UNIVERSITY OF PIRAEUS

DEPARTMENT OF MARITIME STUDIES

M.Sc. in SHIPPING MANAGEMENT

OPERATION ANALYSIS OF SHIPPING COMPANIES AND ESPECIALLY THOSE OPERATING IN THE LIQUEFIED PETROLEUM WITH VERY LARGE GAS CARRIERS 'VLGCs'. CASE STUDY OF DORIAN LPG.

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Dissertation

Submitted to the Department of Maritime Studies of the University of Piraeus as part of requirements for obtaining the Master's degree M.Sc. in Shipping Management.

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Piraeus

December 2020

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ABSTRACT

Maritime transport contributes to the transfer of huge amounts of bulk cargo, ie oil, coal, iron ore and other raw materials and fuel and food, merchandise and other goods.

Today, the global economy is largely based on the movement of goods by sea, which makes it possible to develop in areas that have resources, such as India and China. One sector of the global economy that is showing bloom, is the transport of dangerous goods such as LPG.

The Extended use of gas and liquefied gas generally in recent years from industry, has led to increased demand and consequently has increased the transfer of gas ships. The fact that the LPG is considered to be hazardous load, the conditions of handling and transport are very strict. For this reason, the transfer of these products is done specially by built ships, called LPG Carriers, which are specially designed tanks, with alarm systems in case of leakage.

In this paper there is a presentation of LPG transportation with ships, which is an important economic sector of maritime transport.

PROLOGUE

Maritime transport is the most efficient, cost-effective and safe solution for transporting large masses of cargo, in bulk and in containers, and is a key activity to ensure proper operation and facilitate the development of the global economy . It is estimated that maritime transport accounts for about 80% of the volume of international trade.

Maritime transport, with ever-improving, safer and faster ships, has made access to even the most distant markets accessible, contributed to the global market of major emerging markets such as China and India, and increased the share of internationally traded goods in each country in relation to non-marketable.

The purpose of this dissertation is to present the transport of LPG by ships. LPG transportation by ship is an important sector of the global economy and for this reason an effort will be made to approach this issue.

We know that LPG is the general term used to describe liquefied gases and that hydrocarbons in the liquid phase occupy only 1/250 of the volume needed if stored in the gaseous phase. From a commercial point of view it is therefore practical to store and transport these hydrocarbons in the liquid phase rather than in the gases, thus making their transport by ship an important sector of the global freight economy.

In the first chapter of our work, an extensive reference is made to liquefied gases, the nature of liquefied petroleum gas and the production of liquefied gas.

The second chapter presents the types and ways of transporting liquefied natural gas by ships, as well as the categories of transport ships.

The third chapter refers to the overview of LPG shipping industry and its overall economic rates during the last 10 years as well as its future prospects.

The fourth chapter is an analysis of a case study shipping company (namely Dorian LPG LTD, a company originated from Greece but with international activity) which uses LPG and more especially Very Large Gas Carriers.

The fifth chapter is dedicated to the conclusions of this investigation.

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CHAPTER 1: GENERAL CONCEPTS ABOUT LIQUIFIED GASES

1.1 General information

The petroleum products that are traded in Greece today are the following:

- Propane LPG
- LPG Mix
- Unleaded and Super Car Gasoline
- Lighting Oil
- Oil Internal Combustion Diesel
- fuel jet Ja-1
- deasphalted fuel oil (distillate Vacuum)
- Light External Combustion Oil (Fuel Oil) No. 1
- Light External Combustion Oil (Fuel Oil) No. 2
- Heavy External Combustion Oil (Fuel Oil) No. 3

Refinery is also a product of the asphalt used in paving roads and in the manufacture of various sealing products. The refineries also produce as a by-product gaseous fuel (a mixture of mainly methane, ethane and hydrogen) which is used for combustion in the furnaces of their production units, as well as naphtha (crude gasoline) which is used as a raw material in petrochemicals.

Depending on the degree of synthesis of the refinery, lubricants, greases, solid paraffin, solvents and other petroleum products may also be produced. [1]

1.2 Propane LPG and LPG mixture

The general term liquefied petroleum gas includes propane, butane and mixtures thereof. In Greece there are official specifications for LPG propane and LPG. In commercial liquefied petroleum gas, in addition to these two hydrocarbons, there are also a small proportion of unsaturated compounds in the form of lighter or heavier hydrocarbons.

Characteristic of liquefied petroleum gas is that at moderate pressures they liquefy at normal temperature. With liquefaction their volume is significantly reduced providing a source of concentrated energy. Liquid pressurized liquefied petroleum gas is easily transported by pipelines, ships, tankers and metal cylinders. Reducing the pressure they evaporate and burn burners with a

clean flame and high calorific value. LPG is an excellent fuel from an environmental point of view, because it contains almost no sulfur and burns completely without residues.

The liquefied petroleum gas is colorless and odorless and mercaptans are added in a very small proportion to commercial liquefied petroleum gas to detect any leaks. LPG is heavier than air. Commercial propane has a relative specific gravity density of 1.52 and a mixture of about 1.92. For this reason any leaks of LPG can be very dangerous due to the concentration of LPG, e.g. in basements where strong explosive mixtures are formed.

In Greece, LPG is currently used for heating and cooking in homes or restaurants, in industry as fuel, as propellants in aerosols, as well as in agriculture and poultry, in greenhouses, hatcheries. For transport, the use of LPG has already been allowed in taxis in the capital and in private cars.

The LPG must be completely evaporated and burned in the appliances satisfactorily without causing corrosion or residue in the system. The evaporation and combustion characteristics of commercial liquefied petroleum gas are defined, for typical applications by volatility, vapor pressure and to a lesser extent by their specific density. Volatility is expressed by the temperature at which 95% of the fuel has evaporated. In the Greek Specifications this temperature is -380 0 C max for propane and 20 0 C max for the LPG mixture. The vapor pressure is mainly affected by the content of light hydrocarbons (methane and ethane) and in the Greek Specifications are defined at 37.8 0 C, 14.8kg / cm 2 max relative pressure for propane and 4.5 min - 7.0 max kg / cm 2 for LPG mixture. [1]

The specifications set a limit for the volatile sulfur compounds (15 mg / kg max for both LPG grades) which, in addition to the unpleasant odor, make the LPG corrosive. The specification of copper plate corrosion is also intended to reduce the total sulfur content.

Finally, a basic requirement is the absence of moisture from the liquefied petroleum gas, as the presence of dissolved water creates water vapor during the liquefaction of liquefied gases causing problems in the piping.

The presence in the liquefied compounds of significantly lower volatility than propane and butane can cause serious problems. Low levels of oily compounds can cause blockages in pressure regulators and valves. LPG is controlled in this direction by specifying an evaporation residue (0.05% max by volume) as well as by determining butane (or pentane) and heavier.[2]

1.3 Liquefied gases

A liquefied gas is the liquid form of a substance which, at ambient temperature and atmospheric pressure, would be in gaseous form.

Most liquefied gases are hydrocarbons and the key feature that makes hydrocarbons a major source of energy also makes them dangerous. Because these gases are treated in large quantities, it is necessary to take all necessary measures to minimize the chances of leakage and reduce all sources of ignition.

The most important property of a liquefied gas, in relation to pumping and storage, is its vapor pressure. It is the absolute pressure exerted when the liquid equilibrates with its vapor at a given temperature. The International Maritime Organization, in order to comply with the regulations for the transport of liquefied gases, correlates the impregnated vapor pressure with the temperature, adopting the following rule for the transport of liquefied gases into the sea:

Liquids with a vapor pressure exceeding 2.8 are maintained at 37.8 ° C.

Under this IMO regulation, ethylene oxide would not be suitable as a liquefied gas. However, it is included in the international code of ships carrying liquefied gases in large quantities, because its boiling point at atmospheric pressure is so low that it would be difficult to transport cargo by any method other than that specified for liquefied gases.

In addition, chemicals such as diethyl ether, propylene oxide and isoprene are not strictly liquefied gases, but associate high vapor pressures with the risk of ignition. As a result of such hazards, these chemicals, and several similar compounds, are listed together in the code (reconstruction Equipment Ships Liquefied Bulk) and (Bulk Chemical). Indeed, when transported on chemical tankers, subject to the bulk chemical codes, such products should be stored in separate tanks and not in those built on the ship's structure. [3]

1.4 LPG (LIQUEFIED PETROLEUM GAS)

LPG is a general term used to describe liquefied gases, which consist mainly of hydrocarbons having three or four carbon atoms (3 and 4). These hydrocarbons exist as gases at normal temperatures and ambient pressures, but can be liquefied at medium pressures. If the pressure is then reduced, the hydrocarbons become gaseous again.

The above hydrocarbons in the liquid phase occupy only 1/250 of the volume needed if stored in the gaseous phase. From a commercial point of view it is therefore practical to store and transport these hydrocarbons in the liquid phase and not in gases. [4]

In general use two types of LPG are known, butane and propane or mixtures thereof. The liquefied petroleum gas can be stored in the liquid phase either at ambient temperature at medium pressure or under cooling at lower pressure. If the storage temperature is low enough, the LPG can be stored at

atmospheric pressure. At a temperature of 20 ° C commercial butane has a vapor pressure of about 2 BAR (28 PSIG) and commercial propane 7 BAR (100 PSIG).

LPG in the liquid phase is colorless, weighs about half its weight, equal volume of water and its vapors are denser than air. Commercial butane weighs about twice as much as an equal volume of air, and commercial propane is about one and a half times heavier than an equal volume of air. That is why the gaseous phase of LPG "flows" in the ground and in the sewers, accumulating at the lowest point of the area.

When mixed with air, LPG forms an explosive mixture. The volume ratio of LPG gas to ambient air where an explosive mixture is formed is about 2% to 10%. When the LPG-air mixture is outside the above range, it is either too poor or too rich to ignite in the form of an explosion. Leakage of a relatively small amount of LPG can create a large volume of gas phase and therefore a large volume of explosive mixture. Suitable explosive device detectors are used to check for the presence of LPG in the air and even in an explosive mixture. [1]

Any LPG-air mixture created by a leak or other cause may ignite at some distance from the escape point and the flame may return backwards, ie in the direction of the original source of the leak.

The gaseous phase of the liquefied petroleum gas creates slight anesthesia and can also cause suffocation due to lack of oxygen, if present in sufficiently high concentrations. The liquefied petroleum gas is given an odor before being released for consumption by the addition of an osmogenic substance such as ethylmercaptan or dimethyl sulfide, so that the gas can be detected by smell at concentrations less than 1/5 of the lower explosive limit.

LPG leakage can be detected in other ways than odor. When the liquid is gasified, the cooling effect on the surrounding air causes condensation and even cooling of water vapor in the air. This can be seen as dew at the escape point and thus it is easier to detect the leak.

Due to the rapid ventilation and the consequent drop in temperature, LPG can cause severe burns if it comes in contact with human skin. Operators should use protective equipment such as gloves and goggles if they are exposed to such harmful effects.

If a container containing LPG is emptied it may still contain LPG in gaseous form and may be dangerous. In this form the internal pressure is almost equal to atmospheric, and if the valve leaks or is left open, air can diffuse into the container, forming an explosive mixture and creating a risk of explosion, while LPG can escape to the atmosphere. [2]

1.5 Production of liquefied gas

To understand the various terms used in the liquefied natural gas trade, it is essential to differentiate between raw materials and their constituents in order to differentiate the relationship between natural gas, liquefied natural gas and liquefied petroleum gas.

Gas can occur in:

- Underground wells \
- Condensed tanks
- Large oil fields

Natural gas contains smaller amounts of heavier hydrocarbons (known as liquefied natural gas). This depends on the fluctuating amounts of water, carbon dioxide, nitrogen and other non-hydrocarbons.

The percentage contained in crude gas varies from place to place. The percentages are generally lower in gas wells when compared to those in condensed tanks. Regardless of the source, natural gas requires treatment to remove heavier hydrocarbon and non-hydrocarbon components. This ensures that the product is in an acceptable condition for liquefaction or for use as a gaseous fuel.

The raw feed gas is free of residues. This is followed by the removal of acid gases (carbon dioxide and hydrogen sulfide). Carbon dioxide must be removed as it freezes at a temperature above its atmospheric boiling point and the toxic composite hydrogen sulfide is removed as it causes air pollution when it burns as fuel. Removal of the acid gas causes the gas stream to be impregnated with water vapor, which is then removed.

The gas then passes to a separation unit where further decomposition into propane and butane takes place. Finally, the main gas stream, now usually methane, is liquefied in the final product, liquefied natural gas.

To lower the temperature of methane to about -162 ° C (its atmospheric boiling point) there are three basic liquefaction processes today. These are described below:

Ure Pure process: this is generally similar to the liquefaction cycle, but in order to achieve the required low temperature, three stages are included where each has its own refrigerant, compressor and heat exchangers. The first step uses propane, the second is a condensation step using ethylene and finally the third step uses methane. This procedure is used in facilities before 1970.

- Joint procedure refrigerant (mixed process): while the clean process refrigerant, a three cycles, with the mixed refrigerant process (typically methane, ethane, propane, and nitrogen), the process is accomplished in one cycle. The equipment is less complex than the pure

refrigerant process, but the power consumption is substantially higher and for this reason its use is not widespread.

- precooled mixed refrigerant process (cooled mixed process): This process is generally known as a process (MultiComponent) and is a combination of the above procedures. It is the most common process in operation today. [3]

The fuel for the facilities is mainly supplied by the instantaneous gas during the liquefaction process. If necessary, the additional fuel can be obtained from the crude liquefied gas or from the extracted condensates.

Liquefied petroleum gas is the generic name given to propane, butane and mixtures of the two. These products can be obtained by refining crude oil. When produced in this way they are usually made under constant atmospheric pressure. [1]

However, the main production is in oil-producing countries. In these places the liquefied gas is extracted from natural gases or from quantities of crude oil coming from underground tanks. In the case of a gas source, the crude product consists mainly of methane.

Propane is divided into methane and ethylene. Ethylene can then be synthesized with chlorine to make vinyl chloride. In the case of methane, it is initially reconstituted with steam to hydrogen. Combining this with nitrogen under high pressure and temperature, in the presence of a catalyst, produces ammonia.

Natural gas is transported either through pipelines as a gas or by sea in its liquefied form. Its composition varies according to where it is found, but methane is by far the predominant component, ranging from 70% to 99%. Gas is currently one of the most important products in the global energy market and about 150 million tonnes are transported by sea each year. [5]

A small number of terminals, including various other plants in Europe, have the ability to remove methane and load raw into semipressurized carriers at constant atmospheric pressure. This is carried at 80 ° atmospheric pressure or 45 ° under steam pressure.

