CHALMERS

The Future of Tanker Shipping: Sustainable Business Model for a Changing Market

Adapting to evolving energy demands and regulatory challenges by 2050

Bachelor's thesis in International Logistics

LUDVIG BERGERGÅRD
OSKAR JONASON

DEPARTMENT OF TECHNOLOGY MANAGEMENT AND ECONOMICS

DIVISION OF INNOVATION AND R&D MANAGEMENT
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2025
www.chalmers.s

The Future of Tanker Shipping: Sustainable Business Model for a Changing Market

Adapting to Evolving Energy Demands and Regulatory Challenges by 2050

LUDVIG BERGERGÅRD
OSKAR JONASON

DEPARTMENT OF TECHNOLOGY MANAGEMENT AND ECONOMICS
Division of Innovation and R&D Management
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2025

The Future of Tanker Shipping: Sustainable Business Model for a Changing Market
Adapting to Evolving Energy Demands and Regulatory Challenges by 2050

LUDVIG BERGERGÅRD
OSKAR JONASON

Department of Technology Management and Economics
Chalmers University of Technology
SE-412 96 Gothenburg
Sweden
Telephone + 46 (0)31-772 1000

The cover of this thesis shows a tanker operating in Skaw, reflecting the focus on tanker shipping. The photo was taken by one of the authors.

Gothenburg, Sweden 2025

PREFACE

During our final semester of the bachelor's programme in International Logistics at Chalmers University of Technology in Gothenburg, Sweden, this thesis was successfully completed in May 2025. The purpose of this thesis was based on the simple fact that tanker shipping companies have traditionally transported and relied on oil as fuel, making this dual dependency a topic intriguing to explore. As we hold an interest in the sector, this topic provided valuable insights within the industry.

Given the programme's strong focus on maritime logistics, economics and law, and that this thesis examines business models, we found it fitting to conduct this work within the Department of Technology Management and Economics. We would especially like to extend our sincere thanks to our supervisor, Carl Sjöberger, who is based at this department, for his valuable guidance and support throughout the work of this thesis.

Moreover, given our reliance on interviews, we are deeply grateful to our respondents, not only for their participation, but also for their willingness to support us beyond the interviews. Without your valuable insights, this thesis would not have become the report it has today.

The work has been completed in cooperation between the two of us, where the workload was equally shared and maintained regular communication throughout the process.

Gothenburg, 20 May 2025

Ludvig Bergergård & Oskar Jonason

Gothenburg, Sweden 2025

The Future of Product Tanker Shipping
Adapting to Evolving Energy Demands and Regulatory Challenges by 2050

LUDVIG BERGERGÅRD
OSKAR JONASON

Department of Technology Management and Economics
Chalmers University of Technology

ABSTRACT

This thesis explores the various challenges in the product tanker shipping segment as a result of the ongoing energy transition, with a time horizon extending to 2050. The study was conducted at Chalmers University of Technology as part of the bachelor's programme in International Logistics. It is primarily based on a qualitative approach, using both primary and secondary sources - including interviews with industry stakeholders and analyses of future energy market scenarios. The main purpose has been to investigate how shipowners can adapt their business models to a future market shaped by the energy transition. Key findings reveal that the energy transition leads to a more diverse product mix, which increases the complexity of cargo handling. This, in turn, impacts both the operational flexibility and technical capabilities required from shipowners. Using Osterwalder and Pignuer's business model definition as the analytical framework, three components were identified as central and strongly interconnected: value proposition, key resources, and cost structure. The study is limited to the product tanker segment and excludes crude oil, chemical and liquified energy gas. The geographical scope is focused on the European area, with interview participants mostly operating in Scandinavia. While this thesis identifies several main changes linked to the energy transition, it should be seen as an initial step for further and more comprehensive research.

Key words: product tanker shipping, energy transition, alternative fuels, maritime transport, liquid energy products, regulatory compliance

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

Today, humanity faces the consequences of the industrial revolution and its negative environmental impact, which marked the start for large-scale combustion of fossil fuels (Wandana et al., 2020). According to the World Trade Organisation (2024) global trade has increased 5.8 percent annually between 1995 and 2023. This growth has driven higher demand for industrial production and transportation, including energy for factories, vehicles, airplanes, vessels, and heating, contributing to the challenges we face today.

Among the industries that relates the most to global trade is shipping, with approximately 80% of the volume trade being transported by sea (UNCTAD, 2024). This data justifies the importance of shipping and our reliance on it, particularly for energy supply, as 64% of the world's oil produced was carried by sea during 2021 (Jones, 2022). This makes oil the most commonly traded commodity, transported in millions of barrels per day from exploitation to end-user (IEA, 2022).

Although fossil energy powers many of our sectors, it has a harmful impact on the environment. In 2022, fossil fuels accounted for 81% of total global emissions, with oil alone representing nearly a third (IEA, 2024-a). Consequently, there is an international consensus that fossil energy should be phased out in the long term due to the ongoing climate change (Domenica, 2022). For the tanker shipping segment, this shift towards more sustainable energy sources presents two parallel challenges.

First, as for all shipowners, compliance with increasingly stricter environmental regulation set by authorities such as the IMO and EU (European Commission, 2025-a; IMO, n.d.-c). Secondly, the tanker segment faces a shift as its primary cargo, fossil energy, is being phased out. The future energy market requires shipowners to handle new types of liquid energy products, which may need technical adaptation and different cargo handling operations (Bureau Veritas, 2022).

Complying with the increasingly complex regulations may be a dilemma. Building a ship requires a significant amount of capital and long-term strategic planning due to a ship’s lifespan. This long-term commitment may complicate the industry's ability to keep up with the evolving market and regulatory changes. Shipowners face the challenge of balancing strategic economic decisions with increasingly stringent environmental requirements. Therefore, the question arises: can shipowners adapt to future demands while staying relevant in the energy market?

1.1. Aim of the study and research questions

The purpose of this thesis is to investigate how the ongoing energy transition will impact the product tanker shipping segment up until the year 2050 and accordingly, it aims to identify key challenges that could affect shipowners. By applying a business model framework, the thesis aims to understand how certain parts of a shipowner’s business model may need to adapt in a response to this transition.

The thesis aims to answer following questions:

- How will the energy transition affect the product tanker shipping market?
- How can a shipowner adapt its business model to the future energy shipping market?

1.2. Delimitations

This thesis focuses on the product tanker segment, and in this thesis defined as the transportation of refined liquid energy products such as diesel, kerosine and biofuels. Other types of tankers such as crude oil and chemical tankers are not included. However, there are energy gas products that are transported in liquid form, such as liquefied natural gas (LNG), liquefied biogas (LBG), and liquefied petroleum gas (LPG). In normal temperature these products are in gas form and are cooled down before being transported. These products are also excluded from the thesis.

Further, the study is geographically focused on the European market, with interviewed actors primarily based in Sweden and Scandinavia. This choice is mainly due to the availability of relevant contacts in this region and the accessibility of information. Lastly, the thesis focuses on the period up to and including the year 2050, as it aligns with key climate goals set by the IMO and EU.

While this thesis presents several findings related to the ongoing energy transition, it should primarily be viewed as an exploratory starting point for further and more in-depth research. The thesis does not aim to provide comprehensive solutions, but rather to identify and highlight areas of the product tanker shipping segment that could be explored further in future research.

2. THEORETICAL BACKGROUND

The foundational elements of the thesis are described in the following chapter. It begins with an overview of the tanker shipping industry including relevant business relations, key parties, cost dynamics, and commonly used contracts. This is followed by the energy transition's effect on the shipping industry, with a focus on environmental regulations. Lastly, one of the core aspects of this thesis, the concept of business models, is introduced and defined as a framework for the analysis.

2.1. Tanker shipping

This section dives into the market structure, business relations, costs, profitability and different chartering methods used in tanker shipping, highlighting its role in transporting oil and refined products.

2.1.1. Introduction to tanker shipping

Tanker shipping is a sector within shipping that can be divided into three sub-segments: transportation of oil, chemicals and gas (International Chamber of Shipping, n.d.). In 2024, these three together accounted for about 34.5% of the world fleet in terms of dead weight tonnes (DWT), with oil tankers representing a major share of 28.3% (UNCTAD, 2024). This does not only highlight its importance within tanker shipping, but the shipping industry as a whole.

Notably, in 2023, ten countries accounted for 73% of the world oil production, whereas three of these together contributed nearly 45% (Energy Information Administration, 2024). Additionally, roughly 60% of the world's oil production is transported by sea (ICS, 2021). This high concentration of production in specific regions and the substantial volume carried by sea, underscores the importance of oil transportation in maintaining a stable global supply, making tanker shipping a crucial player in international trade and energy security.

The tanker segment can further be divided into crude oil tankers and product tankers, each serving different purposes and characteristics (Stopford, 2008). Crude oil, which originates directly from the source cannot be used without being refined first and must therefore be transported to a refinery for processing (Nordin, 1998). Since this often involves large quantities, it's economically beneficial to transport by larger tankers. In terms of market composition, the oil tanker fleet (crude carriers and product tankers) consists of approximately 59% product tankers, but when measured in deadweight tonnage (DWT), they represent a smaller share of 29%, which is explained by their generally smaller size (Hafnia, 2023).

Once crude oil has been delivered, it is refined into petroleum products such as diesel, gasoline, or kerosene (Nordin, 1998). These products are then transported to end markets, primarily by product tankers which are smaller than crude tankers, typically ranging from 10,000 to 160,000 DWT, whereas crude oil tankers are significantly larger, ranging from 80,000 to 320,000 DWT (Shipfinex, 2024). The smaller size of product tankers allows them to access a greater number of ports and makes them more suitable for transporting smaller quantities of refined products compared to crude oil. Typically, tankers have an economic lifespan of around 20 to 25 years, after which they are either sold or scrapped due to factors such as stricter regulations, inefficiency, or high maintenance costs (Fritelli, 2024).

2.1.2. Cargo types

With the growing demand and supply of biofuels, technical aspects are increasing, such as the use of epoxy-coated tanks. Transporting biofuels and normal oil products needs cleaning between shipments, and epoxy coatings facilitate easier cleaning while also protecting the cargo in prevention of contamination that may occur when transporting various products (Cioarec, 2020).

In this context, the terms *clean* and *dirty* are often used in shipping to describe different types of cargo (Fritelli, 2024). While *dirty* typically refers to crude oil, *clean* is used for refined petroleum products and within the product tanker segment, the terms Clean Petroleum Products (CPP) and Dirty Petroleum Products (DPP) are used to distinguish between two main cargo categories (ICS, 2021). CPP includes lighter and more refined petroleum products such as gasoline, kerosene and gasoil, whereas DPP refers to heavier types such as fuel oils or residual oils (ICS, 2021).

Table 1. *Commonly traded products in the product tanker segment*

Cargo type (million tonnes)	2015	2019	2020
Naphta	96	87	86
Gasoline	165	196	159
Diesel	273	315	245
Kerosene	96	106	56

Note. Compiled by data retrieved from ICS (2021)

Table 1 presents commonly transported products within the product tanker segment, all of which are categorized as CPP (ICS, 2021). Since most cargo types carried by product tankers are intended for use at the end market, the cleanliness is important to avoid contamination. To prevent this, the cargo tanks are often coated with epoxy or other similar materials. These coatings do not only protect the cargo from reactive contact with materials such as steel but also makes the cleaning process easier and more efficient (ICS, 2021).

2.1.3. Business relations and parties

The key commercial relationships and parties in product tanker shipping, in terms of the core activity (i.e. transporting cargo at sea) is typically between a shipowner and a charterer, often with a shipbroker acting as an intermediary (ICS, 2021). The primary role of a shipbroker is to match cargoes with suitable vessels based on criteria such as cargo type, volume, and geographical position, while also negotiating terms on behalf of their principal, whether that be the owner or the charterer.

Within the industry, the term *owner,* as used in charterparties refers to the contractual party providing the vessel, which is not necessarily the legal owner of the ship (ICS, 2021). For example, a party operating a vessel under a bareboat charter, possess full operational control with not legal ownership, but is still referred to as *owner* in the context of a charterparty. The *charterer* is the party that contracts the vessel and pays the owner in exchange for transportation services, usually an energy company or an energy product trader (ICS, 2021).

2.1.4. Cost structure and profitability

According to Stopford (2009), there is no official standard for cost classification, but three key factors are mentioned that influence the cost of running a shipping company. The first factor is a combination of voyage and operating costs, such as fuel consumption, number of crew and the ship's physical condition. The second factor involves day-to-day expenses, including stores, bunkers, repairs, consumables, interest rates, and more. The third factor relates to how the owner operate and manages the company including administration and operational efficiency. These costs can then be divided into three categories: *capital costs, operating costs* and *voyage costs*, each of which can be classified as either fixed or variable. Table 2 presents these categories with examples and indications on whether they are fixed or variable.

