they will need to fit scrubbers or exhaust gas cleaning systems to reduce the Sulphur content to the prescribed limits. They also have the option to switch to low Sulphur fuel oils like marine diesel oil (MDO) or marine gas oil (MGO) or virtually Sulphur-free LNG fuel or use other alternates. Retrofitting scrubbers which clean the exhaust emissions before they are released into the atmosphere must be approved by the ship's Administration (the flag State). It is expected that the freight rates will see a phenomenal rise across all the shipping sectors. Operational costs will see a massive increment as bunkers make up 70%-80% of the total voyage expenses. As the costs keep rising most owners will try to pass on the expenses to the charterers or other stakeholders. Demand for HSFO will decrease dramatically in 2020, likely to less than 0.8 m bl/d and probably as low as 0.3 – 0.4 m bl/d, representing

barely 10% of today's marine HSFO consumption of 4 m bl/d. Demand will instead switch to compliant fuel with less than 0.5% Sulphur content, i.e. either ULSFO 0.5% or Gasoil 0.5%. Ripple effects of this development will likely be felt across the whole oil product sector and further impact pricing of different crude slates. It is expected global refinery upgrading capacity utilization to be pushed to its limit in 2020 and that the Gasoil to HSFO price spread will in response widen to more than \$450/ton. Non scrubber ships may on the other hand have an advantage as the spread of price of Gasoil over HSFO is likely to reduce over time with newer blends being developed at cheaper prices. However initially in 2020 ships having scrubbers already installed will be the biggest gainers as the price differential between HSFO and compliant fuel will be very high before newer blends are developed bringing down LSFO prices. Complex refineries having coker units will be able to take advantage of the shift in processing HSFO to ULSO as the demand of the cracks will go up. More profit and higher GRMS for such refineries are expected to be registered. LNG fueled ships will have a competitive edge over other tonnages (like tankers) due to the price differential of LNG AND LSFO. LNG is not only the cheapest but also the cleanest fuel available. Installation of scrubbers on the existing tonnages is not picking up as of now as owners are doubtful on the price variation of the compliant fuels. But it is expected as we enter 2020 retrofitting of existing tonnage with scrubbers will pick up especially for ships below 10 years of age. The bright side which Maritime Industry should see is the improvements likely to impact the environment in the coming years as a result of this implementation – pollution campaigners estimate a huge reduction in pollution levels as well as pre matured deaths caused by it will be attained as result of this change. However, on the



## International Symposium on Marine Design and Construction 2019 (SMDC 2019)



downside pollution caused by the water discharge from Inert Gas System (IGS) has not yet been investigated. Many observations and studies are in the process to find if this is more harmful for the sea life and environment. To ensure all ships follow the new regulations several steps are being taken. Surveillance technology, for example air surveillance to check Sulphur content in smoke plumes and use other methods to catch potential offenders. There is no established fine or sanction set by IMO yet therefore it is up to the individual State Party to make sure compliance and implementation of this new rule.

### IMPACT ON REFINERIES

From a refineries' perspective several observations should be considered as an implication of this rule.

- Most refineries that produce High Sulphur fuel oil (HSFO) will be most threatened after the implication of this rule.
- Refineries that produce the lower cracks which include distillate fuels will have the chance to use IMO 2020 as an opportunity rather than a threat.
- The urgent need for refineries that produce only HSFO is to modify their technology so that they can produce the lower cracks which will be in demand. However, refinery modifications even if underway will take time and it is expected such refineries will not be able to be up and running by 2020. Thus, time is no doubt an enemy for most refinery businesses.
- The price differentials for refiners will notably change by 2020. This will cause refiners to bring significant changes in how they process their strategy
- Distillate prices will see prominent increase in prices as compared to high Sulphur residual fuel oils. It is expected that the distillate fuel prices especially in the coastal regions may increase to levels higher than gasoline. This will give refiners the opportunity to create blends by doing product mix optimization. This will further create opportunities for refiners and bunker blenders. It will be refiner's duty to ensure the blends of fuel oil produced are IMO compliant.
- Crude slate optimization must be used by many refineries to produce the requisite blends at the right prices to stay viable in the fuel oil business.
- It is expected that a wide price differential for IMO-2020 compliant fuel and normal HSFO will create an opportunity for many ship owners to install onboard scrubbers or shift to LNG. Likewise, it will also refiners to expand residual upgrading facilities. Investment decisions in the right direction between ship owners and refiners

which will be driven by a wide price differential will help reduce the magnitude of the above market price change.

