Thomas Skogland Ognedal

Bachelor's thesis

Battery hybrid propulsion systems for AHTS vessels

How can AHTS owners gain a competitive advantage by installing battery hybrid propulsion systems into their vessels?

December 2021

NTNU
Norwegian University of Science and Technology
Faculty of Engineering
Department of Ocean Operations and Civil Engineering

NTNU
Norwegian University of Science and Technology

Bachelor's thesis

2021

NTNU

Norwegian University of
Science and Technology

Thomas Skogland Ognedal

Battery hybrid propulsion systems for AHTS vessels

How can AHTS owners gain a competitive advantage by installing battery hybrid propulsion systems into their vessels?

Bachelor's thesis
December 2021

NTNU
Norwegian University of Science and Technology
Faculty of Engineering
Department of Ocean Operations and Civil Engineering

NTNU
Norwegian University of Science and Technology

KANDIDATNUMMER(E):			
10029			
DATO: 16.12.2021	FAGKODE: TS301211	FAGNAVN: PRAKSIS I BEDRIFT	
STUDIUM: SHIPPING MANAGEMENT			ANT SIDER/VEDLEGG: 51/10

VEILEDER(E):
Jan Emblemsvåg

TITTEL:
BACHELOR´S THESIS – BATTERY HYBRID PROPULSION SYSTEMS FOR AHTS VESSELS

SAMMENDRAG:
PLEASE SEE PAGE III

Denne oppgaven er en eksamensbesvarelse utført av student ved NTNU Ålesund.

Preface

The last 20 years the Norwegian Offshore Industry has seen both peaks and depression in terms of income and costs. As the whole Maritime Industry is being pushed in a greener direction with new legislations and technology development. The last years Platform Supply Vessels (PSV) have been installing battery hybrid propulsion systems meanwhile the Anchor Handling Tug Supply Vessels (AHTS) has been running on conventional propulsion systems.

There are several factors why the AHTS segment has not developed proportional with the PSV segment. With the proven results of battery hybrid propulsion systems on PSV vessels, I have had the understanding that owners are now investigating the opportunity to install such systems onboard their AHTS vessels as well. Because of this coming transition, I was eager to investigate myself and to find different angles from charterers, owners, and suppliers to answer my issue that turns to the vessel owner.

During my work with this Bachelor Thesis this fall, I have worked at Seabrokers Chartering AS, and mainly been given tasks regarding the spot market team. I have had a good balance between working and writing, and I have held my planned schedule during the semester.

I wanted to gain a complete overview with interviews with charterer, owner, and supplier, and I have been lucky to have been presented two of these three angles. The highly competition sensitive suppliers' market has made it difficult to provide proportionate information. This wasn´t according to my plan, but I was able to find relevant public information to conduct an estimated consumption analysis for the charterers commercial gain.

I would like to express my sincere gratitude to Seabrokers Chartering AS and my supervisors Jone Sivertsen, Deputy General Manager at Seabrokers Chartering AS, and Professor Jan Emblemsvåg, NTNU, during this semester. Their combined competence and assistance have been of great inspiration. The way Seabrokers have included me in their daily offshore brokering services has been exceptional, and I have earned a lot of experience in daily conversations with charterers, owners, and colleagues. I would also like to express my gratitude to Espen Sørensen, K-Line Offshore, and Sigmund Hertzberg, Lundin Energy Norway, for allowing me to discuss my Bachelor thesis with them and to get their experienced opinions for further discussions.

Summary

The main purpose of this thesis is to investigate how AHTS owners can gain a competitive advantage by installing battery hybrid propulsion systems into their vessels. Through the three main angles: (i) vessel compatibility, (ii) owners' perspective, and (iii) charterers´ commercial gain, the thesis will utilize inductive qualitative methodology to present benefits and challenges related to this transition.

The AHTS market has followed the Norwegian Continental Shelf´s development since the 70´s and has been through both peaks and depressions. The highly advanced and complex AHTS vessels has seen technology developing rapidly. AHTS vessels are some of the most expensive vessels to build and operate. The latest 10 years, owners have been struggling financially due to the 2014 oil price collapse and market downturn. Challenging markets has proved that some owners have lost liquidity and ability to invest in the latest technology. AHTS owners are for that reason, situated at a crossroad where both charterers and governmental instances demand a more environmentally friendly operation. At the same time, finding capital for an investment like this is challenging. A transition like this is crucial for staying competitive in future operation, but with no financing schemes available, the transition is challenging.

Research have been conducted on alternative fuel types such as ammonia and hydrogen, but there are great risk and management challenges involved for a transition like this. The battery hybrid propulsion system has therefore been concluded to be the most suitable solution as of today. Due to the AHTS vessels complex main deck, the battery module is required to be installed below deck. Through the thesis´ interview with K-Line Offshore, a solution where one of the vessels brine tanks can be sacrificed, proves to be the most applicable solution.

A vessel owners income depends on having their vessels on charter hire. It is for that reason; the charterers need that decide whether a vessel is competitive or not. The thesis provides Lundin Energy Norway´s Senior Marine Supervisor, Sigmund Hertzbergs, perspective on the matter. Based on their previous vessel selection procedures and the factors Lundin Energy Norway are valuating, AHTS vessels with a battery hybrid propulsion system installed, will gain a competitive advantage. To investigate the charterers commercial gain, the thesis will conduct a consumption analysis. Even though the analysis prove that the systems provide a considerable commercial gain, the thesis enlightens the challenging financial aspect of this transition.

Glossary

AHTS	Anchor Handling Tug Supply Vessel
Bollard Pull	Total metric tonnes of towing capacity
Charterer	Company or instance that charters the vessel
DWT	Dead Weight Tonnage / A ships loading capacity
HFO	Heavy Fuel Oil
IMO	International Maritime Organization
MGO	Marine Gas Oil
NOx	Nitrine Oxide
Owner	Ship Owner
SOx	Sulphur Oxide
Fixture	Once a vessel has been awarded a contract
S/S Rig	Semi-Submersible Rig
J/U Rig	Jack-Up Rig
DP	Dynamic Positioning
OSV	Offshore Support Vessel
Starboard	Left side of the vessel
Portside	Right side of the vessel
WROV	Work Class Remote Operated Vehicle
M/M	Mass By Mass

Table of content

Figure list

Table list

1 - Introduction

Today's shipping market in general is affected by the sustainable legislations given by the International Maritime Organization and the constant drive for a greener world. Last year the new regulations for the Shipping Industry were initiated, the IMO 2020. The regulation set a new Sulphur emission limit for all ships from 3,5% m/m (mass by mass) to 0,50% m/m. The new regulation forecasts a total drop of 77% in SOx (Suphur Oxides) which are linked to respiratory diseases. The IMO 2020 regulations will mostly affect larger ships that utilize HFO (Heavy Fuel Oil). We´ve seen different approaches to comply with the new IMO regulations. VLSFO (Very Low Sulphur Fuel Oil) has been implemented in the larger DWT fleet. The North Sea Offshore fleet consist mostly of MGO going vessels that emits less SOX, NOx and CO2 compared to larger vessels (International Maritime Organization, 2021).

Platform Supply Vessels (PSV) and Anchor Handling Vessels (AHTS) has the recent years been built with a Diesel Electric propulsion that increases efficiency. To comply with the industries more sustainable demand, some PSV´s has been built and retrofitted with a hybrid propulsion system the last 10 years. Although the PSV and AHTS vessels might seem quite similar, they need a completely different propulsion capacity (Perrott, 2011, p. 5).

The North Sea demand for anchor handling vessels started along with the development of the Oil and Gas industry in the late 60´s and early 70´s. As platforms had to be anchored by up to 12 anchors, the demand for specialized vessels increased. Because of the North Sea´s rough conditions, the type of vessels already operating in the US- and Arabian Gulf couldn't operate in Norwegian nor UK sector. A new generation of anchor handling vessels has therefore continuously been purpose built for the North Sea market. These vessels were built with higher bollard pull as well as a specialized capability of deploying anchors and towing platforms in rough conditions (Perrott, 2011, p. 5).