Liquefied petroleum gases include propane, butane and mixtures of the two. Butane, stored in cylinders known as bottled gas, is widely used as a fuel for heating and cooking. It is also an important growth factor of octane for engine gasoline and a key petrochemical gas. Propane is also used as a bottled gas, especially in cold climates (where its vapor pressure adjusts). However, they are mainly used in electricity generation, for industrial purposes such as metal cutting. About 250 million tonnes of liquefied gases are produced each year worldwide and about 70 million tonnes are transported by sea. [6]

LPG transport by ships

1.6 Physical characteristics of LPG

Property	Propane	Butane	Gasoline
Liquid density, kg/m^3	509	585	765
Calorific value, MJ/kg	46,34	45,56	44,04
Boiling point, ^{0}C	-42	-0,5	30-210
Auto ignition temperature, ^{0}C	510	490	257
Flame temperature, ^{0}C	1980	1775	1720
Flame speed, m/s	0,4	0,4	0,35
Stoichiometric air/fuel, kg/kg	15,8	15,6	14,7
Lower flammability limit, vol.%	2,1	1,5	1,3
Upper flammability limit, vol.%	9,5	8,5	7,6
Octane number	111	103	95

CHAPTER 2: SHIPPING

2.1 Types and ways of transporting liquefied gas by ships

Gas vessels range from small pressurized vessels of approximately 3,500 m^3 (fully pressurized) for the delivery of propane, butane and chemical gases at ambient temperatures to fully insulated or fully refrigerated vessels (fully) over 100,000 m 3 for LNG and LPG transport. Between these two distinct types there is a third type of ship, the semipressurized carriers under constant atmospheric pressure. These vessels are capable of carrying many loads under freezing conditions at atmospheric pressure or at temperatures corresponding to pressures between 5 and 9 bar. [7]

Moving liquefied petroleum gas by sea is now a mature industry, served by a fleet of over 1000 ships. In 2019 the ship numbers in each category were:

1. LNG carriers 300
2. Fully refrigerated ships 216
3. Ethylene carriers 100
4. Semipressurized ships 200
5. Pressurized Ships 450 [8]

Gas carriers use certain design features in conjunction with other vessels to transport liquids such as chemical and oil tankers. Chemical tankers carry their most dangerous cargo to the central tanks, while lower risk cargoes can be sent to the side tanks. The purpose is to protect the dangerous cargo from spilling in the event of a collision. The same principle applies to gas carriers.

A feature almost unique to gas carriers is that cargo tanks are kept under positive pressure to prevent air from entering the cargo storage system. This means that only charge fluid and steam are present in the tank to prevent ignition. In addition, all gas carriers use closed systems during loading or unloading, without releasing vapors into the atmosphere. By these means the release of charge into the atmosphere is effectively eliminated and the risk of steam ignition is minimized. [6]

Gas carriers must comply with the standards set by the International Maritime Organization and with all safety and pollution requirements. Equipment requirements for gas carriers include temperature and pressure control, gas detection and load tank level indicators. All of the above are equipped with appropriate alarms.

There are several variations on the design, construction and operation of these ships depending on the restraint system and the type of cargo they carry. Load holding systems can be pressurized, semipressurized or fully refrigerated or membrane type.

Some of the main features of these variants are:

Fully pressurized vessels fully maintained at constant atmospheric pressure ships):

The transport of liquefied marine gases began in 1934 when an international operation launched two mixed oil tanker / LPG vessels. These ships, mainly oil tankers, had been converted into small, high-pressure tanks for transport, and this conversion allowed this product to be transported over long distances. Today most of them maintained under constant atmospheric pressure have two or three horizontal, cylindrical or spherical tanks and have the capacity to carry up to 5,000 m 3 of volume. However, in recent years ships with spherical tanks, up to 10,000 m 3 , each with five spherical tanks, have been built .

Semi pressurized ships at constant atmospheric pressure:

Despite the early significant discovery of LPG cargo under constant atmospheric pressure, the movement of liquefied marine gases actually began to increase in the early 1960s with the development of suitable metals to retain these liquefied gases at low temperatures.

The first vessels to use this new technology appeared in 1961. They carried gases under constant atmospheric pressure / semi-frozen state. By the late 1960s ships semi-preserved under constant atmospheric pressure / fully frozen had become the choice of shipowners by providing high flexibility in cargo handling. These types of ships use cylindrical or spherical tanks and have the ability to load and unload gas cargoes in both frozen and pressurized facilities. [3]

Carriers of ethylene and chemical gases (Ethylene / chemical carriers):

Ethylene carriers are the most complex of semi-retained tankers under constant atmospheric pressure. The first ship in this category was built in 1966 and, since 1995, there have been approximately 100 such ships in service capacity from 1,000 to 12,000 m^3 .

From this fleet there is a special subgroup of ships capable of handling a wide range of liquid chemicals and liquefied gases simultaneously. These have cylindrical, insulated, stainless steel tanks capable of adapting loads up to a maximum density of 1.8 to temperatures ranging from -104 ° C up to +80 ° C at a maximum pressure of 4 bar. Ships in this category are characterized as the most versatile, as they have the ability to unload and load at all specially constructed terminals .

Fully ships:

The 1960s also saw another significant development in the evolution of gas carriers with the advent of the first fully ship, built to transport liquefied gases at low temperatures. The first ship in this class was built by a Japanese shipyard in 1962. The ship maintained four prism-shaped (box-like) tanks made of 3% nickel steel, allowing cargo to be transported at temperatures as low as -48 ° C. The prismatic tanks allowed these ships to maximize their carrying capacity, making them particularly suitable for transporting large volumes of cargo such as LPG, ammonia and vinyl chloride over long distances. Today, they range from 20,000 to 100,000 m^3.

The main types of cargo containment systems used in modern fully frozen vessels are stand-alone tanks that have rigid foam insulation. Older boats may have independent tanks filled with perlite insulation. In the past there have been some fully frozen boats built with semimembrane or solid tanks and internal insulation tanks, but these systems are now of little interest. [3]

Liquefied natural gas vessels:

Almost at the same time as the development of fully refrigerated LPGs, shipbuilders faced the most demanding challenge, LNG transportation. Natural gas, a clean, non-toxic fuel, is now the third largest source of energy in the world, after oil and coal. Because liquefied gas occupies much less volume, and because of the critical temperature of liquefied methane, LNG shipping only makes commercial sense if it is transported in liquefied form under atmospheric pressure and thus poses a greater challenge to engineering, mainly because must be transported at a much lower temperature than LPG, with a boiling point of -162 ° C.

LNG vessels built use either Technigaz GT96 stainless steel TGZ Mark membrane tanks, which are tanks consisting of two thin-film membranes, or type B (III) prismatic tanks or spherical Tan tanks (Moss Tanks).) of the company Maritime. CD1 tanks have also been used in recent years, which have been shown to be defective with many disadvantages. The ships range between 125,000 and 160,000 m^3 of carrying capacity. [3]

The first LPG vessels built in the 1960s, then called methane tankers, carried rectangular trapezoidal tanks where they later evolved into spherical tanks whose upper sections overlook the main deck of the ship. Even more modern LPG carriers have membrane type tanks.

It should be noted that the transport of liquefied petroleum gas takes place either at very low temperatures, which for some reaches -250 ° F (-121 ° C), or at high pressures, which presents many difficulties as well as special risks. Thus, these ships are considered dangerous in accidents and for this reason the safety measures and restrictions taken on them are very meticulous, hence the higher wages of the sailors of these ships. The approach of such ships is allowed only at special piers of related facilities that provide a high degree of security, anticipation and response to emergencies. [4]

The global tonnage of this type of ships in 1976 reached 3,380,000 kg. of the total worldwide which was 372,000,000, ie about 0.9%. Nevertheless, the increase in the number of such ships is slow but steady, as global needs for LPG consumption increase, where in a single decade 1960-1970 it had doubled from 20 to 42 billion cubic feet.

For a more complete understanding of the carrying capacity of these ships, it is noted that one cubic meter of liquefied natural gas corresponds to 600 cubic meters of natural gas at normal atmospheric pressure. Thus, a LPG with a carrying capacity of 90,000 or 120,000 cubic meters can carry about 50,000,000, or 70,000,000 cubic meters of gas per trip, respectively. [6]

There are two main types of LPG vessels in modern maritime transport: LPG, Gas Tanker (LNG) and LPG (Gas Tanker).

The tonnage of these ships has prevailed to be calculated and declared in cubic meters with the international symbol cbm. [5]

One of the largest ship-owning companies of this type of ships in the world is the Greek company StealthGas, of the Vafeias Group, whose fleet numbers about 40 LPG ships, whose names, in their majority, have the first synthetic word Gas, p. χ. Gas Marathon, Gas Chios etc.

Clarksons, a shipping brokerage firm, sees growth opportunities in the LPG industry, as the total carrying capacity of LPG ships is expected to increase by 4.7% in 2013 and 4.9% in 2014.

It is noted that the carrying capacity of LPG Carriers increased by 1.7%, to 19.9 million sq.m. Last year, ship orders were 51 compared to 23 ships in 2011. Finally, we note that there is a Greek presence in the LPG ship industry, as these companies include Stealthgas, Prime Marine and Diamantis Pateras Maritime.

The English acronym LPG comes from the words Liquefied Petroleum Gas and is used to describe the family of light hydrocarbons, the so-called liquefied petroleum gas. It is also noted that LPG is a natural derivative of gas processing and crude oil refining. [7]

Liquefied petroleum gas is a modern form of multi-purpose energy, with unique characteristics that make it one of the most widely used fuels:

- " Environmentally friendly"
- Cost effective
- Easily accessible

In addition to LPG, fleet ships can carry other petrochemical products of various industrial and commercial uses, such as:

- Propylene
- Butadiene
- Ammonia
- Vinyl chloride monomer (VCM) [8]

2.2 The gas carriers and their tanks

The Liquid Gas Carrier is a tanker specially built for the transport of petroleum gases (Petroleum Gases), as well as natural gases (Natural Gases).

The terms LPG Liquefied Petroleum Gases and LNG Liquefied Natural Gases are used specifically for the transport of these gases. These terms also characterize the respective LPG ships, which are built for the transport of such cargo, that is, we have "LPG Carrier" ships and "LNG Carrier" ships. [6]

These gases are used in many industrial and other human needs. In order to be loaded in the ship's tanks, the gases are pressed enough in order to reduce their volume to the minimum possible and permissible, to the point that they are liquefied.

Many such gases, in order to make and maintain their liquefaction, need to be cooled at a very low temperature at the same time (more than -100 0 C, depending on the nature of the gas and for this reason , often, these gases are called and "Cryogenic". [7]

The first LPG ships were built in the late 1950s and early 1960s. These ships are specialized tankers that carry specific dangerous cargo, which need special handling and precautions, both during loading and transport.

Figure 1: LPG transport vessel.

Apart from these, a very basic and essential difference between them and the common tankers is located right in the cargo areas. The tanks are specially made to be able to accept loads with high pressure and at very low temperatures. That is why they are made of special metals and alloys of nickel and steel or stainless steel and aluminum alloys. Also, the type and manner of construction of the tanks are provided by relevant IMO regulations, according to which they can be:

Independent Tanks:

These tanks are not part of the boat, ie they are not stuck on it but are "self-contained". Around the tank, at a short distance there is a second wall and, between the tank shell and this second wall, an empty space is inserted, which protects the boat from leakage, mainly cooling, which may occur from the cargo tank to the outside. . The independent tanks exist in type "A", with prismatic cross-section, type "B" with mainly spherical cross-section and type "C" with cylindrical cross-section.

Membrane Tanks:

The shell of these tanks is relatively complex. It consists of a thin metal wall (0.5 mm thick film) made of iron-nickel alloy. Its outer side is covered by a 200 mm thick insulating layer, usually made of perlite, then by a second membrane identical to the first and externally again by the same as the previous perlite insulating layer. Reinforced insulation is intended to minimize heat loss from the cargo tank and to protect the surrounding vessel from any cooling leakage.

These tanks of this type are not "self-contained", but are supported on the boat with various strong supports. Their cross-section is rather prismatic and is quite similar to the cross-section of the barn of an ore trucker. [9]

Semi-membrane Tanks:

These are a variant of membrane type tanks with the difference that they are "self-contained" and their first wall is slightly thinner than that of membrane tanks. Their cross section is harmonious, with flat sides and right angles.

Integral Tanks:

These tanks are integrated on the boat, with the difference that around their shell there is very strong insulation, to minimize heat loss from the cargo tanks, but also to protect the construction of the boat around the cooling of the cargo around the tank. They have a prismatic cross-section, which is quite similar to the cross-section of a truck's barn. [9]

LPG ships normally have ballast tanks, such as dry cargo trucks, ie bottom, side and top tanks, etc. Especially the side tanks communicate directly with the bottom, so that the ship has an inner and a second casing-shell, the same as the outside. hull. The existence of a double housing is an explicit and imperative requirement of the Registrars for all LPG vessels.

The loads of LPG are all transported in a liquefied state, because this reduces their volume (up to 600 times, so that their transport is exploitable), but in different conditions depending on the type of each load. Thus, the transport of LPG and LNG is done in different ways or "LPG transport systems" as they are called, depending on the load and mainly, depending on the specific conditions under which each load or group of similar loads must be transported. [8]

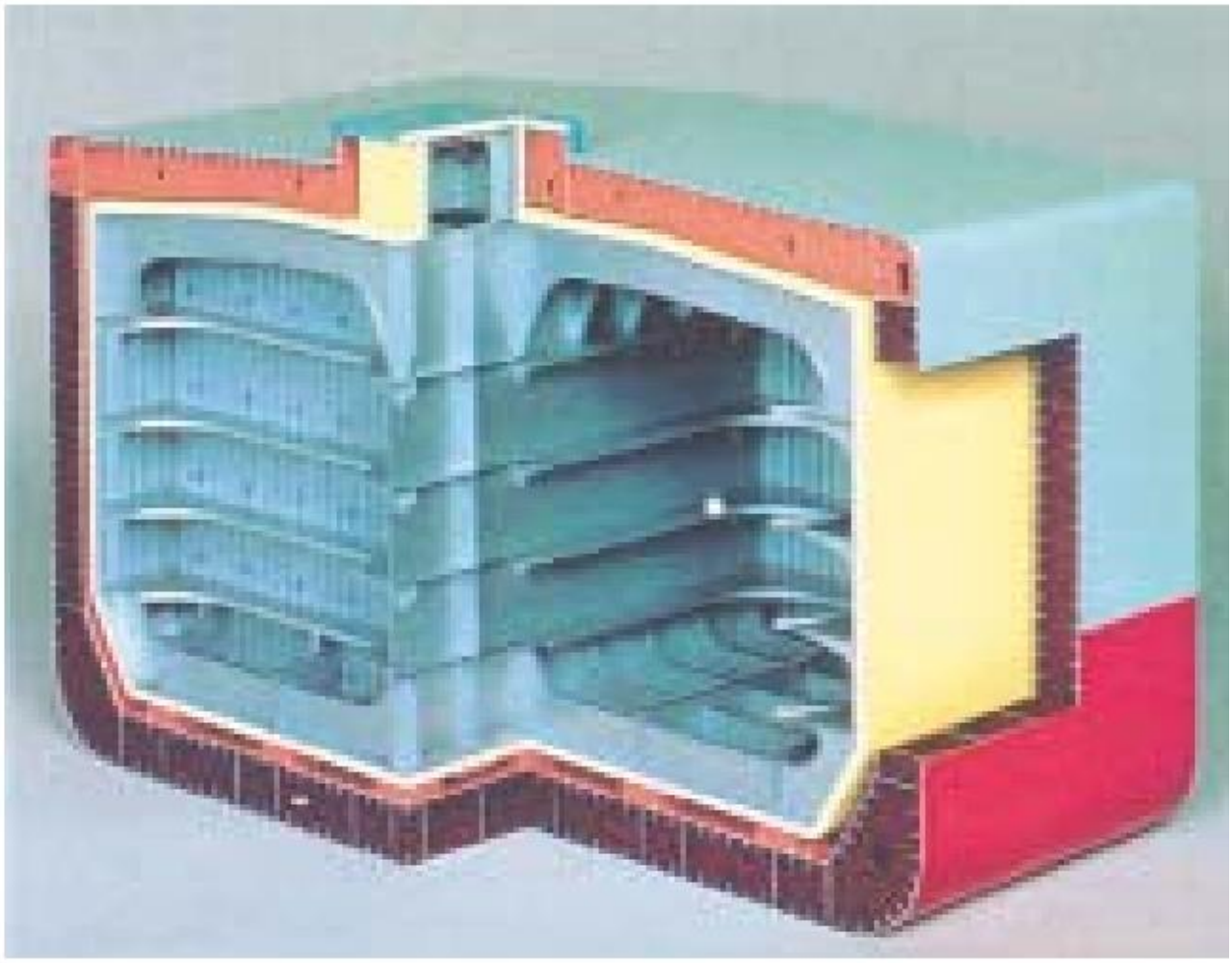

Figure 2: Partial representation of a vessel of a liquefied gas transport vessel. The inside of the cargo tanks is shown, as well as the outer casing.