Table 2. *Common classification of cost categories in shipping*

Cost Category	Examples	Fixed or Variable
Capital costs	Interests on loans for vessel financing.	Fixed
Operating costs	The day to day running of the vessel: crew, administration, insurance, maintenance, repair etc.	Fixed
Voyage costs	Costs associated with the voyage: bunker fuel, port charges, canal tolls, cargo handling etc.	Variable

Fixed costs are predictable expenses that remain constant regardless of the specific ship's operational status (Stopford, 2009). For instance, owning a ship financed through a loan will have interest expenses and depreciation, whether the vessel is in operation or at anchorage. In this context, it can be mentioned that Europe appears to be the largest region for ship financing, with 50% of the top 40 banks, with total lending amounting to approximately 141 billion USD (Glass, 2024).

The same applies to operating costs, meaning that salaries still need to be paid out to the crew and administration, the ship still needs to be insured, and periodic maintenance is generally included in the calculations, as well as repairs (Stopford, 2009). However, operating costs may vary depending on the condition of the ship, as an older ship in worse condition will require more maintenance.

In contrast to capital and operating costs, voyage-related costs are variable, meaning they will vary depending on the vessel operations (Stopford, 2009). If there are no voyages, these costs will be minimal, but if the vessel is in movement, it will rise. For instance, with higher speed comes higher fuel consumption, entering ports and canals leads to charges and tolls. Therefore, depending on how the operation is being done, the company can also control its voyage costs.

2.1.4.1. Profitability

Time Charter Equivalent (TCE) is a highly common metric in the shipping industry for measuring profitability of a vessel based on voyages or charters (Handybulk, n.d.). It is calculated by taking the earnings (i.e. hire or freight rates), subtracting the voyage costs (variable) and then divide by the number of days in the specific voyage or charter. The outcome, *TCE*, will reflect the profitability of the voyage and serve as a standard benchmark, making it easier for comparison across different charter types within the industry (AccountingInsights, 2025). When the *TCE* exceeds both capital and operating costs (which are fixed), it indicates a net profit. Conversely, if it falls below the fixed costs, it results in a loss, whereas matching the fixed costs corresponds to reaching a break-even point.

Generally, the tanker shipping segment is very volatile and cyclical, with freight rates normally fluctuating due to factors such as supply & demand, geopolitical events, economic conditions, seasonal patterns, and more (Regli, 2019). These variations directly impact *TCE*, as lower freight rates lead to less earnings and vice versa. Putting this in context, in weak cycles, tanker vessels would compete for less cargoes, resulting in lower freight rates and a *TCE* that pushes down to the variable cost.

The region in which shipping companies operate also need to be considered when discussing profitability and *TCE*. For instance, operating within the EU involves specific environmental regulations that may not be implied in other regions (European Commission, n.d). Although IMO sets a global standard throughout most regions, other organizations, such as the EU, impose additional ones.

2.1.5. Forms of chartering and shipowner’s earnings

The most used types of contracts between parties in tanker shipping are Voyage Charter (V/C), Time Charter (T/C), Bareboat Charter and Contract of Affreightment (COA) which are presented below, as described by Stopford (2009). These three share a common element known as Charter Party (C/P), which is the fundamental legal contract binding the shipowner and charterer (ICS, 2024). It consists of their agreed-upon responsibilities, how any disputes will be resolved, and other chosen and essential terms.

2.1.5.1. Voyage Charter (V/C)

In a voyage charter, a ship is hired to transport a specific cargo between two destinations for a fixed price, either as a lump-sum or per metric tonnes (MT) (Stopford, 2009). The shipowner covers for all related costs in exchange for an agreed hire rate or lump-sum. Depending on the agreed terms, the responsibility for arising costs, for example in ports, may vary. Since the owner is responsible for the costs, they are naturally also the operator and control the ship, which creates incentives to operate more efficiently to save costs. The terms typically include the allowed time in port for loading and discharging, known as laytime. If this time is exceeded, the charterer will be penalized and owe the owner financially, so called demurrage. Conversely, if loading or discharging is completed faster than the stipulated time, the charterer may have the right to receive compensation, called dispatch.

2.1.5.2. Time Charter (T/C)

In a time charter, a ship is leased for a specified period of time, in exchange the charterer pays an agreed hire, typically daily or monthly. The costs associated with the voyage, such as bunkers, port costs etc (Stopford, 2009). is not included in the hire and thereby covered by the charterer. The owner, on the other hand, provides a fully equipped vessel with capital and operating costs covered. While the shipowner maintains control of the ship's operation, the charterer instructs the owner regarding routes and operations of the vessel. This arrangement offers the owner a predictable income and provides a regular cash flow.

2.1.5.3. Bareboat Charter

In a bareboat charter, the ship is leased for a longer period, ranging from years to decades, with the charterer paying an agreed hire, often on a monthly basis (Stopford, 2009). Unlike other charter types, the ship is delivered without crew, and the owner only covers the capital costs. Consequently, the charterer is responsible for all operating and voyage costs, including crew recruitment, bunkers, maintenance, insurance and more. This type of charter is ideal for those seeking full control over a ship without the financial commitment of purchasing it outright.

2.1.5.4. Contract of Affreightment (COA)

Contract of Affreightment (COA) is similar to a voyage charter in that the shipowner covers all related costs and is responsible for vessel operation. However, under a COA, the shipowner commits to transporting a predetermined quantity of goods within a specified period of time (Stopford, 2009). This arrangement allows the shipowner to use any vessel in their fleet, typically the one closest to the loading port, enhancing efficiency. COAs are commonly used for regular, large-scale shipment where flexibility and cost-effectiveness are prioritized.

2.2. The energy transition

The global energy transition refers to the shift from fossil-based energy sources to sustainable alternatives, where the overall aim in the transition is to reduce the emissions of greenhouse gases (GHG) and prevent a significant change in the climate (Domenica, 2022). This objective is widely supported internationally and is reflected in agreements such as the Paris Agreement, which aims to keep global warming below 2°C, preferably under 1,5°C (UNFCCC, 2015). For this target to be achieved, GHG must be reduced. Consequently, there are several milestones in terms of reducing emissions. The UN estimates that the fossil fuels use must peak before 2025, decrease by 43% by 2030, and reach net-zero emissions by 2050 (UNFCCC, 2015).

The shipping industry is no exception from the energy transition since there are several regulations with the aim of reducing the climate impact caused by the industry. Both The International Maritime Organization (IMO) and the European Union (EU) regulate the industry towards the future, with more strict regulations. The following chapter aims to explain the key regulations affecting a shipowner by both the IMO and EU related to the prevention of climate change.

2.2.1. IMO regulations

The International Maritime Organization (IMO) regulates the environmental impact of shipping through several measures that align with the long-term objectives in the Paris Agreement (IMO, n.d.-c). In contrast to regulations by the EU, IMO regulations apply on a global level. The long-term goal is to transform the shipping industry to achieve net-zero greenhouse gas emissions by 2050 (IMO, n.d.-c). As a result, three key measures have been introduced: the *Energy Efficiency Design Index* (EEDI), *Energy Efficiency Existing Ship Index* (EEXI), and *Carbon Intensity Indicator* (CII), with the aim of increasing energy efficiency (Vasilev et al., 2025).

The Energy Efficiency Design Index (EEDI) entered into force in 2013 and was incorporated into the existing IMO convention MARPOL (IMO, n.d.-a). The regulation applies to new ships with a capacity of 400 GT or above. The requirement is that a ship covered by the regulation must meet a minimum energy efficiency standard, measured in grams of CO_2 emitted per capacity-mile (e.g., cargo capacity per nautical mile). These requirements differ depending on size and the segment in which the vessel operates (e.g., bulk, tank, or container). To assess this, the EEDI tool compares a ship's emissions with a specific reference level (which depends on the segment) and the EEDI index gradually becomes stricter based on the reference level. The regulation is tightened every five years, with Phase 1 starting in 2015, which required a 10% reduction compared to the reference level (IMO, n.d.-a). The regulations do not specify how a shipowner should achieve the reduction, and it is therefore up to the shipowner to determine the approach.

The Energy Efficiency Existing Ship Index (EEXI) targets ships with a capacity of 400 GT or above that already existed when the regulation came into force, in contrast to EEDI that only applies to newly built ships (IMO, n.d.-b). EEXI came into effect in 2022 and was also incorporated into the existing IMO convention MARPOL, and the regulation is based on the same principles as EEDI, where there is a reference level that ships are evaluated against and must fall below to be approved (IMO, n.d.-b). Since the regulation applies only to existing ships, there is not the same need for the regulation to be systematically adjusted as with EEDI. In the future, EEXI will no longer be relevant, however the EEXI measurements will be reviewed before 2026, starting with an update (IMO, n.d.-b).

The Carbon Intensity Indicator (CII) was introduced alongside EEXI in 2022, with the purpose of measuring the operational efficiency, by categories ships in different categories based on operational performance every year (IMO, n.d.-b). The CII regulation applies to all ships of 5 000 GT or above, and the ships are categorized from A–E, based on the reported emissions and transport work. Where A is the best, and if a ship with a D rating for three years in a row or an E rating one year, requires an action plan of improvements (IMO, n.d.-b).

The main difference between CII and the others, EEDI and EEXI, is that CII focuses on the actual operational performance, measured year by year. While EEDI and EEXI set requirements of the design efficiency (i.e. theoretical performance).

2.2.2. EU regulations

The European Union's initiative *Fit for 55* is a plan to reduce greenhouse gas emissions by 55% by 2030 compared to 2020 levels (Malmborg, 2024). The maritime sector is affected through the implementation of *FuelEU Maritime* and the inclusion of shipping in the *European Union Emissions Trading System* (EU ETS).

FuelEU Maritime (Regulation (EU) 2023/1805) will be applied in the year 2025 (European Commission, n.d.-a). This regulation aims to gradually reduce greenhouse gas emissions from ships over 5,000 gross tonnages (GT) by accelerating the use of low-carbon fuels. It applies to all vessels calling at European ports, regardless of their flag state.

The geographical scope of this regulation is extended with 300 nautical miles outside European waters, and the purpose for this, is to prevent vessels from using nearby non-EU ports to avoid the regulation (DNV, 2024-a). For example, if a voyage takes place within and between two EU ports, the emission calculation is based on 100% of the energy used. However, if one of the ports is located outside EU and the geographical scope, the calculation is based on only 50% of the energy used (DNV, 2024-a).

The regulation further sets a cap on the average greenhouse gas intensity of the energy that ships produce, with a threshold that gradually becoming stricter over time (European Commission, n.d.-a). At the time of implementation in 2025, the reduction requirement is set at 2%, gradually increasing to an 80% reduction by 2050. The calculated emissions extend beyond the direct emissions from ships and also include the entire supply chain, from fuel extraction, processing and transportation until the energy is combusted in the ship's engine (also called a well-to-wake measure) (European Commission, n.d.-a).

As another part of *fit for 55*, the maritime sector is included in the European Union Emissions Trading System (EU ETS) from the year 2024 (European Commission, n.d.-b). This means that for every ton of carbon dioxide emissions, a corresponding emission allowance must be matched (Flodén et al., 2023). The regulation applies to all ships over 5,000 GT visiting European ports. If a voyage takes place between two European ports, the emissions are 100% covered by the regulation, while a voyage is 50% covered if only one of the ports is within Europe. To expand the geographical coverage of the system, it has been decided that ports within 300 nautical miles of the nearest EU port will also be fully included (100%), regardless of whether they belong to a non-EU country or not (Council of the European Union, 2023).

The implementation of the *EU ETS* for shipping is happening gradually (Flodén et al., 2023). In 2025**,** 70% of carbon dioxide emissions needs to be reported, increasing to 100% in 2026**.** From 2026**,** methane (CH4) and nitrous oxide (N2O) emissions will also be included in the system. Additionally, from 2027**,** a larger share of the fleet will be covered, as ships of 400 GT and above will be included in the regulation (Flodén et al., 2023).

2.3. Business models

The purpose of this section is to set a theoretical foundation for the concept of business models by defining their meaning and identifying their key components. The goal is to try to understand how a business model, in a general sense, can be described. Further, it defines a business model, later being used as a theoretical framework for the analysis chapter.

2.3.1. The concept of business models

There is no universal definition of the term "business model" in the literature according to several authors (Casadesus-Masanell & Ricart, 2010; Teece, 2010; Osterwalder & Pigneur, 2010). Teece (2010) and Casadesus-Masanell & Ricart (2010) states that all businesses within market economies consist of a business model, regardless if the models are intentionally defined or not. Zott et al. (2011) concludes through a literature review on the concept of business models in different scholars that “business model” is used to describe different types of business phenomena, and its meaning and interpretation can vary depending on subject area. This is also supported by DaSilva & Trkmark (2014), who argue that the concept has been partially used incorrectly over the years by both the industry and academia, as it is often mixed with other concepts. Therefore, it is necessary to define the meaning of the concept within the framework of how it should be used within this thesis.