The aim of this thesis is to investigate the owner's potential benefits and challenges by installing hybrid propulsion systems into their AHTS fleet. To gain a complete perspective of the issue, I will conduct interviews with owners and charterers. The root cause for studying this issue is that the shipping industry is being pushed in a greener direction, and with new regulations, all segments need to be prepared for an operational transition. The North Sea offshore support industry has since the 70´s, been a driver for development of modern technology. As the AHTS segment is in the beginning of a hybrid transition period, with the first planned installation early

2022, it would be interesting to study different factors involving investments, technical issues and how owners will gain a competitive advantage by installing such systems (Wartsila, 2021). The thesis will further describe the North Sea market and the different vessel specifications before the discussions three main angles: The vessels hybrid system compatibility and area of usage, shipowners' perspective, and the potential commercial gain for the vessel charterers.

Figure 1: Platform towage under rough conditions (Kae, 2021)

2 – Theory

Along with the world's technology development throughout the years, the operating vessels in the North Sea has changed a lot. The North Sea vessel fleet has in many ways been a pioneering market with new technologies developing along with the increased activity and demand (Perrott, 2011, p. 131). To gain an overview of the anchor handling market, I´ll describe both the historical and the current North Sea market and the operations conducted.

2.1 - Historical Market

The demand for anchor handling vessels increased along with the production start-up on the Norwegian Continental Shelf in the 70´s. Ekofisk was the first discovered oilfield on Norwegian Continental Shelf, and consisted of fixed structures on the seabed, like many of the first producing oilfields did. The anchor handling vessel's purpose was to assist on towing the structures from the construction site and positioning on the field (Perrott, 2011, p. 5). The Ekofisk storage tank was for instance in 1973 towed from Stavanger and positioned on the Ekofisk field in the southern North Sea. The tank was positioned on the seabed and required four anchor handling vessels. A total of 15 Platforms was from 1975 to 1995 constructed after the Condeep principle with concrete towers up to 303 meters resting on the seabed (Sandberg & Smith-Solbakken, 2020). Concrete structures like the Ekofisk tank and other Condeep structures was a durable solution for water depths up to 300 meters. After the Sleipner A concrete structure sank under construction in Gandsfjorden in 1991, the Princip of Condeep structures was phased out. The Troll A was the last Condeep platform that was positioned on the Norwegian Continental Shelf in 1995 (Sandberg & Smith-Solbakken, 2020). Throughout the years, the largest oil reservoirs were discovered at water depths that fixed rigs couldn't reach (Perrott, 2011, p. 16). The demand for anchored floating platforms therefore increased for the years to come. This transition turned out to be a turning point in the anchor handling market.

As the picture of the Troll A towage below shows, it required eight anchor handling vessels for towage, heading and field positioning. The Semi-Submersible floating platforms that replaced the Condeep structures required 8 to 12 mooring lines. The anchor handling segment reached new demand levels, as the number of mooring operations raised. As a result of this both vessel utilization and daily charter rates increased (Perrott, 2011, p. 47).

Figure 2: Troll A towage in 1995 (Norcem, 2021)

The Crude Oil Price raised from $26,72 in the year 2000 to $98,83 in the year 2011 (Macrotrends, 2021). Norwegian Offshore Shipowners saw a proportional turnover increase in the same period from NOK 13 billion in the year 2000 to NOK 82 billion in the year 2012 (Norwegian Shipowners Association, Appendix 2). Shipowners enlarged their investment equity which resulted in record-high Offshore Support Vessel (OSV) orderbooks at the shipyards. In 2014, the oil supply exceeded the worldwide demand, which resulted in production downgrade and oil price collapse (Perrott, 2011, p. 47).

As the offshore supply market is directly affected by the activity in the North Sea, the anchor handling market collapsed at the same time. Norwegian offshore shipowners who ordered tonnage in the strong 2012 market, received their vessels in the depressed market of 2014 and onwards. The market was overcontracted and we saw yard-new vessels going directly into lay-up after delivery. As technology continuously developed over the last 10 years, the vessel capacities have reached new levels (Perrott, 2011, p. 131). This meant that the anchor handling operation that required eight vessels for 20 years ago, now required only four. This development turned out to be crucial for the laid-up tonnage as newer vessels were more fuel efficient and had higher towing capacity. Some laid-up vessels resumed North Sea operation, and some were sold to other markets around the world. We´re still seeing laid-up tonnage along the Norwegian coast because of this transition.

The below chart illustrates the oil price development the last 20 years where the red circle indicates the 2014 market downturn. In the period before 2014, owners contracted new vessels as described above. Owners are still struggling financially because of their tied-up capital and low income in the years after 2014.

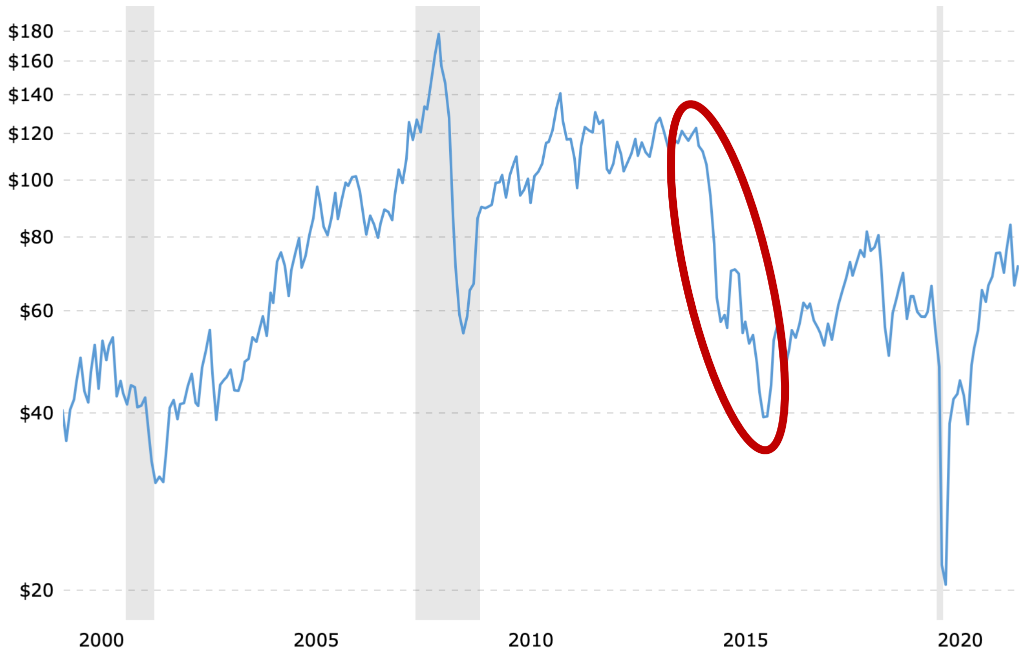

Figure 3: Crude oil price development the last 20 years (Macrotrends, 2021)

The North Sea OSV market correlates directly to Stopfords description of the shipping markets different cycles. A shipping cycle is often referred to as a "7-year cycle". Within these seven years the market will go through the following 4 stages: Through, Recovery, Peak and Collapse. The below chart illustrates Stopfords "7-year shipping cycle" (Stopford, 2009, p. 97).