2.3. Categories of liquefied petroleum gas transport vessels

Also, LPG ships can be classified into an equal number of categories, depending on the capabilities of each ship to handle a cargo and generally respond to a LPG transportation system.

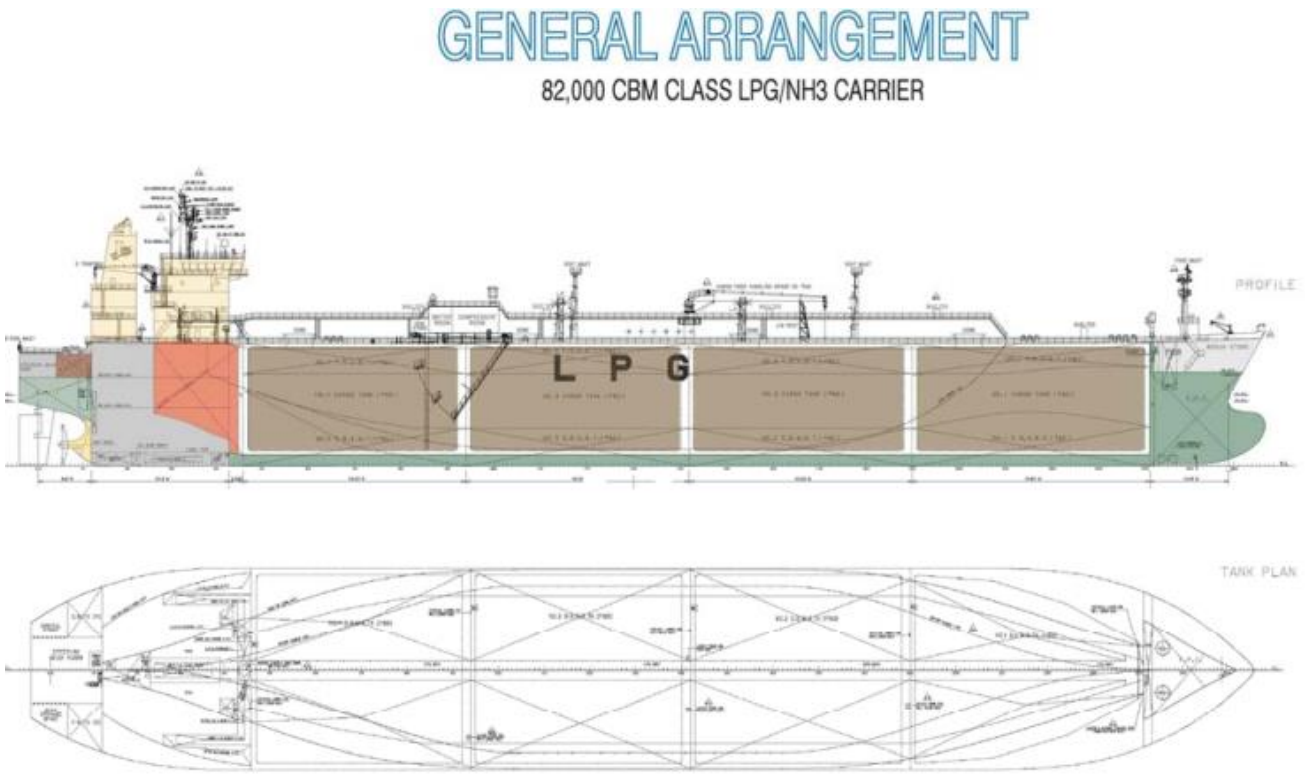

Figure 3: General layout of a liquefied gas carrier.

Based on the established and known LPG transportation systems, LPG ships can be classified into the following categories:

Fully pressures ship:

They are mainly small ships with a capacity of about 1000 m^3 , with cylindrical tanks in horizontal or upright arrangement. They usually transport LPG with high pressure (about 18 kg / cm^2) and at ambient temperature up to 45^0 C.

Semi-refrigerated / Semi-pressured Ship type:

They are made to transport LPG with moderate cooling (-10 up to -50^0 C) and with pressure up to 10 kg / cm^2, have a capacity of up to 12,000 m^3 and usually carry LPG products, ammonia, propane, etc.

Full cooling - Fully-refrigerated / Semi-pressured Ship:

These ships have a capacity ranging from 5,000 to 100,000 m 3 and carry mainly LPG in complete cooling (up to -55 0 C) but at a pressure equal to atmospheric. Their capacity reaches 100,000 m 3 .

Ethylene Ship:

It is a ship with specially made tanks for the transport of ethylene, which is usually transported at a temperature of -104 0 C. Its tanks are made of aluminum alloys and of course, externally, they have very strong and durable insulation. The capacity of these ships ranges from 1000 to 12,000 m 3 .

LNG (LNG Ship):

This ship has tanks similar to those of the ethylene ship and transports LNG products at temperatures down to -163^{o} C. Its capacity ranges from 40,000 to 140,000 m^3 . [5]

Finally, some other features of LPG ships, in terms of their construction and equipment are:

- Cargo areas are isolated from the engine room, boiler room, accommodation areas, chain wells, warehouses, etc. Using intermediate empty watertight spaces.
- The loading pipes pass under the hatch of the tank and from there to the tank, to avoid the risk of any leakage of gas in case of damage to the piping.
- Every Each cargo tank, as a rule, has its own pumping station, which is installed on the main deck.

The IMO, through a relevant Code, classifies LPG in three categories depending on the degree of danger of the cargo they carry to the environment:

- Type 1 G ships (carrying very high risk cargo)
- Type 2 G ships (carrying low risk cargo)
- Type 3G type vessels (carrying minimum dangerous loads) [7]

2.4 Loading - unloading terminal

Terminal equipment is more difficult to describe than ship equipment due to the lack of international design standards .

There are hundreds of LPG terminals around the world. Design patterns vary considerably from country to country and from company to company, and this difference may also be apparent at the pier. Here, it will be found that cargo transfer is usually achieved by using loading arms or pipes.

The provision of a steam return mechanism between the ship and the onshore loading and unloading terminals depends on a number of factors, such as economics, cargo rates, distance of the pier from storage tanks, pressures and temperatures of its products. cargo. [5]

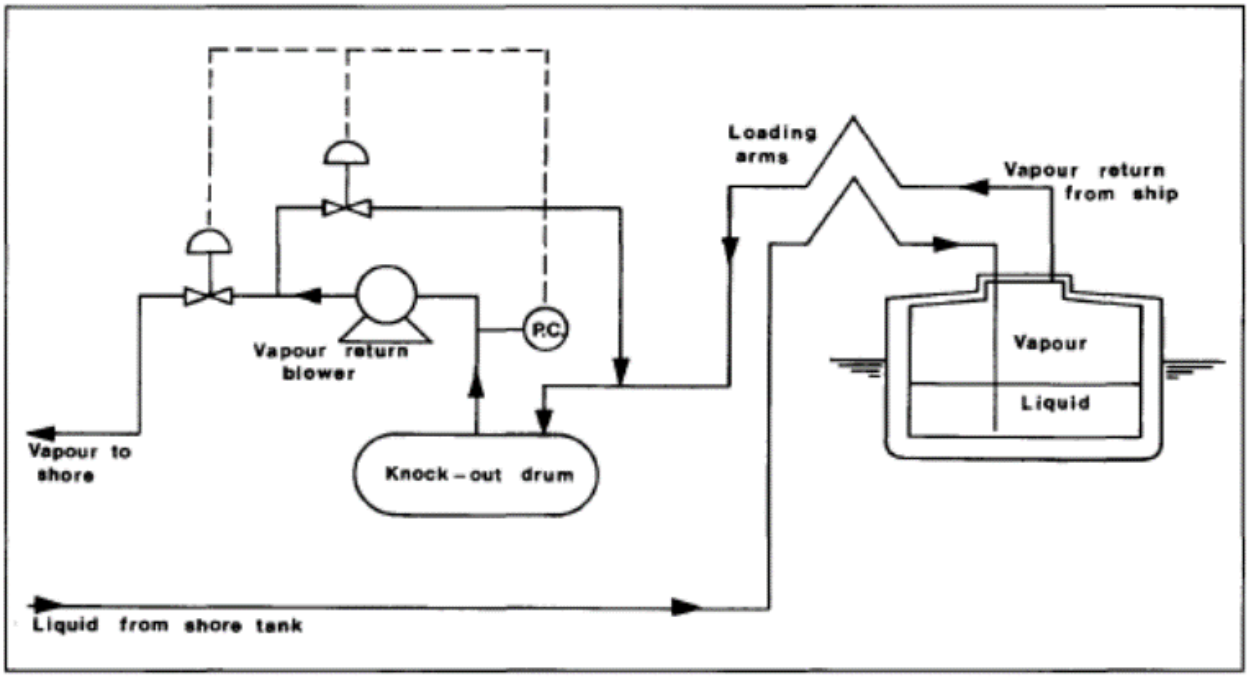

Figure 4: LPG loading terminal

CHAPTER 3. LPG MARKET ANALYSIS

3.1.Introduction

The LPG market has been at the bottom of the shipping cycle for the past three years, with a massive oversupply of ships keeping freight rates and secondhand values close to all-time low levels. A market recovery is finally underway, driven by moderate fleet growth and strong demand growth stimulated by increasing volumes of low-cost US LPG.

VLGC and LGC freight rates recovered markedly during the first ten months of 2019. Vessel demand increased following strong growth in long-haul trade on the back of a favourable LPG price spread between the US and Asia. In the MGC and SGC segments, the recovery has been moderate, as the segments continue to struggle with vessel oversupply. Furthermore, intra-regional trade – the main demand driver for MGCs and SGCs – has been somewhat muted due to low demand from the European petro- chemical sectors. On a positive note, competition from larger ves- sels in MGC market should ease following the recovery in the VLGC segment. In the first ten months of 2019, VLGC spot rates doubled and the one-year timecharter rate was up 65%. In the same period, the one-year timecharter rate for MGCs and SGCs increased by an average of 15%.

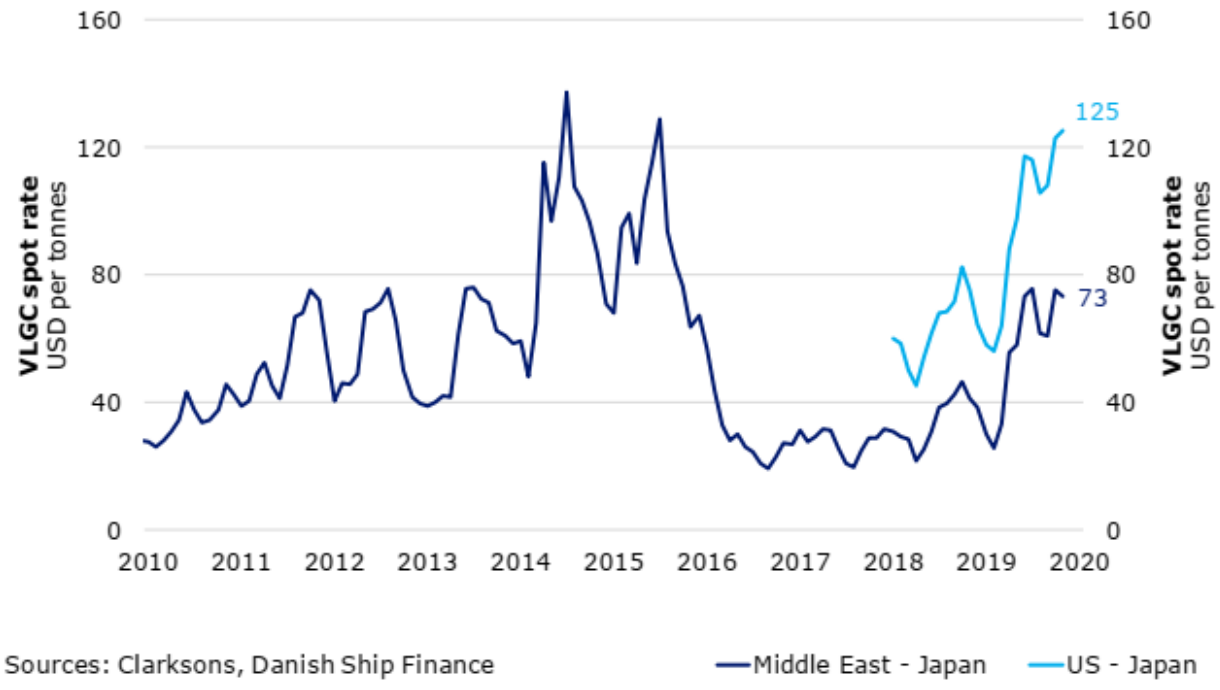

Figure 5: VLG Spot rates

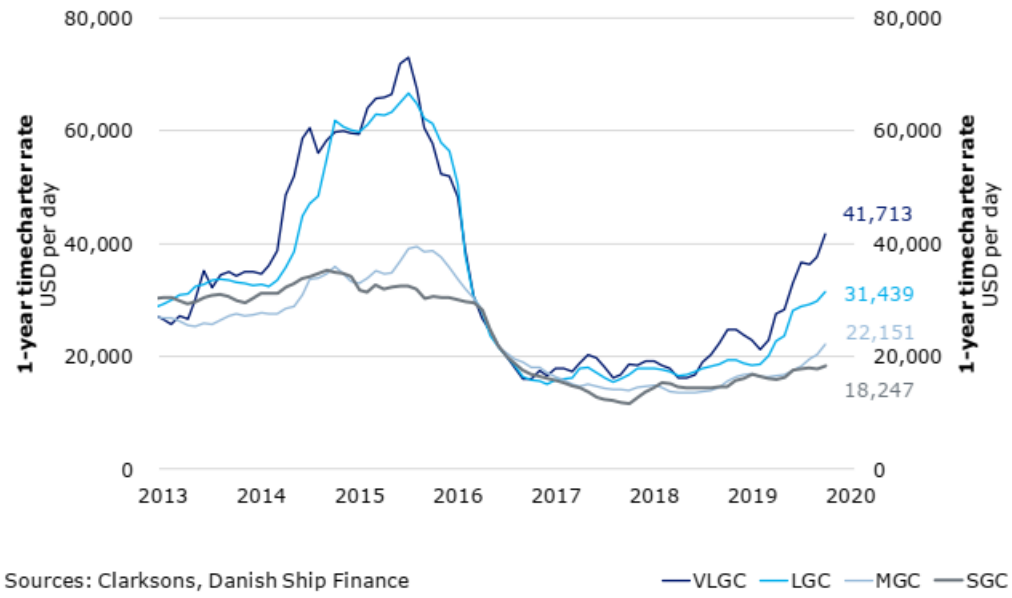

Figure 6: VLGC Timce charter rates

3.2. Supply and demand

Deliveries accelerated during the first ten months of 2019, while the improving freight rates combined with a low number of scrap- ping candidates led to a pause in demolition activity. This resulted in net fleet growth of 4.5% in the period. By comparison, net fleet growth was 0.5% in the same period in 2018. The impact from vessels exiting the fleet to have scrubbers retrofitted was mini- mal; we estimate that retrofits reduced vessel supply by less than 0.2% during the period. We expect demolitions to remain low for the rest of 2019. Consequently, annual fleet growth is expected to accelerate to around 6%.

