Transport Costs Affecting LNG Delivery by Moss Type Carriers

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The paper discusses the influence of transportation costs on the delivery of liquefied natural gas (LNG) by sea. The research part of the project was carried out by using a dedicated LNG Moss type carrier with the capacity of 205,000 m3 and by taking into account the price of the propulsion engine fuel, LNG, as one of the most important factors of the final cost of LNG transportation. The fluctuation of the final costs also depends on the price of construction of a new vessel, the vessel's design, sufficient number of the vessels required for transportation, and the amount of cargo to be shipped from a load port to the import terminal. The port of Murmansk, possibly one of Russia's largest LNG load terminals, was used as port of departure, i.e. port of load. The final destinations, i.e. import terminals, included the ports of Zeebrugge, South Hook, Cove Point, Chiba and Fujian. It should be noticed that this study involved two sailing routes, the Suez Canal and the North East Passage, taking into consideration the harsh weather conditions the vessels might encounter during navigation.

KEY WORDS
~ Transport costs
~ Fuel
~ LNG
~ Moss type ship

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1. INTRODUCTION

This paper deals with the formation of the final price of an energy-generating product, in this particular case the liquefied natural gas (LNG), delivered to the consignee, i.e. to the import terminal. One of the most important items affecting the costs of transportation of this product is the price of propulsion engine fuel which, in this case, is LNG. When determining the final price of the delivered LNG, all the parameters which should be met by the shipping operation have been taken into account, from the load port to the port of discharge. The Moss type ship with the capacity of 205,000 m^3 appears as the logical choice for exporters or shippers wishing to deliver the contracted amount of cargo on time, while keeping the transportation cost to the minimum, because this type of vessel is more cost-efficient than any other vessel of the same capacity and employment. The price of a Moss type ship is about USD 408 million. However, due attention should also be paid to its design.

The port of Murmansk was used as departure port, i.e. the load terminal. It is possibly Russia's largest LNG load port. There are two possible sea routes for shipping LNG: through the Suez Canal and the North East Passage. The final destinations, i.e. import terminals, include the ports of Zeebrugge, South Hook, Cove Point, Chiba and Fujian.

This study took into consideration the harsh weather conditions the vessels might encounter during navigation.

2. FUEL COSTS

In this research a Moss ship having the capacity of 205,000 m^3 uses LNG as her primary source of energy. In the event that natural LNG boil-off is insufficient to feed the propulsion unit, induced heating of LNG is performed. When the main engine runs on LNG, the quantity of consumed LNG has to be taken into account when calculating overall transportation costs and the

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final price of the delivered LNG per ton (USD/ton). Estimated fuel gas consumption is based on daily consumption under various operating conditions. It is provided in Table 1.

Table 1. Fuel prices included in the costs.

Fuel gas (natural or forced boil-off)	310 USD/ton
MDO pilot fuel	680 USD/ton
HFO	not used in the study

The cost of LNG fuel gas consumed by the vessel's propulsion unit is based on data gathered from shippers.

The cost of diesel fuel is based on present-day average three-month consumption.

3. SHIP'S SPEED AND THE ESTIMATION OF COST FACTORS

Given the fact that the costs of building a new Moss type ship carrying 205,000 m3 amount to approximately 408 million USD, this type of vessel is considered a cheaper type of LNG carrier. Therefore further analysis includes the estimation of costs of longer voyages of these types of vessels.

3.1. Costs related to navigation in harsh weather conditions

One of the factors of assessment of seaworthiness of a vessel is her ability to navigate in harsh weather and in ice conditions. Navigation under such circumstances is a key issue and a major challenge in modern shipping. Maritime institutes are regularly testing and examining new models of ship hulls capable of meeting all the requirements of sailing through ice-ridden sea. Ship's speed is an important aspect of navigation and financial economy in the shipping business. Hence all losses occurring during navigation are compared to the speed of an average ship. It is well known that speed may vary up to 30% when navigating under ice conditions. Such navigation affects the overall LNG transportation costs between the load terminal and the port of discharge.

Table 2 presents the costs occurred during the voyage of an LNG Moss type carrier with the capacity of 205,000 m^3, at reduced speed due to ice conditions. The carrier's speed is considerably reduced, up to 30 % of the contracted speed.

It is important to point out that actual shipping costs also involve the overall quantity of delivered cargo and its value that is calculated on the basis of the shipping costs per ton of cargo ton, i.e. per ton of liquefied natural gas (LNG) in this case. The assumed or, in other words, theoretical cost would be the cost under ideal conditions. This cost occurs when the calculation includes the overall amount of the cargo, i.e. liquefied natural gas (LNG), to be shipped with regard to the actual ship's capacity. The comparison of these two values, the actual and the assumed or theoretical cost, does not depend on the exploitation of the fleet (the size and number of the available vessels). When using the maximum efficiency of ship's capacities, the theoretical or assumed cost is always lower than the actual cost.