- LNG AS AN ALTERNATE FUEL
- The next best option is to switch to an alternate fuel that will comply with all the IMO standards. Many industry players along with European and North American governments have been advocating LNG as a best solution for shipping industry's environmental problems. LNG is the cheapest form of bunker fuel with Sulphur content much lesser than the prescribed 0.5% and offering significantly low Sulphur emissions. Lack of compatibility issues as another advantage as consistent specification of this fuel will be available at all ports with LNG bunkering facilities. Dual-fuel engines which can burn MGO and LNG are widely available which helps the ship owner to switch fuels if LNG is not available or becomes more expensive.
- The cost of retrofitting an existing ship with an LNG engine will be prohibitively expensive. A ship owner who is looking into the option of buying an LNG ship must investigate the fact that the capital costs of building an LNG ship involves huge investments upfront. Another disadvantage includes the LNG engines and fuel tanks take up much more space than the conventional fuel tanks causing the amount of cargo that could have been loaded to be lost.
- LNG also needs complex crew training and safety requirements which often acts as a barrier to the widespread use of LNG as a bunker fuel. The availability of LNG bunker terminals needs also to be considered as very few of them are present now on the major shipping lanes. The added disadvantage of methane slippage can cause far more pollution than Sulphur emissions to the environment.

### ADVANTAGES

- LNG is a much cheaper form of fuel almost half the price of crude oil and one third the price of diesel oil.
- It is the cleanest form of fuel with Sulphur content less than 0.1% and for this reason it is most preferred in ECA areas.
- It is a cryogenic fuel. The advantage of cooling and liquefying the fuel is that volume is decreased 600 times as compared to the gas. This improves the energy density significantly.
- Worldwide LNG demand is expected to grow at 5% annually and at an even higher rate after implementation of IMO 2020.



## International Symposium on Marine Design and Construction 2019 (SMDC 2019)



- LNG bunkering is developing at all major ports around the world as more and more environmental norms are forcing shipping to switch to more cleaner forms of fuel. Sooner than later LNG will become the future of ship bunker fuel as it is the cleanest possible fuel available
- New orders for LNG ship building are being placed due to IMO 2020. Lloyd's Register predicted an optimistic scenario predicting about 2000 ships by 2025.

### DISADVANTAGES

- It requires specially designed dedicated tanks and the space required can go up to four times the space required to store other bunker fuels. This eats into the cargo capacity of the ship.
- It requires complex designed LNG storage tanks which are cylindrical in shape and should be able to withstand a pressure of 2 bars.
- The availability and supply chain and bunkering are not yet developed and therefore cannot be operated in many ports of the world yet.
- Building cost of an LNG ship is much higher and complex than other cargo ships.
- The problem of methane slippage which is methane emission while using LNG needs to be investigated as it can cause more environmental pollution than Sulphur emissions.

Even though it is cost-effective to retrofit a vessel to use LNG, the cost of doing so and taking such a ship to dry dock is very high. The reliability of LNG bunker availability at major seaports may not be much but looking at the forecasted LNG bunker demands it can be fairly predicted that LNG will secure itself as a good alternate option for the future. However, from vessel owner's point of view there is a need to study the prices of LNG and traditional MGO as this impacts the operating costs of the ship. This article would study the historical data of LNG prices (Henry Hub), Brent Crude oil and MGO. The relationship study between the three would help ship owners for future decision making. The Henry Hub prices have been considered keeping in view the present and future dominance of LNG exports from USA.