2.3.2. Definitions

Teece (2010) argues that the concept of business models has gained importance due to the development and nature of modern business practices compared to the industrial time. In the past, creating value for a company was more straightforward, but today the business environment and value creation is more complex. Teece (2010) also mentions the rise of the internet as a factor influencing the concept of business models, as it provides access to large amounts of data and enables easy comparison of competitors, as well as an era of new business models based on the internet. Therefore, the concept has not been mentioned to a greater extent before around the year 2000.

Teece (2010) defines the concept of business models as “a business model describes the design or architecture of the value creation, delivery and capture mechanisms employed” (p. 191), and “a business model reflects management's hypothesis about what customers want, how they want it and what they will pay, and how an enterprise can organize to best meet customer needs” (p. 191).

Casadesus-Masanell & Ricart (2010) describes the business model as a set of components that is working together on delivering value. The business model concept is exemplified with the help of a car. The authors argue that different cars create different values for its stakeholders (i.e. driver of the car), since some might prefer a big and powerful car and others might gain more value though a smaller, less powerful car suitable in others contexts. The car itself and its mechanical parts can be seen as a representation of a business model. In this case, the business model is the set of components and the car represents the complete business model. Furthermore, Casadesus-Masanell & Ricart (2010) illustrates their idea of business models and their components by introducing two main sets of components. First, specific decisions by management on how the company should function, and secondly, the outcome and consequence based on that decision. For instance, setting a particular pricing strategy (a decision) may affect sales volume (consequence).

Zott et al. (2011) summarizes the literature on the concept of business models within different fields (E-commerce, Strategy and Technology and Innovation Management) and concludes that there is no commonly accepted definition within any of the studied field. Further, Zott et al. (2011) argues that the concept is used for different purposes within the field. For each field, the authors explain the reason behind the introduction of the business model concept. (1) E-commerce, “to describe new gestalts and Internet-based ways of ‘doing business’” (p. 1035). (2) Strategy, “To explain new network- and activity-based value creation mechanisms and sources of competitive advantage” (p. 1035). (3) Technology and Innovation Management, “To understand how technology is converted into market outcomes” (p. 1035).

Osterwalder & Pigneur (2010) defines the concept as “A business model describes the rationale of how an organization creates, delivers and captures value” (p. 14). Further, the authors also argue that a business model consists of components, and strives to further define the concept in a more practical sense, by dividing a model into nine different components as seen in table 3.

Table 3. Nine business model components by Osterwalder & Pigneur (2010)

Component	Definition
Customer segments	Defines the different groups of customers or organizations that a company delivers its services or products to. Customers can be divided into separate groups depending on things such as different relationships or different market segments.
Value proposition	The value proposition refers to the value created by the company's product or service for its customers in the different segments. It can further explain why the customer is choosing the services or product offered by one company over another.
Channels	The channels refer to both communication ways and the physical distribution between a company and its customers. Within the channels, the value proposition is delivered to the customers.
Customer relationship	Describes the type of relationship the company establishes with customers. The nature of the relationship can be different, depending on strategies and what type of relationship is required.
Revenue streams	Describes the revenue streams from the customers to the company, which can be identified as the value captured in return for delivering its products or services.
Key resources	The key resources refers to the most essential assets a company needs to operate in a successful way, which is for instance to create the value proposition, maintain the channels and care for the business relationships. The resources can be of different nature, such as purely physical or intellectual property.
Key activities	The key activities refers to the most essential activities a company needs to do in order to successfully complete things such as deliver the value proposition and reach customers.
Key partnership	The key partnership describes the network around the company. This can include for instance suppliers and alliances, which help the company operate successfully.
Cost structure	The cost structure refers to the most significant costs associated with operating a business model, and can consist of different types of costs, such as fixed or variable.

2.3.3. Distinguishing business model from other concepts

To further specify the concept of a business model, it could be valuable to distinguish it from related concepts. Casadesus-Masanell & Ricart (2010) argue that both strategy and tactics can be distinguished from the business model. They state that strategy refers to the plan a company uses to achieve its goals and align with targets, which includes choosing the right business model. However, Casadesus-Masanell & Ricart (2010) also describe that, in some cases, strategy is difficult to separate from the business model since the two concepts are closely related. DaSilva & Trkman (2014) also highlights that the strategy refers more to what the company strives to become, and the business model is more of a description of the company at a specific point of time. Teece (2010) also describes that a strategy can be kept apart from the business model, but the author describes the relation between strategy and business model somewhat differently. According to Teece (2010), the business model is a more generic concept, while strategy consists of more specific elements and isolated decisions designed to make the company's value proposition unique in relation to its competitors.

Casadesus-Masanell & Ricart (2010) also describe a company's tactics and how the meaning of tactics sets apart from the business model, where tactical tools can be seen as the operational decisions made by the company at a lower, less strategic level, which occur within the framework of the chosen business model. For instance, while price strategies are often seen as tactical decisions, this is generally not the case in the shipping industry due to its competitive nature. Therefore, the shipping companies rarely have full control over pricing. As a response, the rates are mostly determined by market dynamics, forcing individual companies to focus on what they can change, primarily managing their internal costs and competitiveness.

3. METHODOLOGY

This chapter outlines the methodological approach of the thesis, including how primary and secondary data were collected and analyzed to answer the research questions. Further, it describes how the interviews were conducted and how relevant secondary sources were selected. Finally, ethical considerations related to data handling and interviewee anonymity are presented.

3.1. Choice of method approach and disposition of the thesis

The aim of this thesis was to understand how the energy transition affects the product tanker shipping segment and to propose a theoretical model for how shipowners can adapt their business models to changing market conditions. To achieve this, a mixed method approach was chosen, mainly consisting of qualitative data but also with elements of quantitative data.

A mixed method approach in research involves using both qualitative and quantitative data to address the research problem, allowing for a more comprehensive analysis that uses several perspectives rather than relying on a single method (Denscombe, 2017). The author argues that this approach is problem-driven, focusing on being more pragmatic rather than being purely theoretical. Since the energy transition is expected to impact the product tanker segment in multiple ways, different methods were chosen based on the specific aspect being explored. This allows for a more flexible approach and was identified as suitable for this thesis.

The theoretical background of this thesis aims to provide a comprehensive understanding of the global energy transition, why it is happening and why it is affecting the shipping industry. It examines the regulatory authorities within the European region and what those regulations mean in practice for a shipowner.

Since there is no universal definition on the concept of business models, it is necessary to clarify on how the concept is defined and applied within this thesis. The set of nine components defined by Osterwalder & Pigneur (2010) will be used since it offers a practical structure that will be used as a framework within the analysis on how the energy transition may affect a business model within the segment of product tanker shipping.

To answer the research questions, empirical data in the form of interviews was conducted to gain in-depth information from the industry, consisting of cargo owners, an industry expert and a shipowner. Moreover, to understand how the market of liquid energy will develop, a review of several energy outlooks was conducted. Followed by the analysis chapter, where the empirical data was analysed by using Osterwalder & Pigneur's nine components as a basis. The key findings were then identified and discussed in relation to the theory and research questions.

3.2. Data collection

In the thesis, both primary and secondary data were used in the empirical chapter. The primary data consists of interviews with industry stakeholders, while the secondary data was gathered by market reports on the future energy.

3.2.1. Primary data – interviews

Primary data refers to data collected first-hand by the researcher, rather than obtained from existing sources (Adams et al., 2014). While this can be time-consuming, it is often necessary when existing sources are insufficient. Given that this thesis examines how shipowners may need to adept their business models because of the energy transition, insights directly from the stakeholder were identified as essential.

To broaden the view, stakeholder from different areas of the industry were included. After considerations, three categories were identified: representatives from the production side, shipowners themselves, and someone with a broader market overview. These three provided a foundation for our gathered data. Although not all contacts responded or had the time to participate, Table 4 presents the actors contacted and the outcomes.

Table 4. *Summary of parties contacted for interviews*

No.	Stakeholder	Response (Yes / No / No response)
1	Industry expert	Yes
2	Energy company 1	Yes
3	Energy company 2	Yes
4	Shipowner 1	Yes
5	Shipowner 2	No response
6	Shipowner 3	No response
7	Shipowner 4	No
8	Shipowner 5	No response
9	Shipowner 6	No response
10	Shipowner 7	No response

The interviews were conducted using a semi-structured approach, meaning that open-ended questions were asked in a conversational setting to allow for flexibility and follow-up questions (Adams, 2015). This approach enabled us to get the full truth from the respondents while minimizing the risk of influencing their answers. Each interview lasted for about one hour, which enabled for relevant follow-up questions. For convenience and accessibility, all interviews were conducted via Microsoft Teams, which most likely increased the likelihood of participation. With the respondents' permission, the interviews were recorded to help analyze the data afterwards. Lastly, to ensure that they were informed and well-prepared, the interview questions were shared with the participants in advance.

3.2.2. Secondary data – Energy market outlooks

Data that has already been collected by others such as books, journals and reports, are defined as secondary data and can be used either as a primary source or to complement specific research (Adams el al., 2014). Within this thesis, secondary data has been used as a main source for building a broad understanding of the future energy market, supported by data from several reports. However, in the analysis, it works more as a supplement to our primary data, i.e. interviews. By doing this, we have achieved a solid and comprehensive background that effectively supports the primary data.

3.2.3. Data selection

The selection of interview participants for this study can be described as convenience sampling (Madsen, 2012). The selection criteria were primarily based on the expertise of the participants and the sector within the industry they represented. Besides that, participants were chosen by convenience. Due to the limited time and resources, a convenience sampling approach was necessary to efficiently reach relevant contacts and obtain access to interviewees. This method allowed for a practical selection process, ensuring that the study could gather valuable information with regards to the given timeframe**.**

For the theoretical background, literature searches were conducted in academic databases**,** as well as sources from industry organizations online. The secondary sources for the empirical data were selected based on criteria. First, the reports had to present scenario-based projections of the future energy market. Secondly, the sources had to be published by reputable institutions with expertise in the area. Finally, the reports had to include both quantitative and qualitative data to enable comparisons and provide an overall understanding of the topic.

3.2.4. Analyzing the data

The primary data were gathered through standardized interviews to be able to analyze the data as efficiently as possible. The interview questionnaires were therefore tailored to the category of each participant (i.e. energy company, shipowner, or industry expert). This approach made it easier for comparison between the stakeholder groups. However, some questions were the same across all interviews, which helped provide a broader view on the key issues. Since the interviews were recorded (except for one) and notes were taken, this ensured that no data were lost.

The secondary data was primarily analyzed with a thematic approach. Trends, scenarios and more specifically, the projected development of different energy sources and liquids were identified as relevant parts throughout the different sources. Where applicable, the secondary data were compared with the primary data to identify similarities or contradictions. In addition, selected quantitative figures were included to provide context and improve the clarity of the findings.

3.3. Ethical considerations

Since this study involves interviews with companies, ethical considerations were taken to ensure transparency throughout the process. Before each interview, respondents were informed about the purpose of the thesis, as well as anonymity among the participants.

In order to ensure anonymity, their names nor their company affiliations were disclosed in the thesis. However, information about the interviewees' experience and a description of each participants role were included as this information provides important context and helps the reader understand potential bias. Each recorded interview was stored on a local hard drive and deleted after the transcription had been completed.

4. EMPIRICAL DATA

This chapter aims to lay the foundation for the analysis by presenting the data collected through interviews (primary data) and research (secondary data). Since the primary data is our strongest source, derived directly from industry stakeholders, it is presented first. This is followed by the secondary data, which provides an overview and detailed market data derived from various research reports.

4.1. Interviews – insights from industry stakeholders

Four industry stakeholders were interviewed, forming the primary data for this thesis. Their responses have been categorized and are presented in thematic sections. Each section begins with a shortened version of the relevant interview questions, followed by the participants responses. The complete and original set of interview questions can be found in the Appendix 1-3. Since the questionnaires were slightly adapted depending on each respondent's background, not all participants were asked the same questions.

Table 5 summarizes the interview participants, including their experience and a description of their role. To ensure anonymity, titles have been described rather than stated exactly.

Table 5. *Summary of the interview participants*

Interview	Respondent	Role/s	Experience (years)
1	Industry Expert	Managing director	28
2	Shipowner	Commercial manager & Vessel operator	25 & 6
3	Energy Company 1	Senior management within trade and supply	23
4	Energy Company 2	Senior management within trade and supply	24

4.1.1. Future demand and trade patterns

How do you expect the global demand for refined oil products to change by 2050?

Both *energy companies* expect that the global demand for refined oil products will experience a long-term overall decline towards 2050. They emphasize that the decline is already growing at a faster pace in Scandinavia and Europe, where the demand has peaked earlier due to stricter regulations and a more rapid energy transition, compared to a global level. *Energy company 2* further mentioned that the global peak in demand for fossil energy is likely to happen between 2030 and 2040, depending on which geographical region.