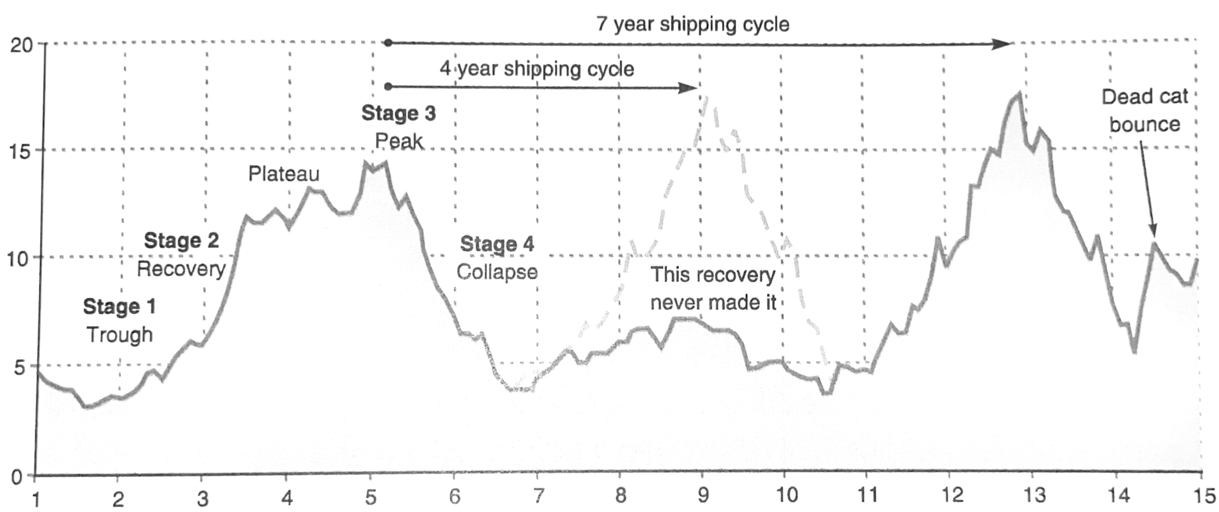

Figure 4: Shipping Cycles (Stopford, 2009, p. 97)

2.2 - Current Market

Today`s anchor handling market is controlled by the supply and demand mechanism that makes the segment very volatile. The North Sea market consists of 29 large charterers and 9 large ship owners that operate a total of 29 Anchor Handling vessels (Overview charterers, owners and vessels, Appendix 8). The purpose of the AHTS vessel in today´s market is to assist on pre-lay, towage and mooring of platforms on the field (Perrott, 2011, p. 5). The activity and demand on the field is controlled by the large platform operating charterers. As platforms need assistance, the charterer enters the market with a requirement through the brokers. At this point the value of the AHTS fixture is subject to the total vessel availability. The daily rate for an AHTS vessel in today´s market isn't linear. That means that if there are three prompt available vessels that competes for the same requirement, the rates will be significantly lower than if there was only one available vessel (Perrott, 2011, p. 50). A typical rate in a case with five available vessels, could vary between 10.000€ to 40.000€. Unlike the case where only one vessel is available, we could see rates varying from 50.000€ to 150.000€ (Seabrokers, 2021). The daily rates alone show the volatility in the market that affects both the income of the owner and the expense of the charterer. To understand furthermore of the North Sea AHTS market, I´ll explain the different work scopes the vessels can carry out.

2.2.1 - Pre-laying procedures

The pre-lay work scopes have the last 20 years become more frequent as the demand for floating and anchor moored platforms has raised. A floating platform is usually moored by 8 or 12 anchors to the seabed installed by assistance of Anchor Handling vessels along with a Remote Operated Vehicle (ROV) (Perrott, 2011, pp. 77, 78). In the first phase of floating platforms, the procedure by towing and mooring the platform on the field was time demanding and costly for the platform operator as it could take up to ten days to finish a Rig Move. This meant ten days of daily platform hire without any income. To increase efficiency, the platform operating companies along with Anchor Handling ship owners developed the procedure of pre-laying an anchor spread. An anchor spread is the mooring system for a floating platform that consist of anchors and mooring lines. The AHTS vessel, often along with two or three additional vessels, deploys individual anchors attached to mooring lines and tightens the line to a certain tension before attaching a buoy on the surface of the water. Deployment of anchors are done on different locations on the seabed, making the spread robust for the North Sea´s harsh conditions. Once the anchor spread has been pre-laid, the platform can be towed to location and hooked up in a couple of days (Intermoor, 2021).

2.2.2 - Towage, mooring and hook-up

The Anchor Handling vessel's main purpose is to assist on in- and offshore towing of mobile floating facilities. The AHTS vessels are equipped with winches capable of handling heavy loads for any kind of towing operation. For the North Sea AHTS segment, the vessels are primarily utilized for off-shore towing, but also in-shore if a platform is to be moved from its construction site before mooring and hook-up (Perrott, 2011, p. 75).

As anchor handling vessels undergoes a great amount of load over a longer period, the vessels are equipped with engines with an output of 20-40.000 BHP. The vessel engines can be used in different configurations specified for the exact operation. The towing operation vary between each tow as the platform properties differs between each other. In today's market, the Anchor Handling vessels are primarily assisting Jack-Up (J/U) and Semi-Submersible (S/S) rigs. These two rig-types are the most common oil-producing facilities in the North Sea and even though the rigs might seem similar, they need a completely different towing approach. The S/S rigs are often very robust and have their own propulsion system for station keeping on field. These rigs are often heavier than the J/U rigs and does often need 2-4 large AHTS vessels for heading control and maintaining momentum (Perrott, 2011, pp. 15, 16). The J/U rigs have three jack-up legs at up to 200 meters that attaches to the ground at field (Maersk Drilling, 2021). These rigs need often less assistance with 2 AHTS vessels and one or two smaller tugs because of their lighter construction.

Figure 5: Far Sapphire and Havila Venus towing the Maersk Inspirer J/U (Repsol, 2021)

2.2.3 - Offshore towage

The Anchor Handlers main purpose is to assist on offshore towage. The offshore towing work scopes vary from moving the rigs from one location to another or in/out of shore. There are different demands for towing equipment during offshore operation. The most common used towing equipment is the 3-point main tow bridle. The bridle provides increased heading control during harsh conditions due to equal amount of tension distribution. As the figure (6) shows, there are three towlines attached to a delta plate. The delta plate is used in all larger towing operations as the plate distributes equal power to each of the towlines (DNV, 2021). S/S rigs have four submersible pontoons with a towage setup like the figure (6) illustrate on each pontoon. The J/U rigs usually have this kind of setup in the fore part of the rig and two similar at each stern side.

The main demanding factor that affects offshore towage is the weather conditions. Based on the work-scope, the wave and wind limits may differ from operation to operation. S/S rigs are often more robust and can move location in harsh conditions. The wave limit for a S/S rig move is often around 2,5 meters. This is due to the rigs capability of ballasting and increasing her draft to prevent rolling in high waves and reduce wind trap. The J/U rigs on the other hand doesn't have the same ballasting capabilities and requires a maximum wave height of 1,5 meters during towage and positioning (Perrott, 2011, pp. 10, 17) (DNV, 2021).

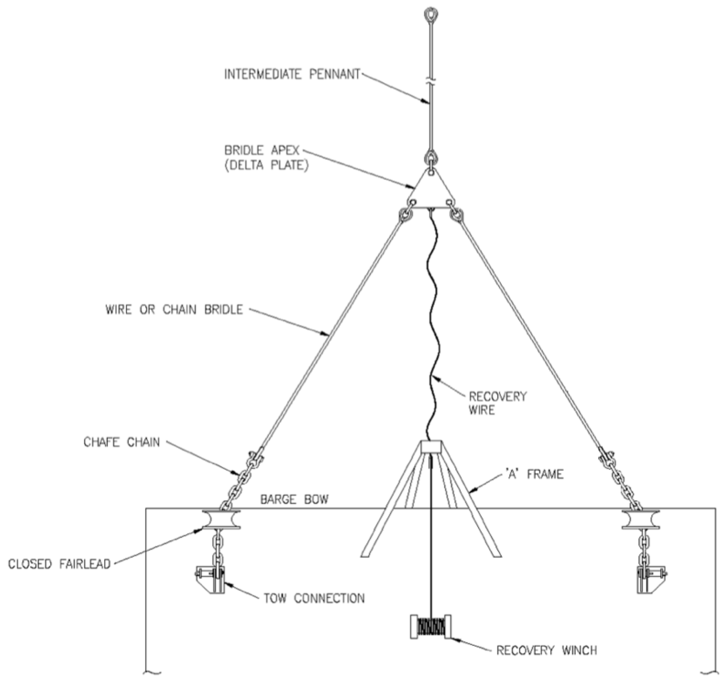

Figure 6: Noble Denton, Main Tow Bridle (DNV, 2021)

2.2.4 - In-shore towage

In-shore Rig towage requires detailed planning and precision performance by the anchor handling vessels crew. Factors such as draft, air-draft, in-shore voyage routing and handling procedures are crucial for a successful operation. To maintain sufficient heading control, a typical in-shore towage requires 4-8 AHTS vessels. The in-shore operation is more demanding than offshore operations because of the small margins regarding draft and clearance to shore (Perrott, 2011, p. 75). A typical in-shore towage will utilize three vessels for forward heading control and two for reversed heading control as the picture of the Aasta Hansteen rig move below shows.