### Literature Review

The International Convention for the Prevention of Pollution from Ships, 1973 which was modified by the Protocol of 1978 (**MARPOL 73/78**), is aimed at minimizing pollution of seas and oceans by ships. It is

one of the important Conventions and was formulated to help in marine environmental protection. The Annex VI of MARPOL documents rules and regulations related to prevention of pollution by air. It also deals with NOX and SOX emissions. It was enforced in 19<sup>th</sup> May 2005. It deals with emissions of exhaust gases coming from ship's engines, boilers etc. and takes steps to curb and prevent such pollution.(Yoon, Shin, & Lee, 2017). In 2016, the IMO announced that there will be a limit to the Sulphur content used in marine fuel oil used. The effective date which was decided for the implication of this law was decided to be 1<sup>st</sup> of January 2020 (**IMO 2017**). According to the law ships would have to use compliant marine fuel which had a Sulphur content of not more than 0.5% Sulphur which is much lower than the current limit of 3.5% Sulphur. This effort was taken to reduce pollution and reduce emission of greenhouse gases (*Concawe, 2016*).

The MEPC meeting held by the Marpol Treaty decided that the implementation of IMO 2020 would be on 1<sup>st</sup> January 2020. The date was decided, and the regulations were adopted in 2008. This transition is about to impact more than 75% of the global marine fuels as these fuels will no longer be compliant after IMO2020,**BIMCO, 2017**. Ship owners will now have to decide on the alternate options available to them. They can be non-compliant and continue using high Sulphur fuel oil or retrofit ships with scrubbers which act as exhaust gas cleaning systems or totally switch to compliant fuels like LNG, methanol, MGO, distillates or biofuels. LNG is one of the better alternatives with Sulphur content less than 0.1% and one of the cheapest forms of fuel. (*Koza et al.2018*) . Once IMO 2020 is implemented the price differential between compliant fuels and HSFO is forecasted to shoot up. Ships may use this fact to their advantage by switching to LNG as LNG is much cheaper as a form of fuel and its price will be much lesser than LSFO. **Maxwell, D. and Zhu, Z. (2018)**.Scrubbers can also be installed in ships in order to reduce Sulphur emissions to the prescribed limits. The downside of fitting a ship with a scrubber is that it will involve very high capital costs which can in turn be saved by shifting to compliant fuels like LNG. The greatest advantage of LNG is that it is much cheaper and cleaner fuel but there are a few downsides that come along with it as building cost of an LNG ship is much higher and involves very high capital costs. Another problem is that LNG ships are more complex to build having the requirement of large storage tanks compared to other cargo ships. Converting to LNG ships with dual flow mechanism is another option which too shall require high capital cost investments(**Agarwal et al. 2018**). There are a very few LNG bunkering terminals in the shipping lanes. There is still not enough infrastructure for LNG



## International Symposium on Marine Design and Construction 2019 (SMDC 2019)



bunkering and the problem of methane slippage can add to the woes of using LNG as an alternate option (Ritz, R. 2014). The Asia Pacific region has experienced huge growth and forecasts are that soon there will be faster growth in the use and trade of LNG. The growth has been even faster in the past decade. The regional policy implications (Roe, M. 2013) in order to attain a low carbon development during the last decade is a result for which this growth has taken place (Choi, G. and Heo, E. 2017). India is located between two biggest bunkering ports of Fujairah and Singapore. It has a great opportunity to position itself and tap into the lucrative bunker market. Policy initiatives need to be taken up to ensure this and promote LNG bunkering in this country to develop India as a major bunkering hub in the South Asia Pacific region. (Yoon et al. 2018). The government is in the process of taking several initiatives and policies to address and remove such concerns. (Gritsenko, D. 2018). One of the cleanest alternatives of HFO is LNG as it has a Sulphur content of 0.1% or lower. It is for this reason preferred in ECA regions. The fuel oil price spread will drastically increase after implementation of IMO 2020 but LNG prices being cheaper will be a better economic alternative for ship owners. (Zhang et al. 2018). LNG bunker is predicted to see a bright future but LNG propelled vessels need a world-wide network of LNG bunkering facilities. Joint studies with relevant port authorities and government administrations to facilitate and harmonize standards and practices of LNG bunkering and creating LNG hubs to meet the LNG needs of international shipping. (Shi, X. 2018). LNG tanks should be able to withstand Analysis 1