In Europe and especially Scandinavia, electrification of passenger vehicles is progressing rapidly and thereby decreases demand for products. However, both *energy companies* highlight that heavy traffic such as trucks, airplanes and shipping will require fossil fuels further into the future.

How do you think the transport flows of oil products will change in the future, and do you expect shifts in geographical trade patterns?

Both *energy companies* anticipate that transport flows of oil products will change, mostly driven by factors such as shifting regional demands and economic development. *The energy company 1* highlights that global market dynamics will influence the availability of transport capacity across different regions, as shipowners are likely to allocate their vessels to the most profitable markets, potentially affecting local trading patterns. Further, *energy company 1* mentions a trend towards a greater mix of refined products, which is expected to increase demand for smaller vessels and/or vessels capable of handling multiple cargo types simultaneously. This trend could cause operational challenges, such as increased berth congestion at ports, requiring adjustments in ports infrastructure to maintain supply chain efficiency.

The energy company 2 similarly expects changes in global trade patterns, with new import and exporting regions globally. This development may be driven by new refineries and changing demand patterns. As an example, they mentioned the relatively new Dangote Refinery in Nigeria, which has created a new export hub for refined products. Additionally, the continent of Africa is expected to develop in the future which likely creates an increased energy demand of the region.

4.1.2. Alternative fuels and their implications

Which alternative energy sources do you see replacing traditional fossil fuels?

Both *energy companies* state that the choice of alternative energy sources to replace fossil fuels will vary significantly between different sectors. There is no single energy source that can replace oil products across all sectors, as each sector requires different solutions depending on several factors. Both *energy companies* point to electricity as a major energy source within passenger transport, while traffic modes such as shipping, aviation and heavy industry will have more difficulties to substitute fossil energy. Technological breakthroughs in energy production and scalability are seen as necessary to substitute in all sectors.

The energy company 1 also mentions that shipping for instance can use better fossil alternatives than traditional heavy fuel oil (HFO) such as marine gasoil (MGO), as a substitute for using HFO with scrubber technology. Furthermore, *energy company 2* highlights biofuels such as hydrotreated vegetable oil (HVO) and biogas as potential alternatives, especially within limited regions such as bus transport where there will be sufficient infrastructure.

How do you think these alternative fuels will affect tanker requirements, logistic chains and transport infrastructure?

Both *energy companies* anticipate that alternative fuels will, to some degree, lead to changes in tanker vessel requirements and logistic systems. However, the nature of these changes will vary depending on the type of fuel and operational context.

Energy company 1 notes a trend in the clean petroleum product (CPP) segment, where vessels in some cases (depending on exact cargo type) need to be classed to carry chemicals. This is due to certain products being classified partly as chemicals, requiring vessels to meet stricter criteria. As a result, the distinction between Annex I (oil) and Annex II (chemicals) under the MARPOL convention is becoming less clear, which demands increased operational flexibility.

Energy company 2 compares crude oil and some refined products with many biofuels and feedstocks and emphasis that fossil products are more chemically stable (since it has been stored for a very long time) compared to biofuels and feedstocks, which are usually more sensitive and more prone to degradation over shorter time spans. This instability creates new challenges in storage, handling and cleaning. Consequently, tanker operations will need to adapt to manage this increased complexity.

Do you believe there will still be a market for liquid energy products in the future, and what would substitutes mean for shipowners in terms of vessel adaptation?

Both *the shipowner* and *the industry* expert believe that there will continue to be a market for liquid energy products in the future. However, they point out that some changes are expected, such as the product mix and the logistical infrastructure.

The shipowner also mentions cargo types beyond the traditional ones (e.g. gasoline, diesel and kerosene) such as animal fats and vegetable oils. Compared to traditional cargo types, these products require different handling. For instance, they can be temperature sensitive, and mishandling can damage both cargo and the cargo handling equipment, which indicates the importance of correct handling procedures. The sensitivity of certain cargo types requires vessels to be technically equipped and that crews are properly trained to manage a wider range of products.

The industry expert explains that the number of liquid energy products is very likely to expand, including alternatives such as biofuels, synthetic fuels and ammonia. However, sea transport is likely to remain vital even if fuels and other liquified energy products could be produced more locally in the future.

4.1.3. Regulatory compliance and technical adaption

What investments in technology or alternative fuels will be needed to meet future requirements?

The shipowner and *the industry expert* both state that meeting future requirements will require investments and strategies in different areas, including renewable fuels, energy efficiency and other technological approaches. The different investments and strategies chosen depends on factors such as age and already existing technology on the vessel.

The shipowner explains that in newbuilding's, the long-term perspective is important due to the vessel's life span (could be 20 years). In such cases, dual-fuel engines, battery capacity and shore power connections are some examples of important technologies needed. On the other hand, older and already existing vessels that are not fitted with modern technology can be retrofitted with necessary adaptations. However, these investments must be compared to the age of the vessel and the remaining economical lifespan. An example used by *the shipowner* is fuel optimization technologies, which adjusts the consumption based on real-time factors such as wind and sea movements.

Further, from a purely theoretical standpoint, *the shipowner* explains that a potential strategy could be to accept penalties for not complying with environmental regulations. The approach is based on a comparison between the cost of penalties and the cost of adaptation. However, *the shipowner* emphasized that this is not a part of their actual strategy but rather discussed as a theoretical option.

The industry expert describes a similar approach in regard to adaptation. Firstly, a relatively cost-efficient measure is to increase the energy efficiency of a vessel, appropriate for older vessels which usually lack energy efficiency technology and design. These can be configurations such as hull friction reduction, improve the design of rudder and propeller, wind-assisted technologies as well as duel saving optimization technologies implemented by the shipowner. Further, in the long-term perspective it is necessary to shift focus towards alternative fuels. However, to achieve long-term compliance (i.e. up to 2050) it is necessary to combine energy efficiency measures with alternative fuels.

Additionally, when considering and comparing different future fuel alternatives, *the industry expert* highlights the importance of measuring the emissions from a full life-cycle perspective (well-to-wake), rather than only considering emissions from combustion onboard vessels. This broader view should not only apply to shipowners but also be adopted by regulating authorities.

4.1.4. Uncertainties in adapting to new requirements

What are the main challenges, obstacles or uncertainties you face in adapting your operations to new environmental and regulatory requirements during the energy transition?

Both *the shipowner* and *the industry expert* highlighted challenges in complying in new requirements, primarily related to regulatory complexity, technical limitation, fuel availability, and economic factors.

The shipowner emphasizes that many regulatory frameworks, such as FuelEU Maritime, are sometimes vague, offering multiple pathways to compliance without clear guidance. For instance, the regulation allows for trading greenhouse gas (GHG) surpluses but offers limited detail on how these mechanisms will function in practice. The rapid implementation of such policies is perceived as problematic, especially when practical support or technical instructions are insufficient.

Fuel availability emerges as a shared concern. Both actors point to uncertainty around the future supply of alternative fuels, especially biofuels and electro fuels. According to *the industry expert*, current volumes of renewable fuels available to shipping fall far short of what is needed to meet long-term regulatory targets. For *the shipowner*, the challenge lies in ensuring reliable access to the chosen fuel type in the vessel's expected operational areas. Without enough supply, compliance becomes difficult to achieve in practice.

Technological integration is another issue raised by both actors. *The shipowner* highlights the complexity of integrating new fuel systems into existing vessel technology, which requires close collaboration with engine manufacturers, classification societies, and insurers. If guidelines are not followed, the worst case could lead to operational problems and potentially warranties or lost insurance coverage. *The industry expert* adds that many fuel technologies are still relatively untested in long-term commercial operations, making performance and maintenance outcomes uncertain.

Finally, both actors underscore the financial risks involved. The cost of renewable or low-emission fuels is still significantly higher than conventional options, and sudden shifts in political direction may make previous investments less economically viable. *The shipowner* refers to the removal of Sweden's national biofuel blending mandate as an example of how unpredictable policy changes can negatively impact investment decisions. Consequently, both actors stress the need for long-term regulatory clarity and stable access to alternative fuels to guide operation and investments.

4.1.5. Business models and industry collaborations

Could converting product tankers for other uses become relevant, and what challenges might that involve?

The shipowner states that there are currently no plans for any conversion or specializations of product tanker vessels. However, they note that some future products, such as liquid rubber, may require a higher degree of vessel modifications to allow such a conversion.

The industry expert believes that conversion is possible but highlights the cost comparison between building a new ship and converting an existing vessel. They further point out that during a transitional phase, the market remains small, the risks are high and the time required for conversion may delay market entry. As a result, shipping companies may initially rebuild parts of their ships to handle smaller volumes.

Do you believe your business model needs to change for the future product tanker market?

Both *the shipowner* and *the industry expert* have reflected on whether their business models need to change to meet the future product tanker market. According to *the shipowner*, their business model has gradually evolved over the past ten years, primarily to enable the transport of a wider range of cargoes, particularly biofuels, which they consider represent the biggest share of the transitional volume. That said, they clearly stated that their original business model remains intact, with most adaptations relating to the types of products being carried in the tanks, rather than any fundamental changes to the overall business model.

In line with what *the shipowner* expressed, *the industry expert* agrees with the need for adaptations in the business model. Further stating that the biggest change will lie in the product mix, meaning that in the future there will be a greater variety of products, resulting in smaller batches and a wider range of qualities. In such a scenario, more diverse cargoes will need to be transported on the same vessel. Additionally, *the industry expert* sees the possibility for the market to become more small-scale and regional, with a larger share of transports occurring over shorter distances before eventually entering the global supply chains.

Could new models for collaboration between shipping companies and energy companies become relevant in the future?

Energy Company 1 states that collaboration models remain uncertain but emphasizes that a desirable future trend is increased focus on pooling and sharing of resources. By collaborating on fleet capacity and logistics, shipping companies could reduce emissions and optimize transport efficiency. They highlight that such sharing models could become a key strategy for meeting both economic and environmental demands in the evolving shipping market.

Energy Company 2, believes that there is added value in maintaining strong relationships with energy companies (themselves), and suggests that this value will increase further as the implementation of rules and regulations continues to grow.

The industry expert's thoughts align well with both energy companies and points out that collaboration between energy and shipping companies is likely to evolve and become more strategic in the future. The need for long-term guarantees and stable supply chains is expected to grow, particularly as the transported products become more specialized and require tailored solutions. According to *the industry expert*, closer collaborations in the form of alliances or long-term agreements could help ensure access to the right vessels.

4.1.6. The future and scenarios

Do you see your company still active in the energy market by 2050, and if so, how will the business have changed?

Both *energy companies* see themselves as relevant players in the market 2050, although with slightly different focuses. While both expect a decline in demand for conventional fuels and a rise in demand for biofuels, *energy company 2* believes that e-fuels will experience a breakthrough.

The energy company 1 further elaborates that they expect to supply a greater share of their fuels to other sectors, such as heavy transport, the defence industry, and aviation. They underscore that the market for conventional ship fuels will diminish, pushing the industry towards a more specialized and niche production. Moreover, they highlighted the importance of politics, especially in Europe, since it sets the framework for the fuel market and as a result, they will have to adapt and specialize to remain competitive.

What future scenarios do you see as ideal and, conversely, as nightmare scenarios?

Energy company 1 described an ideal future scenario as one where the industry can make long-term decisions based on clear and stable conditions, and they also underline the importance of predictability for enabling strategic investments. This view is also shared by *energy company 2*, who also highlighted clear, long-term political frameworks and regulatory stability to support future planning and investment.

The shipowner similarly expressed that an ideal future scenario would be based on clear and consistent political directions. They explained that such stability would provide the necessary basis for long-term planning, especially due to the scale and longevity of investments, which for a vessel often span up to 20 years. *The industry expert* agreed with these perspectives, adding that an ideal future scenario would involve a stable geopolitical environment where free trade is upheld, and political decisions create predictability for the industry as a whole. *The industry expert* further noted that a stable business climate and clear frameworks would allow shipping companies to plan long-term and invest in future vessels and fuels with confidence.

As for the nightmare scenario, *energy company 1* identifies one of the biggest risks as a continued "jo-jo effect", referring to a situation where companies invest a large amount of money in the energy transition based on current political decisions, only to see those decisions reversed or changed after a political shift. This creates significant uncertainty and risks slowing down the necessary developments within the industry. *Energy Company 2* aligns with this concern regarding political uncertainty and highlights that frequent changes in political directions make it difficult to think long-term.

The industry expert expressed that geopolitical instability would be a negative scenario and explained that disruptions in trade routes, introduction of sanctions or major changes in energy supply flows could create problems with the supply and demand of liquid energy products.

Questions about where the energy will come from and how it will be transported will become more complex, which may affect the market dynamics and profitability.

The shipowner stated that a major breakthrough in energy supply could be a negative scenario, especially if it makes today's energy supply chains unnecessary. Further explaining that if refineries and liquid energy become less important, it would directly affect the product tanker market.