3.2. Navigation costs affected by ship's design and size

The assessment of costs related to fuel consumption is based on the drag that the hull creates when moving through water and the efficiency of the prime mover. Modern LNG carriers are fitted with bulbous bows designed to break through the ice

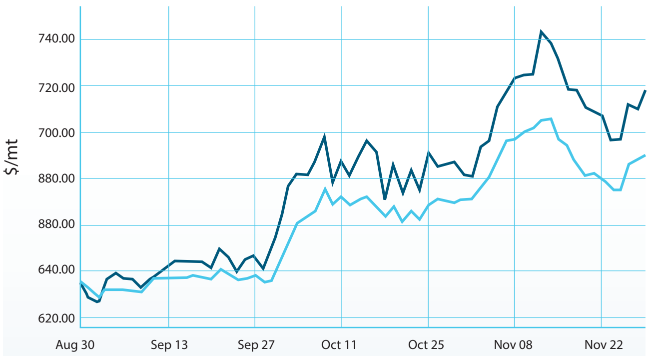

Figure 1.
Price of the diesel fuel in Singapore during the period August-November 2010.
Source: www.bunkerworld.com

Figure 2.
LNG Carrier (Moss Type) Source: http://www.hoeghlng.com/shipping/fleet/Pages/Arctic-Princess.aspx

Table 2.
Transport costs for the Moss type ship with the capacity of 205,000 m^3 at the speed reduced by 30 %.

ROUTE		NUMBER OF VESSELS	AMOUNT OF CARGO (ton)	ACTUAL COST USD/ton	THEORETICAL COST USD/ton
Murmansk	Zeebrugge	10	16 187 111	62.39	61.83
Murmansk	Zeebrugge	10	16 200 110	62.08	58.79
Murmansk	South Hook, UK	11	16 163 027	68.39	64.54
Murmansk	South Hook, UK	10	16 177 615	62.62	61.43
Murmansk	Cove Point, USA	16	15 851 162	103.79	101.39
Murmansk	Cove Point, USA	16	15 864 928	103.42	98.15
Murmansk	Chiba, Japan, Suez	35	14 734 635	333.49	328.68
Murmansk	Fujian China, Suez	31	14 924 009	292.14	292.07
Murmansk	Chiba, Japan, NSR	25	15 525 069	163.63	160.92
Murmansk	Fujian, China, NSR	28	15 319 381	187.36	187.41

more efficiently. However, the advantages of these designs in ice conditions have been neutralised by certain shortcomings that such hulls presented offshore in ice-free conditions. One of the drawbacks is the reduction of a ship's speed. In offshore navigation, this disadvantage implies the increase in fuel consumption by 10 %, which consequently results in increased shipping cost of liquefied natural gas (LNG), as the delivered amount is considerably lower than expected. Table 3 shows the changes in the final price of the delivered LNG carried by this type of vessels.

4. SHIPPING COSTS dependant on PRICE OF FUEL GAS (LNG)

The price of fuel (LNG) strongly affects shipping costs. The basic price of LNG, as pointed out at the beginning of this study, is 310 USD/ton. As this research deals with vessels that carry this energy-generating product, the shipper uses part of the cargo to feed the propulsion unit. It should be noticed that, when unloading cargo in the final port of discharge, the shipper

Table 3.
Costs induced by the increase in fuel gas consumption by 10% in the offshore navigation of the Moss type vessel with the capacity of 205,000 m^3.

ROUTE		NUMBER OF VESSELS	AMOUNT OF CARGO (ton)	ACTUAL COST USD/ton	THEORETICAL COST USD/ton
Murmansk	Zeebrugge	9	16 182 905	57.07	54.35
Murmansk	Zeebrugge	9	16 191 566	56.87	52.56
Murmansk	South Hook, UK	9	16 157 557	57.67	57.11
Murmansk	South Hook, UK	9	16 166 781	57.45	55.25
Murmansk	Cove Point, USA	15	15 813 419	99.27	94.64
Murmansk	Cove Point, USA	14	15 824 002	93.45	92.69
Murmansk	Chiba, Japan, Suez	34	14 585 329	331.80	323.55
Murmansk	Fujian, China, Suez	30	14 787 997	289.50	287.72
Murmansk	Chiba, Japan, NSR	20	15 611 275	132.85	129.84
Murmansk	Fujian, China, NSR	23	15 384 980	156.68	156.41

Table 4.
Costs of the Moss type carrier with the capacity of 205,000 m³ with the included price of LNG fuel of 60 USD/ton.