This section would study the relationship between LNG and Brent Crude oil. LNG is taken as dependent

very high pressures. They also complex structural designs from a safety point of view. LNG is liquefied at -169 C hence the safety and storage need expert handling. LNG bunkering is still at a developing stage with very fewer bunkering terminals on major shipping lanes. The ship crew must be adequately trained on how to use LNG as a new bunker fuel. Extra examinations and certification courses must be done so that the crew have experience and proficiency in dealing LNG as bunker fuel. The routine maintenance may be lesser and easy to plan for LNG being a cleaner fuel although troubleshooting can take time when the engineers are less familiar with the system. The new shipbuilding prices of the LNG segment is an important aspect in the decision making of business players. Additionally, there is always an element of risk as these prices can be volatile and new ship building prices fluctuate with time. (Raju, Sengar, Jayaraj, & Kulshrestha, 2016). Bunkers make up to 80% of the operational costs of any ship and this is the primary reason why many ship owners would opt for LNG even though there are several drawbacks.

### RESEARCH METHODOLOGY

The research methodology would consist of studying relationship between

1. LNG and Brent Crude prices.
2. LNG and MGO prices.
- 3.

### Data

The monthly prices from April 2014 till April 2019 of 61 observations has been taken for LNG (Henry Hub), Brent crude oil and MGO bunker prices.

variable and Brent Crude oil as independent for regression purpose. The regression is shown in Figure 1 and in Equation 1.



## International Symposium on Marine Design and Construction 2019 (SMDC 2019)

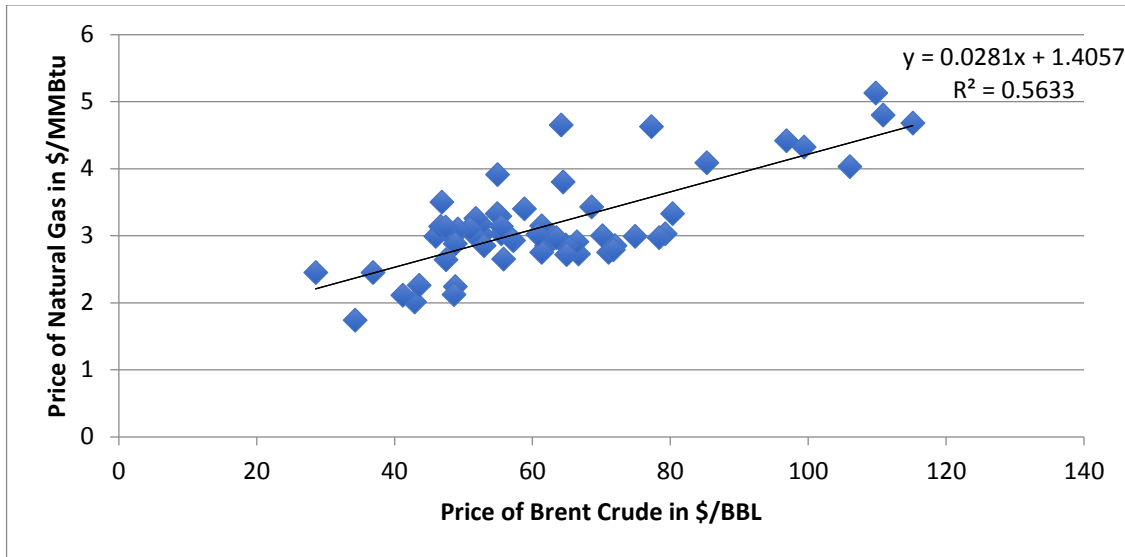


Figure 1 -Simple Linear Regression between LNG and Brent Crude

$$y = 0.0281x + 1.4057$$

(1)

$$R^2 = 0.56334$$

- The independent variable is x (Brent Crude) Price and the dependent variable is y (LNG) price.  $y = 0.0281x + 1.4057$  which means on an average the LNG price is going up 0.0281 times the price of crude oil. Again, it shows no effect on price change related to crude price fluctuations. The intercept is the value

of the dependent variable when  $x=0$ , which means when the value of crude oil is 0 \$ the price of LNG is 1.4\$/MMBtu. This helps us make a clear prediction that LNG prices are marginally increasing with price of Brent crude increasing.  $R^2 = 0.56334$  which indicates there is not much correlation between crude and LNG prices.