4.2. Projecting the energy market

As the product tanker market relies on the transportation of energy products, understanding the energy market is crucial for analysing its future. The world is undergoing a significant transition to sustainable energy sources. Driven by climate regulations, change in consumer behaviour and technological achievements. This chapter provides an overview of the energy forecasts beginning with a global perspective followed by a section focusing on trends specific to the European market.

4.2.1. Global energy outlook

This section outlines global energy trends, with a focus on presenting future projected scenarios for energy demand and shifts in the energy mix. In addition, it aims to describe how liquid energy products are expected to develop up to the year 2050.

4.2.1.1. Global energy mix projections

Based on a forecast from 2024 by IEA, the global energy mix based on the current policy setting (STEPS scenario) is illustrated in figure 1. IEA (2024-b) expects the demand for oil to increase up until around 2030, after which it is expected to gradually decrease. The most notable change can be observed in the clean energy category, as the demand is projected to steadily increase. However, as illustrated in the right side of figure 1, there is a significant difference between the three different scenarios outlined by IEA (2024-b).

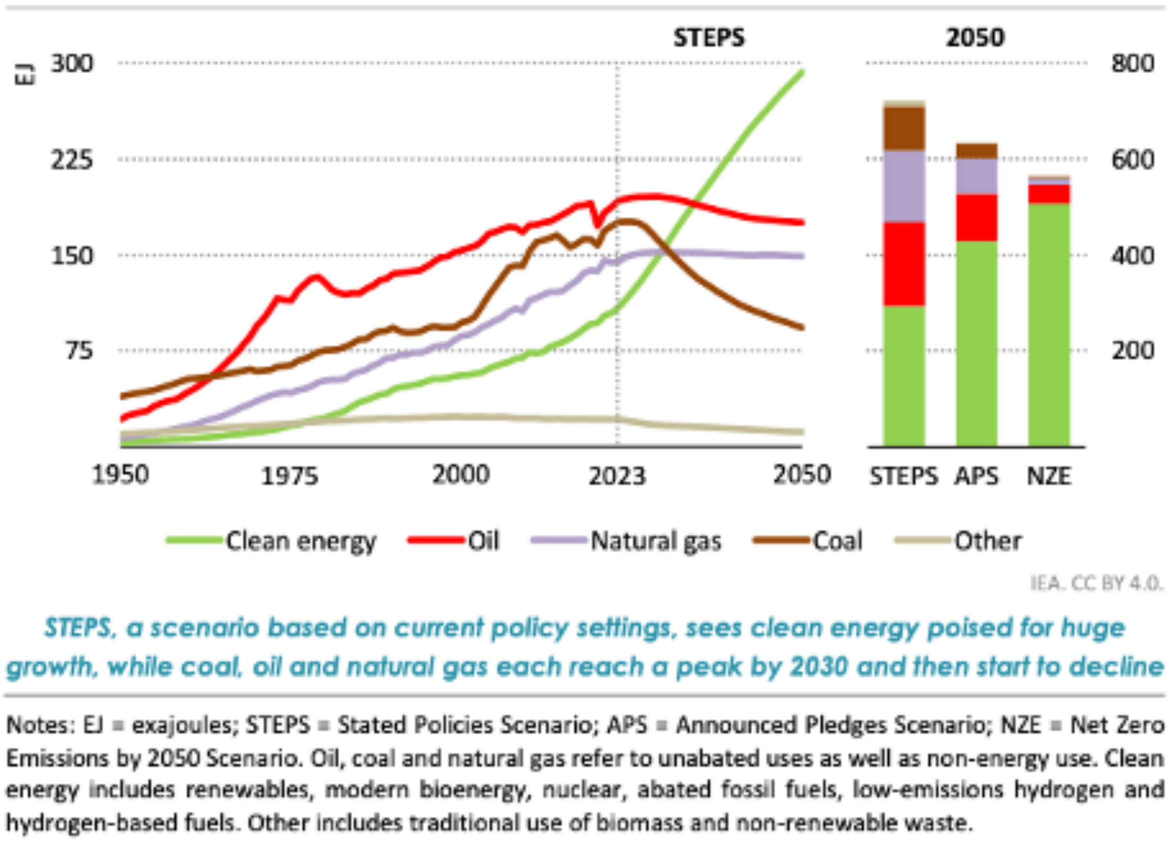

Figure 1. *Global energy mix projections under different scenarios toward 2050 (IEA, 2024-b)*
Note. Reprinted with permission under license CC BY 4.0.

In the scenario based on the current policy settings (STEPS), fossil energies such as oil and natural gas are projected to continue making up a very large share of the total global energy demand, with only a minor decrease in demand compared to the levels in 2023 (IEA, 2024-b). In the next scenario, *announced pledges scenario* (APS), which reflects all national energy and climate promises, the clean energy is expected to account for a substantially larger share relative to fossil energy, and total global energy demand is projected to be lower than in the *STEPS* scenario. In the final scenario, the net zero emissions scenario (NZE), where the energy sector reaches global net-zero carbon dioxide emissions alongside various air quality goals, clean energy is by far the dominant energy source. In this scenario, oil use is minimal, and the overall global energy demand is projected to decrease even further.

In BP's (2024-a) energy outlook, the main scenarios are presented as the *Current Trajectory* and the *Net Zero Trajectory*. The *Current Trajectory* scenario is based on existing technology and policies, while the *Net Zero Trajectory* aligns with the goals of the Paris Agreement. BP (2024-a) emphasizes that these scenarios can be seen as two bounding points, representing a range of possible outcomes between the two points.

The main difference between the scenarios presented by BP (2024-a) relate to the future roles of oil and renewables in the global energy mix. In the *Current Trajectory* scenario, oil remains a very important energy source, accounting for about 25 % of the total energy demand, while renewables accounting for about the same amount. In the *Current Trajectory* scenario, the share of oil as a source declines significantly to approximately 10 %, while renewables become the dominant source, exceeding 50 % of the total energy demand. Further, the total global energy demand in the *Net Zero* scenario is significantly lower compared to the *Current Trajectory* scenario, from about 600 to 430 EJ of energy globally.

Overall, the scenarios presented by BP (2024-a) largely reflect those presented by IEA (2024-b), especially when comparing BP's *Current Trajectory* and *Net Zero Trajectory* to IEA's *STEPS* and *NZE* scenarios. In both sets of projections, oil and renewable or clean energy sources represent the categories with the highest degree of uncertainty of future possible pathways in the energy market.

4.2.1.2. Global outlook for liquid energy products

To further understand how the energy transition may impact the product tanker shipping market, it is essential to distinguish between the different types of energy based on their physical form, i.e. liquid or solid. This section is therefore focusing on the liquid energy forms, which are relevant for the product tanker segment.

Table 6 shows the global demand across different industries for various liquid energy sources under the three scenarios outlined by IEA (2024-b): *STEPS*, *APS* and *NZE*. Similar to the trends observed in the global energy mix for these scenarios, the demand for liquid energy sources follows a similar pattern.

Table 6. *Global demand of liquid energy in three different scenarios by IEA (2024-b)*

Numbers in million barrels per day		**STEPS**			**APS**			**NZE**		
	2023	**2030**	**2035**	**2050**	**2030**	**2035**	**2050**	**2030**	**2035**	**2050**
Road transport	42.7	43.3	40.2	34.8	40.5	34.1	16.8	31.9	20.1	2.3
Aviation and shipping	11.6	13	13.5	14.5	11	10.1	7.5	9.3	7	1.8
Industry and petrochemicals	20	23.3	24.6	25.3	21.4	20.9	17.5	19.7	18.2	13.1
Buildings and power	11.4	9	7.7	6.1	8.1	6.1	3.6	6.6	3.6	0.4
Other sectors	13.3	13.1	13.1	12.5	11.8	10.9	8.4	10.8	8.9	5.3
World oil demand	**99.1**	**101.7**	**99.1**	**93.1**	**92.8**	**82**	**53.7**	**78.3**	**57.8**	**23**
Liquid biofuels	2.3	2.9	3.2	4.1	4.9	6.3	7	6	6.8	5.9
Low-emissions hydrogen-based fuels	0	0	0.1	0.6	0.3	1.4	4.6	0.7	2.0	5.6
Worlds liquids demand	**101.4**	**104.7**	**102.4**	**97.9**	**98**	**89.7**	**65.4**	**85**	**66.6**	**34.5**

Note. Adapted with permission under license CC BY 4.0

In the *STEPS* scenario, the oil demand remains nearly unchanged between 2023 and 2050 (IEA, 2024-b). However, the small decline in oil consumption is almost entirely balanced by the increased demand for alternative fuels (biofuels and low-emission hydrogen), resulting in an overall stable volume of liquid energy demand. The reduction in oil demand is particularly notable in the road transport sector, driven by the progressive adoption of electric vehicles according to IEA (2024-b).

In the *APS* scenario, a significant decline in the total liquid energy demand can be identified between 2023 and 2050 (IEA, 2024-b). Again, the most notable reduction occurs within the road transport sector, where electrification is assumed to advance both more extensively and at a faster pace, which affects the demand up to 2035 as well. The overall decrease in liquid energy demand in *APS* is also consistent with the broader reduction in total global energy demand under this scenario.

In the *NZE* scenario, demand is significantly lower across all categories, except for biofuels where the demand remains relatively stable, and low-emission hydrogen expects to increase a lot in relation to 2030 levels (IEA, 2024-b). However, even in the *NZE*, oil demand is projected to have a demand of 23 million barrels per day by 2050. While the relative increase in biofuels and low-emission hydrogen is large in relation to 2030, the growth in absolute terms remains fairly low. Overall, the total demand for liquid energy is significantly lower, which also aligns with the total global energy demand in the *NZE* scenario.

4.2.2. Regional energy outlook in Europe

According to IEA (2024-b), the European Union accounts for about 10% of the global energy demand and is projected to remain a leader within the energy transition. In the *Stated Policies Scenario* (STEPS), the energy mix between different energy sources is illustrated in figure 2 and in contrast to the global outlook in the same scenario, the oil demand is decreasing in the European market.

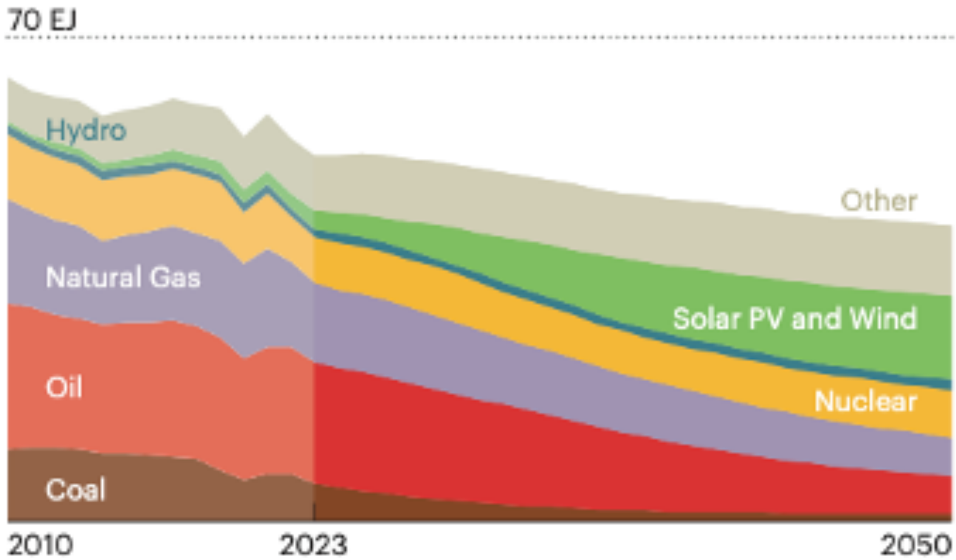

Figure 2. *Energy mix within the EU in STEPS scenario. (IEA 2024-b)*
Note. Reprinted with permission under license CC BY 4.0.

In the European Union, the most significant share of the oil consumption can be linked to the transport sector, which is also the sector that contributes most to the CO2 emissions (37%), followed by the energy sector (24%) (DNV, 2024-b). By 2050, emissions from transport are projected to decrease to nearly 20% compared to the 2023 levels, primarily due to electrification. However, DNV (2024-b) highlights that aviation and shipping remain challenging to decarbonize, as future solutions for these are still uncertain.

BP (2024-b) presents two scenarios, *Current Trajectory* (based on current policy settings and technology) and *Net Zero Trajectory* (aligning with the Paris Agreement), both of which project a significant total energy consumption within the EU. Under the *Current Trajectory*, total energy demand is expected to fall by 24% by 2050. In the *Net Zero Trajectory*, the decline is projected to reach 43%. However, despite the overall projected decrease in energy demand, biofuels and other synthetic fuels are projected to increase by 65-85 % in both scenarios.