During the first nine months of 2019, seaborne LPG volumes grew by 8%, propelled by US and Asia-Pacific exports and Asian imports. Declining LPG prices pushed volumes from the US to Asia, although the US-China trade conflict has brought Chinese imports of US LPG almost to a standstill. To offset the decline in US vol- umes, China has been sourcing more LPG from the Middle East and the Asia-Pacific region. Consequently, US exports to Asia (non-China) have increased, which has had a positive effect on travel distances. Growth in US export distances has outweighed the decline in Chinese import distances. During the first nine months, export volumes from the Middle East declined by around 5%, due to the reintroduction of sanctions on Iran. We expect the attack on Saudi Aramco’s processing facilities is likely to curb Mid- dle East exports and boost Asian demand for US LPG in the fourth quarter of 2019.

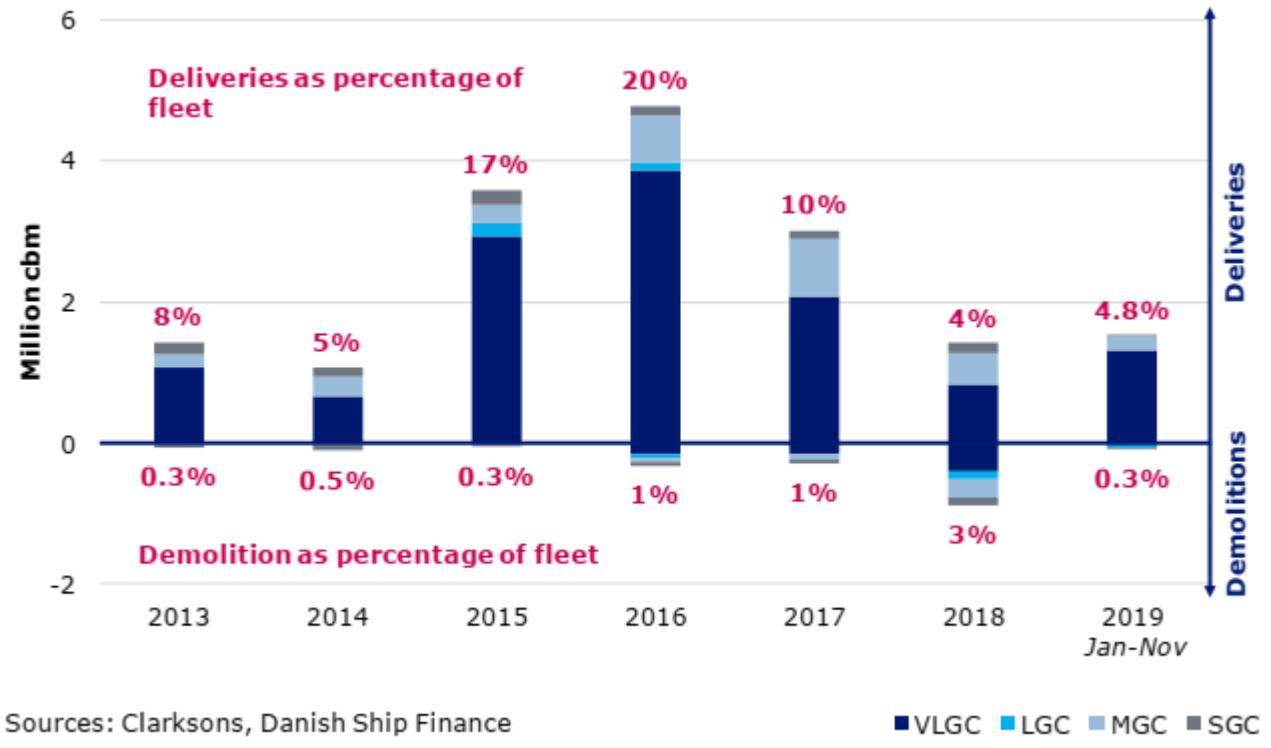

Figure 7: LPG Fleet

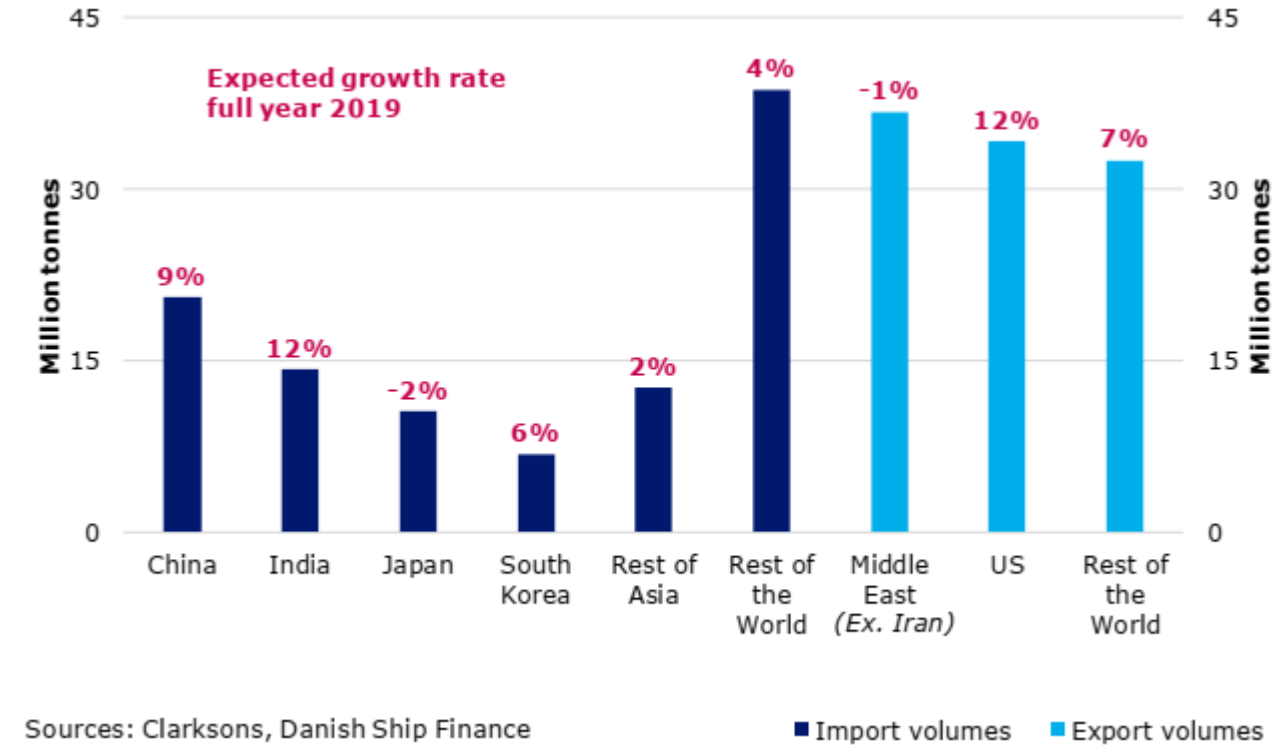

Figure 8: Seaborne LPG

3.3. Contracting

LPG contracting has increased steadily since 2016, particularly in the VLGC segment. This indicates that the market expects US ex- port volumes to continue to increase in the years to come. How- ever, it seems that owners are being careful not to push the fleet into oversupply, while some are refraining from ordering due to uncertainty over future fuel types and vessel specifications. What- ever the reason, contracting did not increase in the first nine months of 2019 compared to the same period in 2018. Nonetheless, the balance remains delicate and increasing contracting ac- tivity could easily push the fleet into oversupply. Newbuild orders reached around 6% of the fleet in the first nine months. In the second quarter, newbuild prices for VLGCs, MGCs and SGCs were USD 71 million, USD 47 million and USD 39 million, respectively.

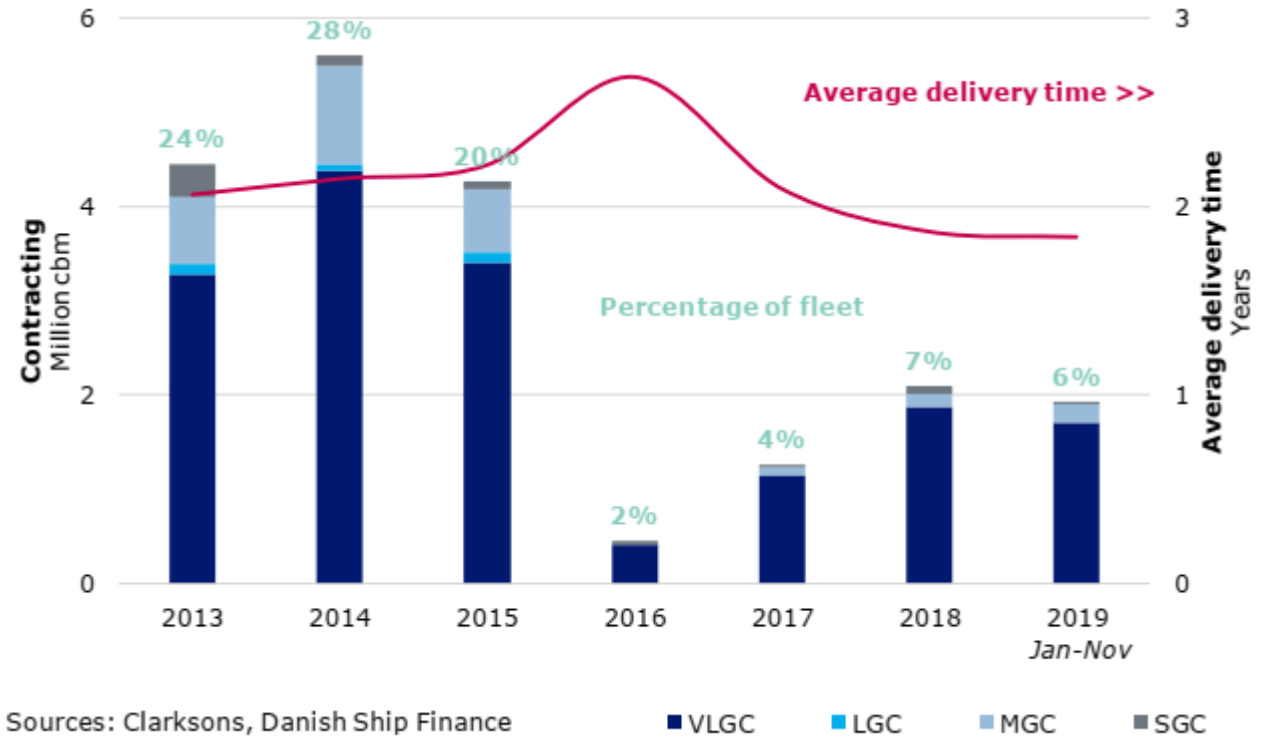

Figure 9: LPG contracting

3.3.activity in the secondhand market

Shipowners selling off non-scrubber-fitted assets and exiting cer- tain vessel segments has boosted activity in the sale and pur- chase market to an all-time high while keeping secondhand prices relatively low. In the first nine months, a total of 28 transactions involving 36 ships took place in the secondhand market: 17 SGCs, seven MGCs, three LGCs and nine VLGCs. Only five of the vessels were fitted with scrubbers. Buyers were mostly shipowners al- ready in the LPG market, although some owners took advantage of the low prices to enter new vessel segments, e.g. the VLGC segment.

Scrubbers have mostly been fitted to VLGC vessels but also to some MGCs and SGCs, depending on the specific trade of the vessels and the overall strategy of the owner.

Prices have remained relatively flat despite high activity in the secondhand market.

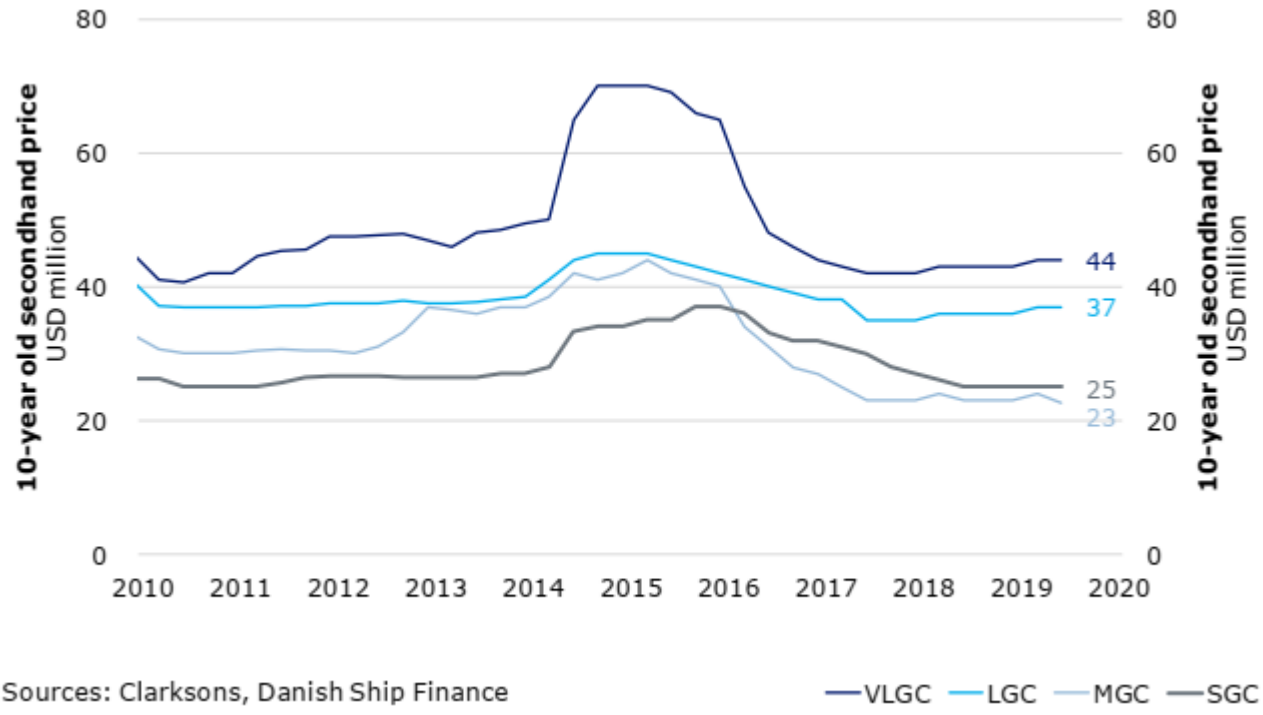

Figure 10: Second hand prices

3.4. Outlook

The outlook for the LPG market is positive. Asia will continue to drive demand, although competition from alternative energy sources, like natural gas and electricity, is increasing in the household sector. Furthermore, we expect Chinese demand growth to be kept in check by the US-China trade conflict. We also remain sceptical about long-term LPG demand from the petrochemical sector due to an increasing global focus on and rapid advances in plastic recycling. However, in the short to medium term, we believe the market will be propelled by increasing volumes of long-haul US exports.

3.5.Crapping potential in the VLGC segment

The LPG fleet consists of around 835 vessels. The orderbook contains 61 ships: 40 VLGCs, seven MGCs and 14 SGCs, equalling 12% of the fleet. Around 7% of the fleet is older than 25 years: 25 VLGCs, 11 MGCs and 21 SGCs. If demand begins to slow, the orderbooks in the MGC and SGC segments could be absorbed by older ships exiting the fleets with the vessels' economic lifetime

being maintained at around 30 years. In contrast, absorption of the VLGC orderbook would reduce the economic lifetime of VLGC ships to around 20 years.