ROUTE		NUMBER OF VESSELS	AMOUNT OF CARGO (ton)	ACTUAL COST USD/ton	THEORETICAL COST USD/ton
Murmansk	Zeebrugge	9	16 220 028	50.27	47.51
Murmansk	Zeebrugge	9	16 227 888	50.21	45.87
Murmansk	South Hook, UK	9	16 197 021	50.44	49.82
Murmansk	South Hook, UK	9	16 205 393	50.37	48.13
Murmansk	Cove Point, USA	15	15 884 079	85.92	81.27
Murmansk	Cove Point, USA	14	15 893 783	80.31	79.50
Murmansk	Chiba, Japan, Suez	34	14 767 552	292.04	283.84
Murmansk	Fujian, China, Suez	30	14 951 894	254.65	252.83
Murmansk	Chiba, Japan, NSR	20	15 700 111	115.67	112.57
Murmansk	Fujian, China, NSR	23	15 494 424	135.10	134.70

retains a part of the cargo to serve as fuel gas on the way back to load port. This results in the reduced amount of delivered LNG. Taking these aspects into consideration, LNG exporters stipulate the prices for amounts actually delivered to import terminals. The price of LNG intended to be used as propulsion engine fuel is 60 USD/ton, which considerably reduces transportation costs. Table 4. shows the changes in LNG transportation costs, i.e. the price of propulsion engine fuel affecting transportation costs.

5. FLUCTUATION OF SHIP PRICE

It is well known that the initial price of construction of a new Moss ship with the capacity of 205,000 m³ is USD 408 million. However, when calculating the costs presented in the preceding tables, it is evident that these costs considerably influence the final price of delivered liquefied natural gas. If the costs arising from shipping LNG from load port to import terminal were included in the initial price of construction of a new vessel,

Table 5.
Cost of the delivered LNG with regard to a 10 % increase in price of building a Moss ship with the capacity of 205,000 m³.

ROUTE		NUMBER OF VESSELS	AMOUNT OF CARGO (ton)	ACTUAL COST USD/ton	THEORETICAL COST USD/ton
Murmansk	Zeebrugge	9	16 220 028	59.13	56.25
Murmansk	Zeebrugge	9	16 227 888	58.95	54.39
Murmansk	South Hook, UK	9	16 197 021	59.68	59.08
Murmansk	South Hook, UK	9	16 205 393	59.48	57.14
Murmansk	Cove Point, USA	15	15 884 079	102.38	97.49
Murmansk	Cove Point, USA	14	15 893 783	96.27	95.47
Murmansk	Chiba, Japan, Suez	34	14 767 552	335.87	327.37
Murmansk	Fujian, China, Suez	30	14 951 894	293.38	291.54
Murmansk	Chiba, Japan, NSR	20	15 700 111	137.00	133.82
Murmansk	Fujian, China, NSR	23	15 494 424	161.14	160.84

the price of Moss type carrier would increase by around 10 %, eventually amounting to 449 million USD.

6. CONCLUSIONS

Since transportation costs are the basis for defining the overall price of liquefied natural gas (LNG) delivered at import terminals, it is obvious that both shippers and exporters strive to decrease these costs. By projecting and reducing costs, the energy-generating product, in this particular case LNG, becomes an easily available and competitive product on the market. Naturally, not all parameters affecting the costs of LNG transportation can be eliminated, but serious efforts aimed at the reduction of these costs have been made.

The paper has made it clear that the hull design of Moss type carrier affects the formation of LNG price in different ways, depending on whether the vessel passes through the Suez Canal or the North-East Passage, and whether the vessels sails under harsh weather conditions or not, through the ice passages or ice-free offshore areas. The construction of new LNG ships that meet all the requirements of navigation under complex conditions lead to the conclusion that such vessels also have minor shortcomings that can not be eliminated but can be compensated for.

The increase in the number of vessels has been aimed at reducing the factor of time loss during navigation but this, in return, increased shipping costs and, consequently, the price of the energy-generating product. As the just-in-time delivery of energy-generating products is essential for both the exporters and buyers of LNG, their efforts to control the costs have lead to a decrease of the price of LNG as propulsion engine fuel used onboard ships designed and employed to carry LNG. It is evident that an increase in ship's speed by 10 % results in higher consumption of fuel gas which subsequently reduces the amount of LNG delivered to import terminals.

Based on this study, it can be concluded that by properly selecting the ship's design and capacity the shipper may contribute to the reduction of costs related to fuel gas consumption and control the price of construction of a new ship which is included in the final price of LNG, thereby eventually decreasing the overall price of liquefied natural gas.

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