In terms of towing equipment, all in-shore rig moves will require the same equipment as offshore towage. All vessels will use the same delta plate tow bridle on all tow connections to the rig. The main difference between in- and offshore towage is the towline length. J/U rigs usually requires a towline length of up to 600m offshore where S/S rigs usually requires a towline length of up to 1500m. For in-shore towage at shallow waters, a towline of up to 600m is a normal procedure (DNV, 2021).

Figure 7: Towage of the Aasta Hansteen (Andersen, 2018)

2.2.5 - Mooring and hook-up

Once the rig has been successfully moved from one location to another, the Anchor Handling vessels task is to assist on mooring and hook-up. There are several methods of mooring and hook-up depending on the rig-type and water depths. S/S rigs are in today´s market is usually operated on Dynamic Positioning (DP) or anchored up on a pre-laid anchor spread as described above. The below figure (8) illustrates a floating S/S rig moored by Drag anchors installed by AHTS vessels (Intermoor, 2021).

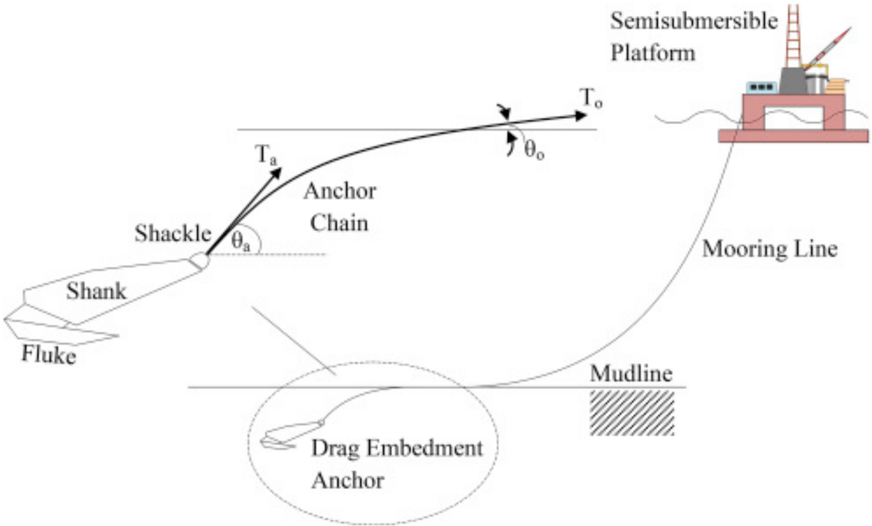

Figure 8: Drag Anchor Mooring on a S/S Rig (Moharrami & Shiri, 2018)

The mooring operation of a J/U rig is somewhat less demanding for the AHTS vessels than the S/S rigs. This is due to the J/U´s three “legs” that are self-moored to the seabed at shallow waters. The vessel’s purpose is to assist the J/U on station keeping during jack-up as most of these rigs doesn’t have their own propulsion system (Perrott, 2011, pp. 15, 16).

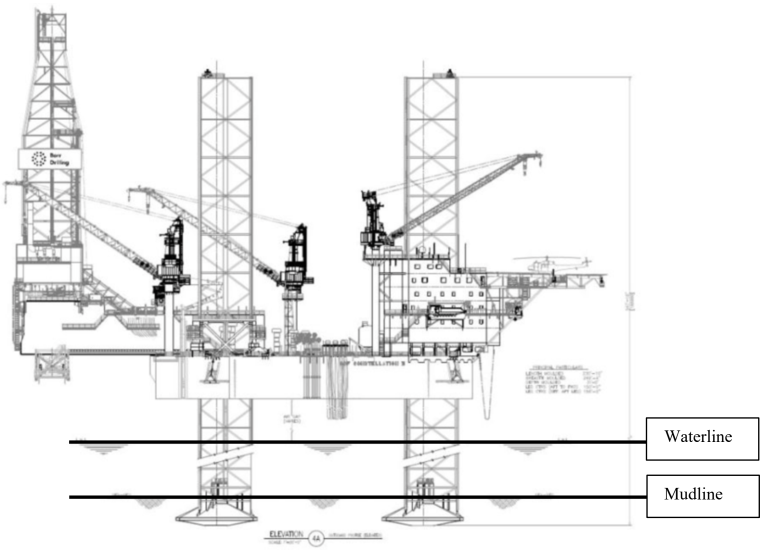

Figure 9: J/U Rig fix moored to the seabed (Ocean Energy Resources, 2020)

2.3 - The Anchor Handling Vessel

To gain an overview of the different technical specifications of the anchor handling vessel, going forward, the thesis will be based on one of the largest AHTS vessels operating in today's North Sea market. The KL Sandefjord is a state-of-the-art vessel delivered from STX Langsten in 2011. She has a Length Overall (LOA) of 95,2 meters and a bollard pull capacity of 390 metric tonnes (K-Line, Appendix 1).

Figure 10: KL Sandefjord (Giske, 2018)

Figure 11: The KL Sandefjord towing the Njord A platform (Equinor, 2016)

The AHTS vessels has some characteristic equipment both on- and under deck. In daily operation, the on-deck equipment is the most central equipment and serve different purposes to achieve a successful operation.

2.3.1 - Shark jaw and steering pins

To restrict unwanted, sudden direction of change during chain and tow-line operations, the stern deck is equipped with a shark jaw and steering pins (Kongsberg, 2021). During all towing operations, two steering pins will be raised from deck to avoid sling of the towline. This way the deck-crew can work up close to the towline without the risk of sudden line movement. As anchors are deployed, a certain chain-length is attached before the actual mooring line starts. To prevent an uncontrolled anchor deployment, the shark jaw will be raised from deck to lock the chain in place. This way the deck-crew safely can perform the necessary work before final deployment or loading of an anchor. As the below pictures shows, the shark jaw and steering pins are situated just in front of the stern roller.

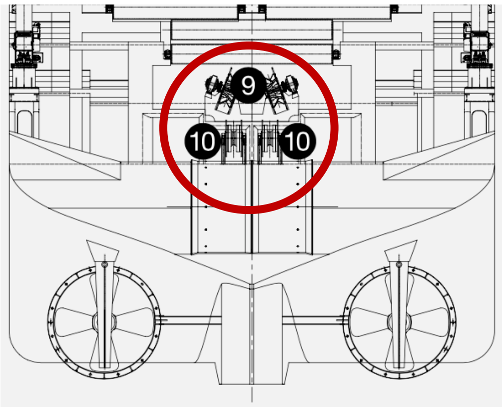

Figure 12:Steering pins and Sharkjaw (K-Line, Appendix 1)

Figure 13:Sharkjaw and steering pins in operation (SDM Korea)

2.3.2 - Stern roller

As the AHTS vessels are handling chains and equipment over the stern of the vessel, the hull material gets exposed to deterioration. To prevent unnecessary wear, the stern is equipped with a stern roller (Perrott, 2011, p. 64). The twin stern roller equipped on the KL Sandefjord has a dimension (Kongsberg, 2021) of 3 meters in length and 4,5 meters in diameter. The stern roller, provided by RRM, has a Safe Work Limit (SWL) at 500 tonnes and a Maximum Work Limit (MWL) at 750 tonnes (K-Line, Appendix 1). As anchors, buoys and chains are being loaded or offloaded, the stern roller rotates in the working direction to avoid wear.

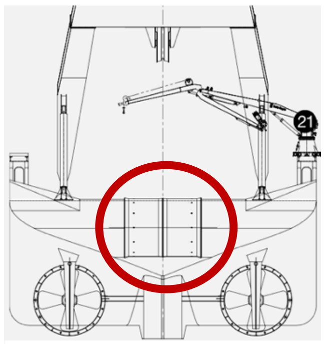

Figure 14: Stern Roller (K-Line, Appendix 1)

2.3.3 - Winches

The AHTS vessels most important equipment are the vessels winches that assist on anchor handling and towage. The KL Sandefjord is equipped with several winches that serve different purposes. The vessel is equipped with two anchor handling winches, one special handling winch, two secondary winches, and two tugger winches midships and in the aft of the vessel. The anchor handling winch has the largest capacity of the vessels equipped winches. It has a maximum pulling capacity of 600 tonnes and has a length of 2,5 meters and a 2 meters diameter (K-Line, Appendix 1). The below illustration shows the winch set arrangement onboard the KL Sandefjord.