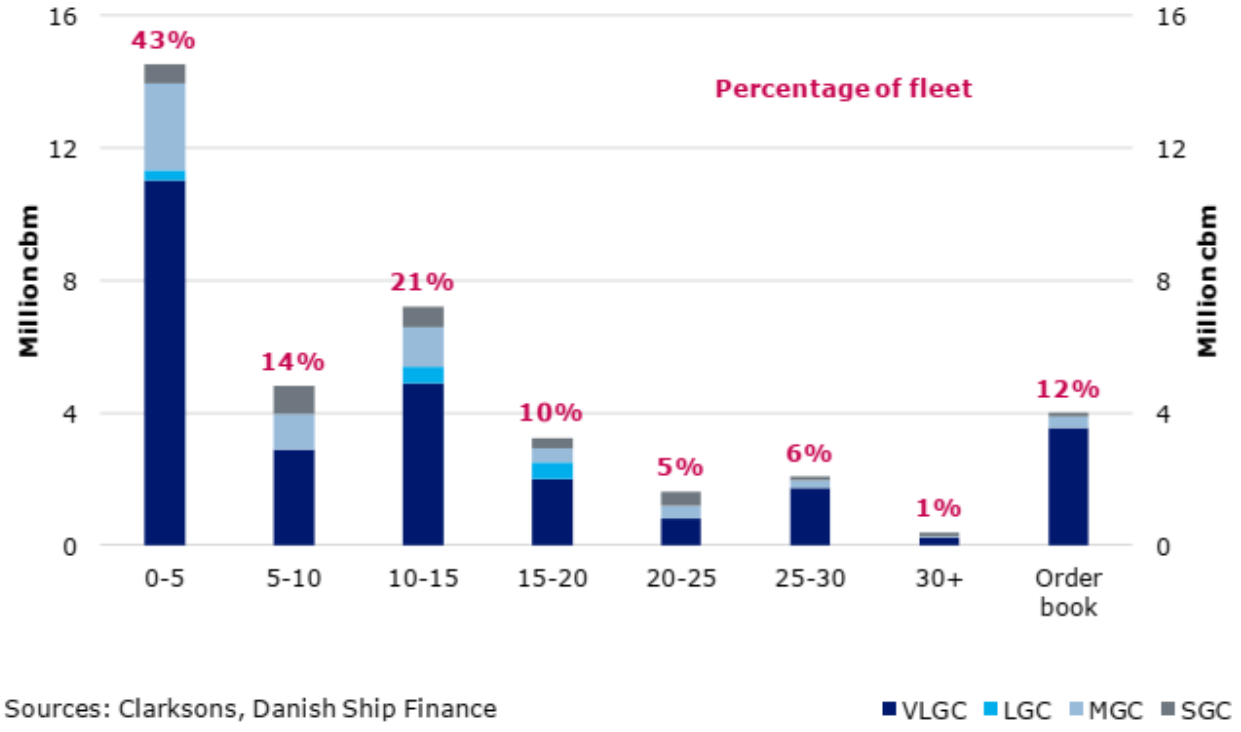

Figure 11: LPG Orderbook

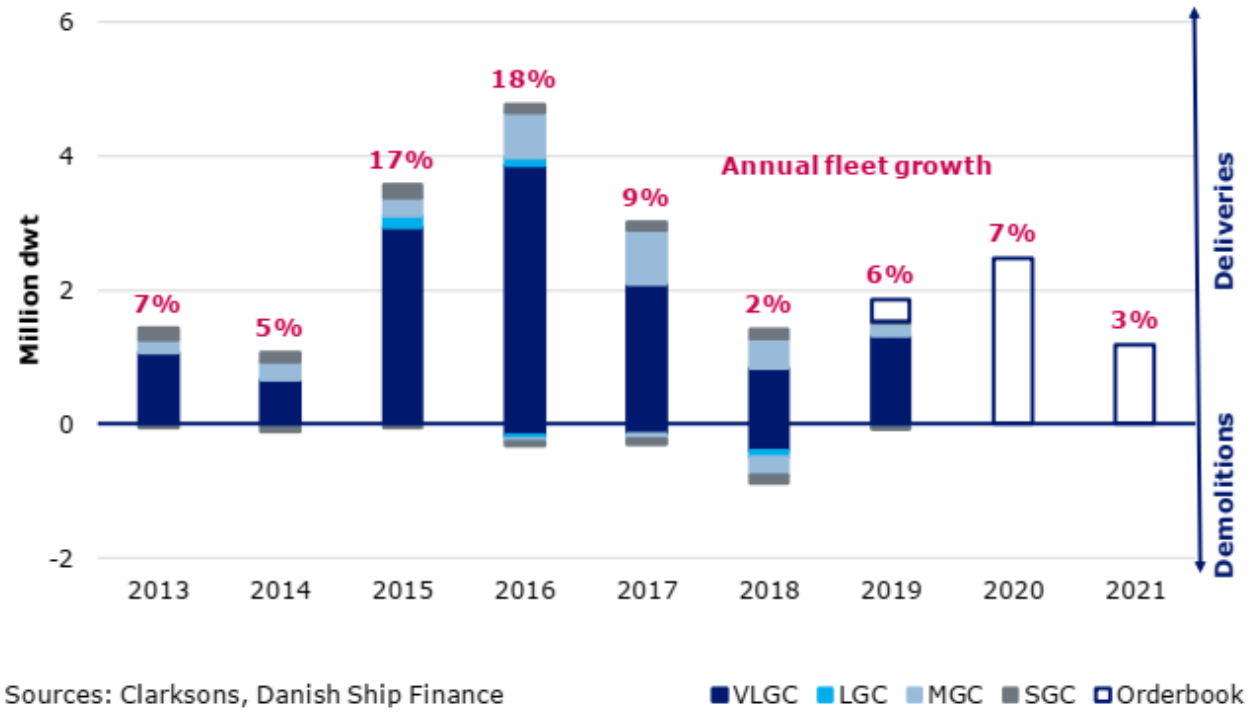

Figure 12: LPG Fleet prospects

3.6.Fleet Growth

Fleet growth is scheduled to accelerate to 6% in 2019 and increase further to 7% in 2020 and 2021 (excluding future demolition). Growth will be driven by the VLGC segment, which is set to see fleet expansion of 15% by end-2021, leaving the segment vul- nerable if demand fails to absorb incoming vessels. Given the current market conditions, we expect demolition activity to remain relatively low. Furthermore, the freight rate recovery could stimulate contracting activity. With an average delivery time of less than two years currently, new contracts could add to fleet growth in 2021, pushing supply ahead of demand.

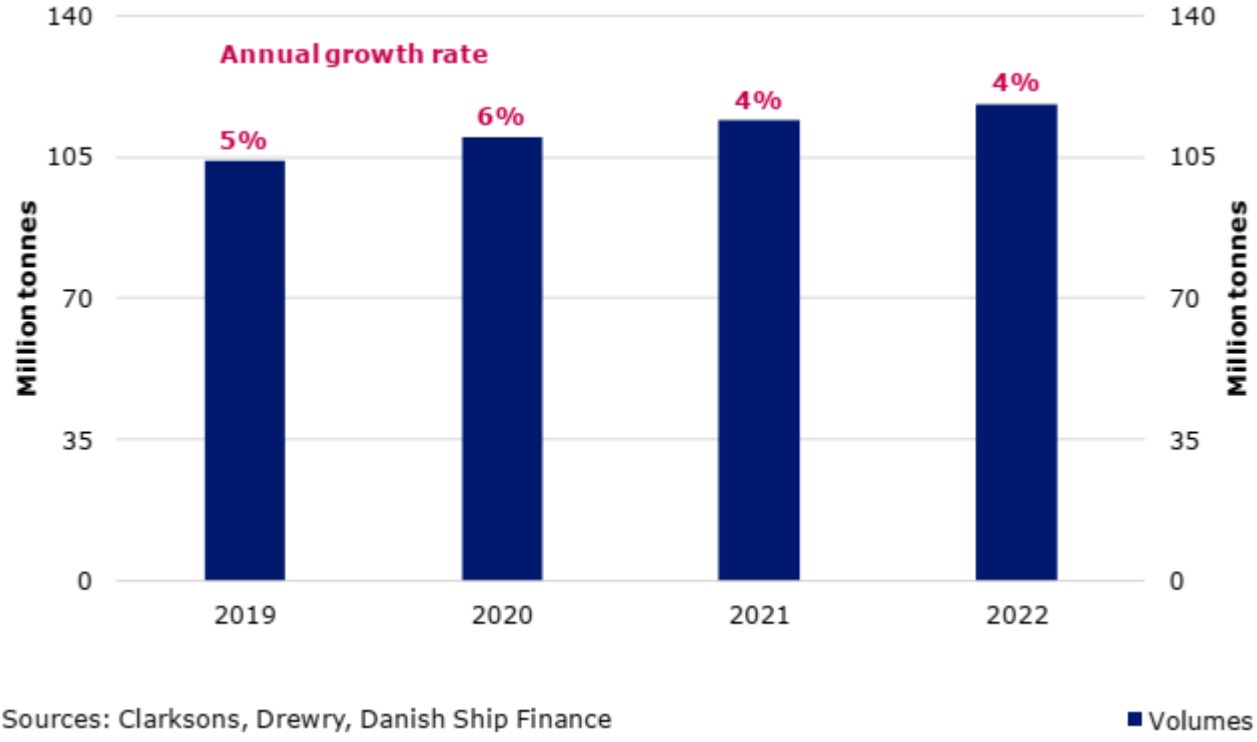

Figure 13: LPG Seaborne Expected Volumes

3.7.Future prospects

We expect seaborne LPG demand is set to grow around 5% per year until end-2022. Hence, fleet growth is expected to outpace demand on a volume basis in 2019 and 2020. However, increasing long-haul trade from the US to Asia is expected to boost travel distances and push distance-adjusted demand ahead of supply. In periods with slow growth in long-haul trade, though, the large influx of new VLGC ships will result in supply outpacing demand. VLGC freight rates are likely to decline sharply in such periods.

Over the next three years, US export capacity is set to expand by around 15 million tonnes. The increasing availability of low-cost US LPG is expected to stimulate global demand growth, especially from the Asian and European petrochemical sectors. Given suffi- cient demand growth,

US exports could accelerate growth in LPG volumes beyond our forecasts. However, the US-China trade conflict is limiting the growth potential. Middle Eastern LPG exports are expected to grow at a CAGR of around 2-3% over the next three years. The relatively slow growth will be driven by a steady increase in domestic demand from the household and pet- rochemical sectors.

Asia accounts for 65% of global LPG imports and for around 70% of import volume growth. Asian LPG imports are expected to grow by around 7% annually over the next three years, driven primarily by China, India and South Korea. In China, both the household and petrochemical sectors, especially with new propane dehydrogenation capacity coming online, will drive demand. In India, the household sector continues to be the main demand driver. Since 2016, the government has encouraged households to switch from dirty-burning fuels, like wood and coal, to LPG by subsidising LPG prices. Household sector demand is declining in South Korea, but increasing demand from the petrochemical sector should result in overall demand growth.

China is becoming increasingly dependent on Middle Eastern LPG imports. This reliance could increase Chinese import prices and in turn lead to slower growth in Chinese LPG demand. According to our forecasts, we expect Chinese LPG growth to be limited to around 4-6% per year. This is a conservative estimate and import volumes could increase beyond our estimate if the US- China trade conflict is resolved.

3.7. Competition from alternative fuels in the household sector

In the household sector, LPG is a transitional fuel. As markets mature, LPG is replaced by natural gas and electricity. This is happening in China, especially in the north east of the country, due to pipeline imports of Russian natural gas, and some large cities in India, although the effect on LPG demand is being miti- gated by growing consumption outside large cities. However, the rapid development and declining costs in wind and solar energy could speed up the transition process. Furthermore, LPG demand potential in emerging markets, like Africa, could shrink as elec- tricity becomes price competitive. These factors will impact the long-term growth potential of the seaborne LPG market.

Global plastic production is expected to double by 2030. This will create long-term LPG demand growth from the petrochemical sector. According to IHS Energy petrochemical LPG demand will grow at a CAGR of 4% up to 2030. Hence, the sector will account for around 50% of LPG demand growth. However, increasing fo- cus on plastic recycling, especially chemical recycling where plastic is used as a feedstock to produce LPG, could lower the propor- tion of virgin LPG needed in plastic production. This could result in less intense demand for seaborne LPG from the petrochemical sector in the medium to long term.

LPG transport by ships

CHAPTER 4. LPG SHIPPING COMPANIES IN GREECE. CASE STUDY OF DORIAN LPG LTD

4.1.Overview

Dorian LPG is a liquefied petroleum gas shipping company and a leading owner and operator of modern very large gas carriers ("VLGCs"). Its founding executives have managed vessels in the LPG shipping market since 2002.

The company currently owns and operates a fleet of 22 modern VLGCs, including 19 new fuel-efficient 84,000 cbm ECO-design VLGCs and three 82,000 cbm VLGCs. The twenty-two VLGCs in their fleet have an aggregate carrying capacity of approximately 1.8 million cbm and an average age of 6.0 years.

The company provides in-house commercial and technical management services for all of the vessels in its fleet, including its vessels deployed in the Helios Pool. Its mission is to arrange safe, reliable , clean and trouble free transportation, and we are committed to the highest quality of customer service.

Dorian LPG has offices in Connecticut, USA, Copenhagen, Denmark, London, United Kingdom and Athens, Greece. Dorian LPG is incorporated in the Republic of The Marshall Islands and headquartered in the United States.

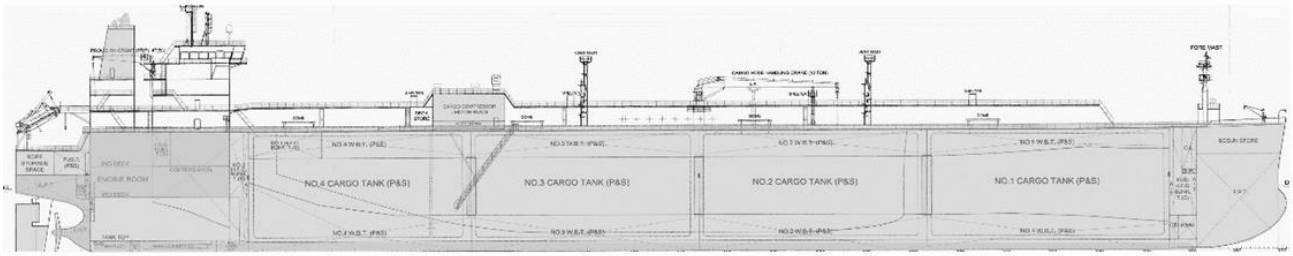

Figure 14: Blueprint of a typical LPG ship of Dorian LPG LTD

4.2.Fleet list of Dorian LPG LTD

ORIAN LPG VESSELS					
Type	Name	CBM	Delivered	Yard	Flag
ECO VLGC	CARAVELLE	84	2016	Hyundai SHI	Bahamas
ECO VLGC	CHALLENGER	84	2015	Hyundai SHI	Bahamas
ECO VLGC	COPERNICUS	84	2015	Daewoo SME	Bahamas
ECO VLGC	CHAPARRAL	84	2015	Hyundai SHI	Bahamas
ECO VLGC	COMMANDER	84	2015	Hyundai HI	Bahamas
ECO VLGC	CRATIS	84	2015	Daewoo SME	Bahamas
ECO VLGC	CHEYENNE	84	2015	Hyundai SHI	Bahamas
ECO VLGC	CLERMONT	84	2015	Hyundai SHI	Bahamas
ECO VLGC	CONSTELLATION	84	2015	Hyundai HI	Bahamas
ECO VLGC	CRESQUES	84	2015	Daewoo SME	Bahamas
ECO VLGC	COMMODORE	84	2015	Hyundai SHI	Bahamas
ECO VLGC	CONSTITUTION	84	2015	Hyundai SHI	Bahamas
ECO VLGC	CONTINENTAL	84	2015	Hyundai SHI	Bahamas
ECO VLGC	COBRA	84	2015	Hyundai SHI	Bahamas
ECO VLGC	CONCORDE	84	2015	Hyundai HI	Bahamas
ECO VLGC	COUGAR	84	2015	Hyundai SHI	Bahamas
ECO VLGC	CORVETTE	84	2015	Hyundai HI	Bahamas
ECO VLGC	CORSAIR	84	2014	Hyundai HI	Bahamas
ECO VLGC	COMET	84	2014	Hyundai HI	Bahamas
VLGC	CAPTAIN NICHOLAS ML	82	2008	Hyundai HI	Bahamas
VLGC	CAPTAIN JOHN NP	82	2007	Hyundai HI	Bahamas
VLGC	CAPTAIN MARKOS NL	82	2006	Hyundai HI	Bahamas

Figure 15: Cresques LPG ship

Figure 16: Captain John LPG ship

Figure 17: Copernicus LPG ship

Figure 18: Corsair LPG ship

4.3. Ship Management

In order to deliver the highest level of service to our customers, Dorian LPG spends significant resources on ensuring the health, safety and security of our staff as well as their commitment to the environment.

