Universitetet i Stavanger

UNIVERSITY OF STAVANGER BUSINESS SCHOOL

MASTER'S THESIS

STUDY PROGRAMME:	THIS THESIS HAS BEEN WRITTEN WITHIN THE FOLLOWING FIELD OF SPECIALISATION:
Økonomi og administrasjon	IS THE THESIS CONFIDENTIAL? **NO** **(NB!** Use the red form for confidential theses)

TITLE:

Policy instruments and the uptake of zero-emission solutions in international shipping of Norway – A study of Sea- Cargo A/S

AUTHOR(S)		SUPERVISOR:
Candidate number: **2052** …… ……	Name: **TINE BOWITZ GJØSTEIN** …… ……	**THOMAS LAUSDAL**

Abstract

This thesis researches the policy instruments implemented by the Norwegian Government to motivate international shipping to invest in zero- emission energy solutions. The perspective of the thesis is that for innovation to occur the technological innovation system must be well functioning. By researching identified drivers and barriers, this thesis gives an insight into what instruments seem efficient in increasing the functionality of the TIS. By using Sea-Cargo A/S' investment in rotor sails as a case study, the thesis seeks to uncover what motivated them, and if the Norwegian government's policies affected them in any way.

Contents

1. Introduction 4

1.1. Research purpose 4

1.2. Research question 5

1.3. Delimitation 5

2. What are rotor sails 6

3. Literature review 7

4. Theoretical Review 8

4.1. Drivers and barriers for the uptake of wind propulsion 8

4.2. The Technological Innovation System 8

4.3. The seven system functions of the rotor sails in the TIS 9

4.4. The role of governments in renewable energy 10

5. Methodology 11

5.1. Research philosophy 11

5.1.1. Ontology 11

5.1.2. Epistemology 13

5.2. Research approach 13

5.2.1. Inductive approach 13

5.2.2. Deductive approach 13

5.3. Research Methods 14

5.3.1. Quantitative approach 14

5.3.2. Qualitative approach 14

5.4. Research strategy 15

5.5. Questionnaire design 15

5.5.1. Part 1: The system functions 15

5.5.2. Part 2: Fulfillment of the system functions 16

5.5.3. Part 3: Why invest in rotor sails 16

5.6. Securing quality 16

5.6.1. Validity 16

5.6.2. Reliability 17

5.7. Adequacy 17

6. Findings and analysis 17

6.1. Why the Norwegian government motivate towards green shipping 17

6.1.1. Norway and the United Nations 18
6.1.2. IMO Strategy on reduction of GHG emissions from ships 21
6.1.4. The technological innovation system 22
6.1.5. Summary 23
6.2. What policy instruments are implemented by the Norwegian government 23
6.2.1. Barriers for the uptake of wind propulsion 23
6.2.2. Policy instruments 26
6.2.3. Identified policy instruments and how they improve the TIS 32
6.2.4. Summary 32
6.3. What affected Sea- Cargo's investment decision 33
6.3.4. The process that led to rotor sails 38
6.3.4.1. Incentives driving the decision 39
6.3.5. Summary 39
7. Conclusion 40
Appendix 1 – Questionnaire 42
Appendix 2 - Questionnaire results 58

1. Introduction

The world is becoming increasingly concerned about climate change and the environment, with continuous demonstrations worldwide. Shipping is carrying 90% of world trade and is considered the most energy efficient mode of transportation. Yet, it is inevitable that the industry will be affected by the movement (Stensvold, 2020). As the Norwegian Prime Minister says,

"The threats to our climate and the health of our oceans can only be addressed through innovation and global cooperation"
(DNV GL, 2017),

and stricter regulations from the International Maritime Organization will result in an increased demand for environmentally friendly technology the next decades.

Sea- Cargo A/S was founded in 2001 through a merger between Seatrans and Nor Cargo. The two companies were the markets leading sipping lines for trade between the West Coast of Norway and the United Kingdom, as well as mainland Europe. The main shareholder is Seatrans with a share of 96% (Sea- Cargo A/S, 2021). The company is asset- based, meaning they own their own ship, terminals, equipment, and infrastructure. Through teamwork and innovation with customers, the company aims at having the most advances and cost- effective transport systems available.

In 2019 the company applied for a grant from ENOVA to support the installation of two rotor sails on their vessel SC Connector. This application was approved the same year, and the company received a grant of 18,8 million NOK. Enova argues that the project will contribute to technological innovation, knowledge development and knowledge diffusion (ENOVA SF, 2020). The installation of such a zero- emission solution is predicted to reduce the vessel's fuel consumption by 25%, and if successful, will be a revolutionary development in the industry (Stensvold, 2020), (ENOVA SF, 2020).

1.1. Research purpose

The overall purpose of this thesis is to gain knowledge regarding the Norwegian government's implementation of incentives towards the uptake of zero- emission solutions in shipping, and to research to what extent these incentives have affected Sea- Cargo A/S to invest in the rotor sail solution. The result of this thesis seeks to address whether the policy instruments implemented by the Norwegian

government is decisive for ship owners' willingness to invest in zero- emission solutions, or if there are other forces driving them. By using Sea- Cargo A/S' investment in rotor sails as a case study, the thesis will show whether the governments have affected their decision process, and with that the likeliness of the same affect to other ship owners in Norway.

1.2. Research question

The thesis aims at answering the following research question:

"How does the Norwegian government give international shipping incentives to invest in green energy, and to what extent did they affect Sea- Cargo A/S to invest in rotor sails?"

Here are some definitions needed to understand the scope of the research question:

- *International shipping:* Norwegian ship owners operating in international seas
- *Incentives:* policies motivation green energy or discouraging use of fossil fuel
- *Green energy:* low- or zero-emission energy solutions for vessels.

Sea- Cargo A/S will be addressed as Sea-Cargo from now on.

To answer the research question, the following sub- question will be explored to secure a more comprehensive research result.

1. Why the Norwegian government motivate towards green shipping

2. What policy instruments are implemented by the Norwegian government

3. What did Sea- Cargo's chose to invest in rotor sails

The first sub- question will provide an understanding as of why the government to support green energy in international shipping and what they gain from it. The second sub- question then looks at how the government support do so through policy instruments. The last question then looks at if and how these policies have affected Sea- Cargo in their decision to invest in rotor sails.

1.3. Delimitation

This thesis is limited to researching the Norwegian governments implemented policies promoting green energy for international shipping. Because the industry itself is international, I acknowledge that the governments impact on the industry may be somewhat limited.

The nature and effect of the policies may not be valid for other countries. The thesis only looks at the governments incentives towards green energy, and mainly towards wind propulsion as it concerns the solution chosen by Sea- Cargo. It does not address other technological solutions. Further, the paper researches the decision of Sea-Cargo, and their experience of the policy instruments or surrounding environment may only be valid for them.

2. What are rotor sails

In 1926, Anton Flettner sailed across the Atlantic with a technology later known as Flettner rotors. The technology was invented by Sigurd Savonius and is based on an aerodynamic principle known as the Magnus effect (Sclavounos, Mazarakis, & Katsanos, 2020) (Norsepower, 2020). The Magnus effect is a phenomenon where a rotating object immersed in a flowing fluid sustains a force perpendicular to the line of its rotating motion (Wang & Fan, 2013).

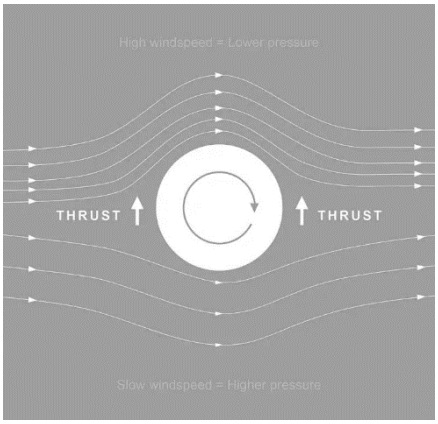

Figure 1: Magnus Effect (Norsepower, 2020)

By installing rotating cylinders on a vessel, the rotation in cross flow generates a lift force and pulls the vessel ahead as seen in figure 1**.**

Some actors, such as Norsepower, have developed their modernized version of the Flettner rotor. In collaboration with Norsepower, Sea- Cargo have installed two 35-meter-tall rotor sails on their vessel SC Connector, which are estimated to reduce CO2 emissions by 25% (Norsepower, 2021) (Maritime Bergen, 2020). The sails will be used in a hybrid solution with a battery pack from Norwegian Electric Systems. This will make SC connector a zero- emission ship during sailing and at quay (Sea- Cargo A/S, 2020). Norsepower's rotor sail solution also enables SC Connector to tilt the sails when needed, allowing them to sail under bridges and powerlines as needed in the North Sea, making SC Connector the world's first installation of tiltable rotor sails (Norsepower, 2021).

3. Literature review

Rojon & Dieperink (2014) concludes that in 2014 the TIS of rotor sails was poorly functioning. This is based on 14 semi-structured interviews with experts such as 9 Shipping; Energy Ship; FutureShip; Global Maritime Investment Group; Greenheart Project; Interna-tional Association of Ports and Harbors; International Maritime Organization; Maersk; Propelwind; Skysails; Sustainable Shipping Initiative; Transport & Environment; University College London and Zodiac Maritime Agencies (Rojon & Dieperink, 2014; 395). By being poorly functioning, they argue that there are more barriers than drivers in the market for actors to uptake wind propulsion.

My study will give an insight to which degree the research paper of Rojon & Dieperink (2014) is outdated, as technology is a fast-moving industry. With rotor sails becoming a desired technology, and an increased focus on renewable energy and reduced emissions, the TIS could be better performing than first assumed in 2014. It can also be discussed whether the drivers and barriers should be seen in an TIS perspective, if government legislation and incentives play an important role in the diffusion of wind propulsion as this will vary among countries.

Talluri, Nailanda, & Giuliani (2018) have researched the effects of rotors sails of various diameters on specific routes in comparison to other fuel alternatives such as gas turbine and diesel. As rotor sails are an insufficient energy source by itself, they consider hybrid solutions with a combination of the former and rotors sails. Their analysis takes two different scenarios to research the consequences of emission taxes on cost. The first scenario assumes same CO2 emission tax on both natural gas and MDO fuels to determine if one specific tax amount would make one alternative more attractive than others. The second scenario assumes different carbon taxation rates as legislated by British Columbia. This legislation is designed to favor natural gas solutions rather than oil. One of the routes they have researched is Oslo, Norway – Southampton, UK, where they determine that the most cost-efficient alternative is gas turbine with no rotor sails in both scenarios.

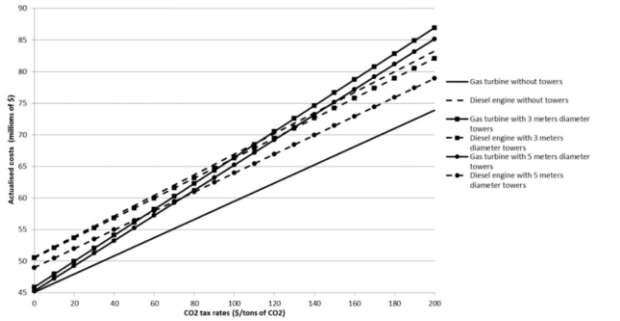

Fig. 11. Influence of the CO_2 tax rates on the economic viability of the different propulsive configurations for the second route (North Sea).