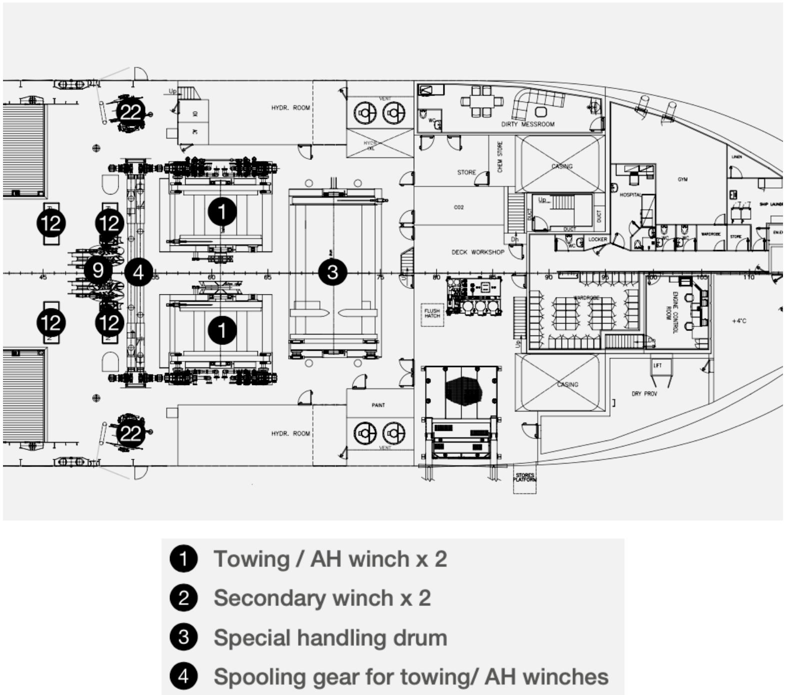

Figure 15: Winch arrangement (K-Line, Appendix 1)

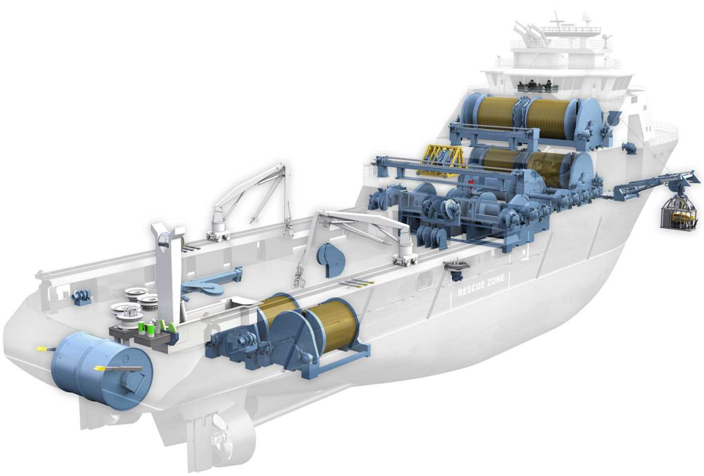

Figure 16: Illustration of Kongsbergs winch sets (Kongsberg, 2021)

All the above-described deck equipment are all connected to the vessels hydraulic power unit. The hydraulic power unit is driven by an electrical engine that receives power from the vessel's main diesel engines (K-Line, Appendix 1). For that reason, with some modifications, the vessels hydraulic system could be connected to a battery hybrid propulsion system. The hydraulic power unit doesn't emit nearly as much as the vessels propulsion system. For that reason, the owners need to analyze what part of the vessel the potential battery unit should utilize its power on.

2.3.4 - Remote Operated Vehicle (ROV)

During prelay operations and recovering of anchor spreads, the charterer may require an ROV to assist on the operation. The KL Sandefjord is therefore equipped with an ROV hangar at the vessels starboard side and is capable of carry a Work Class ROV (WROV) which is equipped with "arms" to assist on complex subsea intervention operation such as seabed installation construction and maintenance (Perrott, 2011, p. 77), (K-Line, Appendix 1). The ROV is electrical driven, which could make it possible to connect it to the vessels battery hybrid propulsion system if profitable. The figure (17) below shows the KL Sandefjord´s ROV hangar.

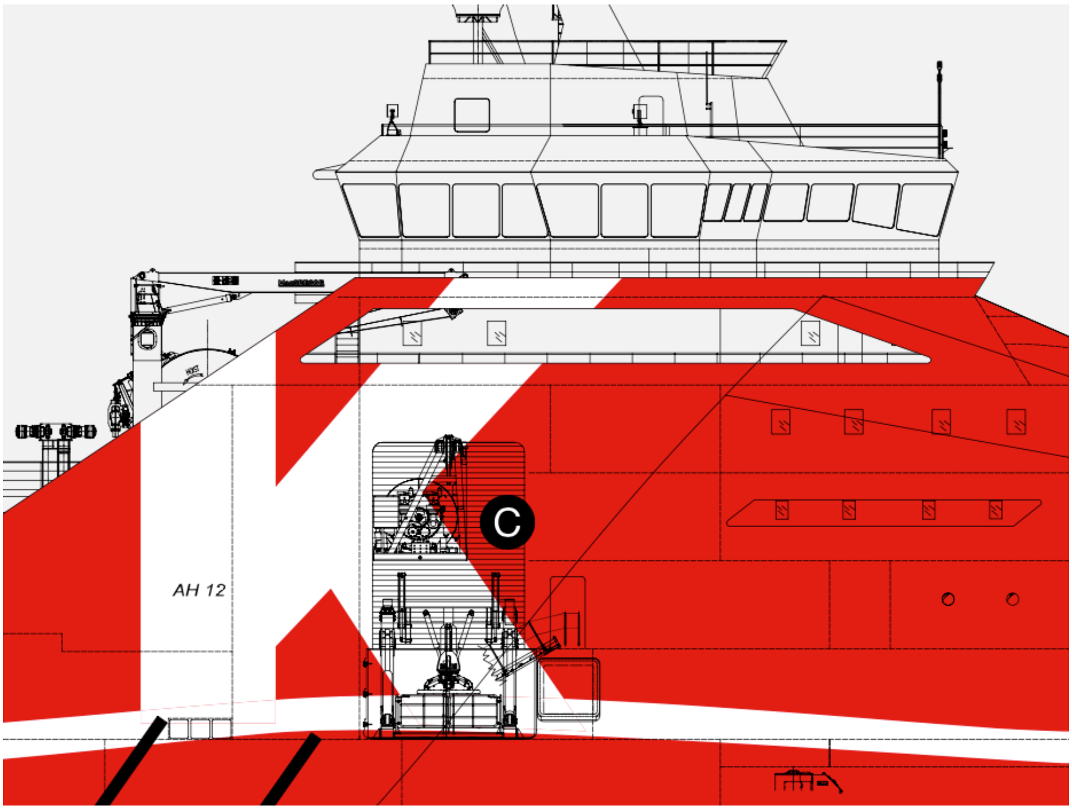

Figure 17: KL Sandefjords ROV Hangar (C), (K-Line, Appendix 1)

2.3.5 - Propulsion system

The AHTS vessels propulsion system is the most complex equipment onboard. There have been some developments on Anchor Handling Vessels propulsion systems over the years. There are two main types of systems in general, the Diesel-Mechanic system and the Diesel-Electric system. The Diesel-Mechanic system consist of two main diesel engines running directly on the shaft (K-Line, Appendix 1). These systems are the most common on AHTS vessels because of their even power distribution. The modern vessels operating in today's market on the other hand is equipped with a Diesel-Electric system (Perrott, 2011, p. 119).

The Diesel Electric system is in many ways similar to the Diesel-Mechanic system. The main difference is that the shaft is powered by an electrical engine that is powered by the main diesel engines. Because of the electrical engines capability of providing all available power instantly, the Diesel-Electrical system is a more efficient system. The KL Sandefjord´s system is called a hybrid solution because the vessels crew can run the engines in different modes. That means that the crew can select between Diesel-Electrical or Diesel-Mechanical power distribution based on the current operation. During towage or anchor handling, the vessel is requiring all available power over time. The vessel will in this case be running on the Diesel-Mechanical mode. During stand-by on location or during prelay operation, the Diesel-Electrical mode will be engaged to provide all available thrust as fast as possible for enhanced station-keeping. Systems like this are therefore called hybrid systems, even though there isn't a battery pack installed, like the battery hybrid propulsion system the thesis will discuss further on (Perrott, 2011, p. 119).