The company's in-house commercial management capabilities are enhanced by its participation in the Helios LPG pool, which is jointly owned by Dorian LPG and Phoenix The following features of ship management can be distincted:

- Fully integrated commercial and technical management

Dorian's in-house commercial and technical management services meets or exceeds the demanding requirements of major oil companies and allows the company to maintain control over all aspects of its business.

- Focused on health, safety, security, environment and quality

Dorian's in-house commercial and technical management services meets or exceeds the demanding requirements of major oil companies and allows us to maintain control over all aspects of our business.

- Comprehensive staffing and training

As Dorian LPG's VLGC fleet rapidly expanded from three to 22 vessels in an 18-month period, the company invested heavily in its personnel in order to be able to be a top service provider in the LPG shipping industry. All new hires are gas-experienced personnel who passed the company's difficult vetting process. Each crew member undergoes extensive training on internal systems and spends several months becoming accustomed to the company's advanced safety management system.

4.4. Health, Safety, Environment, Quality

Dorian LPG is Guided by the Following Principles:

- To Provide Safe and Healthy Occupations

The company will strive to create a working environment where accidents will not occur and in which employees, customers, contractors and the public will not be exposed to health hazards. The company's employees and ship contractors will be trained in workplace health and safety, and encouraged to adopt a healthy lifestyle.

- Market Products that can be Used Safely

All products will be evaluated to ensure that, despite inherent hazards, they can be stored, handled, transported, and safely used.

- Progressive Improvement of the Company's Environmental Performance

The company will protect the environment by seeking to minimize the impact of its activities. Dorian will strive for progressive improvement in the environmental performance of its ships by reducing emissions, wastes, and the use of energy, applying the best available pollution control techniques that are commercially viable.

- Respect the Interests of the World Community

Dorian will communicate openly with those who live or work with it onboard or ashore to ensure their understanding of our operations and our understanding of their concerns. Dorian will also seek to participate with all relevant bodies in resolving H.S.&E. issues associated with its operations.

In addition, Dorian LPG will comply will all relevant Statutory Regulations and strive to comply with and better Industry Recommended Standards where they apply to its marine operations. The Company will endeavor to maintain high standards of security for all staff on Company ships and in shore establishments.

4.5.Recent financial rates of Dorian LPG

4.5.1.Highlights for the Second Quarter Fiscal Year 2021

Revenues of $54.7 million and Time Charter Equivalent ("TCE")(1) rate for Dorian's fleet of $26,015 for the three months ended September 30, 2020, compared to revenues of $91.6 million and TCE rate for our fleet of $47,623 for the three months ended September 30, 2019.

Net income of $0.5 million, or $0.01 earnings per diluted share ("EPS"), and adjusted net income/(loss)(1) of $(3.4) million, or $(0.07) adjusted earnings/(loss) per diluted share ("adjusted EPS"),(1) for the three months ended September 30, 2020.

Adjusted EBITDA(1) of $22.3 million for the three months ended September 30, 2020.

TCE, adjusted net income/(loss), adjusted EPS and adjusted EBITDA are non-U.S. GAAP measures. Refer to the reconciliation of revenues to TCE, net income to adjusted net income, EPS to adjusted EPS and net income to adjusted EBITDA included in this press release under the heading "Financial Information.

4.5.2.Second Quarter Fiscal Year 2021 Results Summary

Net income amounted to $0.5 million, or $0.01 per diluted share, for the three months ended September 30, 2020, compared to of $40.7 million, or $0.74 per diluted share, for the three months ended September 30, 2019.

Adjusted net loss amounted to $(3.4) million, or $(0.07) per diluted share, for the three months ended September 30, 2020, compared to adjusted net income of $41.4 million, or $0.75 per diluted share, for the three months ended September 30, 2019. Net income for the three months ended September 30, 2020 is adjusted to exclude an unrealized gain on derivative instruments of $4.0 million. Please refer to the reconciliation of net income to adjusted net income/(loss), which appears later in this press release.

The $44.8 million decrease in adjusted net income/(loss) for the three months ended September 30, 2020, compared to the three months ended September 30, 2019, is primarily attributable to a decrease of $36.9 million in revenues and increases of $4.0 million in vessel operating expenses, $2.4 million in charter hire expenses, $0.7 million in depreciation and amortization, and a $2.8 million unfavorable change in realized gain/(loss) on derivatives, partially offset by a decrease of $2.6 million in interest and finance costs.

The TCE rate for Dorian’s fleet was $26,015 for the three months ended September 30, 2020, a 45.4% decrease from a TCE rate of $47,623 for the same period in the prior year, primarily driven by reduced spot market rates. Please see footnote 7 to the table in "Financial Information" below for information related to how we calculate TCE. Total fleet utilization (including the utilization of our vessels deployed in the Helios Pool) increased from 92.9% in the quarter ended September 30, 2019 to 97.4% in the quarter ended September 30, 2020.

Vessel operating expenses per day increased to $10,591 for the three months ended September 30, 2020 compared to 8,594 in the same period in the prior year. Please see "Vessel Operating Expenses" below for more information.

4.5.3.Revenues

Revenues, which represent net pool revenues—related party, time charters and other revenues earned by our vessels, were $54.7 million for the three months ended September 30, 2020, a decrease of $36.9 million, or 40.3%, from $91.6 million for the three months ended September 30, 2019. The decrease is primarily attributable to a reduction in average TCE rates, partially offset by increased fleet utilization. Primarily driven by a reduction of spot market rates, average TCE rates decreased by $21,608 from $47,623 for the three months ended September 30, 2019 to $26,015 for the three

months ended September 30, 2020. The Baltic Exchange Liquid Petroleum Gas Index, an index published daily by the Baltic Exchange for the spot market rate for the benchmark Ras Tanura-Chiba route (expressed as U.S. dollars per metric ton), averaged $51.589 during the three months ended September 30, 2020 compared to an average of $65.991 for the three months ended September 30, 2019. Our fleet utilization increased from 92.9% during the three months ended September 30, 2019 to 97.4% during the three months ended September 30, 2020.

4.5.4.Charter Hire Expenses

Charter hire expenses for the vessels chartered in from third parties were $4.5 million and $2.1 million for the three months ended September 30, 2020 and 2019, respectively. The increase of $2.4 million, or 119.9%, was caused by an increase in time chartered-in days, which increased from 92 for the three months ended September 30, 2019 to 184 for the three months ended September 30, 2020.

4.5.5.Vessel Operating Expenses

Vessel operating expenses were $21.4 million during the three months ended September 30, 2020, or $10,591 per vessel per calendar day, which is calculated by dividing vessel operating expenses by calendar days for the relevant time-period for the technically-managed vessels that were in our fleet. Vessel operating expenses per vessel per calendar day increased by $1,997 from $8,594 for the three months ended September 30, 2019 to $10,591 for the three months ended September 30, 2020. The increase in vessel operating expenses for the three months ended September 30, 2020, when compared with the three months ended September 30, 2019, was primarily the result of a $3.5 million, or $1,723 per vessel per calendar day, increase in operating expenses related to repairs and maintenance, spares and stores, and coolant costs, which is inclusive of an increase of $1.6 million, or $810 per vessel per calendar day, in operating expenses related to the drydocking of vessels including repairs and maintenance, spares and stores, coolant costs, and other drydocking related operating expenses. Additionally, we experienced an increase in crew wages and related costs of $0.8 million, or $413 per vessel per calendar day.

4.5.6.General and Administrative Expenses

General and administrative expenses were relatively flat at $5.9 million for both the three months ended September 30, 2020 and the three months ended September 30, 2019. Dorian experienced increases of $0.8 million in salaries, wages and benefits, $0.6 million in higher insurance premiums, and $0.2 million in legal and professional fees, which is largely a result of costs incurred in our transition from being an emerging growth company under the Jumpstart Our Business Startups Act,

offset by reductions of $1.1 million due to the timing of annual cash bonuses to certain employees and $0.5 million in stock-based compensation.

4.5.7.Interest and Finance Costs

Interest and finance costs amounted to $6.7 million for the three months ended September 30, 2020, a decrease of $2.6 million, or 28.4%, from $9.3 million for the three months ended September 30, 2019. The decrease of $2.6 million during this period was due to a decrease of $2.9 million in interest incurred on our long-term debt, primarily resulting from a decrease in LIBOR rates and a reduction of average indebtedness, partially offset by an increase of $0.2 million in amortization of deferred financing fees and loan expenses. Average indebtedness, excluding deferred financing fees, decreased from $692.0 million for the three months ended September 30, 2019 to $657.5 million for the three months ended September 30, 2020. As of September 30, 2020, the outstanding balance of our long-term debt, net of deferred financing fees of $11.8 million, was $634.5 million.

4.5.8.Unrealized Gain/(Loss) on Derivatives

Unrealized gain on derivatives amounted to $4.0 million for the three months ended September 30, 2020, compared to an unrealized loss of $0.7 million for the three months ended September 30, 2019. The favorable $4.7 million difference is attributable to an increase of $3.0 million in favorable fair value changes to our interest rate swaps resulting from changes in forward LIBOR yield curves and an increase of $1.7 million in favorable changes to our forward freight agreement ("FFA") positions.

4.5.9.Realized Gain/(Loss) on Derivatives

Realized loss on derivatives was $2.1 million for the three months ended September 30, 2020, compared to a realized gain of $0.7 million for the three months ended September 30, 2019. The unfavorable $2.8 million change is primarily attributable to (1) decreases in floating LIBOR resulting in a $2.1 million unfavorable variance on realized losses in the current period on our interest rate swaps and (2) unfavorable settlements of $0.7 million on our FFA positions.

4.5.10.Fleet

The following table sets forth certain information regarding Dorian’s fleet as of October 28, 2020.

Table 1: Overview of current Dorian's Fleet

	Capacity (Cbm)	Shipyard	Sister Ships	Year Built	ECO Vessel(1)	Scrubber Equipped	Employment	Charter Expiration(2)
Dorian VLGCs								
Captain Markos NL(3)	82,000	Hyundai	A	2006	—	—	Pool(4)	—
Captain John NP	82,000	Hyundai	A	2007	—	—	Pool(4)	—
Captain Nicholas ML(3)	82,000	Hyundai	A	2008	—	—	Pool-TCO(5)	Q4 2021
Comet	84,000	Hyundai	B	2014	X	X	Pool(4)	—
Corsair(3)	84,000	Hyundai	B	2014	X	X	Time Charter(6)	Q4 2022
Corvette(3)	84,000	Hyundai	B	2015	X	X	Pool(4)	—
Cougar	84,000	Hyundai	B	2015	X	—	Pool(4)	—
Concorde(3)	84,000	Hyundai	B	2015	X	X	Time Charter(7)	Q1 2022
Cobra	84,000	Hyundai	B	2015	X	—	Pool(4)	—
Continental(8)	84,000	Hyundai	B	2015	X	—	Pool(4)	—
Constitution	84,000	Hyundai	B	2015	X	X	Pool(4)	—
Commodore	84,000	Hyundai	B	2015	X	—	Pool-TCO(5)	Q4 2020
Cresques(3)	84,000	Daewoo	C	2015	X	X	Pool(4)	—
Constellation	84,000	Hyundai	B	2015	X	X	Pool(4)	—
Cheyenne	84,000	Hyundai	B	2015	X	X	Pool(4)	—
Clermont	84,000	Hyundai	B	2015	X	—	Pool(4)	—
Cratis	84,000	Daewoo	C	2015	X	X	Pool(4)	—
Chaparral	84,000	Hyundai	B	2015	X	—	Pool(4)	—
Copernicus	84,000	Daewoo	C	2015	X	X	Pool(4)	—
Commander	84,000	Hyundai	B	2015	X	—	Pool(4)	—
Challenger	84,000	Hyundai	B	2015	X	—	Pool-TCO(5)	Q4 2020
Caravelle	84,000	Hyundai	B	2016	X	—	Pool(4)	—
Total	1,842,000							

4.5.11.Market Outlook & Update

Global seaborne LPG liftings during the third calendar quarter of 2020 totaled 26.1 million metric tons, a 7.9% decline compared to 28.3 million metric tons during same period during 2019. Calendar 2020 year-to-date volumes have totaled 79.7 million metric tons, slightly below 2019 year-to-date volumes of 81.9 million metric tons.

While quarterly global volumes declined year-over-year, U.S. export volumes increased during the third calendar quarter of 2020, totaling 11.5 million metric tons, an 11.0% increase over the 10.3 million metric tons during the same period in 2019. These gains were offset by lower Middle Eastern exports, which totaled 9.0 million metric tons in the quarter, a decrease of 11.5% from the same time period in 2019, which totaled 10.3 million metric tons. The lower export volumes are attributable to OPEC+ production cuts that were extended through year end in June 2020.

Through the third calendar quarter of 2020, continued LPG demand and subdued global production levels resulted in relatively strong prices relative to naphtha. Propane held a price advantage over naphtha in the Far East for most of the quarter before shrinking towards the end of September. Delayed winter stocking increased Asian LPG prices, particularly towards the end of the quarter. In

Europe, propane cracking held a price advantage over naphtha throughout the third calendar quarter, while butane cracking was attractive until the end of September.

For the third calendar quarter of 2020, the Baltic Index averaged $52 per metric ton, compared to an average of $41 per metric ton in the previous quarter. For the fourth calendar quarter to date, the Baltic Index has averaged $60 per metric ton. The VLGC orderbook stands at approximately 11% of the current global fleet. An additional 33 VLGCs, equivalent to approximately 2.8 million cbm of carrying capacity, are expected to be added to the global fleet by calendar year-end 2022. The average age of the global fleet is now approximately 9.6 years old.

A return to more favorable commodity price relationships, the ongoing increase in secular demand for LPG as a more environmentally friendly alternative to other forms of energy and forecasted high levels of U.S. exports as evidenced by export capacity and pipeline investments are expected to provide long-term support for VLGC demand.

The above summary is based on data derived from industry sources, and there can be no assurances that such trends will continue or that anticipated developments in freight rates, export volumes, the VLGC orderbook or other market indicators will materialize.

4.5.12.Seasonality

Liquefied gases are primarily used for industrial and domestic heating, as a chemical and refinery feedstock, as a transportation fuel and in agriculture. The LPG shipping market historically has been stronger in the spring and summer months in anticipation of increased consumption of propane and butane for heating during the winter months. In addition, unpredictable weather patterns in these months tend to disrupt vessel scheduling and the supply of certain commodities. Demand for our vessels therefore may be stronger in the quarters ending June 30 and September 30 and relatively weaker during the quarters ending December 31 and March 31, although 12-month time charter rates tend to smooth these short-term fluctuations and recent LPG shipping market activity has not yielded the expected seasonal results. To the extent any of our time charters expires during the typically weaker fiscal quarters ending December 31 and March 31, it may not be possible to re-charter our vessels at similar rates. As a result, we may have to accept lower rates or experience off-hire time for our vessels, which may adversely impact our business, financial condition and operating results.