Figure 2: Influence of the CO2 tax rates on the economic viability of the different propulsive configurations for North Sea (Talluri, Nailanda, & Giuliani, 2018)

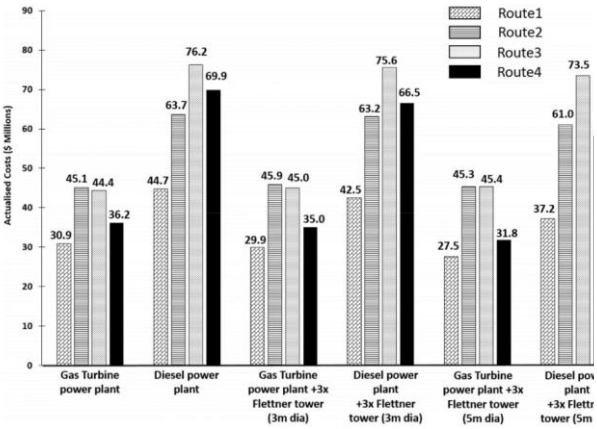

Fig. 14. Actualised costs with the application of the British Columbia tax rates for the analysed configurations.

Figure 3: Actualized costs with the application of the British Columbia tax rates for the analyzed configuration (Talluri, Nailanda, & Giuliani, 2018)

My study will contribute to this theory by touching the topic of why Sea- Cargo has chosen to invest in rotor sails despite the findings of Talluri, Nailanda, & Giuliani (2018), and if they perhaps are using a different hybrid solution than those considered in their research paper. This could show that the parameters of Talluri, Nailanda, & Giuliani (2018) are highly case sensitive and not applicable for similar routes and technologies.

4. Theoretical Review

4.1. Drivers and barriers for the uptake of wind propulsion

Rojon & Dieperink (2014) presents a list of drivers and barriers for the uptake of wind propulsion which will be the main theory for answering this paper's research question. Rojon & Dieperink's findings are a result of researching wind propulsion as a technological innovation system (TIS) with seven system functions that needs to be fulfilled to secure an efficient system. While discovering that the performance of the TIS of rotor sails is poor, they identify a list of structural barriers and drivers influencing TIS development of wind propulsion cf. figure 4.

4.2. The Technological Innovation System

The TIS perspective will be the basis for this paper as well to secure consistency in the collected data compared to the original theory. A TIS is defined as

"a network of agents interacting in the economic/industrial and are under a particular institutional infrastructure and involved in the generation, diffusion, and utilization of technology"
(Carlsson & Stankiewicz, 1991; 94).

However, this paper will not evaluate the current TIS of wind propulsion, but rather focus on Sea- Cargo's impression of the TIS of rotor sails and to which degree the identified drivers and barriers have affected them accordingly in their decision-making process.

4.3. The seven system functions of the rotor sails in the TIS

By having expert online interviews, Rojon & Dieperink were able to map the current fulfillment of the seven system functions and their importance which is presented in figure 4.

The seven structural functions are described by (Hekkert, Suurs, Negro, Kuhlmann, & Smits, 2007) as

F1) Entrepreneurial activities
The activities of the innovation system which relate to business startups, diversification, and testing of new technologies.

F2) Knowledge development
Educational activities on the technical, social, and economic aspects of new technologies.

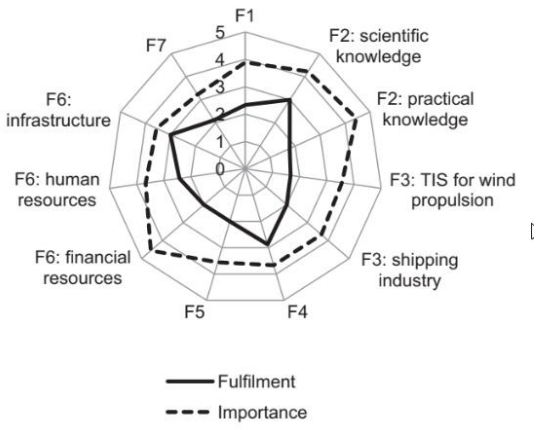

Figure 4: The importance and fulfillment of system functions (Rojon & Dieperink, 2014)

F3) Knowledge diffusion
Those activities and processes of innovation that focus on information dissemination, awareness raising, and capacity-sharing and resource sharing among system actors.

F4) Guidance of the search
This function is about creating hope and optimism about the future of new technologies. The aim of this function is also reducing the uncertainty and risks associated with new technologies.

F5) Market formation
It covers functions, activities, and processes that can create tools for new technologies. This function will extend the market for new technologies by providing market protection standards.

F6) Resource mobilization
Human and financial resources are economic variables for the emergence and success of an innovation. This function distributes the necessary resources for the development and diffusion of new technologies among actors of the innovation system.

F7) Creation of legitimacy

New technologies often fail to gain approval from key actors and policymakers. This function carries out activities that provide legitimacy for new technologies

(Hekkert, Suurs, Negro, Kuhlmann, & Smits, 2007) (Esmailzadeh, Noori, Aliahmadi, Nouralizadeh, & Bogers, 2020).

Sea Cargo A/S will give their evaluation of these system functions and what their impression of each function's importance.

4.4. The role of governments in renewable energy

The government's motivation and policies for renewable energy is a subject of this paper, and so it is important to address the role of governments in renewable energy. Governments are driven by a desire to improve social welfare and must direct the companies towards this goal by providing a system for market development through rules and regulations. For this to happen, the government must provide concrete financial support types and prevent unsustainable production through consistent policies (White, Lunnan, Nybakk, & Kulisic, 2013). These aids to do so are known as policy instruments, which can be divided into three types: 1) Regulatory instruments, 2) Economic and financial instruments, 3) Soft instruments (Borrás & Edquist, 2013). In relation to renewable energy, Esmailzadeh, Noori, Aliahmadi, Nouralizadeh, & Bogers (2020) have identified policy instruments for the development of renewable energy cf. figure 6. This paper will research the consistency of the Norwegian

Table 3
Overview of structural barriers and drivers influencing TIS development of wind propulsion.

	Structural barrier	Structural driver
External factors Hard institutions	Economic crisis Lack of policies promoting wind propulsion Lack of stringency of air pollution and GHG emission reduction policies Weak compliance and enforcement mechanisms Lack of financial incentive schemes Lack of start-up finance Lack of public finance for R&D activities Split incentive	Rising fuel prices Future introduction of MBMs Development of alternative financing mechanisms Emergence of voluntary benchmarking tools
Soft institutions	Lack of trust among actors Conservative and risk-averse industry	Great entrepreneurial drive Increasing demand for environmentally-friendly shipping services
Knowledge infrastructure	Lack of demonstration projects and practical trials Lack of independent 3rd party testing	New research consortia
Interaction	Little collaboration between technology providers Lack of knowledge exchange platforms Weak network between actors in- and outside of TIS	Emerging collaboration and lobbying activities among technology providers
Physical infrastructure	Ill-suited port loading and unloading equipment	

Figure 5: Structual Drivers and Barriers (Rojon & Dieperink, 2014)

government's policies for renewable energy, which instruments they have taken into use and how efficient they have been given Sea- Cargo's decision to invest in rotor sails.

Policy Instruments
Custom duty exemptions
Feed-in tariffs
Funding to support R&D
Venture capital in the field of energy
R&D equipment
Risk coverage support
public-private partnership (PPP)
demand pull policy
anti-dumping policy
tariff policies
distributed energy policy and demonstration projects

Figure 6: Policy instruments for development of renewable energy

5. Methodology

As defined by Sachdeva (2007) *"Methodology is the underlying theory and analysis of how research does or should proceed, often influenced by discipline."* (Sachdeva, 2007).

In the following section the chosen methodology of this paper is presented, and with that the research philosophy, research approach, methods, strategy and the reliability and validity of the collected data.

5.1. Research philosophy

The research philosophy refers to the system of beliefs and assumptions about the development of knowledge. While one might be unaware of it, you have assumptions about the reality you research, human knowledge and the extent your own values influence your research process (Saunders M. N., 2015) (Saunders, Lewis, & Thornhill, 2015). As a researcher you undertake assumptions which all affect your understanding of the research question and your use and interpretation of findings.

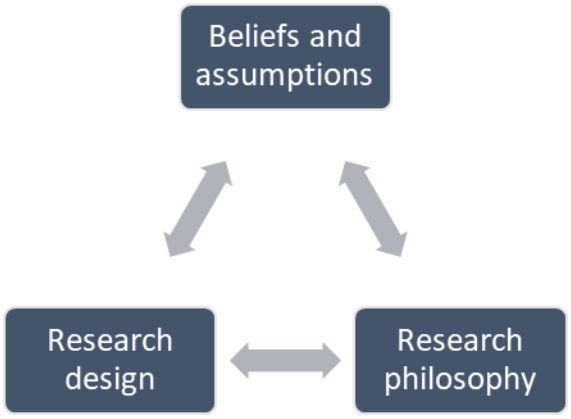

Figure 7: Research philosophy

For instance, the research question of this paper assumes that the government have implemented policies to promote green energy in international shipping. This assumption is based on my prior assumptions to the subject and does affect my attitude towards the research.

5.1.1. Ontology

Ontology is defined by Saunders M. N. (2015) as assumptions about the nature of reality, and says something about how you see the world, and with that your choice of

research subject. Your ontology can either be objective or subjective.

An objective ontology views social entities as physical, existing independently of our perception of it. With this point of view, there exists only one true world (Saunders, Lewis, & Thornhill, 2015) (Eriksson & Kovalainen , 2008).

A subjective ontology assumes reality is a construct of the social actors' perceptions and actions. In ontology subjectivism is embraced as nominalism, believing there is no one true reality because actors perceive and experience reality differently (Saunders M. N., 2015).

This thesis takes use of both ontologies. The question of what policy instruments the Norwegian government has taken use of is researched with an objective ontology. There is a very clear answer as to what regulations, economic and financial aids or soft instruments that are meant to motivate towards a zero- emission society. However, the reason for Sea- Cargo's decision to invest in rotor sails is viewed through a subjective ontology. There is no real or true answer to the question and the company's answers are from their own perception of reality. Further, the preparation of questions and gathered information is affected by my own

Assumption type	**Questions**	**Continua with two sets of extremes**	
		Objectivism	***Subjectivism***
Ontology	What is the nature of reality?	Real	Nominal/decided by convention
	What is the world like?	External	Socially constructed
	For example: – What are organizations like? – What is it like being in organizations? – What is it like being a manager or being managed	One true reality (universalism) Granular (things) Order	Multiple realities (relativism) Flowing (processes) Chaos
Epistemology	How can we know what we know?	Adopt assumptions of the natural scientist	Adopt the assumptions of the arts and humanities
	What is considered acceptable knowledge	Facts	Opinion
	What kinds of contribution to knowledge can be made	Observable phenomena	Attributed meanings
		Law-like generalizations	Individuals and contexts, specifics

Table 1: Ontology and Epistemology (Saunders M. N., 2015)

subjective ontology regarding what is important and my formulation of questions.