The KL Sandefjord is equipped with two main Wartsila Engines with a capacity of 8000/7680kW at 750/720 rounds per minute (RPM). The power supply is delivered by five Caterpillar generators with a capacity of 2 188kW each at 1 800 RPM. The main engines along with the generators delivers a total of 34 000 brake horsepower (BHP) (K-Line, Appendix 1). The below illustration shows the arrangement of the KL Sandefjords engine room.

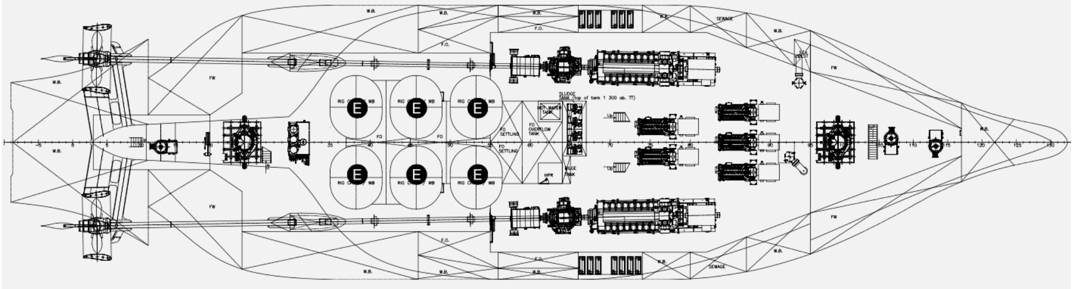

Figure 18: KL Sandefjord, engine room/tank top (K-Line, Appendix 1)

2.3.6 - Thruster systems

The KL Sandefjord has one of the most advanced thruster equipment installed. A thruster is a "Maneuvering devices designed to deliver side thrust or thrust through 360°. Thrusters are used to allow ships to be more independent from tugs and give them more maneuverability for special tasks. "There are three general types of thrust devices: the lateral thruster or tunnel thruster, which consists of a propeller installed in an athwartship tunnel; a jet thruster which consists of a pump taking suction from the keel and discharge to either side; and azimuthal thruster, which can be rotated through 360°" (Wartsila, 2021). The KL Sandefjord is equipped with two tunnel thrusters in the fore part of the vessel and one tunnel thruster in the aft part of the vessel. These thrusters deliver sideways thrust and are the most used thruster types on OSV vessels. The vessel is also equipped with two retractable azimuth thrusters in the fore and aft part of the vessel (K-Line, Appendix 1). These thrusters can be deployed and provide 360° thrust and will improve station keeping on location. The below illustration shows the different thrusters installed on the KL Sandefjord.

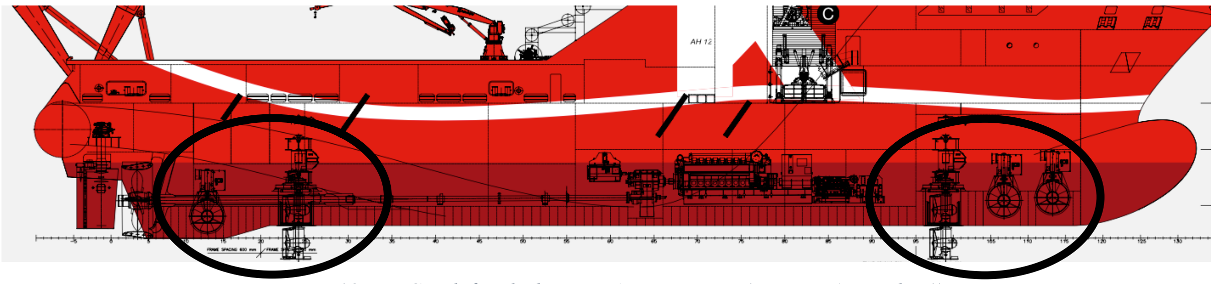

Figure 19: KL Sandefjord Thruster Arrangement (K-Line, Appendix 1)

Both the vessels main propulsion- and thruster systems are diesel-electrical driven. The systems are connected to the vessels same power distribution grid. With a battery hybrid propulsion system installed, all the propellers electrical engines could be connected to the fully electrical power grid and be operated optimal by the vessel operators.

2.3.7 - Bollard pull

We´ve now gone through the main equipment onboard an AHTS vessel which leaves us with the total pulling capacity. The Bollard Pull (BP) of an AHTS is the most central vessel capacity. Every AHTS vessel is required to hold a valid Bollard Pull certificate to operate and is issued by completing a BP test. A BP test is done by attaching a towline to a mooring pile and applying maximum forward thrust. This way the vessel owners can determine the exact towing capacity over a period of time (Menon, 2021). As a charter requirement is published and sent to the owners via the brokers, the BP limit is stated based on the scope of work. During rig moves, the general limitation is a minimum of 200 tonnes BP. Based on the BP certificate, only a selection of vessels will be able to compete for the charter.

2.4 - The battery hybrid propulsion system

The latest years the demand for battery hybrid propulsion systems has increased which has resulted in a larger number of suppliers offering such systems. As most modern PSV vessels already have these systems installed, AHTS owners are also investigating the possibilities and potential benefits of such systems. So, how can AHTS owners gain a competitive advantage by installing battery hybrid systems? The systems are highly compatible with the modern AHTS fleet as most vessels are built with a diesel-electric propulsion system. The diesel electric propulsion system is driven by five diesel generators that delivers power to an electrical engine that drives the propeller (K-Line, Appendix 1). Based on the above described AHTS operations, when will a battery hybrid propulsion system be applicable and benefit the charterer?

The AHTS vessels have different operating modes based on the operation the vessel will conduct. During heavy load operation during towing over a longer distance, the hybrid system won´t serve its purpose as the battery capacity won´t last for long under such loads. So, during which operations will the charterer benefit from a vessel with a hybrid system installed?

Hybrid systems serve their best purpose during lower loads for example during DP operations (Dynamic Positioning). Charterers utilize the AHTS vessels for pre-laying operations as described earlier. During operations like this, two vessels normally install 8-12 anchors on the seabed while laying on DP or applying low amount of load manually for station keeping. It is during operations like this the hybrid systems would be highly applicable and profitable. During pre-lay operation under good to medium weather conditions the power demand is low enough to be supplied by the battery hybrid system alone or in a combination with the diesel generators, depending on which mode the vessel is operated in.

To maximize the effect of these systems, Wartsila and other suppliers integrates an energy management system (EMS) that allows the operator to decide at which power load the system will activate. This way, the vessel operator can set a power load limit the vessel will run on fully electrical power with no emissions, in a combination with the diesel engines or on a fully diesel power supply (Wartsila, 2018). With a system like this, the charterer can be assured that when the power load is at a certain amount, the vessel will run as efficient as possible to reduce both cost and emission.

2.4.1 - Wartsila HY

To explain how the battery hybrid propulsion system works, the thesis will below be based on Wartsila´s acknowledged "HY" system. As described above, the system is controlled by an EMS system that allows the operator to vary between different operating modes. The KL Sandefjord is equipped with five diesel generators (C) that provides power to the shaft through the electrical engines (F) (K-Line, Appendix 1). Wartsila´s HY system implements two DC-hubs (E) which converts the diesel generated power to electrical power to supply the propellers (G) shaft. The battery module (D) installed on deck or individually adapted is also passing through the DC-hub allowing the shaft- or thruster (A) power to vary between diesel generated power or clean battery power. The system is all linked up to the vessels customized AC switchboard (B) that ensures safe operation of the system (Wartsila, 2018).