Furthermore, BP (2024-b) summarizes the energy mix with different energy sources, where the categories “oil” and “renewables” are of particular interest since they are the only categories containing liquid energy. The category *oil* includes refined products, while the category *renewables* cover biofuels. However, the latter also include non-liquid energy, making it difficult to clearly assess the possible liquid energy demand in Europe based on this category.

In the *Current Trajectory*, oil and renewables combined is projected to decline from a 41% in 2020 to 15% of total energy demand by 2050. Meanwhile, the renewables category is expected to increase from 17% to 56% of the energy mix (BP, 2024-b). In the *Net Zero Trajectory*, the shift is even bigger, with total share of the oil expected to decrease from 41% to 6.8%, while *renewables* are expected to rise to 72% of total energy demand by 2050 (BP, 2024-b).

4.2.2.1. Key factors of regional demand change

Several factors influence the regional energy demand in Europe. Two of the most significant factors are the electrification in the transport sector and improved energy efficiency, as both are central components in the long-term strategy.

In 2024, Europe accounted for approximately 3 million Electrical Vehicles (EV) sales, representing 17.5% of global sales (Rho Motion, 2025). Looking ahead to 2025, projections indicate continued growth, with Parodi (2025) forecasting a 14% increase in EV sales. Given that the road transport sector consumes nearly 50% of the region's oil demand according to the European Parliament (2022). This trend highlights the region's strong potential to reduce oil dependency through transportation electrification. To accelerate this transition, the European Union has introduced a central regulation mandating that all new cars and vans sold from 2035 onwards must be zero-emission vehicles, which is further expected to drive EV adoption and further reduce oil demand in the region (IEA, 2024-c).

EU member states are obligated to follow various frameworks aimed at achieving net-zero emissions by 2050 (European Consilium, 2025). A key part of this aim is the Energy Efficiency Directive, which targets improvements across buildings, transport and industry (European Commission, n.d.). According to IEA (2024-d), energy efficiency is considered the ”first fuel” of the energy transition, as it is both cost-effective and efficient in terms of reducing CO2. The IEA (2024-d) further estimates that energy efficiency improvements will account for over one-third of the CO2 emissions reductions and more than two thirds of the decline in oil demand by 2030, mostly driven by technological innovation and electrification. This corresponds to an estimated 25% reduction in energy use per device by 2030 compared to 2022 levels.

In addition to these key drivers, geopolitical developments are also an important factor within the energy industry. According to BP (2024-a), events such as Russia's invasion of Ukraine and instability in the Middle East have increased attention to energy security and the need to reduce dependence on fragile supply chains. This has created incentives for both improving energy efficiency and relocating energy production closer to the end markets, with the aim of creating more resilient energy systems in the EU (BP, 2024-a).

5. ANALYSIS

The purpose of this chapter is to interpret and analyse our primary data with support of secondary data in relation to the theoretical framework presented in chapter 3. Using Osterwalder & Pigneur's (2010) business model and its nine components as a reference, we will conduct a thematic analysis. Systematically, each component is examined with regards to how the energy transition impacts a tanker shipping company and its business model can be adapted up until 2050. However, not all components are fully covered by the empirical data and these are therefore disregarded.

5.1. Customer segment

Customer segments define the groups of customers that a company delivers its services to (Osterwalder & Pigneur, 2010). All interview participants, as well as secondary sources such as BP (2024-a) and IEA (2024-b), suggest that the product mix of cargoes will become more diversified in the future. Depending on who manufactures these products, the customer segments may change. Historically, and still today, oil companies have been the main cargo owners (ICS, 2021). Both *Energy company 1* and *2* mention that they will produce partially different products in the future, depending on demand, which could potentially lead to an increase in the number of producers. *The industry expert* also notes that certain products may be produced more locally. In such a case, if the future energy market consists of more producers due to increased specialization in liquid products, a more diverse product mix could also lead to a broader customer base.

5.2. Value proposition

The value proposition refers to the value created by a company's product or service (Osterwalder & Pigneur, 2010). As concluded regarding the future energy market, all interview participants and secondary sources of the energy market such as BP (2024-a) and IEA (2024-b) indicate that the future will involve a more diversified cargo mix. This implies that shipowners must adapt the value they offer to customers, as future cargo types require different handling procedures and equipment. Without such adjustments, the service provided to cargo owners or charterers risks losing relevance and value. Therefore, to remain competitive, shipowners must enhance their technical capabilities, handling procedures and crew competence to meet specific requirements of these new cargoes. As highlighted by *the shipowner,* this may include ensuring temperature control, using appropriate tank coatings and applying specialized cleaning procedures. Failing to do so could risk damage the cargo and the vessel itself.

Another aspect of value creation is the ability to comply with future regulations, as stated by *the shipowner* with support from IMO (n.d.-c) and the European Commission (n.d.-a; n.d.-b). From a cargo owner's perspective, a future-proof fleet is especially important in the context of long-term charters, as it ensure alignment with upcoming regulatory requirements. This was described as a strategic and relevant consideration by *the shipowner*, especially when designing new vessels. Such features may include dual-fuel engine technology, efficiency systems, batteries and shore-connecting abilities, all helping future-proof a vessel over a typical 20-year lifespan.

5.3. Channels

Channels refer to how a company communicates and delivers their services and products to its customers (Osterwalder & Pigneur, 2010). In the context of this thesis, it has not been considered an important factor influencing the business model. As none of the data collected highlights this area as affected, it is excluded from further analysis.

5.4. Customer relationship

Customer relationship describes the type of relationship there is between a company and its customer (Osterwalder & pigneur, 2010). The shipping industry is highly dependent on interpersonal relationships, governed not only by contracts (such as time charters, voyage charters, and COAs) but also by mutual trust (ICS, 2021).

The energy transition and the tightening of environmental regulations highlight a growing need for closer customer relationships. As the industry is becoming more strategic and complex, with a more diverse cargo mix, both *energy companies* agreed on the necessity of closer and more long-term collaborations with shipowners. *Energy company 1* also emphasized the future potential of pooling with shipowners, which in practice would imply partnerships with shared goals and flexibility. This, they mean, would help ensure access to the right vessel at the right time, along with technical capabilities and operational flexibility.

These perceptions are supported by *the industry expert*, who emphasizes the benefits of more collaborative and long-term partnerships. Such partnerships would not only facilitate the compliance with more strict regulations, but also the growing need for handling specialized products, investments in energy-efficient technologies, and managing operational challenges.

5.5. Revenue streams

In return for the value created by the company, revenue streams from customers are generated, and this flow of income is described within this component (Osterwalder & Pigneur, 2010). Findings based on the data indicate that while the structure for generating revenue remains unchanged, some adjustments are expected.

Both the *shipowner* and *the industry expert* anticipate a shift toward transporting more biofuels instead of traditional oil products. Although this shift is not expected to affect how revenue is being generated but rather influence the technical aspects of the business. This view is supported by the secondary data, which indicates a decrease in demand for refinery products after 2030. While this may reduce freight volumes and thereby revenues, the market for biofuels is expected to expand, offering new revenue opportunities.

Another insight, highlighted by both *the industry expert* and *shipowner*, is the diversification of the future product mix. The industry particularly highlighted that this may lead to smaller volumes per shipment, more varied products, and an increased frequency of shorter voyages. Such developments would require greater flexibility in vessel operations and would potentially result in a higher number of cargoes per ship. While these changes may create new possibilities for generating revenue, they may also involve higher costs.

To be short, the energy transition will not necessarily bring down revenue streams. However, shipowners who are not proactive enough to adapt their services and technical capabilities to handle new types of products risk falling behind. While the structure for generating revenues remains intact, the conditions under which revenue is made are changing.

5.6. Key resources

Key resources are the most essential assets needed to deliver the company's value proposition to its customers across various segments (Osterwalder & Pigneur, 2010). In the context of tanker shipping, the key resource is certainly the ship itself. However, it is possible to break down the essential parts of a ship's operation. These areas may include the crew, the vessel's technical equipment and capabilities, and bunker fuel. All these parts, among others, are necessary for the vessel to operate effectively.

These resources will likely remain unchanged, but certain aspects and requirements may change. An increased mix of products, each with varying handling needs, will demand greater flexibility in the vessel's technical equipment as well as the crew's competence, especially if a great variety of product will be transported, as noted by *the shipowner*. Therefore, handling different cargoes requires the crew to be properly trained to ensure the safety of the cargo, vessel and crew, as emphasized by *the shipowner*. This highlights the crew as a key resource.

Another important resource of the vessel, both in terms of cost and its purpose in operating a ship, is the bunker fuel. *The industry expert* highlighted some uncertainties regarding future fuel choices, such as limited availability for the shipping industry, uncertain and limited infrastructure and the current high cost compared to conventional bunker fuels. Both *the shipowner* and *the industry expert* agree that alternative fuels will be a necessity in order to comply with regulations in the long-term. However, if the supply of a desired alternative fuel cannot be guaranteed and remains uncertain in future, its availability could evolve into a strategic resource.

5.7. Key activities

Key activities refer to the core duties of a company, i.e. what the company actually does to create value for its customers (Osterwalder & Pigneur, 2010). From a shipowner's perspective, this may include planning and executions of voyages, making sure the cargo is handled correctly, regulatory compliance and more (Stopford, 2009).

While these are important aspects of the business, we have chosen to allocate them under other components that better reflect the themes raised in our empirical data, such as key resources, value proposition and customer relationships. These are also the areas where the respondents focused more on, with an emphasis on strategic aspects rather than day-to-day activities. Therefore, the component have been excluded from this analysis.

5.8. Key partnership

Key partnership refers to the external actors that the company needs in order to deliver the value proposition (Osterwalder & Pigneur, 2010). In the context of tanker shipping, actors that are identified as central are energy companies, charterers, brokers, classification societies, technical service providers, bunker fuel suppliers (ICS, 2021).

However, it is possible to identify some partnerships that may become more, or possibly already has become, more strategically important. *The industry expert* highlighted uncertainties regarding the choice of fuel. If uncertainties about supply and infrastructure persist in the future, the partnership between a shipowner and bunker suppliers could become more important for the business model. The same applies to relationships with classification societies and engine manufacturers. *The shipowner* mentioned that the industry is still in the early stages regarding the operation of certain fuels. Engine manufacturers and classification societies were described as cautious when it comes to approvals (due to uncertainties in new technologies), which could result in a scenario where partnership with classification societies and manufacturers become closer than before, when only conventional fuels are used.

5.9. Cost structure

The cost structure is a central aspect of any business model, referring to the most significant expenses associated with running a business (Osterwalder & Pigneur, 2010). In the context of shipping, these costs are typically divided into capital costs, operating costs and voyage costs (Stopford, 2009). Some of these costs are fixed, such as capital expenditures and insurance, while others are variable, such as bunkers, canal tolls, and port charges.

The empirical data points out how the increasing need for investments in order to comply with regulations is growing the complexity of the industry. Both *the shipowner* and *the industry expert* emphasize that the energy transition is affecting the cost structure in various ways, and one that both agreed on is investments aimed at improving the energy efficiency. This could include fuel optimization, dual-fuel engines, hull enhancements and shore power connections. Retrofitting (i.e. modifying existing vessel) is also discussed and is primarily focused on older and existing vessels and due to the scale of investment, such upgrades must be weighed against the vessel’s age and remaining lifespan.

Additional costs arise from the implementation of FuelEU Maritime and the EU Emission Trading System (EU ETS) (European Commission, n.d.-a; n.d.-B). These drive shipowners to invest in more environmentally friendly fuels (i.e. alternative fuels), and to purchase emission allowances, thereby increasing both fixed and variable costs.

The shipowner and *the industry expert* point out the much higher prices of alternative fuels (such as biofuels) compared to conventional bunker fuels. As demand for alternative fuels rises, this could lead to higher voyage costs, thereby increasing variable costs. On this topic, *the industry expert* warned of potential supply shortage which could drive prices up further.

Moreover, the use of alternative fuels brings different operational challenges if these are transported as cargo, as mentioned by *the shipowner*. Compared to conventional bunker fuels, alternative fuels often require specific temperatures, managing shorter storage times due to degradation risks. In some cases, compliance with dual classifications under MARPOL Annex I and II is required according to *the energy company 1*. This implies both technical adaptations onboard and specialized training for crew, meaning added costs.

Both *the shipowner* and *the industry expert* expressed concerns about the unpredictability of regulations, technological developments and as mentioned earlier, biofuel availability. These uncertainties are factors that investors may consider, and therefore risk a premium being applied. Thereby increasing cost of capital.

6. DISCUSSION

This chapter discusses the main findings of the thesis in relation to its purpose: to understand how the energy transition is affecting the product tanker shipping segment. The first part reflects on the mainly affected components in the business model framework applied. The second part addresses uncertainties as a common concern, both in terms of the energy market projections and as expressed by several industry actors who view regulatory developments as a potential negative future scenario. Finally, the third section provides a critical discussion on the methodology and the data used in the thesis.