5.1.2. Epistemology

Epistemology is defined as

"[…] assumptions about knowledge, what constitutes acceptable, valid and legitimate knowledge, and how we can communicate knowledge to others"
(Saunders M. N., 2015; 127).

The epistemology sets the grounds of your research methods and is important to acknowledge to be aware of the limitations of your research methods.

Objective epistemology studies the world through observable and measurable facts. Subjective epistemology studies the world through the assumptions and opinions of actors. (Saunders M. N., 2015)

I would categorize the epistemology for this thesis as objective as well as subjective. While some facts are observable and measurable, others are based on my own assumptions and opinions and that of Sea- Cargo. Therefore, the data collection of this thesis consists mainly of qualitative data.

5.2. Research approach

The research approach can be classified into two categories: deductive reasoning and inductive reasoning. The choice between the two depends on whether you begin your researched based on theory, or if you begin your research with observations ending in a theory.

5.2.1. Inductive approach

An inductive research approach begins with collection of data and concludes with the generation of theory (Goddard & Melville, 2004) (Saunders M. N., 2015). It involves searching for patterns in observations of a phenomenon and the following explanations and theories for those patterns through hypotheses (Bernard, 2011).

Figure 8: Inductive reasoning

5.2.2. Deductive approach

A deductive approach begins with theory and collects data to explain patterns of the phenomenon in question (Yin, 2003) (Saunders M. N., 2015). It involves researching if problems could be general and explain why something is rather than what.

Figure 9: Deductive reasoning

The choice of research approach depends on the circumstances surrounding the

research. A summary of this is seen in table 2.

This thesis is based on deductive reasoning. While presented with the case of Sea- Cargo, I first looked for theories relevant for the subject of innovation and diffusion of technology. Based on my findings I formulated the research questions and collected data accordingly. While the literature on rotor sails is rather scarce, there exists theories discussing barriers for the uptake of wind propulsion and the role of government in renewable energy. I have developed a research question aimed to supplement these theories.

5.3. Research Methods

There are two types of research methods: quantitative research and qualitative research. This thesis uses a combination of the two.

5.3.1. Quantitative approach

Through this approach one use numbers and calculations to describe or measure a level of occurrences. Research methods within quantitative research are close-ended questionnaires, experiment analyzed with correlation and regression analysis. (Fellows & Liu, 2015)

The quantitative approach is used in this thesis through a close- ended questionnaire where the participants can choose answers based on a scale of 1 – 5, cf. Appendix 1.

5.3.2. Qualitative approach

The qualitative approach is used to understand the perceptions of the world. The collected data gives an insight into the researched object's beliefs, understandings, opinions and views. Common qualitative research methods are descriptions, quotations, observations and conducted interviews. The data is more difficult to analyze as it requires a lot of filtering and sorting. (Fellows & Liu, 2015)

The qualitative approach is used in this thesis through an open- ended questionnaire. In addition, I have collected secondary data through newspaper articles, company websites and governmental websites.

	Deductive reasoning	Inductive reasoning
Existing literature	Abundant	Scarce
Time management	Scarce	Abundant
Risk	Risk adverse	Risk- loving – no theory may emerge

Table 2: Inductive and Deductive reasoning (Yin, 2003)

5.4. Research strategy

The research strategy is a general plan on the approach for answering the research question, and can be divided into five categories: 1) experiments, 2) surveys, 3) history, 4) archival analysis and 5) case studies (Saunders, Lewis, & Thornhill, 2009) (Yin, 2003). The choice of research strategy depends on three conditions:

1. The type of research questions posed.
2. The extent of control a researcher has over actual behavioral events.
3. The degree of focus on contemporary events compared to historical events.

(Yin, 2003)

A summary of these conditions sorted by the five categories is seen in table 3.

The purpose of this thesis is to explain "how", making a strategy of experiment, history, or case study suitable. However, this thesis researches a current situation and does not require my control over behavioral events, making case study the most suitable option.

This thesis is an explanatory paper, which seeks "to answer a particular question or explain a specific issue/phenomenon. As in exploratory studies, propositions/hypotheses are used but here, as the situation is known better (or is defined more clearly), theory and so on can be used to develop the hypotheses which the research will test. Also, this could be a follow-on from exploratory research which has produced hypotheses for testing" (Fellows & Liu, 2015; 12)

5.5. Questionnaire design

The primary data collection for this thesis consists of a 3- part questionnaire with a total of 51 questions, where part 1 and 2 are close- ended and part 3 open. The questionnaire is seen in appendix 1.

5.5.1. Part 1: The system functions

The purpose of part 1 is to identify Sea-Cargo's opinion of each function's importance. Being presented with each of the seven functions, and a description as of what it means, the subjects must answer by a Likert 5-poing scale for level of importance. This because I want to

Research strategy	Form of research questions	Requirement of control over behavioural events	Focus on temporary events
Experiment	How, why	Yes	Yes
Survey	Who, what, where, how many/much	No	Yes
History	How, why	No	No
Archival Analysis	Who, what, where, how many/much	No	Yes/No
Case study	How, why	No	Yes

Table 3: Research Strategy (Yin, 2003)

compare the answers of Sea- Cargo to the theoretical findings of (Rojon & Dieperink, 2014).

5.5.2. Part 2: Fulfillment of the system functions

The purpose of part 2 is to identify Sea-Cargo's opinion of each functions' presence. There are three questions linked to each function that is to be answered by a Likert 5-pointscale for level of agreement. This because I want to compare the answers of Sea- Cargo to the theoretical findings of (Rojon & Dieperink, 2014). The subjects were allowed to add comments to each function if deemed relevant by the subject themselves.

5.5.3. Part 3: Why invest in rotor sails

The purpose of part 3 is to understand why Sea- Cargo has chosen to invest in rotor sails, and what effected their decision. This part contains 13 open- ended questions designed to given in insight to their decision-making process. Not only why they made the decision to invest in rotor sails, but also what other options they considered, whether they've considered such technologies previously, and the process they've gone through.

The subjects are aware of each parts purpose, and the categorizing of their answers. This to make the subjects reflect on their answers validity to each function and minimize the risk of confusion as of the questionnaire's purpose.

The questionnaire was sent to the Sea-Cargo's Chief of Finance (CFO) and Sea-Trans' Chief of Technical Operations (CTO). Reason for this is that the two employees are the ones who have been most involved with the project regarding the technical specifications and the financial aspect of the investment. While more subjects would be preferrable, time management and the availability of Sea-Cargo limited those options.

The result of the questionnaire is attached in appendix 2, where I've taken the average score given in part 1 and 2 to present the view of the company.

5.6. Securing quality

5.6.1. Validity

To secure the validity of this thesis, I have made sure to have a good coherence and natural flow in the thesis' sub- questions. Each sub- question is reliant on the results of the previous one to answer the thesis' research question. By using a deductive approach, I have secured that there is a good coherence between the collected data and theory. Based on this I would argue that the thesis is valid.

5.6.2. Reliability

The collection of data stems from various sources, positively affecting the reliability of the data. None of the data collected is confidential, this the results from the subjects have no intent to withhold information when giving their answers. One thing possibly having a negative affect is that Sea- Cargo could have the incent to present their company as attractive as possible, causing them to romanticize their decision to invest in rotor sails and the efficiency of the chosen solution. However, this thesis does not aim at researching the efficiency nor success of the project. The situation can be problematic as the company could have intentions of promoting an overly well-functioning TIS to defend their decision to invest. Further, the open- ended questions are prepared by me, and with that can cause a bias towards being overly- positive to the project and market situation.

5.7. Adequacy

It would be preferable to have more questionnaire subjects to secure its results. Further, having interviews with the company would be a preferred method rather than questionnaire, as it would secure a higher qu ality of the data collected and avoid misunderstandings. To secure a better adequacy, all statements are referenced, and quotations are cited to avoid misinterpretation of definitions.

6. Findings and analysis

6.1. Why the Norwegian government motivate towards green shipping

Behind every governmental decision is the desire to improve social welfare, and renewable energy can increase social welfare in multiple ways. Most prominent is the direct reduction of negative externalities such as pressure on ecosystems and the impact on human health (IRENA, 2017), but renewable energy also contributes to an increased GDP.

Studies show that reducing global CO^2 emissions in line with the Paris Agreement would boost GDP by 0,8% in 2050, which constitutes 19 trillion USD (IRENA, 2017). This increase is assumed to be stimulated by investments in renewables and energy efficiency, as well as by enabling policies, including carbon pricing and recycling of revenues from reduced income taxes (IRENA, 2017). While the Paris Agreement does not include international shipping (Stensvold, 2020), ocean- based industries can outperform the growth of the global economy by 2030 (DNV GL, 2017), and the Norwegian

government recognizes the competitive advantage green shipping offers. Being the world's forth larges shipping nation, having a green fleet can increase their international position and competitive advantage in the market (The Ministry of Climate and Environment, 2019) (Norwegian Shipowners' Association, 2021).

The renewable energy sector will also secure employment for 25 million people worldwide, offsetting the loss in the conventional energy sector. The creation of job opportunities is also an important driver for the Norwegian government, as they aim to create job opportunities in the districts (The Ministry of Climate and Environment, 2019) (White, Lunnan, Nybakk, & Kulisic, 2013).

To ensure these social benefits, the government must provide a system for market development that supports free market forces. Drivers must guide companies towards the government's goal, and drivers for renewable energy include energy security, energy supply, energy affordability, sustainability and adapting to and mitigating climate change (White, Lunnan, Nybakk, & Kulisic, 2013). The Norwegian government is focused on providing these drivers for the market of shipping, and as stated by their prime minister:

"We recently launched an ambitious strategy for our ocean industries, with a view to paving the way for sustainable growth for years to come. Moreover, my government will soon launch its first white paper on the role of the oceans in our foreign policy. Key points in the white paper include a firm commitment to the sustainable use of resources, and concrete measures to combat the threats facing our oceans" (DNV GL, 2017; 4)

While the increased social welfare drives the Norwegian government, the country's national policy goals and industry interests are also driven by their membership in the United Nations (UN) and the International Maritime Organization (IMO). As stated in The Ministry of Climate and Environment (2019), the focus on green shipping supports the government's desire to reach their international climate commitments and goals of reducing emissions in the transport sector.

6.1.1. Norway and the United Nations

Norway has been a part of the UN since the organization was founded in 1945 and has since been a large contributor to the organization through economic, military, and human resources (United Nations Association of Norway, 2021). Being a small country, it is important for Norway to have an influence in international

politics, and this is ensured through their membership.

Much of Norway's climate policy has taken place through the UN (United Nations Association of Norway, 2021) and the country has been an active lobbyist in favor of the Paris Agreement. In 2016, the Prime Minister of Norway was assigned the leader of the UN Sustainability Team towards achieving the UN sustainable development goals ((United Nations Association of Norway, 2021) (Ask, 2021), and with that announced that Norway should pave the way for sustainable growth ((United Nations Association of Norway, 2021) (DNV GL, 2017).

6.1.1.1. The Paris Agreement

In December 2015, the Paris Agreement was formed, becoming a game changer in the global work towards a climate neutral world by 2050 ((United Nations Climate Change, 2021) (The Ministry of Climate and Environment, 2019). The goal of the treaty is to limit global warming to no more than 2 degrees Celsius, preferably 1,5 (United Nations Association of Norway, 2020). While only the wealthiest countries were obliged to reduce emissions previously, this new agreement applies to all countries, and each country must develop an action plan and report their progress every fifth year as of 2023 (United Nations Climate Change, 2021) (United Nations Association of Norway, 2020).