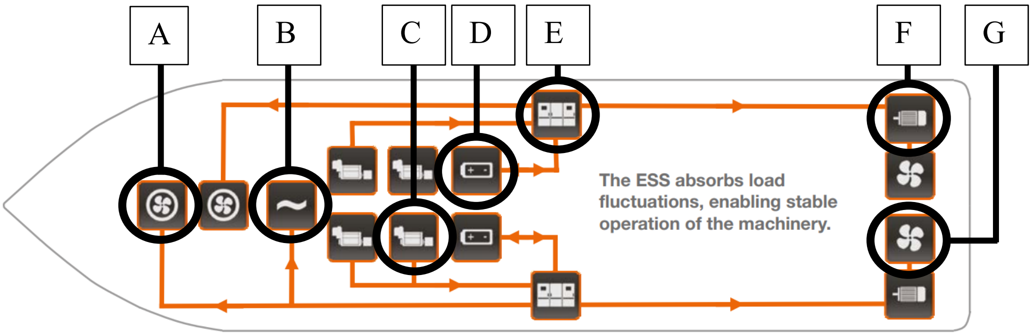

Figure 20: Wartsila Battery Hybrid Propulsion System Overview (Wartsila, 2018)

The below chart shows Wartsila´s relative fuel consumption comparison for the different propulsion systems on a tug. The chart is based on the most common Diesel-Mechanic propulsion solution which is stated at 100%. The modern AHTS vessels such as the KL Sandefjord has a Diesel-Electric propulsion system which will, based on the below measures, have an estimated fuel reduction of up to 22% (Waage, et al., 2018).

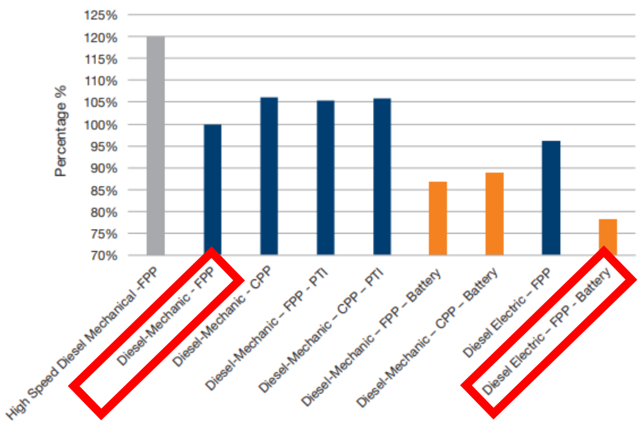

Figure 21: Fuel Reduction Relative Comparison (Waage, et al., 2018)

3 - Approach and methodology

There are multiple reasons why I´m investigating how AHTS owners can gain a competitive advantage by installing battery hybrid propulsion systems into their vessels. First, the entire industry is being pushed in a greener direction and the different parties in the offshore segment are all developing new technologies to increase efficiency and reduce their environmental footprint. Secondly, as I´ve experienced during my internship at Seabrokers´ Spot division, the AHTS segment is volatile and the competition for requirements and work scopes are high. I therefore was eager to conduct research on what information existed in the current market and combine them all together to get a clear overview of what factors AHTS owners could consider for increasing their competitive advantage.

3.1 – Problem formulation

As I´ve been included in the commercial aspect of the AHTS segment this semester, I wanted to conduct research from the Owners perspective to increase the understanding of the market. I wanted to investigate the possible solutions for both reducing the AHTS vessels environmental footprint and increasing their market position. Different technologies already exist in the market, and I chose to formulate the research question regarding the solution with proven results on PSV vessels. To understand how these systems could impact the commercial aspect for AHTS owners, I decided to base my Bachelor´s thesis on the following research question: How can AHTS owners gain a competitive advantage by installing battery hybrid propulsion systems into their vessels?

An important part of the research is to understand the AHTS market, and the different operations conducted. The vessels technical specifications are also essential to understand what components that may be compatible with such systems. The further discussion of the thesis will be based on inductive qualitative methodoly where I´ll be discussing my two interviews conducted with Sigmund Hertzberg, Senior Marine Supervisor at Lundin Energy Norway and Espen Sørensen, COO at K-Line Offshore.

3.2 – Interviews and selection

I have had a goal to conduct interviews with both charterer, owner, and supplier to get a complete overview on the problem and was able to get the charterers and owners personal perspective. Unfortunately, the suppliers of the battery hybrid propulsion systems couldn’t participate in an interview because the information is too competition sensitive. I therefore had to do research on all publicly available data from suppliers, and where able to retrieve relevant information to gain an overview of the problem and retrieve data to conduct an analysis with estimated results.

Regarding the selection of interview participants, I wanted to angle the thesis to an Owner that had not concluded on their decision yet. Maersk Supply Services has already decided to install these systems into their AHTS vessel, the Maersk Minder, in the beginning of 2022 (Wartsila, 2021). Even though it would´ve been interesting to get their perspective as well, I was lucky to get K-Line Offshore´s perspective during their consideration phase and what factors they take into consideration before a conclusion is made.

3.3 – Data and literature

The theory this thesis is based on is a combination between publicly available data, vessel specification from K-Line Offshore and the Institute of Chartered Shipbrokers´ theory book "Offshore Support Industry". The methodology theory is based on Aksel Tjora´s "Kvalitative Forskningsmetoder i praksis" (Tjora, 2017). The Institute of Chartered Shipbrokers is a London-based organization that offers subjects within the different shipping segments. Their theory books are all written by shipping professionals with great experience within the specific markets and has given me great insight in the AHTS segment.

3.4 - Structure

I have structured the thesis by above describing the historical and current market, the different operations conducted and the AHTS vessels central specifications. The thesis will further discuss relevant theory along with the charterer and owners' perspective retrieved from the interviews conducted to test out the thesis problem.

3.5 – Delimitation

The thesis will further be limited to the commercial aspect of the battery hybrid propulsion transition. The systems provide great emission reductions and could be analyzed as a research question alone. However, the thesis going forward, will be based on how the AHTS owners can gain a competitive advantage by installing the systems into their vessels. For that reason, the thesis´ focus will be the commercial factors involved in the transition.

4 – Case results

Based on the above vessel- and market description, the thesis will further discuss how owners can gain a competitive advantage by implementing battery hybrid propulsion systems into their vessels. By gathering market information and interviewing both charterer, owner and supplier, the thesis will investigate whether an investment in such systems will be both commercially and financial advantageous for vessel owners. The thesis will further be based on three main angles: The vessels hybrid system compatibility and area of usage, shipowners' perspective, and the potential commercial gain for the vessel charterers.

4.1 - Vessel compatibility and owners' perspective

The latest years the supplier competition has increased and almost every large propulsion system supplier is now offering systems that would be applicable for AHTS vessels. Even though the systems may differ from each other, they all serve for the same purpose, to decrease vessel emission and increasing effectiveness. As mentioned earlier, such systems have been implemented on PSV vessels for some years already. Why hasn´t the AHTS segment moved proportionally during this development? This is due to the different propulsion capacities and installation obstacles of the AHTS vessel.

4.1.1 – Vessel compatibility

A PSV has typically 800-1000m2 of free deck space which makes the battery integration uncomplicated (Perrott, 2011, p. 6). Some of the most utilized battery hybrid systems are the SeaQ Power system by Vard and Wartsila´s HY system. These power solutions integrate the batteries into a 20ft container which is normally placed on a PSV´s cargo deck as the below figure (22) shows (Vard, 2021).