### Analysis 2

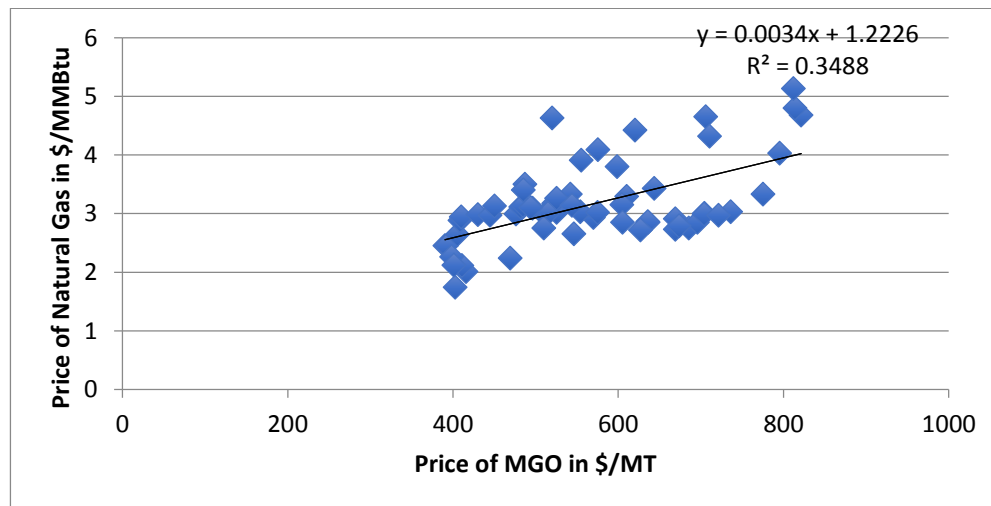


Figure 13- Simple Linear Regression between LNG and MGO

$$y = 0.0034x + 1.2226$$
$$R^2 = 0.34877$$





## International Symposium on Marine Design and Construction 2019 (SMDC 2019)



The independent variable is  $x$  (MGO) Price and the dependent variable is  $y$  (LNG) price.

$y = 0.0034x + 1.2226$  which means on an average the LNG price is going up 0.0034 times the price of MGO. There is hardly any change in LNG price. The intercept is the value of the dependent variable when  $x=0$ , which means when the value of MGO is 0 \$ the price of LNG is 1.226\$/MMBtu. This helps us make a clear prediction that LNG prices are independent of MGO price change.  $R^2 = 0.34887$  which indicates there is a very less or almost co-relation between LNG and MGO prices and neither depend on each other.

### Conclusion

The date of 1 January 2020 was set as per regulations to bring a global Sulphur cap on all marine fuels. The time left to make this transition is too short for ships. LNG is the cleanest alternate fuel with a Sulphur content less than 0.1% much lower than the prescribed Sulphur cap. However, they have a very high installation and fixed capital cost. There will be a dramatic increase in freight rates across all the shipping sectors. It is expected global refinery upgrading capacity utilization to be pushed to its limit in 2020 and that the Gasoil to HSFO price spread will in response widen to more than \$450/ton but it is still not clear whether they will be able to cope up with the demand. Demand will switch to compliant fuel with less than 0.5% Sulphur content, i.e. either ULSFO 0.5% or MGO 0.5% or LNG with less than 0.1% Sulphur. However, the problems of using LNG as an alternate fuel will be complicated as there are a very few LNG bunkering terminals worldwide and there will be added problem of methane slippage. On the upside LNG as an alternate fuel is virtually Sulphur free and it will be a great advantage to use it as environmental pollution will be greatly reduced. Since Jan 2019 to April 2019 crude oil prices have started picking up and the trend is expected to continue even after the implication of IMO2020. This will allow LNG to be the best alternate option as the differential price spread will increase between LNG and MGO making it a cheaper and more viable option. This analysis gives a clear indication that MGO prices are increasing with price of Brent crude also increasing. However, LNG prices are marginally increasing. This proves that LNG prices are delinked from the fuel oil bunker prices. LNG prices showing almost very slight change with IMO 2020 looming large shows that it will be a great option as an alternate fuel in terms of economics as bunker costs 70%-80% of the operational expenses of a ship.