Through the Paris Agreement, Norway's goal is to reduce emissions by 40% within 2030 compared to 1990. They intend to do so through national rules and regulations (The Ministry of Climate and Environment, 2019). Although the Paris Agreement does not involve international shipping (Stensvold, 2020), it has an indirect impact on the governance of the shipping industry; to achieve being a low-emission society Norway must reduce the emissions of international shipping as well (Maritime Bergen, 2020).

6.1.1.2. Green shipping and the Sustainable Development Goals

While the Paris Agreement does not affect Norway's drive towards green international shipping directly, their role in achieving the UNs Sustainable Development Goals does. In June 2021 the government presented a national plan of action to achieve the development goals by 2030 (United Nations Association of Norway, 2021) (Ministry of Local Government and Modernisation, 2021). By supporting renewable energy solutions in shipping, the country will positively affect the biosphere, society, and economy.

Biosphere

Green shipping reduces harmful discharges to sea, reduces emissions to air and the use of hazardous chemicals.

Society

Green shipping creates job opportunities and growth in the economy and secures a sustainable transportation of food. The use of renewable energy solutions and continuation to develop and implement such solutions allows for affordable and clean energy in the market.

Economy

Green shipping creates jobs across industries and services facilitating economic growth. It supports innovation though the upgrades of vessels to new technologies, and investments in R&D to exploit sustainable resources. It also ensures responsible production by reducing harmful discharges.

(DNV GL, 2017)

6.1.1.3. The International Maritime Organization

IMO was established in 1948 by the United Nations at a conference in Geneva, and currently has 174 members. Their purpose is:

"to provide machinery for cooperation among Governments in the field of governmental regulation and practices relating to technical matters of all kinds affecting shipping engaged in international trade; to encourage and facilitate the general adoption of the highest practicable standards in matters concerning maritime safety, efficiency of navigation and prevention and control of marine pollution from ships"

(International Maritime Organization, 1958) (International Maritime Organization, 2021)

After the disaster of Torrey Canyon in 1967, the problem of pollution became very important ((Bell & Cacciottolo, 2017) (Vaughan, 2017). Through international treaties and other legislation, the IMO works to prevent such problems and improve future shipping by ensuring members' government implement their measures (International Maritime Organization, 2021).

6.1.2. IMO Strategy on reduction of GHG emissions from ships

In April 2018, the IMO adopted an initial strategy on reduction of GHG emissions from ships, with reference to the Paris Agreement temperature goals (The Ministry of Climate and Environment, 2019) (International Maritime Organization, 2018). The ambition of the strategy is presented in three levels:

1) Carbon intensity of the ship to decline through implementation of further phases of the energy efficiency design index (EEDI) for new ships to review with the aim to strengthen the energy efficiency design requirements for ships with the percentage improvement for each phase to be determined for each ship type, as appropriate;
2) Carbon intensity of international shipping to decline to reduce CO^2 emissions per transport work, as an average across international shipping, by at least 40% by 2030, pursuing efforts towards 70% by 2050, compared to 2008; and
3) GHG emissions from international shipping to peak and decline to peak GHG emissions from international shipping as soon as possible and to reduce the total annual GHG emissions by at least 50% by 2050 compared to 2008 whilst pursuing efforts towards phasing them out as called for in the Vision as a point on a pathway of CO^2 emissions reduction consistent with the Paris Agreement temperature goals.

(International Maritime Organization, 2018; 6)

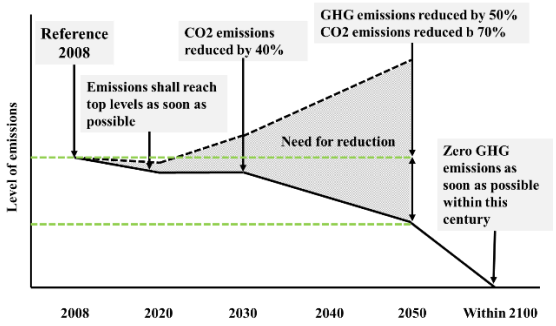

Figure 10: IMO strategy. Stapled line is expected reduction in emission in a business-as-casual scenario. Solid line is reduction in emission according to IMOs ambition. (The Ministry of Climate and Environment, 2019)

These ambitions are to be measured through a three- period timeline, where candidate measures set by the Committee should be fulfilled. Short- term measures are to be finalized and agreed by the Committee between 2018 – 2023, mid-term measures between 2023 – 2030, and long- term measures between 2030 – 2050.

6.1.3. Norway and the IMO strategy

As said by the minister of Climate and Environment, the IMO strategy is a milestone in the work to reduce emissions

from international shipping. It is views as the Paris Agreement of shipping, and it is a huge breakthrough that the strategy contains a vision of zero emissions (Ministry of Climate and Environment, 2018).

Norway has been a member of IMO since it was founded in 1956 and has since had a leading role in IMOs climate work (United Nations Association of Norway, 2021) (Ministry of Climate and Environment, 2018). Being the initiator for the IMO strategy since 2016, the Norwegian government is very pleased that the agreement has been implemented by the IMO and wants to show the world that one can be environmentally friendly and still make money (Ministry of Climate and Environment, 2018).

It is safe to say that the IMO strategy drives Norway to focus on renewable energy and green shipping. The Norwegian Shipowners' Association is also supportive of IMOs strategy towards making the shipping industry a zero- emission industry, this is demonstrated by the association's four goals:

- Members of the Norwegian Shipowners' Association shall reduce emissions by 50% per unit within 2030 compared to 2008
- Members of the Norwegian Shipowners' Association shall only order ships with zero- emission technology from 2030
- Members of the Norwegian Shipowners' Association's fleet shall be climate neutral in 2050
- The Norwegian Shipowners' Association shall work for an international legislation against the use of fossil fuels in 2050
  (Norwegian Shipowners' Association, 2020)

6.1.4. The technological innovation system

As noted by the IMO, technical innovation and introduction of alternative fuels or energy sources is crucial to achieving the goals set by the organization (International Maritime Organization, 2018). Wind propulsion is one alternative to fossil fuels but have only been adopted by a few actors in the market (Rojon & Dieperink, 2014). To understand what stimulates or hinder the diffusion of such technology, one must view innovation and diffusion as a collective act. Since the Norwegian government is determined to support the UN's development goals and IMO, they must improve the technological innovation system (TIS) surrounding wind propulsion as research shows that the current TIS is poorly functioning.

6.1.5. Summary

The Norwegian government is driven by the desire to increase social welfare, and green energy in international shipping will not only improve the environment but also increase GDP and create new job opportunities. Their membership and involvement in the UN's Sustainable Development Goals and IMO strategy plan for a zero- emission society certainly motivates the government to focus on green energy. To successfully increase the development and diffusion of zero-emission technologies, the government must support the TIS of such technologies.

6.2. What policy instruments are implemented by the Norwegian government

6.2.1. Barriers for the uptake of wind propulsion

The Norwegian Shipowner Association have listed four measures needed from the government for them to reach the goal of a zero- emission shipping industry within 2050. They express that the government must:

1. Target research and development funds for the development and testing of zero- emission solutions
2. Establish a research- and development fund for zero-emission technology under the auspices of the IMO
3. Regulate the market to make investments in zero- emission technology profitable as soon as possible, at latest within 2030.
4. Establish an international legislation against the use of fossil fuels from 2050.

(Norwegian Shipowners' Association, 2020)

This signals that the conditions for investing in renewable energy, and with that, wind propulsion, are not ideal today. This suggests that the barriers identified by Rojon & Dieperink in 2014 may still be relevant today.

In 2018, DNV GL was commissioned by the Ministry of Climate and Environment, the Norwegian Maritime Authority and the Business Sector's NOx Fund to map the barriers for implementing zero- emission solutions in shipping of dry cargo, and possible measures to break down these barriers (DNV GL, 2018). The identified barriers are divided into eight categories:

1) Lack of demand and low profitability for green shipping
2) Shipping owners' investment capacity and access to capital

3) Ship owners' adaptation ability
4) The transportation of dry cargo is international
5) Government requirements and framework conditions
6) Price level and availability of alternative fuels
7) Information and knowledge
8) Barriers to moving goods from road to sea

This paper will not discuss the eighth category as it is deemed irrelevant for the uptake of wind propulsion.

6.2.1.1. Lack of demand and low profitability for green shipping

DNV GL argue that short- term agreements between ship owners and cargo owners makes ship owners unwilling to invest in zero- emission solutions due to uncertainty in future demand. Not many cargo owners demand eco- friendly transportation nor set environmental requirements to their cargo transporters. As a cargo owner, it is difficult to set such demands when doing business in an international market. They claim that the lack of regulations from government and demand from end- customers gives no incentives or motivation to ensure eco-friendly transportation of goods as it often comes at a higher cost (DNV GL, 2018). As stated by the CEO of DNV GL the pressure for change in shipping industry is more external than internal (Stensvold, 2020).

However, studies conducted by the Norwegian School of Economics show that companies that ensures environmental CSR are deemed more innovative and attractive among their customers, resulting in an increased loyalty (Andreassen, Kurtmollaiev , & Lervik-Olsen, 2020). Online shoppers are becoming more conscious of their carbon footprint, and 3/10 consumers considers a company's the environmental impact when shopping online (Bring, 2019) (FAUNA, 2021).

6.2.1.2. Ship owners' investment capacity and access to capital

The transition to zero- emission solutions require large investments, whether through purchase of new zero- emission ships or by rebuilding current ships. Access to capital is low, as zero- emission solutions are complex with little testing making lenders unwilling to finance projects. It is considered a high- risk investment due to uncertainty of technological development, investment- and operating costs, and the price of fuel. Higher demands to equity and uncertain cashflows lead to large risk premiums, making ship owners unwilling to finance zero- emission solutions themselves (DNV GL, 2018).

6.2.1.3.Shipping owners' adaptation ability

Transitioning to zero- emission solutions require obtaining new information, and sufficient time and resources. Being able to transition while maintaining daily operations as normal can be challenging, especially for smaller ship owners. Being a high- capital investment, ensuring profitability is essential for making the transition successful (DNV GL, 2018).

In addition, zero- emission technologies are very new, and effect is not widely proven yet. There is uncertainty as to whether the systems of such technologies work when implemented, creating an uncertainty of operational risk, cf. appendix 2.

6.2.1.4.The transportation of dry cargo is international business

Sailing internationally, government requirements and framework conditions in Norway are not the only regulations affecting the industry. Policies made by the Norwegian government may not achieve the expected results as they would with national shipping (DNV GL, 2018).

6.2.1.5.Government requirements and framework conditions

Investments in zero- emission solution is only desirable if demanded or profitable. Current marked mechanisms and government requirements does not give incentive to such investments today. Further, it is critical that requirements for zero- emission solutions are set on an international level rather than national, to avoid competitive disadvantage in the international market.