6.1. Business model implications of the energy transition

During the ongoing energy transition, the product tanker segment is primarily influenced by two forces: a shift in the cargo composition and increasingly strict environmental regulations. Using the Osterwalder & Pigneur (2010) business model framework in the analysis, three components were identified as particularly relevant for this context: value proposition, key resources and cost structure. These were chosen since they are closely linked and showed most interesting effects in connection with the energy transition. This is explained by how much the value proposition is evolving due to the shift toward a broader and more complex mix of cargoes, which subsequently demands additional requirements on vessels and operational capabilities, i.e. their key resources. Simultaneously, compliance with environmental regulations, increased handling complexity and investment needs, all impact the cost structure. While other components of the business model also matter, these three stand out as the most critical areas where adaptation is needed to remain competitive.

6.1.1. Value proposition

Historically, transportation mainly involved a limited range of traditional oil products. However, the modern market has expanded to include a much broader variety, some of which are more sensitive and complex to handle. This trend is projected to continue, at least to some extent, across all future scenarios outlined by IEA (2024-b) and BP (2024-a & 2024-b), reinforcing the need for product tanker operators to handle new types of cargo safely and efficiently as a core part of their value proposition.

A broader product mix implies that shipowners must take more factors in account, which may create opportunities not only to diversify their services but also to specialise in handling specific types of products, rather than attempting to embrace them all. Just as the tanker market is segmented into dirty and clean petroleum products (DPP and CPP), a similar form of internal segmentation could happen within the product tanker segment. Supported by *energy company 1*, which anticipates a more niche-oriented production and underscored the need for specialisation in order to remain competitive.

Moreover, with increasingly stringent environmental regulations, it is highly unlikely that non-compliant vessels will remain attractive to customers and charterers, who are involved in the approval process prior to each charter agreement. This is particularly evident in the European market, where region-specific regulations such as FuelEU maritime (European Commission, n.d.-a) and the EU ETS (European Commission, n.d.-b) are creating stronger incentives to reduce emissions. Therefore, being compliant with regulations is arguably an important part of the value a shipowner provides.

6.1.2. Key resources

Another central aspect for shipowners is the vessel itself, i.e. the key resource, which enables the most fundamental part of the value creation, to transport cargo from one place to another. While shipping remains the most cost-effective way to transport cargo and alternatives do exist, there are no viable substitutes for seaborne transport. This is mainly due to its unique capacity, efficiency and cost-effectiveness on a global level, characteristics that are difficult to replicate with other transport modes.

With this in mind and considering the world economy's vulnerability to disruptions in energy supply, it is unlikely that shipping will be replaced by other transport modes anytime soon. This, in a model where value is created through vessel operations, delivering value under changing conditions will not be possible without adapting the vessel and crew to future demand.

6.1.3. Cost structure

Evolving technical and operational demands directly impact the cost structure, especially in terms of compliance and the handling of a more diversified cargo mix. In the European context, regulations such as FuelEU Maritime (European Commission, n.d.-a) and the EU ETS (European Commission, n.d.-b) will directly affect the costs, both through charges on CO_2 emissions and through the investments required to ensure long-term compliance. Adapting vessels to handle heated or chemically classified cargo is also likely to increase both capital and operational costs.

Consequently, overall operating costs are expected to rise, with direct implications for profitability. This creates stronger incentives on shipowners to cut other costs, optimize parts of their business models, and run their operations more efficiently. Since much of these cost pressures are driven by new regulations, managing the cost structure effectively will be highly relevant for staying competitive in the product tanker segment.

6.2. Uncertainty as a challenge

Uncertainty has been identified as a common theme across both the primary and secondary data. Although the interview participants represent different types of actors (i.e. shipowner, an industry expert and energy companies), they all share a similar concern about unpredictability of political and regulatory developments. Notably, it is not the political agenda itself that is criticized, but rather the potential instability and lack of clarity about its future direction.

This concern is further supported by the energy outlooks published by IEA (2024-b) and BP (2024-a; 2024-b). The scenarios presented in these reports illustrate a wide range of possible outcomes, with the most notable differences concerning the relative share of fossil energy versus clean or renewable energy. These differences are significant, as the most environmentally favourable scenario, the share of clean or renewable energy is almost twice as high as in scenarios based on current policy settings and available technologies.

6.2.1. Implications of the market

When considering how these scenarios may impact the future cargo mix for the product tanker segment, it is relevant to examine the development of liquid energy products, as illustrated in Table 6. A comparison between Figure 1, which presents the global energy mix across all energy categories and Table 6, which is based on the same three scenarios but limited to liquids, reveals several broad similarities in the same scenarios. However, one important difference can be identified. Non-fossil liquid energy, represented as *liquid biofuels* and *low-emission hydrogen-based fuels* in Table 6, is a part of the category *clean energy* in Figure 1 (IEA, 2024-b). The broader category of *clean energy* also contains non-liquid energy sources such as wind and solar power. Therefore, the share of biofuels and hydrogen-based liquids in Table 6 should not be directly compared to the broader categories of *clean* or *renewable energy*. Instead, *clean energy* in terms of liquids constitutes a smaller share compared to fossil-based liquids in all scenarios.

Looking more closely at the energy mix within the EU market, as shown in Figure 2, it is possible to conclude that the energy transition in Europe is progressing faster than in the global outlooks. Figure 2 corresponds to the *STEPS* scenario, which is the least changing scenario, that indicates a very small decline in fossil energy on a global level (as seen in Figure 1), but greater in the European region. This is further supported both by the interviewed *energy companies* and the outlooks from IEA (2024-b) and BP (2024-a; 2024-b). However, due to the lack of EU-specific data on liquid energy, only a broad understanding of the regional demand for liquids can be made. The electrification of passenger transport is the primary factor for declining fossil energy demand in the EU, but at the same time, fossil energy will remain an important energy source for heavy transport industry (BP, 2024-a). Together with increased demand for clean or renewable liquid energy in all the scenarios published by IEA (2024-b) and BP (2024-b), liquid energy will certainly be an important energy source up to 2050, in EU as well as globally.

6.2.2. Implications for long-term environmental compliance

On the other hand, when reflecting on what the variety of scenarios might mean for shipowners in terms of long-term regulatory compliance, a few uncertainties can be identified. Even though the key regulations presented by the IMO (n.d.-a; n.d.-b) and the EU (n.d.-a; n.d.-b) can arguably be considered stable in terms of their environmental targets, they do not specify exactly how these long-term goals are to be achieved. This approach allows for flexibility but also introduces a degree of uncertainty for involved stakeholders.

As explained by *the shipowner* in the interview, the methods on how to achieve long-term compliance are typically developed in consultation with actors such as classification societies, manufacturers and insurance providers to ensure all parties approve the chosen solutions. Additionally, if a shipowner opts for a propulsion system compatible with a specific alternative fuel, long-term demand for that fuel must be secured to make the investment less risky, requiring both infrastructure and a stable supply.

However, both *energy company 1 & 2*, as well as BP (2024-a) and IEA (2024-b) highlight that sectors like shipping and aviation are likely to remain dependent on fossil energy longer than many other sectors. Instead of a drastic shift, a gradual increase in the use of sustainable fuels is expected over time, indicating a slower transition within these industries. At the same time, there are strong incentives to include alternative fuels, as the cost of emitting CO_2 within the EU will increase over time (European Commission, n.d.-b).

The ability to adapt must be balanced against the risk of overinvesting in the wrong technologies or regulatory directions, which logically is relevant for an industry with assets characterized by long financial lifespans. Since no clear path towards long-term compliance has been identified, but rather a variety of possible methods, uncertainty is a central aspect. At the same time, it is equally important that the conditions required to meet the targets for 2050 and beyond are realistically possible. Political ambition must therefore remain aligned with what is practically achievable, something that appears uncertain, depending on which future scenario that becomes reality.

6.3. Methodology discussion

The choice to structure the empirical data collection around first-hand insight from stakeholders within the industry was supported by market reports on the future energy market. In this way, we aimed to support the interview statements and gain complementary or broader perspectives.

While the market reports tend to be neutral and offer a wide, more nuanced perspective, the primary data from industry stakeholders carries the risk of being too specific or, at the very least, more subjective. Therefore, we found it important to influence the respondents as little as possible, which led to the decision of semi-structured interviews. This allowed the questions to be more openly asked, giving the respondents the chance to interpret them based on their own understanding. This approach sometimes resulted in varying interpretations, which could be seen as a limitation. However, this does not mean that one interpretation is more correct than the other but rather reflects their varying areas of expertise. In the end, their perspectives also complemented each other.

Another potential issue is the reduced reliability that can come from a small number of interviews and to address this we aimed to include as many relevant stakeholders as possible which ultimately ended in four interviews. However, only one of the respondents represented as a shipowner, which means that the shipowner's perspective may have been underrepresented. We were aware of this risk and therefore reached out to as many as seven shipowners, whereas two responded and only one interview was possible to conduct. That being said, to help balance this limitation, we included an industry expert whose broader market view helped complement the more specific viewpoints of the other respondents.

7. CONCLUSION

The energy transition brings two parallel challenges to the product tanker segment: complying with increasingly stringent environmental regulations, while simultaneously facing a gradual phase-out of the segment's main cargo. Consequently, both the regulatory and commercial developments are affecting the industry, with the European region in lead of this transition. While fossil energy is expected to remain an important resource for shipping and other heavy industries longer than other sectors, the market is moving towards a greater mix of liquid energy products, including biofuels and hydrogen-based alternatives. This increased diversity introduces new operational challenges in cargo handling and vessel requirements, including stricter demands for temperature control and cleaning, tank coating, and chemical compatibility between different cargoes. Since these developments were highlighted by all the respondents and supported by the secondary data, it is reasonable to conclude that the cargo diversity, together with the uncertainty surrounding energy market projections, will remain central aspects throughout the energy transition.

As a shipowner, adapting the business model in the energy transition will likely be essential to remain competitive ahead. Using the framework by Osterwalder & Pigneur (2010), three interlinked components were identified as particularly relevant: value proposition, key resources and cost structure. Among these, the value proposition stands out as the central one. Future demand requires services that are compliant with increasingly stringent regulations, emit less emission to both avoid associated costs and align with environmental targets, as well as possess the capability to meet the future need of the transport market, as the segment faces a broader variety of cargoes.

Consequently, the shift in the value proposition, the key resources, the vessel itself, will need to change to meet future requirements, which in turn will impact both operational and capital costs. In this sense, the value proposition is not only central, but the driving force behind how the business model must evolve to remain relevant in the long term.

8. RECOMMENDATION FOR FUTURE RESEARCH

The thesis has focused specifically on product tanker shipping, a segment traditionally dedicated to transporting refined fossil-based energy products. However, including other parts of maritime energy transportation, such as crude oil or liquefied gas carriers, could provide a broader understanding on how the energy transition is impacting the sector as a whole.

A central component of this thesis has been the use of scenario-based energy outlooks with varying outcomes. A future economic analysis comparing these scenarios and their implications for areas such as profitability or investment risk could provide a more precise idea on how the energy transition is affecting the shipping segment under different conditions.

One interviewee pointed to the fact that the company's business model had gradually been adjusted over several years, primarily due to a broader range of transported cargo types. This indicates that the company is actively adapting to future markets. As a suggestion, future research could include more in-depth case studies of several shipowners, possibly from different regions, to better understand how the business models are gradually evolving.

Finally, both the interview data and the secondary sources indicate that the energy transition is progressing faster within the European region compared to other parts of the world and is likely to continue doing in the future. Therefore, it could be valuable to compare different geographical regions and possibly explore how regional regulations are affecting shipowners, especially shipowners active within multiple jurisdictions.

REFERENCES

Adams, J., Khan, H. T. A., & Raeside, R. (2014). *Research methods for business and social science students* (2nd ed.). SAGE Publications India.

Adams, W. C. (2015). Conducting semi-structured interviews. In J. S. Wholey, H. P. Hatry, & K. E. Newcomer (Eds.), *Handbook of practical program evaluation* (3rd ed.). Jossey-Bass.

AccountingInsights. (2025). *What Is Time Charter Equivalent and How Is It Calculated?* https://accountinginsights.org/what-is-time-charter-equivalent-and-how-is-it-calculated/

Bureau Veritas. (2022). *The global Energy Transition: An opportunity tanker owners can't miss.* https://marine-offshore.bureauveritas.com/magazine/global-energy-transition-opportunity-tanker-owners-cant-miss

BP. (2024-a). *bp Energy Outlook 2024 edition.* https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/energy-outlook/bp-energy-outlook-2024.pdf

BP. (2024-b). *Bp Energy Outlook – 2024 Insights from the EU.* https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/energy-outlook/bp-energy-outlook-2024-region-insight-eu.pdf

Casadesus-Masanell, R., & Ricart, J. E. (2010). From strategy to business models and onto tactics. *Long Range Planning, 43*(2–3), 195–215. https://doi.org/10.1016/j.lrp.2010.01.004

Cioarec, V. (2020). *The vessel requirements in biodiesel trade*. https://www.commoditylaw.eu/articalDetails.php?idArticolText=80

Council of the European Union. (2023). *Text of the trilogue agreement on the EU emissions trading scheme. Brussels: Council of the European Union.* https://data.consilium.europa.eu/doc/document/ST-6210-2023-INIT/en/pdf

DaSilva, C. M., & Trkman, M. (2014). Business model: What it is and what it is not. *Long Range Planning, 47*(6), 379–389. http://dx.doi.org/10.1016/j.lrp.2013.08.004

Denscombe, M. (2017). *The good research guide* (6th ed.). Open University Press.