### Reference

Acciaro, M., Lng, A. N., Publication, J., Kerzers, K., Han, C. hwan, Calderón, M., ... Sea/LNG Ltd. (2018). Market fundamentals, competition

and natural-gas prices. *Asian Journal of Shipping and Logistics*, 29(2), 61–70.  
<https://doi.org/10.1016/j.ngib.2016.12.008>

Blikom, L. P. (2014). Status and way forward for LNG as a maritime fuel. *Australian Journal of Maritime & Ocean Affairs*, 4(3), 99–102.  
<https://doi.org/10.1080/18366503.2012.10815715>

Hulshof, D., van der Maat, J. P., & Mulder, M. (2016). Market fundamentals, competition and natural-gas prices. *Energy Policy*, 94, 480–491.  
<https://doi.org/10.1016/j.enpol.2015.12.016>

Koza, D. F., Ropke, S., Boleda Molas, A., Zhang, H. Y., Xi, W. W., Ji, Q., ... Lee, S. (2018). Natural gas prices, LNG transport costs, and the dynamics of LNG imports. *Energy Economics*, 39(2), 217–226.  
<https://doi.org/10.1016/j.eneco.2010.06.012>

Pfoser, S., Schauer, O., & Costa, Y. (2018). Acceptance of LNG as an alternative fuel: Determinants and policy implications. *Energy Policy*, 120(December 2017), 259–267.  
<https://doi.org/10.1016/j.enpol.2018.05.046>

Raju, T. B., Sengar, V. S., Jayaraj, R., & Kulshrestha, N. (2016). Study of Volatility of New Ship Building Prices in LNG Shipping. *International Journal of E-Navigation and Maritime Economy*, 5, 61–73.  
<https://doi.org/10.1016/j.enavi.2016.12.005>

Roe, M. (2013). Maritime governance and policy-making: The need for process rather than form. *Asian Journal of Shipping and Logistics*, 29(2), 167–186.  
<https://doi.org/10.1016/j.ajsl.2013.08.003>

Schinas, O., & Butler, M. (2016). Feasibility and commercial considerations of LNG-fueled ships. *Ocean Engineering*, 122(August 2016), 84–96.  
<https://doi.org/10.1016/j.oceaneng.2016.04.0>



## International Symposium on Marine Design and Construction 2019 (SMDC 2019)



- 31  
Shi, X., & Variam, H. M. P. (2018). Key elements for functioning gas hubs: A case study of East Asia. *Natural Gas Industry B*, 5(2), 167–176. <https://doi.org/10.1016/j.ngib.2018.03.001>
- Thomson, H., Corbett, J. J., & Winebrake, J. J. (2015). Natural gas as a marine fuel. *Energy Policy*, 87(November), 153–167. <https://doi.org/10.1016/j.enpol.2015.08.027>
- Wang, S., & Notteboom, T. (2013). The Adoption of Liquefied Natural Gas (LNG) as a Ship Fuel: a Systematic Review of Perspectives and Challenges. *Transport Reviews: A Transnational Transdisciplinary Journal*, (January 2015), 37–41. <https://doi.org/10.1080/01441647.2014.981884>
- Yin, J., & Fan, L. (2018). Survival analysis of the world ship demolition market. *Transport Policy*, 63(April 2017), 141–156. <https://doi.org/10.1016/j.tranpol.2017.12.019>
- Yoon, B., Shin, J., & Lee, S. (2017). Technology assessment model for sustainable development of LNG terminals. *Journal of Cleaner Production*. <https://doi.org/10.1016/j.jclepro.2017.10.187>