Recent agreements and fees implemented by the government such as the NOx- fund, signals an expected increase in emission costs and sanctions against fossil fuels. However, it is uncertain when and how this will be implemented, and the duration of potential benefits, possibly making ship owners reluctant to invest based on these incentives. An example of this is the CO2- fee on LNG. In 2018, the Norwegian government decided to remove the CO2- fee exemption on LNG, making it no longer financial beneficial to use LNG as an alternative to fossil fuels (NOx-fondet, 2018). After criticism from the industry, the government decided to reinstate the exemption as of April 1st 2020 (The Norwegian Tax Administration, 2020).

While the IMO strategy plan is a great step in the right direction for regulating emissions at an international level, it is a slow- moving movement. The IMO must consider the interests and economic condition of several nations, making it difficult to find a middle ground that pleases all parties. Some might argue that IMO is moving too slowly for the shipping sector to meet future emission reduction

targets (Bergman, 2020) (Hand, 2019) (Bannon, 2019) (DNV GL, 2018)

6.2.1.6. Price level and availability of alternative fuels

As wind propulsion currently must be used in a hybrid solution, cf. Appendix 2, one must consider additional alternative fuels for zero- emission ships as well as the cost of rotor sails. This can be batteries, LBG, biodiesel, hydrogen, and LNG. For ship owners to consider such solutions, the price of alternative fuels must be competitive compared to traditional fuels. As of today, alternative fuels have a much higher price level than marine diesel, apart from LNG due to the CO^2- fee exemption. Another barrier is the shortage of supply of biofuels and hydrogen causing delivery and price levels to be uncertain. However, this is not an issue for LNG and electricity (DNV GL, 2018). When considering wind propulsion, there are still few manufacturers in the market, making the technology scarce and very expensive as well, cf. appendix 2.

Regardless of alternative fuel, access to such is limited in Norway. While ship owners decide of whom to buy fuels, and where to bunker, access to suppliers of different fuels can be a challenge given the strict safety at the docks and the cost of transferring to a suitable dock (DNV GL, 2018).

6.2.1.7. Information and knowledge

The lack of demand for emission free transportation from cargo owners can be explained by the lack of knowledge regarding their carbon footprint, and information about their options for a zero-emission freight. As of ship owners, some may not consider the long- term benefits of investing in zero- emission solutions such as avoiding future disincentives because of the large investment costs.

6.2.1.8. Barriers in the TIS

The barriers identified above confirms some of the findings of Rojon & Dieperink (2014), influencing the TIS of wind propulsion negatively. The conditions in Norway contribute negatively to the TIS is summarized in table 4.

6.2.2. Policy instruments

As the administrative director of the Norwegian Shipowners Association says, an increased focus on shipping should be an important and central priority to reach the goals of a 40% reduction in CO^2 emissions by 2030 (Norwegian Shipowners' Association, 2015). The Norwegian government has expressed that they wish to be a leader in the transition to zero- emission shipping (The Ministry of Climate and Environment, 2019), and will do so based on three main priorities:

1. Advocate stricter environmental requirements to IMO and

contribute to making Norwegian innovation an international standard.

2. Create an ambitious national policy for the development of low- and zero- emission solutions with global potential.
3. Help developing countries to make necessary changes in their shipping industry by offering financial aid. (The Ministry of Climate and Environment, 2019) (Green Voyage 2050, 2021)

In their action plan for green shipping (The Ministry of Climate and Environment, 2019), the Norwegian government presents a list of things they wish to follow through:

- Have an ambition to reduce emissions from domestic shipping with 50% within 2030
- Stimulate low- and zero emission solutions within all categories of shipping
- Stimulate environmentally friendly growth and competitive advantages in Norwegian maritime industry, and facilitate increased export of low- and zero emission solutions
- Ensure a competitive ship register to attract actors to sail under the Norwegian flag
- Consider an environmental benefit scheme for low- and zero- emission ships in NIS and NOR
- Be a leader and advocate to IMO
- Strengthen the collaboration with IMO towards helping developing countries reduce their emissions (The Ministry of Climate and Environment, 2019)

The action plan also presents policy instruments introduced by the government to reach their goals, for the maritime industry as a whole and specific policies for cargo ships. These can be divided into regulatory instruments, economic and financial instruments, and soft instruments.

External factors	Price level and availability of alternative fuels
Hard institutions	Lack of demand and low profitability for green shipping Ship owners' investment capacity and access to capital Lack of government requirements and framework conditions
Soft institutions	Ship owners' investment capacity and access to capital
Knowledge infrastructure	Ship owners' adaptation ability Information and knowledge
Interaction	The transportation of dry cargo is international Information and knowledge

Table 4: Barriers for uptake of wind propulsion in Norway

6.2.2.1. Regulatory instruments

Regulatory instruments are legal tools meant to regulate social and market interactions (Borrás & Edquist, 2013). There are three legislations giving incentives to invest in low- and zero-emission solutions, and one potential future legislation.

The Ship Safety and Security Act

The act regulates environmental security. IMO's International Convention for the Prevention of Pollution from Ships (MARPOL) is ratified under this act, meaning that Norway is obliged to follow the convention and changes made to it.

Pollution Control Act

The purpose of this Act is to protect the outdoor environment against pollution and to reduce existing pollution, to reduce the quantity of waste and to promote better waste management (Ministry of Climate and Environment, 1981)

The Harbor Act

The purpose of this act is to secure accessibility, safe travel and prudent use and management of the waters. This involves setting environmental requirements for shipping.

Other

The government plans on demanding zero-emission transportation for public purchases where it is convenient. They intend to do so by setting tender requirements while providing aid schemes. The purpose is to transfer freight from land to sea, increasing the demand for cargo shipping.

(The Ministry of Climate and Environment, 2019)

6.2.2.2. Economic and financial instruments

Economic and financial instruments are specific economic or financial incentives and support for social and economic activities (Borrás & Edquist, 2013). The Norwegian government have some economic incentives and disincentives, but carbon pricing is not sufficient to justify the cost of new technology. Therefore, several support schemes have been introduced trough organizations owned by the state of Norway to supplement the incentives to invest in low- and zero-emission solutions (The Ministry of Climate and Environment, 2019). Below is an excerpt of the most significant instruments.

Grant for goods transfer from road to sea

The Norwegian Coastal Administration administrates and manages subsidies for goods transfer from road to sea. The subsidy is given to ship owners within the European Economic Area (EEA) who apply for funding to projects that provides clear benefits for the society). The subsidies are to be given over a three- year perspective and were assigned 82 million

NOK in 2017.
(Ministry of Transport, 2017) (The Ministry of Climate and Environment, 2019)

Grant for investments in efficient and environmentally friendly harbors
The Norwegian Coastal Administration also administrates and manages subsidies for investments in efficient and environmentally friendly harbors. The subsidy is given to harbor owners and operators who plan to invest in the building, replacement or upgrading of harbor infrastructure. The grant is to be given over a three- year period, and were assigned 50 million NOK in 2019.
(Norwegian Coastal Administration, 2021) (Ministry of Transport, 2019) (The Ministry of Climate and Environment, 2019).

Reduced electricity fee for ships in business
In 2017 the Norwegian government introduced a reduced electricity fee for ships in business. While ordinary rate is 0,156 NOK per kWh, ship in business will receive a rate of 0,05 NOK per KwH. The purpose is to give incentives to electric zero- emission solutions.
(The Ministry of Climate and Environment, 2019)(Norwegian Tax Administration, 2021)

CO^2- emission fee
Norway was one of the first counties to introduce the CO^2- emission fee in 1992. Today the fee is 590 NOK per ton. The government has decided to increase this rate by 5% yearly until 2025, expecting the fee to be 2000 NOK pr. Ton in 2030 (Holter, 2021).

Other
The Norwegian government has expressed the interest of subsidies for low- and zero-emission ships registered to Norway. They intend to offer close follow- up from the state and financial benefits. They also plan on introducing a discount scheme for environmentally friendly ships at dock.
(The Ministry of Climate and Environment, 2019)

ENOVA
ENOVA is a state- owned enterprise established in 2001 with the purpose to *"promote a shift towards more environmentally friendly energy consumption and production, as well as the development of energy and climate technology»*
(Ministry of Climate and Environment, 2021)

The organization offers financial aid and advice to projects contributing making Norway a low- emission society by 2050 (ENOVA, 2021), and has so far supported 4363 projects with a total of 3,66 billion NOK (ENOVA, 2021).

The organization has management agreement with the Ministry of Climate and Environment on a four-year basis, with 2021 – 2024 being the current management

period. In the current agreement, ENOVA has an larger mandate tan previous years, and the ministry is trusting ENOVA to contribute to meeting Norway's climate commitments and the transition into a low-emission society. While the ministry has set ENOVAs main priority, the organization still decides which projects to prioritize but is encouraged to choose those with the larges effect on the goal of a zero-emission society (Ministry of Climate and Environment, 2020). One third of ENOVAS budget goes towards transportation projects, where the main part is maritime business (The Ministry of Climate and Environment, 2019).

Innovation Norway

The state- owned enterprise Innovation Norway was established in 2004 through a merger between four state- owned organizations and is one of the largest grants in Norway (Ryen, 2014)(The Ministry of Climate and Environment, 2019). Their purpose is to steer companies towards doing business in a more sustainable way.

"We contribute to sustainable growth and export for Norwegian businesses through capital and expertise […] Today, about 50 percent of our total financial portfolio has an environmentally focused profile." (Innovation Norway, 2020)

They provide risk relief for businesses that create value through the development and testing of new technologies. The maritime business is the second to largest recipient of funds and received approximately 73 million in financial aids in 2017.

The Research Council of Norway

The Research Council of Norway was established in 1993 with the purpose of "promoting research and innovation of high quality and relevance and to generate knowledge in priority areas to enable Norway to deal with key challenges to society and the business sector." (The Research Council of Norway, 2021). MAROFF is the council's most important program for maritime research and innovation, meant to stimulate investments that strengthens the industry's competitive advantage, adaptability and collaboration with research environments and actors in the industry (The Ministry of Climate and Environment, 2019). In 2019 the council received 11,3 million NOK for research and innovation.

6.2.2.3. Soft instruments

Soft instruments are largely complementing regulatory and economic instruments and involves recommendations and voluntary agreements such as code of conduct or public and private partnerships (Borrás & Edquist, 2013).

Short Sea Promotion Centre Norway
SPC- N was established in 2003 and is one of multiple competence centers in a European network of centers in short sea shipping. Their purpose is to increase the competitive advantage of short sea shipping through creation and diffusion of knowledge and information, and motivate interactions between actors in the market (SPC-N, 2021) (The Ministry of Climate and Environment, 2019).

Green Shipping Program
GSP was established in 2015 as a partnership program between private and public business actors in shipping. Their objective is to assist Norway in becoming the world leader on environmentally friendly and efficient shipping. The program received 7 million NOK in 2019 (DNV GL, 2016).

Other
In addition to the instruments above, the Norwegian government have expressed a number of other measures they wish to implement or motivate.

From road to sea initiative
While actors can apply for funding of projects supporting the transfer of goods from road to sea, the government has expressed they wish to transfer 30% of goods to sea by 2030. This is estimated to reduce emissions by 1,5 million ton accumulated from 2021 – 2030 (The Ministry of Climate and Environment, 2019). Such initiative signals that there may be future incentive towards such transfers and enables actors to align their interests with that of the government.