DNV. (2024-a). FuelEU Maritime: *How to prepare for compliance*. https://www.dnv.com/news/fueleu-maritime-how-to-prepare-for-compliance/

DNV. (2024-b). *Energy transition outlook 2024*. https://www.dnv.com/energy-transition-outlook/download/?utm_source=googlecpc&utm_medium=search&utm_campaign=eto_2024

_download&gad_source=1&gad_campaignid=21616551769&gbraid=0AAAAo9W8r2KG54xtyiawvYV5u5JS0s2_&gclid=Cj0KCQjw5ubABhDIARIsAHMighbwYGXuoF7NbsUeHSF9kzpwWvkSfMaIGFGUji7gsBoZq41zAYyyOzwaAiu6EALw_wcB

Domenica, V. (2022). The energy transition in the current global context. *Rivista Geografica Italiana, 129*(1). https://doi.org/10.3280/rgioa1-2022oa13368

Energy Information Administration. (2024). *What countries are the top producers and consumers of oil?* https://www.eia.gov/tools/faqs/faq.php?id=709&t=6

European Commission. (n.d.-a). *Decarbonising maritime transport – FuelEU Maritime.* Retrieved 2025-02-10 from https://transport.ec.europa.eu/transport-modes/maritime/decarbonising-maritime-transport-fueleu-maritime_en

European Commission. (n.d.-b). *FAQ – Maritime transport in EU Emissions Trading System (ETS)*. Retrieved 2025-03-25 from https://climate.ec.europa.eu/eu-action/transport/reducing-emissions-shipping-sector/faq-maritime-transport-eu-emissions-trading-system-ets_en

European Commission. (n.d.-c). *Energy Efficiency Directive*. https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficiency-targets-directive-and-rules/energy-efficiency-directive_en

European Council. (n.d.). *Climate*. https://www.consilium.europa.eu/en/topics/climate/

Flodén, J., Zetterberg, L., Christodoulou, A., Parsmo, R., Fridell, E., Hansson, J., Rootzén, J., Woxenius, J. (2024). Shipping in the EU emissions trading system: implications for mitigation, costs and modal split. *Climate Policy*, 1-19. DOI:10.1080/14693062.2024.2309167

Fritelli, John. (2024). The Global Oil Tanker Market: An Overview as It Relates to Sanctions. *Congressional Research Service* (R47962). https://sgp.fas.org/crs/row/R47962.pdf#:~:text=have%20several%20different%20holds%20in,crude%20oil%20tankers%29%20and

Glass, D. (2024). *Non-bank lending takes a larger bite of the ship finance mix*. https://www.seatrade-maritime.com/shipping-finance/non-bank-lending-takes-a-larger-bite-of-the-ship-finance-mix

Hafnia. (2023). *Annual Report 2023*. https://annualreport2023.hafnia.com

Handybulk. (n.d.). *TCE - Time Charter Equivalent.* Retrieved 2025-03-25 from https://www.handybulk.com/tce-time-charter-equivalent/

Jones, C., Bullock, S., Ap Dafydd Tomos, B., Freer, M., Welfle, A., & Larkin, A. (2022). *Shipping's role in the global energy transition: A report for the International Chamber of Shipping*. Tyndall Centre for Climate Change Research, University of Manchester. https://tyndall.ac.uk/news/new-shipping-emissions-report/

UNCTAD. (2024). *Review of Maritime Transport 2024*. https://unctad.org/publication/review-maritime-transport-2024

International Chamber of Shipping. (n.d.). *Tankers*. Retrieved 2025-03-03 from https://www.ics-shipping.org/explaining/ships-ops/tankers/

International Energy Agency (IEA). (2022). *Europe*. https://www.iea.org/regions/europe/oil

International Energy Agency (IEA). (2024-a). *Greenhouse Gas Emissions from Energy Data Explorer*. https://www.iea.org/data-and-statistics/data-tools/greenhouse-gas-emissions-from-energy-data-explorer

International Energy Agency (IEA). (2024-b). *World energy outlook 2024*. https://iea.blob.core.windows.net/assets/140a0470-5b90-4922-a0e9-838b3ac6918c/WorldEnergyOutlook2024.pdf

International Energy Agency (IEA). (2024-c). *Global EV Outlook 2024. Moving towards increased affordability*. https://iea.blob.core.windows.net/assets/a9e3544b-0b12-4e15-b407-65f5c8ce1b5f/GlobalEVOutlook2024.pdf

International Energy Agency (IEA). (2024-d). *Energy Efficiency*. https://www.iea.org/energy-system/energy-efficiency-and-demand/energy-efficiency

Institute of Chartered Shipbrokers (ICS). (2021). *Tanker Chartering* (6th ed.). Witherby Publishing Group.

International Maritime Organization (IMO). (n.d.-b). EEXI and CII – ship carbon intensity and rating system. Retrieved 2025-02-18 from https://www.imo.org/en/MediaCentre/HotTopics/Pages/EEXI-CII-FAQ.aspx

International Maritime Organization (IMO). (n.d.-c). *IMO's work to cut GHG emissions from ships*. Retrieved 2024-02-18 from https://www.imo.org/en/MediaCentre/HotTopics/Pages/Cutting-GHG-emissions.aspx

Madsen, R. E. (2016). Statistics for non-statisticians (2nd ed.). Springer.

Malmborg, F. (2024). At the controls: Politics and policy entrepreneurs in EU policy to decarbonise maritime transport. *Review of Policy Research 41*(2), 1-34. DOI:10.1111/ropr.12609

Nordin, T., (1998). *Om olja.* Svenska Petroleum Institutet.

Osterwalder, A., & Pigneur, Y. (2010). *Business Model Generation*: *A Handbook for Visionaries, Game Changers and Challengers*. John Wiley & Sons.

Parodi, A. (2025). *Global electric vehicle sales up 25% in record 2024.* https://www.reuters.com/business/autos-transportation/global-electric-vehicle-sales-up-25-record-2024-2025-01-14/

Regli, F., Nomikos, K, N., (2019). The eye in the sky – Freight rate effects of tanker supply. *Transportation Research Part E: Logistics and Transportation Review* Volume 125, 402-424. https://doi.org/10.1016/j.tre.2019.03.015

Rho motion. (2025). *Rho Motion View: Over 20M EVs to be Sold Globally in 2025.* https://rhomotion.com/news/rho-motion-view-over-20m-evs-to-be-sold-globally-in-2025/

Shipfinex. (2024). *Tanker Ships and Their Types.* https://www.shipfinex.com/blog/tanker-ships-and-types

Stopford, M. (2009) *Maritime Economics* (3rd ed.). Routledge.

Teece, D. J. (2010). Business models, business strategy and innovation. *Long Range Planning, 43*(2–3), 172–194. https://doi.org/10.1016/j.lrp.2009.07.003

United Nations Framework Convention on Climate Change (UNFCCC) (2015). *The Paris Agreement. What is the Paris Agreement?*. https://unfccc.int/process-and-meetings/the-paris-agreement

UNCTAD. (2024). *Review of Maritime Transport 2024.* https://unctad.org/system/files/official-document/rmt2024_en.pdf

Vasilev, M., Kalajdžić, M., Momčilović, N. (2025). On energy efficiency of tankers: EEDI, EEXI and CII. *Ocean Engineering*, Volume 317. https://doi.org/10.1016/j.oceaneng.2024.120028

Wadanambi, R. T., Wandana, L. S., Chathumini, K. K. G. L., Dassanayake, N. P., Preethika, D. D. P., & Arachchige, Udara. S. P. R. (2020). The effects of industrialization on climate change. *Journal of Research Technology and Engineering, 1*(4), 86–94.

https://www.researchgate.net/publication/344479407

World Trade Organisation. (2024). *Thirty years of trade growth and poverty reduction*. https://www.wto.org/english/blogs_e/data_blog_e/blog_dta_24apr24_e.htm?utm_source=chatgpt.com

Zott, C., Amit, R., & Massa, L. (2011). The business model: Recent developments and future research. *Journal of Management, 37*(4), 1019–1042. https://doi.org/10.1177/0149206311406265

APPENDIX 1

Questionnaire used for the Shipowner

Introduction
Brief introduction / purpose of the thesis
Who are you / your background and role in the company?
Number of years in the role / industry?

Market Development

1. How do you view the development of the tanker market up to 2050? What major changes do you expect? How are you preparing for them?

2. What factors do you consider to be the main drivers behind future changes in the product tanker market? (Follow-up to the previous question)
    - Is it possible to estimate when these changes will have the greatest impact?

3. Is there any future scenario that you would consider particularly challenging?

Business Development and Technological Factors

4. What new business opportunities do you see in the tanker market going forward? Is there potential for new collaboration models with energy companies or other actors (e.g. authorities or private entities)?

5. How do you view the possibility of converting vessels to other uses than traditional product tanker transport, such as alternative fuels, carbon storage, etc.?
    - What challenges do you see in adapting vessels for such a transition?

6. What technological changes do you expect by 2050?
    - How could these be integrated into your operations?
    - Is there any technological area you believe will be significant in the future but is barely discussed today?

External Factors and Market Changes

7. What do you see as the biggest challenges for the tanker market in connection with the energy transition? Considering both the transport market and the environmental impact of operations.

8. How do you assess that future regulations, market conditions, and legislation will affect you?

9. What is your view on the competition from alternative modes of transport and energy sources? What factors could affect the long-term relevance of the tanker market?

Economic Conditions and Business Model

10. What factors do you see as crucial for maintaining profitability in the future? Does the business model need to be adjusted?
11. How would you describe your business model today (do you, for example, have a clearly formulated one?), and do you see a need to change it to meet future demands/changes?

APPENDIX 2

Questionnaire used for the industry expert

Introduction

Brief introduction / purpose of the thesis
Who are you / your background and role in the company?
Number of years in the role / industry?

Market Development

1. How do you view the development of the tanker market up to 2050? What major changes do you expect? How do you think product tanker owners are preparing?

2. What factors do you consider to be the main drivers behind future changes in the product tanker market?
    - Is it possible to estimate when these changes will have the greatest impact?

3. Is there any future scenario that a product tanker owner might find particularly challenging?

Business Development and Technological Factors

4. What new business opportunities do you see in the tanker market going forward? Is there potential for new collaboration models with energy companies or other actors (e.g. authorities or private entities)?

5. How do you view the possibility of converting vessels to uses beyond traditional product tanker transport, such as alternative fuels, carbon storage, etc.?
    - What challenges are associated with adapting vessels for such a transition?

6. What technological changes do you expect by 2050?
    - How could these be integrated into a shipowner's operations?
    - Is there any technological area that you believe will become significant in the future but is barely discussed today?

External Factors and Market Changes

7. What do you see as the biggest challenges for the tanker market in connection with the energy transition—both in terms of the transport market and the environmental impact of operations?

8. How do you assess that future regulations, market conditions, and legislation will affect product tanker owners?

9. What is your view on competition from alternative modes of transport and energy sources? What factors could affect the long-term relevance of the product tanker market?

Economic Conditions and Business Model

10. What factors do you see as crucial for tanker owners to maintain profitability in the future? Do their business models need to be adjusted?

APPENDIX 3

Questionnaire used for the energy companies

Introduction
Brief introduction / purpose of the thesis
Who are you / your background and role in the company?
Number of years in the role / industry?

Future demand for fossil fuels

1. How do you expect global demand for refined oil products to change by 2050?

Trade patterns and transport needs

2. How do you think the transport flow of oil products will change in the future?
    - Do you foresee any changes in geographical trade patterns? For example, new export or import regions, altered routes, or shifting demand in different parts of the world?

Impact of alternative energy sources

3. Which alternative energy sources do you see as the main replacements for traditional fossil-based products?

4. How do you think these alternative fuels will affect:
    - The requirements for tanker vessels
    - The logistics chains and transport infrastructure

5. What requirements do you think tanker shipping companies will need to meet to remain an attractive transport partner for energy companies?

Future and market position

6. Do you still see yourselves as a player in the market in 2050?
    - If yes, what does your business look like by then?

7. What scenario do you see as an "ideal" future development?
    - What factors could represent a "nightmare" scenario for the market or your business?

DEPARTMENT OF TECHNOLOGY MANAGEMENT AND ECONOMICS
DIVISION OF INNOVATION AND R&D MANAGEMENT
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2025
www.chalmers.se

CHALMERS