4.5.13.Financial Information

The following table presents our selected financial data and other information for the periods presented:

Table 2: Main financial data

	Three months ended		Six months ended	
(in U.S. dollars, except fleet data)	September 30, 2020	September 30, 2019	September 30, 2020	September 30, 2019
Statement of Operations Data				
Revenues	$ 54,710,277	$ 91,624,875	$ 127,875,601	$ 152,790,421
Expenses				
Voyage expenses	858,919	855,023	1,674,114	1,194,137
Charter hire expenses	4,518,850	2,055,000	9,234,448	4,110,000
Vessel operating expenses	21,435,904	17,393,685	38,825,267	33,513,638
Depreciation and amortization	17,202,714	16,473,418	34,093,127	32,739,839
General and administrative expenses	5,912,810	5,895,406	17,215,786	12,631,241
Total expenses	49,929,197	42,672,532	101,042,742	84,188,855
Other income—related parties	632,680	314,084	1,100,703	937,367
Operating income	5,413,760	49,266,427	27,933,562	69,538,933
Other income/(expenses)				
Interest and finance costs	(6,665,144)	(9,303,373)	(15,752,380)	(19,000,655)
Interest income	91,349	344,919	216,184	706,955
Unrealized gain/(loss) on derivatives	3,968,686	(667,110)	3,472,880	(6,737,899)
Realized gain/(loss) on derivatives	(2,129,695)	709,146	(2,935,924)	1,742,141
Other gain/(loss), net	(141,006)	361,887	(228,367)	537,480
Total other income/(expenses), net	(4,875,810)	(8,554,531)	(15,227,607)	(22,751,978)
Net income	$ 537,950	$ 40,711,896	$ 12,705,955	$ 46,786,955
Earnings per common share—basic	0.01	0.75	0.25	0.86
Earnings per common share—diluted	$ 0.01	$ 0.74	$ 0.25	$ 0.85
Other Financial Data				
Adjusted EBITDA[1]	$ 22,295,472	$ 67,337,351	$ 63,409,539	$ 105,719,734
Fleet Data				
Calendar days[2]	2,024	2,024	4,026	4,026
Time chartered-in days[3]	184	92	376	153
Available days[4]	2,126	2,051	4,258	4,134
Operating days[5][8]	2,070	1,906	3,824	3,956
Fleet utilization[6][8]	97.4 %	92.9 %	89.8 %	95.7 %
Average Daily Results				
Time charter equivalent rate[7][8]	$ 26,015	$ 47,623	$ 33,002	$ 38,321
Daily vessel operating expenses[9]	$ 10,591	$ 8,594	$ 9,644	$ 8,324

(in U.S. dollars)	As of September 30, 2020	As of March 31, 2020
Balance Sheet Data		
Cash and cash equivalents	$ 145,059,032	$ 48,389,688
Restricted cash—current	434,753	3,370,178
Restricted cash—non-current	81,411	35,629,261
Total assets	1,674,099,810	1,671,959,843
Total debt including current portion—net of deferred financing fees of $11.8 million and $11.2 million as of September 30, 2020 and March 31, 2020, respectively.	634,498,695	634,975,219
Total liabilities	684,508,636	694,907,645
Total shareholders' equity	$ 989,591,174	$ 977,052,198

1.Adjusted EBITDA is an unaudited non-U.S. GAAP financial measure and represents net income/(loss) before interest and finance costs, unrealized (gain)/loss on derivatives, realized (gain)/loss on interest rate swaps, gain on early extinguishment of debt, stock-based compensation expense, impairment, and depreciation and amortization and is used as a supplemental financial measure by management to assess our financial and operating performance. It is believed that adjusted EBITDA assists Dorian's management and investors by increasing the comparability of its performance from period to period. This increased comparability is achieved by excluding the potentially disparate effects between periods of derivatives, interest and finance costs, gain on early extinguishment of debt, stock-based compensation expense, impairment, and depreciation and amortization expense, which items are affected by various and possibly changing financing methods, capital structure and historical cost basis and which items may significantly affect net income/(loss) between periods. It is believed that including adjusted EBITDA as a financial and operating measure benefits investors in selecting between investing in us and other investment alternatives.

Adjusted EBITDA has certain limitations in use and should not be considered an alternative to net income/(loss), operating income, cash flow from operating activities or any other measure of financial performance presented in accordance with U.S. GAAP. Adjusted EBITDA excludes some, but not all, items that affect net income/(loss). Adjusted EBITDA as presented below may not be computed consistently with similarly titled measures of other companies and, therefore, might not be comparable with other companies.

The following table sets forth a reconciliation of net income/(loss) to Adjusted EBITDA (unaudited) for the periods presented:

Table 3: Net income/(loss) to Adjusted EBITDA (unaudited)

	Three months ended		Six months ended	
(in U.S. dollars)	September 30, 2020	September 30, 2019	September 30, 2020	September 30, 2019
Net income	$ 537,950	$ 40,711,896	$ 12,705,955	$ 46,786,955
Interest and finance costs	6,665,144	9,303,373	15,752,380	19,000,655
Unrealized (gain)/loss on derivatives	(3,968,686)	667,110	(3,472,880)	6,737,899
Realized (gain)/loss on interest rate swaps	1,451,629	(709,146)	1,993,334	(1,742,141)
Stock-based compensation expense	406,721	890,700	2,337,623	2,196,527
Depreciation and amortization	17,202,714	16,473,418	34,093,127	32,739,839
Adjusted EBITDA	$ 22,295,472	$ 67,337,351	$ 63,409,539	$ 105,719,734

2. Dorian defines calendar days as the total number of days in a period during which each vessel in our fleet was owned or operated pursuant to a bareboat charter. Calendar days are an indicator of the size of the fleet over a period and affect both the amount of revenues and the amount of expenses that are recorded during that period.

3.Dorian defines time chartered-in days as the aggregate number of days in a period during which Dorian time chartered-in vessels from third parties.

4. Dorian defines available days as the sum of calendar days and time chartered-in days (collectively representing our commercially-managed vessels) less aggregate off hire days associated with scheduled maintenance, which include major repairs, drydockings, vessel upgrades or special or intermediate surveys. Dorian uses available days to measure the aggregate number of days in a period that its vessels should be capable of generating revenues.

5.Dorian defines operating days as available days less the aggregate number of days that the commercially-managed vessels in our fleet are off–hire for any reason other than scheduled maintenance (e.g., repositioning following drydocking, commercial waiting, etc.). Dorian uses operating days to measure the number of days in a period that its operating vessels are on hire (refer to 8 below)

6.Dorian calculates fleet utilization by dividing the number of operating days during a period by the number of available days during that period. An increase in non-scheduled off hire days would reduce our operating days, and, therefore, our fleet utilization. Dorian uses fleet utilization to measure its ability to efficiently find suitable employment for its vessels.

7.Time charter equivalent rate, or TCE rate, is a non-U.S. GAAP measure of the average daily revenue performance of a vessel. TCE rate is a shipping industry performance measure used primarily to compare period–to–period changes in a shipping company's performance despite changes in the mix of charter types (such as time charters, voyage charters) under which the vessels may be employed between the periods. Dorian’s method of calculating TCE rate is to divide revenue

net of voyage expenses by operating days for the relevant time period, which may not be calculated the same by other companies. Note that our calculation of TCE includes Dorian's portion of the net profit of the Helios Pool, which may also cause our calculation to differ from that of companies which do not account for pooling arrangements as Dorian does.

The following table sets forth a reconciliation of revenues to TCE rate (unaudited) for the periods presented:

Table 4: Revenues to TCE rate (unaudited)

	Three months ended		Six months ended	
(in U.S. dollars, except operating days)	September 30, 2020	September 30, 2019	September 30, 2020	September 30, 2019
Numerator:				
Revenues	$ 54,710,277	$ 91,624,875	$ 127,875,601	$ 152,790,421
Voyage expenses	(858,919)	(855,023)	(1,674,114)	(1,194,137)
Time charter equivalent	$ 53,851,358	$ 90,769,852	$ 126,201,487	$ 151,596,284
Pool adjustment*	(22,760)	—	1,585,112	—
Time charter equivalent excluding pool adjustment*	$ 53,828,598	$ 90,769,852	$ 127,786,599	$ 151,596,284
Denominator:				
Operating days	2,070	1,906	3,824	3,956
TCE rate:				
Time charter equivalent rate	$ 26,015	$ 47,623	$ 33,002	$ 38,321
TCE rate excluding pool adjustment*	$ 26,004	$ 47,623	$ 33,417	$ 38,321

* Adjusted for the effect of a reallocation of pool profits in accordance with the pool participation agreements due to adjustments related to speed and consumption performance of the vessels operating in the Helios Pool.

8. Dorian determines operating days for each vessel based on the underlying vessel employment, including our vessels in the Helios Pool, or the Company Methodology. If Dorian was to calculate operating days for each vessel within the Helios Pool as a variable rate time charter, or the Alternate Methodology, its operating days and fleet utilization would be increased with a corresponding reduction to our TCE rate. Operating data using both methodologies is as follows:

Table 5: Operating data with the use of both methodologies

	Three months ended		Six months ended	
	September 30, 2020	September 30, 2019	September 30, 2020	September 30, 2019
Company Methodology:				
Operating Days	2,070	1,906	3,824	3,956
Fleet Utilization	97.4 %	92.9 %	89.8 %	95.7 %
Time charter equivalent rate	$ 26,015	$ 47,623	$ 33,002	$ 38,321
Alternate Methodology:				
Operating Days	2,126	2,051	4,258	4,134
Fleet Utilization	100.0 %	100.0 %	100.0 %	100.0 %
Time charter equivalent rate	$ 25,330	$ 44,256	$ 29,639	$ 36,671

In addition to the results of operations presented in accordance with U.S. GAAP, Dorian provides adjusted net income and adjusted EPS. It is assumed that adjusted net income and adjusted EPS are useful to investors in understanding our underlying performance and business trends. Adjusted net income and adjusted EPS are not a measurement of financial performance or liquidity under U.S. GAAP; therefore, these non-U.S. GAAP financial measures should not be considered as an alternative or substitute for U.S. GAAP. The following table reconciles net income and EPS to adjusted net income and adjusted EPS, respectively, for the periods presented:

Table 6: Net income and EPS to adjusted net income and adjusted EPS

	Three months ended		Six months ended	
(in U.S. dollars, except share data)	September 30, 2020	September 30, 2019	September 30, 2020	September 30, 2019
Net income	$ 537,950	$ 40,711,896	$ 12,705,955	$ 46,786,955
Unrealized (gain)/loss on derivatives	(3,968,686)	667,110	(3,472,880)	6,737,899
Adjusted net income/(loss)	$ (3,430,736)	$ 41,379,006	$ 9,233,075	$ 53,524,854
Earnings per common share—diluted	$ 0.01	$ 0.74	$ 0.25	$ 0.85
Unrealized (gain)/loss on derivatives	(0.08)	0.01	(0.07)	0.12
Adjusted earnings/(loss) per common share—diluted	$ (0.07)	$ 0.75	$ 0.18	$ 0.97

TCE, adjusted net income, adjusted EPS and adjusted EBITDA are not recognized measures under U.S. GAAP and should not be regarded as substitutes for revenues, net income and earnings per share. Dorian's presentation of TCE, adjusted net income, adjusted EPS and adjusted EBITDA does not imply, and should not be construed as an inference, that its future results will be unaffected by unusual or non-recurring items and should not be considered in isolation or as a substitute for a measure of performance prepared in accordance with U.S. GAAP.

4.6.Corporate Gobernance

Corporate Governance involves the processes and procedures used to manage the business affairs of a company and includes the structure and balance of power between the management and board. This section provides bios of board and committee members, as well as charters and codes of conduct developed for the various committees.

The following Corporate Governance Guidelines ("Guidelines") have been adopted by the Board of Directors (the "Board") of Dorian LPG Ltd. (the "Company") to assist the Board in the exercise of its responsibilities and to promote the effective functioning of the Board and its committees. These Guidelines are not intended to change or interpret any applicable law or regulation. The Board will review and amend these Guidelines as it deems necessary and appropriate.

4.6.1.Board Composition

Size of Board.

The number of directors that constitutes the Board will be fixed from time to time by a resolution adopted by the Board in conformity with the Company's Articles of Incorporation (the "Articles") and Bylaws (the "Bylaws"). The Nominating and Corporate Governance Committee of the Board (the "Nominating Committee") periodically reviews the size of the Board to ensure that the current number of directors most effectively supports the Company.

Majority of Independent Directors.

The Board will have a majority of directors who meet the criteria for independence required by the NYSE Listed Company Manual upon the expiration of any transition period following the Company's initial public offering. Audit Committee members will satisfy additional independence requirements pursuant to Securities and Exchange Commission ("SEC") and the NYSE Listed Company Manual.

The Board shall consider the relationships that each director has with the Company (either directly or as a partner, stockholder or officer of an organization that has a relationship with the Company) and only those directors who the Board affirmatively determines have no material relationship with the Company (either directly or as a partner, stockholder or officer of an organization that has a relationship with the Company) will be considered independent directors, subject to additional qualifications prescribed under the NYSE Listed Company Manual or under applicable law.

In the event that a director becomes aware of any change in circumstances that may result in such director no longer being considered independent under the NYSE Listed Company Manual or under applicable law, the director shall promptly inform the Chairman of the Board. If such circumstances cannot be resolved, such director should submit to the Board written notification of such circumstances and an offer of resignation from the Board and each of the committees on which such director serves. The Board need not accept such offer of resignation; however, the submission of such offer of resignation provides the opportunity for the Board to review the appropriateness of the continuation of such individual's membership on the Board. In some cases, it may be appropriate for such director to be replaced as a member of one or more of the committees on which he or she serves but be retained as a director.

Board Membership Criteria

1.Qualifications.

The Board seeks members from diverse professional and personal backgrounds who combine a broad spectrum of experience and expertise with a reputation for integrity. This assessment will include an individual's independence, as well as consideration of diversity, age, skills and experience in the context of the needs of the Board.

3.Simultaneous Service.

No director should serve on more than six other public company boards. Directors should advise the Chairman of the Board and the chair of the Nominating Committee in advance of accepting an invitation to serve on another public company board.

4.Expectations.

Each director will be expected to:

- dedicate sufficient time, energy and attention to ensure the diligent performance of his or her duties;
- comply with the duties and responsibilities set forth herein and in the by-laws of the Company;
- comply with all duties of care, loyalty and confidentiality applicable to directors of publicly traded corporations organized in our jurisdiction of incorporation; and
- adhere to the Company's Code of Ethics, including, but not limited to, the policies on conflicts of interest expressed therein.

New Directors

The Nominating Committee has, as one of its responsibilities, the recommendation of director candidates to the full Board. Nominees for directorship will be selected by the Nominating Committee in accordance with the policies and principles in its charter. The Nominating Committee will consider candidates recommended by shareholders. In considering candidates submitted by shareholders, the Nominating Committee will take into consideration the needs of the Board and the qualifications of the candidate. The Nominating Committee may establish procedures, from time to time, regarding shareholder submission of candidates.

Retirement

1.Term Limits.

The Board does not favor term limits for directors, but believes that it is important to monitor overall Board performance. Therefore, the Nominating Committee shall review each director's continuation on the Board at the time of the director's re-nomination to the Board. This will also allow each director the opportunity to confirm his or her desire to continue as a member of the Board.

2.Directors Changing Their Present Job Responsibilities.

The Board expects directors to inform the Nominating Committee of a change in their business position including, without limitation, retirement from the position on which their original nomination was based, in order to provide an opportunity for the Board, through the Nominating Committee, to review the continued appropriateness of Board membership under the circumstances.

Directors' Duties.