Letter of intent
The government wants to initiate a dialogue with relevant actors to discuss a letter of intent for the renewal of cargo ships. The purpose is to uncover areas of cooperation that can stimulate the renewal of cardo shops and the collaboration between private and public actors.

(The Ministry of Climate and Environment, 2019)

Grant for sustainable biofuels
The Ministry of Climate and Environment have expressed they wish to research the opportunities and consequences of grants for sustainable biofuels. This signals that such alternative fuels may be of public interest and allows companies to align their interests with that of the government before potential disincentives arise.

(The Ministry of Climate and Environment, 2019)

Public procurement
The government has published a white paper on public procurement and how public actors can contribute to reaching the environmental goals as efficient as possible.

(The Ministry of Climate and Environment, 2019)

Innovation Partnership
Innovation Norway motivates innovation partnership to promote innovation and develop new products and solutions to the market (The Ministry of Climate and Environment, 2019).

National Program for Vendor Development
The program aims at helping public sector apply innovative procurements to boost innovation (Innovative Procurements, 2021).

In accordance with Esmailzadeh, Noori, Aliahmadi, Nouralizadeh, & Bogers (2020), it comes to show that the government take use of many of the instruments suggested for development of renewable energy solutions. Most significant are funding to support R&D, venture capital, public- private partnerships, demand pull policy and distributed energy policy and demonstration projects (Borrás & Edquist, 2013).

6.2.3. Identified policy instruments and how they improve the TIS

The identified instruments are drivers for the uptake of wind propulsion, and some where not present in 2014 when researched showed that the TIS for wind propulsion was poorly functioning (Rojon & Dieperink, 2014). This makes one question as to whether the system is as poorly functioning as first assumed with Norway's dedication to IMO and UN. Since the TIS is not geographically delimited, incentives introduced by the Norwegian government has a limited range of affect. The incentives will however affect Norwegian actors greatly, which is why improvements of the TIS must be discussed. I would argue that all the seven structural functions of the TIS is improved through the instruments listed in previous section. The instruments are aimed at not only motivating zero- emission ships, but also the diffusion of knowledge and networking in the industry for the benefit of reaching the IMO strategy. The government provides resources as well as regulations that contribute to market formation and in the future the legitimacy of new technology. One can argue that the current state of the functions and the TIS should be re-evaluated as the IMO strategy of 2018 has had a severe impact on policies.

6.2.4. Summary

There still are may barriers for the uptake of zero- emission technologies in international shipping. The Norwegian government have implemented many economic and financial instruments and soft instruments to reduce such barriers

and improve the functionality of the TIS in addition to the pre- existing regulatory instruments. Enova stands out as the most significant instrument, having a great impact on Norway's plan to become a low-emission society

6.3. What affected Sea-Cargo's investment decision

6.3.1. Sea- Cargos view of the TIS

Rojon & Dieperink (2014) claims that the reason for the low uptake of wind propulsion in international shipping is explained by a poorly functioning technological innovation system for wind technologies. While they have found the seven system functions to be poor based on expert opinions in 2014, it looks as if Sea-Cargo have a different view on the TIS. The purpose of this section is to answer to what extent governmental incentives have motivated the company to invest in rotor sails, thus their view of the TIS and their impression of each system functions is important to review as it sets the basis for their decision. A willingness to invest in rotor sails could merely be explained by Sea- Cargo's belief of a well-functioning innovation system, or there are incentives that trumps the barriers that follows a low functioning system. An overview of Sea-Cargo's opinion of the system functions importance and fulfillment compared to (Rojon & Dieperink, 2014) can be seen in figure 11.

6.3.1.1. The system functions' importance

Sea- Cargo's opinion of the system functions importance varies to some degree from that found by Rojon & Dieperink (2014) as seen in "Comparison of importance" in figure 11. They believe that knowledge development and knowledge diffusion are the most important functions in the TIS, giving them the maximum score of 5. Followed are entrepreneurial activities, guidance of the search and creation of legitimacy with a score of 3,5. In their opinion, the least important functions are market formation and resource mobilization.

Based on Sea- Cargo's evaluation of the system functions importance one can assume they believe the absence of knowledge development or diffusion prevents innovation. This evaluation is very reasonable given that development, diffusion and use of knowledge is very important for growth and development (Conceicão, Heitor, Gibson, & Shariq, 1998) (Wamea, 2009).

Their evaluation of the system functions' importance gives an insight into what the company values when deciding to invest in rotor sails. For them to willingly rebuilt SC Connector by adding rotor sails, the

functions they value as highly important should be fulfilled to the extent of their importance.

6.3.2. The system functions' fulfillment

The system functions' fulfillment is evaluated by assessing three statements within each function. Sea- Cargo's opinion of the system functions' fulfillment varies a lot from that of Rojon & Dieperink (2014), with Sea- Cargo being more positive to the state of the TIS, cf. figure 11. Note that while Rojon & Dieperink's (2014) scoring is of the overall TIS for wind propulsion, Sea- Cargo has assessed each function in their own perspective as investors in rotor sails. Rojon & Dieperink's (2014) does however divide between different wind technologies, and with that discuss rotor sails' effect on the overall score.

6.3.2.1. Entrepreneurial activities

Rojon & Dieperink (2014) gives the fulfillment of entrepreneurial activities a score of 2,3/5, considered a low/medium score. They argue that entrepreneurial activities for rotor sails have been discontinuous over the years due to dropping oil prices making fossil fuels more attractive. They are considering the entrepreneurial activities in a historical perspective as to why the entrepreneurial activities have not been developed as much as other energy technologies.

Sea- Cargo gives the fulfillment of entrepreneurial a score of 2,85/5, cf. 2.1 in appendix 2. As their CFO elaborates, Sea-Cargo are the first ship owners to install rotor sails in such a large scale, and the result of the project will be a game changer for the rotor sail industry (appendix 2, 2.1.1). This implies that the conclusion made by Rojon & Dieperink (2014) may still be relevant, as the rotor sail solution still lacks testing and there are very few suppliers available in the market (appendix 2).

6.3.2.2. Knowledge development

Rojon & Dieperink (2014) have given the knowledge development a fulfilment score of 2,38/5 which is low/medium. The rotor sail TIS is however assessed to be low. This complementary to the entrepreneurial activities;

"Development of knowledge is mainly dependent on entrepreneurs which implies that activities related to this function were often not continues when entrepreneurs experienced setbacks"
(Rojon & Dieperink, 2014; 396)

Again, the function is assessed on a historical basis, which may not have been of consideration to Sea- Cargo in their assessment.

Sea- Cargo gives the fulfillment of knowledge development a score of 2,83, same as the entrepreneurial activities. As their CFO points out, the technology itself is old, but the use of the technology commercially is new (appendix 2, 2.2.1). This gives the impression that Sea- Cargo does view knowledge development as a compliment to entrepreneurial activities, and if there is not much movement in the market, there is not many opportunities for knowledge development in their point of view.

6.3.2.3. Knowledge diffusion

Rojon & Dieperink (2014) considers the fulfillment of knowledge diffusion to be low with a score of 1,75/5. Once again it is due to the absence of knowledge development, and the fact that knowledge is primarily diffused within partnerships, limiting access to knowledge.

Sea- Cargo gives knowledge diffusion a score of 3,8/5 which is deemed a high score. This is an interesting observation given the large deviation from that of Rojon & Dieperink. Sea- Cargo considers conditions today rather than historically,

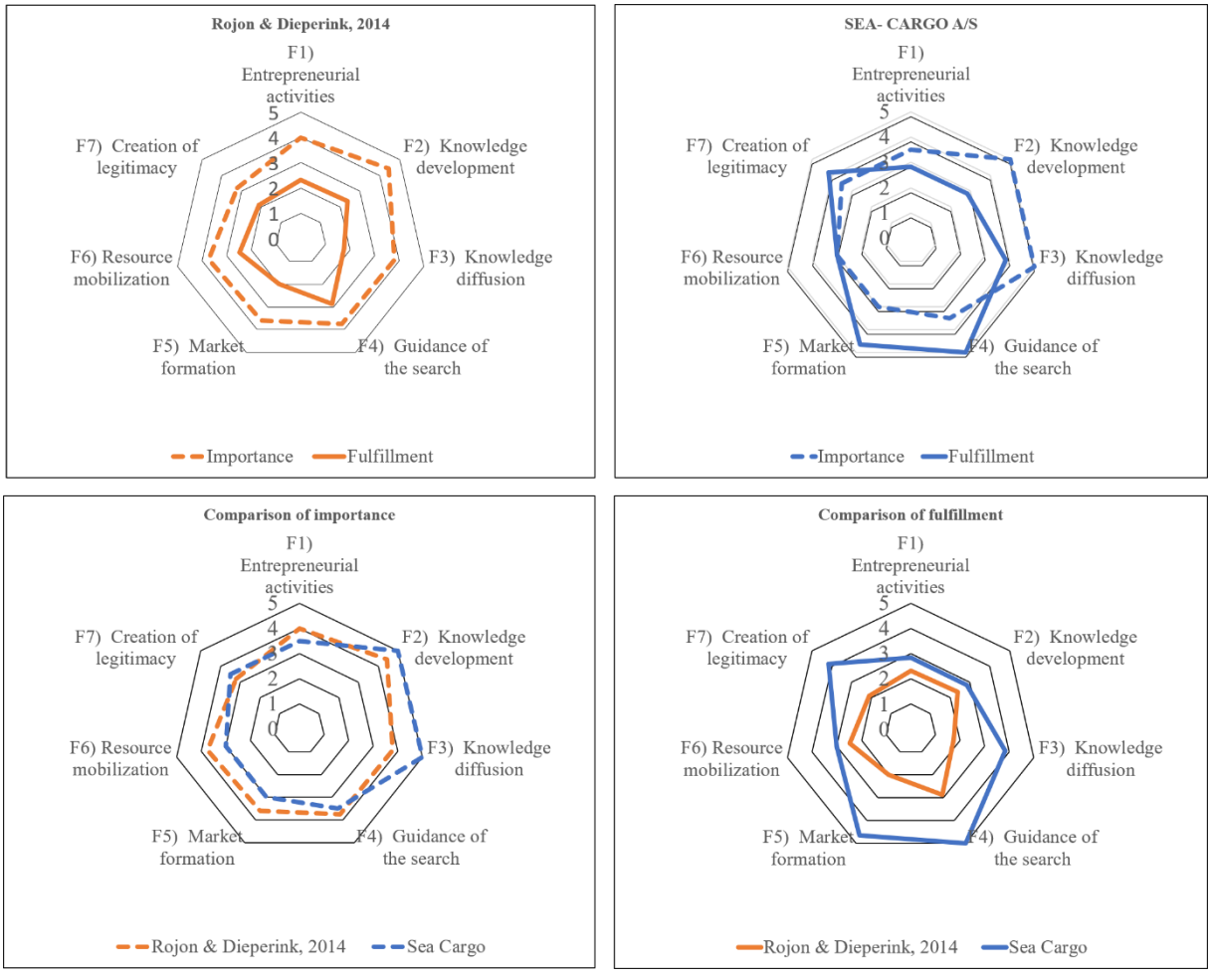

Figure 11: Comparison of system functions importance and fulfillment

and while scoring knowledge development and entrepreneurial activities low, they experience that information is easily accessed and that knowledge flows between actors in the market. As put by their CTO *"Scientific papers on the subject are easily available."* (Appendix 2, 3.6).