The Board is elected by stockholders to provide oversight and strategic guidance to senior management. The basic responsibility of the directors is to exercise their business judgment to act in what they reasonably believe to be the best interests of the Company and its stockholders. In discharging that obligation, directors should be entitled to rely on the honesty and integrity of the Company's officers, employees, outside advisors and independent auditors. The Board selects and oversees the members of senior management, to whom the Board delegates the authority and responsibility for the conduct of the day-to-day operations of the business.

Directors are expected to attend Board meetings and meetings of committees on which they serve, and to spend the time needed and meet as frequently as necessary to properly discharge their responsibilities. Directors are expected to review meeting materials prior to Board and committee meetings and, when possible, should communicate in advance of meetings any questions or concerns that they wish to discuss so that management will be prepared to address the same. Each director's

attendance at, and preparation for, Board meetings and meetings of committees on which they serve, shall be considered by the Nominating Committee when recommending director nominees. Directors are expected to attend the Company's annual meeting of shareholders. A director who is unable to attend the Company's annual meeting of shareholders (which it is understood will occur on occasion) is expected to notify the Chairman of the Board.

4.6.2.Board activities

Board Meetings

1.Selection of Agenda Items and Executive Sessions.

The Chairman of the Board and Chief Executive Officer should establish the agenda for Board meetings. Each Board member is free to suggest the inclusion of items on the agenda. Each Board member is free to raise at any Board meeting subjects that are not on the agenda for that meeting. The independent directors will meet at least twice yearly in executive session without any non-independent directors or members of the Company's management present. There may, but does not need to be, a single presiding director at all executive sessions. If, however, one director is chosen to preside at all executive sessions, his or her name shall be disclosed in the annual proxy statement. If a presiding director is not chosen to preside at all executive sessions, then the responsibility will rotate quarterly among the chairs of the Audit, Compensation, and Nominating Committees. Presently, Mr. Thomas Coleman has been chosen to serve as the lead independent director at all executive sessions.

2.Distribution of Materials.

The Company shall distribute, to the extent practicable and sufficiently in advance of meetings to permit meaningful review, written materials for use at Board meetings.

3.Attendance of Non-Directors.

The Board believes that attendance of key executive officers augments the meeting process, and such attendance should be encouraged except where prohibited by regulatory requirements or when the Board meets in executive session.

4.Number of Meetings.

The Board should meet as frequently as needed for directors to discharge their responsibilities. Without limiting the foregoing, the Board should endeavor to hold a minimum of four regular meetings per year, and special meetings as required.

Communication with the Board.

A majority of our independent directors has approved procedures with respect to the receipt, review and processing of, and any response to, written communications sent by shareholders and other interested persons to our Board of Directors. Such communications may be addressed to: Dorian LPG Ltd., c/o Dorian LPG (USA) LLC, 27 Signal Road, Stamford, Connecticut 06902. Mail addressed to "Outside Directors" or "Non-Employee Directors" will be forwarded or delivered to the lead independent director, who is presently Mr. Thomas Coleman. Mail addressed to the "Board of Directors" will be forwarded or delivered to the Chairman of the Board.

The Secretary of our Company is authorized to open and review any mail or other correspondence received that is addressed to the Board, a committee or any individual director. If, upon opening any correspondence, the Secretary determines that it contains materials unrelated to the business or operations of the Company or to the Board's functions, including magazines, solicitations or advertisements, the contents may be discarded.

Any interested party, including any employee, may make confidential, anonymous submissions regarding questionable accounting or auditing matters or internal accounting controls and may communicate directly with the Chairman of the Board by letter to the above address, marked for the attention of the Chairman of the Board. Any written communication regarding accounting, internal accounting controls or other financial matters are processed in accordance with procedures adopted by the Audit Committee.

Conflicts of Interest

Directors shall avoid any action, position or interest that conflicts with an interest of the Company, or gives the appearance of a conflict. The Company annually solicits information from directors in order to monitor potential conflicts of interest and directors are expected to be mindful of their fiduciary obligations to the Company.

Director Compensation.

A director who is also an officer of the Company or of an affiliate of the Company will not receive additional compensation for such service as a director. The form and amount of non-employee director compensation will be determined by the Board upon the recommendation of the Compensation Committee in accordance with the policies and principles set forth in its charter. The Board is aware that questions as to directors' independence may be raised when directors' fees and emoluments exceed what is customary. Similar concerns may be raised when the Company makes substantial charitable contributions to organizations in which a director is affiliated, or enters into

consulting contracts with (or provides other indirect forms of compensation to) a director. The Board will critically evaluate each of these matters when determining the form and amount of director compensation and will ensure that such payments do not violate the applicable independence requirements of the NYSE Listed Company Manual.

O*rientation and Continuing Director Education*

The directors and the Company are committed to ensuring that all directors receive orientation and continuing education.

Assessing Board Performance

The Board will conduct an annual self-evaluation, overseen by the Nominating Committee, to determine whether it and its committees are functioning effectively. The Nominating Committee will be responsible for establishing the evaluation criteria and implementing the process for this evaluation, as well as considering other corporate governance principles that may, from time to time, merit consideration by the Board..

Access to Officers and Employees

Board members have complete and open access to the Company's Chief Executive Officer and Chief Financial Officer. Board members who wish to have access to other members of management may coordinate such access through one of the foregoing or may contact such members of management directly.

Interaction with Third Parties

The Board believes that management should speak for the Company and that the Chairman should speak for the Board. In order to ensure compliance with applicable securities laws and to avoid the potential detriment to the interests of the Company and its stockholders and other constituencies that could result from inconsistent communications, the members of the Board will refer inquiries from institutional investors, analysts, the press, customers or clients to the Chief Executive Officer or the Chief Financial Officer.

Board Authority

The Board and each committee have the power to hire independent legal, financial or other advisors as they may deem necessary, without consulting or obtaining the approval of any officer of the Company in advance.

Confidentiality

The Board believes maintaining confidentiality of information and deliberations is an imperative. Information learned during the course of service on the Board is to be held confidential and used solely in furtherance of the Company's business.

4.6.3.Board Committees.

The Board will have at all times an Audit Committee, a Compensation Committee and a Nominating and Corporate Governance Committee. Each of these Committees shall consist solely of independent directors. Committee members will be appointed by the Board upon recommendation of the Nominating Committee with consideration of the desires of individual directors.

The Board may, from time to time, establish or maintain additional committees as necessary or appropriate.

Rotation of Committee Assignments and Chairs.

The Nominating Committee shall annually review the committee assignments. While the Board does not favor mandatory rotation of committee assignments or chairs, in making its annual recommendations to the Board regarding committee composition, the Nominating Committee shall consider the rotation of the chairman and members of committees, factoring in directors' experiences, interests and qualifications, with a view toward balancing the benefits derived from continuity against the benefits derived from the diversity of experience and viewpoints of the various directors.

Committee Charters.

Each of the Audit, Compensation, and Nominating Committees shall have its own charter. The charters will set forth the purposes, goals and responsibilities of these committees as well as qualifications for committee membership, procedures for committee member appointment and removal, committee structure and operations and committee reporting to the Board. The charters will also provide that each committee will annually evaluate its own performance. Other committees may have a charter, as determined by the Board.

Frequency and Length of Committee Meetings.

The chair of each committee, in consultation with the committee members, will determine the frequency and length of the committee meetings consistent with any requirements set forth in the committee's charter.

4.6.5. Chief Executive Officer Evaluation and Management Succession

CEO Compensation.

The Compensation Committee will conduct an annual review of the Chief Executive Officer's compensation and, either as a Committee or together with the other independent directors, set the Chief Executive Officer's compensation level based on this review in accordance with the policies set forth in the charter of the Compensation Committee.

Succession.

The Board or the Nominating Committee shall work with the Chairman of the Board and the Chief Executive Officer to plan for Chief Executive Officer succession, as well as to develop plans for interim succession for the Chief Executive Officer in the event of an unexpected occurrence.

4.6.6. Amendment and Availability of the Guidelines

Amendment.

The Board may amend, waive, suspend or repeal any of these Guidelines at any time, with or without public notice, as it determines necessary and appropriate in the exercise of the Board's judgment or fiduciary duties.

Availability.

These Guidelines will be included on the Company's website and will be made available upon request to the Company's Secretary.

CHAPTER 5. CONCLUSIONS

This study was a review about maritime industry developments related to alternative fuels. LPG, ethane, and hydrogen fuels were focus points of the study. Alternative fuelled ship numbers, bunkering ports/areas, bunkering types, engine concepts, and rules and regulations about these alternative fuels were investigated.

According to the investigation, LPG, and methanol is more flexible than ethane. LPG can be supplied from terminals, bunker ships or by truck. On the other hand, methanol can only be supplied by trucks for now. By using alkaline electrolysis system on ship, hydrogen is produced onboard by the electrolysis of the purified water. For this reason, there is not any concern about hydrogen fuel bunkering.

LPG has 12 ships in operation which has the highest number after the LNG, but it seems that LNG takes LPG's place, and it can be assumed that LPG fuelled ship number will not increase too much in the future. The reasons are better emission values of LNG to LPG, and lower study numbers with LPG fuelled ships.

Methanol can be considered as new for marine industry. There are only 2 ships in operation, and 6 in order. However less number of ships, bunkering capability is high and it also has various selections of engine concepts. In addition to this, it does not lose its actuality in academic area. Baltic countries focus on methanol fuel use on diesel engines, and government supports studies about methanol fuel use on diesel engines. Methanol can be another future fuel like LNG, especially in Baltic Region, and improve its ship number.

Hydrogen is mostly used as fuels to fuel cells for electricity production. There are many fuel cell applications on ships. On the other hand, hydrogen use as an additive fuel on diesel engines has not been used much on ship engines. No need of bunkering and storage of hydrogen is positive side of alkaline electrolysis system, but research focus on LNG and methanol reduces interest to hydrogen combustion on diesel engines. For this reason, hydrogen can be second or third alternative fuel choice in maritime industry.

Ethane has the less change to be a good choice of alternative fuel for maritime industry. It has strong competitors like LNG and methanol. Due to its lack of bunkering capability, legislation problems, and less amount of engine concept selection, ethane reduces its change to become a future alternative fuel in maritime industry.

Moreover, the research made at a greek shipping company which activates on the domain of LPG ships, revealed that despite the financial crisis and the drawbacks caused by the recent case of Coronavirus-19, Dorian LPG (the company) remains profitable and even expands its activities.

More specifically, according to https://www.vmqstocks.com/vmqanalyzer.cfm?ticker=LPG Dorian LPG Ltd (LPG) falls within the deep value range of the value spectrum, while it has a weak Momentum Score of 38. It has a Quality Grade of A, which is considered very strong.

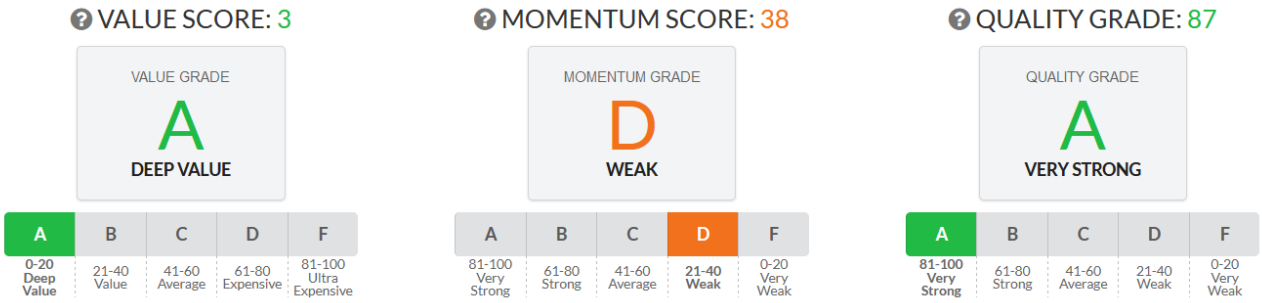

Figure 19: Overall assessment of financial thesis for Dorian LPG

The overall assessment of Dorian LPG Ltd. Is summarized in the concluding remarks of the following brief Porter Five (5) Forces Analysis

Threats of New Entrants

New entrants in Shipping brings innovation, new ways of doing things and put pressure on Dorian LPG Ltd. through lower pricing strategy, reducing costs, and providing new value propositions to the customers. Dorian LPG Ltd. has to manage all these challenges and build effective barriers to safeguard its competitive edge.

How Dorian LPG Ltd. can tackle the Threats of New Entrants?

- By innovating new products and services. New products not only brings new customers to the fold but also give old customer a reason to buy Dorian LPG Ltd. ‘s products.
- By building economies of scale so that it can lower the fixed cost per unit.
- Building capacities and spending money on research and development. New entrants are less likely to enter a dynamic industry where the established players such as Dorian LPG Ltd. keep defining the standards regularly. It significantly reduces the window of extraordinary profits for the new firms thus discourage new players in the industry.

Bargaining Power of Suppliers

All most all the companies in the Shipping industry buy their raw material from numerous suppliers. Suppliers in dominant position can decrease the margins Dorian LPG Ltd. can earn in the market.

Powerful suppliers in Services sector use their negotiating power to extract higher prices from the firms in Shipping field. The overall impact of higher supplier bargaining power is that it lowers the overall profitability of Shipping.

- How Dorian LPG Ltd. can tackle Bargaining Power of the Suppliers
- By building efficient supply chain with multiple suppliers.
- By experimenting with product designs using different materials so that if the prices go up of one raw material then company can shift to another.Developing dedicated suppliers whose business depends upon the firm. One of the lessons Dorian LPG Ltd. can learn from Wal-Mart and Nike is how these companies developed third party manufacturers whose business solely depends on them thus creating a scenario where these third party manufacturers have significantly less bargaining power compare to Wal-Mart and Nike.

Bargaining Power of Buyers

Buyers are often a demanding lot. They want to buy the best offerings available by paying the minimum price as possible. This put pressure on Dorian LPG Ltd. profitability in the long run. The smaller and more powerful the customer base is of Dorian LPG Ltd. the higher the bargaining power of the customers and higher their ability to seek increasing discounts and offers.

How Dorian LPG Ltd. can tackle the Bargaining Power of Buyers?

- By building a large base of customers. This will be helpful in two ways. It will reduce the bargaining power of the buyers plus it will provide an opportunity to the firm to streamline its sales and production process.
- By rapidly innovating new products. Customers often seek discounts and offerings on established products so if Dorian LPG Ltd. keep on coming up with new products then it can limit the bargaining power of buyers.
- New products will also reduce the defection of existing customers of Dorian LPG Ltd. to its competitors.

Threats of Substitute Products or Services

When a new product or service meets a similar customer needs in different ways, industry profitability suffers. For example services like Dropbox and Google Drive are substitute to storage hardware drives. The threat of a substitute product or service is high if it offers a value proposition that is uniquely different from present offerings of the industry.

How Dorian LPG Ltd. can tackle the Treat of Substitute Products / Services

- By being service oriented rather than just product oriented.
- By understanding the core need of the customer rather than what the customer is buying.
- By increasing the switching cost for the customers.

Rivalry among the Existing Competitors

If the rivalry among the existing players in an industry is intense then it will drive down prices and decrease the overall profitability of the industry. Dorian LPG Ltd. operates in a very competitive Shipping industry. This competition does take toll on the overall long term profitability of the organization.

How Dorian LPG Ltd. can tackle Intense Rivalry among the Existing Competitors in Shipping industry

- By building a sustainable differentiation
- By building scale so that it can compete better
- Collaborating with competitors to increase the market size rather than just competing for small market.

By analyzing all the five competitive forces Dorian LPG Ltd. strategists can gain a complete picture of what impacts the profitability of the organization in Shipping industry. They can identify game changing trends early on and can swiftly respond to exploit the emerging opportunity. By

understanding the Porter Five Forces in great detail Dorian LPG Ltd. 's managers can shape those forces in their favor.

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