6.3.2.4. Guidance of search

The guidance of search receives a score of 2,88 by Rojon & Dieperink (2014), making it relatively well fulfilled. Historically it was expected that rotor sails would revolutionize commercial shipping (Rojon & Dieperink, 2014) (Seybold, 1925).

Sea- Cargo recognize this expectation and gives the guidance of search a fulfillment score of 5/5. They experience an increase in governmental support, incentives from the UN and an increased willingness to explore renewable energy technologies signaling optimism about the future of rotor sails.

6.3.2.5. Market formation

Rojon & Dieperink (2014) has deemed market formation of rotor sails to be completely absent. Wind propulsion technologies must openly compete with more established technologies. Yet it received a score of 2/5 without elaboration as to why.

Sea- Cargo gives the fulfillment of market formation a score of 4,67/5. While acknowledging that the technology still is in its early days, they experience activities such as financial aids and future negative sanctions on fossil fuels contributing to market formation. They expect more overseas operators to be the next movers (Appendix 2, 2.5.1).

6.3.2.6. Resource mobilization

Resource mobilization is assessed to be poorly fulfilled by Rojon & Dieperink (2014) although it has a score of 2,48/5. This contradicts 2,3/5 being a medium score in the entrepreneurial activities, and Rojon & Dieperink does not elaborate on why one is deemed lower than the other. They justify the given score of 2,24 with the struggle to secure financial resources.

Sea- Cargo gives resource mobilization a fulfillment score of 3/5, signaling they're experiencing a relatively easy access to financial aids as well as human capital and knowledge. As put by their CTO, once they had a basic understanding of the physics behind rotor sails, they easily contacted Norsepower who provided case studies for their vessel. There are still very few manufacturers in the market, and this the human capital may be somewhat limited (appendix 2, 2.6.1).

6.3.2.7. Creation of legitimacy

According to Rojon & Dieperink (2014) there were no activities related to the creation of legitimacy reported in their research, however they did find some activities linked to the promotion of wind propulsion in general, scoring the function a 2/5.

Sea- Cargo scores creation of legitimacy a 4,17/5. They have the impression that the technology is being actively lobbies, is a legitimate alternative to fossil fuel and exists in a market with little uncertainty. The last fining is very interesting and will be discussed later in this paper.

The fulfillment of the system functions is lacking compared to their importance, from Sea- Cargo's point of view, cf. figure 12. The most important factors, knowledge development and diffusion, has the largest deviation, while market formation and guidance of the search seems to be over-stimulated in the TIS according to the company. This is an interesting observation, as while the TIS seems to be medium functioning, there are still very important functions that should be satisfactory fulfilled. Based on the company's own valuation of these functions, the degree of fulfillment cannot explain why the company is willing to invest in rotor sails.

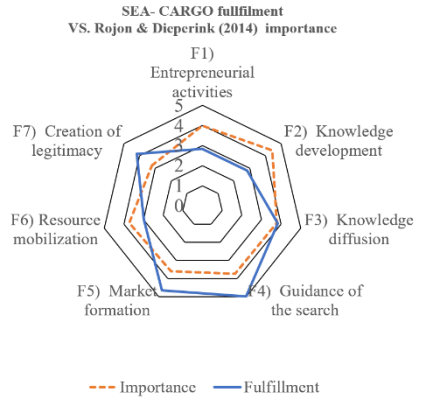

Figure 12: Sea Cargo fulfillment, Rojon & Dieperink (2014) importance

6.3.3. Main barriers

The company have identified some important barriers themselves against investing in rotor sails in random order:

1. The facilitation for alternative fuels in the market
2. The need for a hybrid solution
3. The production capacity and availability of manufacturers
4. High capital expense

The first two barriers affect the functions of entrepreneurial activities and knowledge development negatively. The fact that alternative fuels are more facilitated in the market, and the development of such technologies shows that the entrepreneurial activities of other technologies are more present. Rotor sails failing to be a sufficient stand- alone energy solution, proves there are opportunities for knowledge development that are yet to be explored and other technologies might have reached that target already.

The low production capacity and availability of manufacturers decrease the resource mobilization in the market. However, the fulfillment of resource mobilization is approximately the same as its importance, so this barrier does not seem to be of importance.

The last barrier identified is the high capital expense of rotor sails. Being a fairly new alternative, rotor sails still have a high production cost, increasing the price level of the technology. This is deemed an external factor, as the need for capex does not directly concern any of the system functions. However, it does complement the perception of low entrepreneurial activities and knowledge development.

Because of this evaluation of the system functions fulfillment and barriers, there are likely some incentives that surpasses the barriers the current system represents making Sea- Cargo willing to invest in the technology.

Looking at the Sea- Cargo's fulfillment compared to Rojon & Dieperink's (2014) importance, the correlation is somewhat improved, cf. figure 12. The most important system functions such as knowledge development and entrepreneurial activities are still far from sufficiently fulfilled, but the increased importance of resource mobilization, market formation and guidance of the search may offset this explaining their trust in the technology. It is possible that Sea-Cargo unconsciously believes the importance set by Rojon & Dieperink's (2014) is more accurate, based on their decision to invest in rotor sails.

6.3.4. The process that led to rotor sails

Environmental focus is a part of the company's vision, as they state

"Actions and measures are constantly evaluated in order to reduce the risk for accidents and dangerous occurrences. Fundamental to this long-term strategy is the company's commitment to protecting the environment, the safety of life on land and at sea."

(Sea- Cargo A/S, 2021)

They began researching alternative fuel solutions due to the risk of future regulations and cost of bunkers and fees. They're experiencing that financial institutions are reluctant to finance new vessels with old technology, and they saw the need to reduce their dependence on fossil fuels (Appendix 2, 3.1). While this is the first time they considered rotor sails, they have previously considered other wind assisted technologies (Appendix 2, 3.5). They did not follow through on these alternatives at that time due to the high cost and operational difficulties that follows as most of the solutions are not as

ready for market as desired. They also considered batteries and electric propulsion previously, but again, the alternatives where scrapped due to the high costs. This time around they considered several solutions, but most of these would require major reconfigurations to the vessel's engine, while rotor sails can easily be implemented today and can be moved from one vessel to another if needed (Appendix 2, 3.4). After researching the technology, the company contacted the main manufacturer of rotor sails, Norsepower, who provide them with case studies for their vessel though close collaboration (Appendix 2, 3.6)

6.3.4.1. Incentives driving the decision

The company admits to being highly affected by the UNs sustainable development goals as well as IMO strategy for 2050 (appendix 2, 3.10) showing that the regulatory instruments implemented by the government is the main reason for investing in rotor sails; the company is simply fearful of future regulations and related taxes and fees on fossil fuel.

"Historically the bunkers prices have been low and by that there have not been any incentives to move away from heavy fuel bunkers oil."

CFO (Appendix 2, 3.7)

However, the technology of rotor sails is very expensive, and without the grant of 38% of the investment cost from ENOVA, the company would not have invested in rotor sails (Appendix 2, 3.13). This strengthens the assessment of the financial resource mobilization in the market; while the technology is very expensive, access to financial aids is possible eliminating the barrier.

"The investment would not have taken place at this stage if we had not received a grant from ENOVA"

CFO (Appendix 2, 3.13)

The lack of financial aid for investments in old solutions is certainly forcing the company to consider other alternatives, and by this zero- emission alternatives. It is reasonable to think that financial institutions have aligned their interest with that of the government, shifting the focus of the industry towards low- and zero-emission solutions. As it is unknown whether financial institutions are facing future legislations or taxations regarding lending money, the lobbying is making the instruments highly effective.

6.3.5. Summary

In conclusion there are high barriers in the market preventing companies from being able to invest in rotor sails by themselves. Sea- Cargo are dependent on financial aids, which the government has implemented through multiple economic and financial policy instruments. The grant received

from ENOVA is said to be decisive for Sea- Cargo's willingness to invest in rotor sails. If they were not given the ENOVA grant it is uncertain whether they would have been able to receive funding elsewhere, but with the government's policy instruments and the shift in financial institutions priorities it is likely. It not, they would not have chosen this option.

The regulations set by the IMO have certainly pushed Sea- Cargo towards choosing zero- emission technology in the renewal of their vessel SC Connector. Without the commitment from the Norwegian Government towards IMO and MARPOL, it is not certain that the company would have chosen a zero-emission solution.

With this one can conclude that Sea- Cargo chose to invest in rotor sails merely because of the efficiency of the technology itself, the push from IMO and UN, and the financial aids available in the market.

7. Conclusion

This thesis aims at answering how the Norwegian government gives international shipping incentives to invest in green energy, and to what extent they affected Sea- Cargo A/S to invest in rotor sails. This is done through the perspective of rotor sails being a part of a technological innovation system, where seven functions must be sufficiently fulfilled for innovation to take place and the diffusion of technology.

I have looked at the importance of governmental involvement in improving green energy in international shipping and identified multiple drivers and barriers ship owners experience today. Further I have looked at how well- functioning the TIS is today from Sea- Cargo's point of view and how the policy instruments implemented by the Norwegian government have affected their investment choice.

The thesis shows that the government gives incentives through the implementation of numerous regulatory, economic and financial and soft instruments. In the case of Sea- Cargo, the Norwegian governments membership in the UN and IMO has the greatest affect in motivating towards investing in green energy, especially IMOs strategy towards a zero- emission society within 2050. While zero- emission solutions involve high capital expenses, financial instruments such as ENOVA contributes to eliminate such barriers. In the case of Sea- Cargo the investment in rotor sails would not have happened if it were not for the grant received from ENOVA. With that it is safe to say the instruments implemented by the government has been highly effective in the case of Sea Cargo.

It would be interesting to further research such effect on other ship owners to see how well functioning the TIS actually is, and why others have chosen to invest in green energy or not. The results of Sea-Cargo does imply that the findings of Rojon & Dieperink (2014) could be outdated.

Appendix

Appendix 1 – Questionnaire

Investing in rotor sails

Environmental governance is constantly increasing in the world, where consumers and companies are interested in reducing their carbon footprint. For actors in freight, however, this is a major challenge, as renewable energy sources come with large investment costs and one can ask whether it is financially beneficial.

The purpose of this study is to investigate how well-functioning the innovation system around rotor sails is, and why Sea Cargo A / S has chosen this energy solution for its ship SC Connector.

The results in this survey will be used for a master's thesis on the subject at the University of Stavanger. To preserve anonymity, you will be referred by job title rather than name.

The survey is divided into three parts, the first two are answered by a scale of 1 -5, while the third part seeks more in- depth answers.

Estimated time: 30 – 60 min

*Må fylles ut

1. E-postadresse *

General info

2. Your name and title *

3. Your role in the decision to invest in rotor sails *

Part 1: The system functions

For innovation to occur, seven system functions must be present.
This section aims to identify Sea Cargo A/S opinion of each function's importance. Please rate the following on a scale of 1 – 5.

1: Not important
2: Slightly important
3: Moderately important
4: Important
5: Very important

4. ENTREPRENEURIAL ACTIVITIES *

The activities of the innovation system which relate to business startups, diversification, and testing of new technologies.

Markér bare én oval.

	1	2	3	4	5	
Not important	◯	◯	◯	◯	◯	Very important

5. KNOWLEDGE DEVELOPMENT *

Educational activities on the technical, social, and economic aspects of new technologies

Markér bare én oval.

	1	2	3	4	5	
Not important	◯	◯	◯	◯	◯	Very important

6. KNOWLEDGE DIFFUSION *

Those activities and processes of innovation that focus on information dissemination, awareness raising, and capacity-sharing and resource sharing among system actors

Markér bare én oval.

	1	2	3	4	5	
Not important	◯	◯	◯	◯	◯	Very important

7. GUIDANCE OF THE SEARCH *

This function is about creating hope and optimism about the future of new technologies. The aim of this function is also reducing the uncertainty and risks associated with new technologies

Markér bare én oval.

	1	2	3	4	5	
Not important	◯	◯	◯	◯	◯	Very important

8. MARKET FORMATION *

Functions, activities, and processes that can create tools for new technologies. This function will extend the market for new technologies by providing market protection standards.

Markér bare én oval.

	1	2	3	4	5	
Not important	◯	◯	◯	◯	◯	Very important

9. RESOURCE MOBILIZATION *

This function distributes the necessary resources for the development and diffusion of new technologies among actors of the innovation system

Markér bare én oval.

	1	2	3	4	5	
Not important	◯	◯	◯	◯	◯	Very important

10. CREATION OG LEGITIMACY *

This function carries out activities that provide legitimacy for new technologies

Markér bare én oval.

	1	2	3	4	5	
Not important	◯	◯	◯	◯	◯	Very important

Fulfillment of the system functions

This section aims to identify Sea Cargo's opinion of each functions presence.
Please rate the following statements on a scale of 1 – 5.

1: Strongly disagree
2: Disagree
3: Neither agree or disagree
4: Agree
5: Strongly agree

ENTREPRENEURIAL ACTIVITIES

11. 1A) There is an increase in suppliers of rotor sails in the market *

Markér bare én oval.

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly agree

12. 1B) There has been great technological development over the last years *

Markér bare én oval.

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly agree

13. 1C) Rotor sails will be a widespread technology in the future *

Markér bare én oval.

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly agree

14. Comments to entrepreneurial activities

KNOWLEDGE DEVELOPMENT

15. 2A) There are many research projects on the effects of rotor sails *

Markér bare én oval.

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly agree

16. 2B) A lot of the technology behind rotor sails is patented *

Markér bare én oval.

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly agree

17. 2C) There are many research articles on rotor sails *

Markér bare én oval.

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly agree

18. Comments to knowledge development

KNOWLEDGE DIFFUSION

19. 3A) There are multiple networking opportunities for us to discuss rotor sails with other actors *

Markér bare én oval.

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly agree

20. 3B) One can easily stay updated on developments of rotor sails *

Markér bare én oval.

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly agree

21. 3C) We contribute with feedback and proposal for improvements to our suppliers and other actors *

Markér bare én oval.

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly adree

22. Comments to knowledge diffusion

GUIDANCE OF THE SEARCH

23. 4A) There is an increase in governmental support for the uptake of renewable energy solutions *

Markér bare én oval.

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly agree

24. 4B) EU climate targets impact the uptake of rotor sails positively *

Markér bare én oval.

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly agree

25. 4C) Actors in the market are more open for renewable energy technologies than previously

Markér bare én oval.

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly agree

26. Comments to guidance of search

MARKET FORMATION

27. 5A) There is an increase in financial support for investments in renewable energy propulsion *

Markér bare én oval.

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly agree

28. 5B) There will be negative sanctions for the use of fossil fuels in the future *

Markér bare én oval.

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly agree

29. 5C) Our competitors have or will likely also invest in rotor sails *

Markér bare én oval.

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly agree

30. Comments to market formation

Resource mobilization

31. 6A) There are many opportunities for financial aids for investments in rotor sails *

Markér bare én oval.

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly agree

32. 6B) We can easily hire/access the human capital needed for implementation and usage of rotor sails *

Markér bare én oval.

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly agree

33. 6C) Research and knowledge are easily accessible, enabling competence development of our employees *

Markér bare én oval.

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly agree

34. Comments on resource mobilization

Legitimacy

35. 7A) Actors in the market actively lobby to promote rotor sails *

Markér bare én oval.

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly agree

36. 7B) Research proves that rotor sails is a legitimate alternative to fossile fuel *

Markér bare én oval.

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly agree

37. 7C) There is no uncertainty in the market of rotor sails

Markér bare én oval.

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly agree

38. Comments to legitimacy

Why invest in rotor sails?

This section aims to understand why Sea Cargo has chosen to invest in rotor sails, and what effected your decision.

39. Why did you decide to look into new energy solutions? *

40. Why did you choose to invest in rotor sails? *

41. Are rotor sails a sustainable solution by itself, or is it necessary with a hybrid solution? *

42. What other options did you look into, and why were they cut short? *

43. Have you considered rotor sails or other renewable energy solutions previously? If so, why did you not follow through at that time? *

44. Can you describe the process and availability of information once you decided on rotor sails? *

45. What do you believe is the reason that other actors have not invested in rotor sails? *

46. Is the rotor sail solution suitable for all routes and countries? If not, do you believe it will be at some point? *

47. What do you consider as the biggest risks with investing in rotor sails? *

48. To what extend has UNs climate goals affected your investment decision? *

49. Can you list three main drivers for the uptake of rotor sails? *

50. Can you list three main barriers against the uptake of rotor sails? *

51. Do you have any additional comments on what effected your decision to invest in rotor sails? *

Hopp til spørsmål 52

52. Er du åpen for å bli kontaktet om evt. oppfølgingsspørsmål? *

Merk av for alt som passer

- [ ] Ja
- [ ] Nei

Del uten navn

Appendix 2 - Questionnaire results

		CFO	CTO
	Role in decision:	Part of project group	Project/ tech lead
1.1	Entrepreneurial activities	4	3
1.2	Knowledge development	5	5
1.3	Knowledge diffusion	5	5
1.4	Guidance of search	4	3
1.5	Market formation	3	3
1.6	Resource mobilization	3	3
1.7	Creation of legitimacy	4	3
2.1	Entrepreneurial activities	3,33	2,33
2.1.1	Comments	Sea-Cargo is the first to install rotor sails in a size/scale that will give about 25% reduction in the bunker consumption. Proving the effect will be a game changer for the rotor sail industry.	
2.2	Knowledge development	3,33	2,33
2.2.1	Comments	The rotor sail "technology" itself is old. It is using this technology commercially, in a way that really makes a difference to the consumption of bunkers oil, that is "new".	

2.3	Knowledge diffusion	4	3,66
2.4	Guidance of search	5	5
2.5	Market formation	4,33	5
2.5.1	Comments	Still very early days - and we expect more overseas operators to be the most likely next movers.	
2.6	Resource mobilization	3,33	2,66
2.6.1	Comments	For the moment there are still few actors and manufacturers within the industry.	
2.7	Creation of legitimacy	4	4,33
2.7.1	Comments	Rotor sail alone cannot replace fossil fuel, but be an important part of a hybrid solution that in total can replace or make a major reduction in the consumption of fossil fuel.	
3.1	Why did you decide to look into new energy solutions?	Due to future regulations and related cost of bunkers and charges/fees. Finance institution reluctant to finance new vessels with "old" solutions.	We need to reduce our dependence on fossil fuels.

3.2	Why did you choose to invest in rotor sails?	Rotor sails can be installed on "old" vessels without having to the change the original set up of the vessel. It is a stand-alone system that gives you a very good effect on the bunkers consumption. Can be moved from one vessel to another. Only a capex cost. The use of the rotor sail has almost no cost and the "wind" is for free!	It's the only 'clean' fuel saving option with positive ROI at current oil prices.
3.3	Are rotor sails a sustainable solution by itself, or is it necessary with a hybrid solution?	Depending on the wind conditions, you can sail the vessel at "normal" speed with only use of the rotor sails. However, you will need other solutions to maneuver in and out of port and also when wind conditions are not optimal. Rotor sail will normally have to be part of a hybrid solution.	No, rotor sails only cover part of the energy cost of transport. Other technologies are needed to reach a zero emission. (Yes. If you accept the limitations of a tall ship.)
3.4	What other options did you look into, and why were they cut short?	Several solutions have been considered. Most	All of them. Too expensive. This may

		of the alternative solutions are still not "ready for market" and would need major reconfiguration to the vessels engine to be installed.	change in the future, but rotor sails can be implemented today.
3.5	Have you considered rotor sails or other renewable energy solutions previously? If so, why did you not follow through at that time?	Several solutions have been considered. Most of the "new" solutions are still not "ready for market"	This was the first time we considered rotor sails. We have previously considered other wind assisted technologies. Cost and operational difficulties disqualified the latter. We also considered batteries and electric propulsion. Again, cost.
3.6	Can you describe the process and availability of information once you decided on rotor sails?	Very few suppliers available so depended on working very closely with the main manufacturer of rotor sail (Norsepower) to get the information needed.	Scientific papers on the subject are easily available. Once we had a basic understanding of the physics, we contacted Norsepower (which, to my knowledge, was (and is) the only commercially available rotor sail solution). Norsepower provided case studies

			for our vessel. Which we verified using a mix of in-house and 3rd party calculations.
3.7	What do you believe is the reason that other actors have not invested in rotor sails?	Historically the bunkers prices have been low and by that there has not been any incentives to move away from heavy fuel bunkers oil. Previous installations have been of a size/scale that has only made a small contribution to the bunker's consumption/ power use on board.	Other actors have invested. Our vessel was not the first rotor sail installation. It is unique because of the relative (large) size of the sails compared to vessel.
3.8	Is the rotor sail solution suitable for all routes and countries? If not, do you believe it will be at some point?	I work best where the wind conditions are stable, and you sail in open sea. The newly developed tilt mechanism, that allows you to tilt down the rotor sail to be able to sail below bridges and power lines, makes the use of rotor also interesting for short sea operators.	No. The viability of rotor sails depends on wind resources and vessel time at sea.
3.9	What do you consider as the biggest risks with investing in rotor sails?	The cost of bunkers and alternative solutions. The cost of	Operational risks. The systems need to work.

		installing the rotor sails (capex) also need to come down. Too few installation keep the productions cost of the rotor sails at a high cost..	
3.10	To what extend has UNs climate goals affected your investment decision?	Very much so, but mostly due to the charges that will come into effect using fossil fuel.	IMO 2050 certainly did. UN climate goals may have accelerated the decision indirectly.
3.11	Can you list three main drivers for the uptake of rotor sails?	- Reduction of fossil fuel - Low cost of use/ wind is free of cost - Well known/proven technology	fuel saving, cost, renewable
3.12	Can you list three main barriers against the uptake of rotor sails?	- development of other alternatives/ marked standards - rotor sails are only a partly solution - need to be combined with other solutions - production capacity / few manufacturers	knowledge, capex, uncertainty regarding future solutions
3.13	Do you have any additional comments on what effected your decision to invest in rotor sails?	The investment would not have taken place at this stage if we had not received a grant from ENOVA of 38% of the investment cost.	