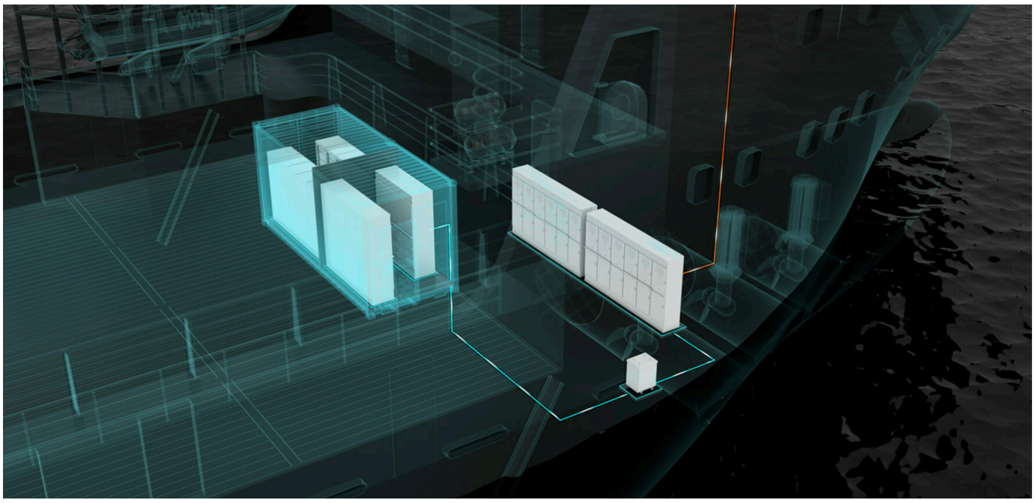

Figure 22: Containerized battery solution for PSV´s (Vard, 2021)

Unlike the PSV, the AHTS vessels deck is more complicated due to the vessel's winches and other deck equipment used during operation. As the whole industry is being pushed in a greener direction, AHTS owners also need to investigate the possibility to decrease their footprint even though implementation of systems like these may be challenging and expensive. For that reason, Vard and other suppliers are offering individual system integration for AHTS vessels.

AHTS vessels are equipped with tanks under deck to carry rig chains and other commodities such as brine, drill water and mud. The battery hybrid propulsion suppliers can individually integrate their systems into AHTS vessels by installing the battery module under deck (Sørensen, 2021, Appendix 5). As the PSV´s usually supply rigs with these types of commodities, the AHTS vessels brine tanks are not often utilized. For that reason, K-Line Offshore has investigated the possibility to sacrifice one of the KL Sandefjord´s brine tanks. By removing one of the brine tanks, the battery module can be placed under deck out without interfering with deck operations or stability. Another option is to install the battery module in the engine room. The one downside with installing the battery module in the engine room is that the generated heat can´t be controlled in the same way as in the tank arrangement where cooling systems could be installed (Sørensen, 2021, Appendix 5). The below figure (23) shows the vessels two brine tanks marked in red.

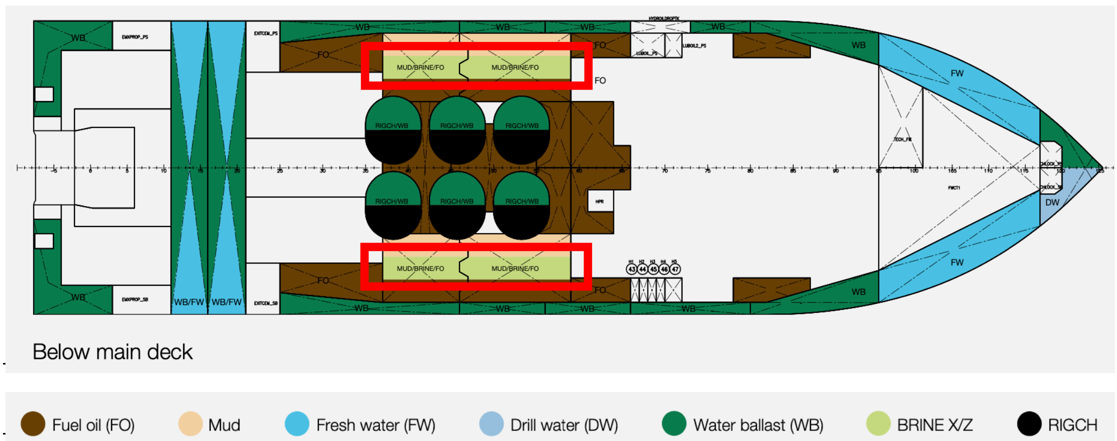

Figure 23: KL Sandefjord, tank plan (K-Line, Appendix 1)

As the battery module is connected to the vessels main power grid, the vessels other operational equipment could also be connected to the system. The KL Sandefjord´s winch set is all hydraulicly powered and cannot be connected as the vessel is equipped today. There is, on the other hand, solutions where K-Line Offshore can retrofit an electric motor to make the winches applicable to the battery module. By retrofitting such equipment, the vessel operator can regenerate power into the battery during slacking of the winch. As of today, the only energy the winches generate is heat (Sørensen, 2021, Appendix 5).

4.1.2 - Owner's perspective

Normally, it´s the vessel owners' responsibility to ensure their vessels are following the technology development in the market. As described above, the offshore segment has seen some tough years with vessels in lay-up and lost capital as the oil-price collapsed in 2014. For that reason, the latest years some owners have struggled to find capital to upgrade their vessels according to the market's available technology. K-Line Offshore on the other hand, contracted two top-modern AHTS vessels in 2011 and has since the delivery of these vessels, had a leading position in the market.

Figure 24: K-Line Offshore (K-Line, 2021)

K-Line Offshore AS is an Arendal-based daughter-company of the Kawasaki Kisen Kaisha Ltd. The company was established in 2007 and is known for its high-quality vessels. As of today, K-Line Offshore owns four PSV vessels and two AHTS vessels, all operating in the North Sea market (K-Line Offshore, 2021).

We´ve already seen Maersk Supply Services concluding on their decision to install a battery hybrid propulsion system into the Maersk Minder, and for that reason, other vessel owners may be forced into the same direction. As some owners may struggle to get such an investment funded, not all will be able to upgrade their vessels according to the available technology. For that reason, Enova has been offering financial support for OSV owners to install shore-power and battery hybrid propulsion solutions into their vessels. Unfortunately, Enova ended the financial support for battery hybrid conversion for OSV vessels in 2018. This means that vessel owners must bear the full cost of the potential investment (Enova, 2021).

Will a potential investment in a battery hybrid propulsion system influence K-Line Offshore´s commercial pricing? Based on K-Line Offshore´s COO, Espen Sørensen, they might need to increase their daily rate. On the other hand, an investment in such systems is likely to gain charterers more than the increased daily hire. By investing in a battery hybrid propulsion system in the KL Sandefjord, K-Line Offshore therefore may increase their market position. In a competitive market, charterers will save both fuel costs and environmental footprint for their operations (Sørensen, 2021, Appendix 5).

4.2 - Charterers commercial gain

The owners are dependent on requirements and work-scopes from the charterer. It is the charterers needs that decides whether the vessel owner has a competitive advantage with their quoted vessels or not. For that reason, the thesis will further be based on an interview conducted between Lundin Energy Norway´s Senior Marine Supervisor, Sigmund Hertzberg, and myself.

Figure 25: Lundin Energy Norway (Tollaksen, 2020)

Lundin Energy Norway AS was established in 2004 and started off as an exploration company and has developed into a large developer and operator. Lundin Energy Norway is one of the largest charterers in the North Sea OSV market and is known for developing new solutions, and their focus carbon footprint, cost, and efficiency (Lundin Energy Norway, 2021).

Does the current market already have factors that give some AHTS owners a competitive advantage? Lundin Energy Norway recently required AHTS vessels for the rig move of the Valaris Viking on the Edvard Grieg field (Hertzberg, 2021, Appendix 4), (Seabrokers, 2021). In this case, Lundin Energy Norway required two sister vessels to apply similar amount of thrust during the rig move (Hertzberg, 2021). At the time of entering the spot market, both K-Line Offshore and Siem Offshore had their two sister vessels laying prompt available for the job. The two K-Line vessels, KL Saltfjord and KL Sandefjord, has among the highest capacity in the market and are commonly on charter for Lundin Energy Norway. Their competing vessels on this requirement were the Siem Pearl and the Siem Opal, which is an older vessel design with lower capacities. The two vessels where both quoted on the same price level, which allowed Lundin Energy Norway to select the preferred vessel on an environmental basis (Hertzberg, 2021, Appendix 4). Both the K-Line Offshore- and the Siem Offshore´s vessels are equipped with a conventional diesel-electric propulsion system (K-Line, Appendix 1), (Hertzberg, 2021, Appendix 4). The Siem vessels stands out in this case because the vessels are equipped with UREA technology. Vessels that utilize UREA reagents in their propulsion system have the possibility to control and reduce Nitrogen Oxide (NOx) emissions (Yara, 2021). As the commercial level between these two vessel types were similar, Lundin Energy Norway chose the Siem Offshore vessels based on their environmental competitive advantage (Hertzberg, 2021, Appendix 4).

Lundin Energy Norway has a reputation of chartering vessels based on their competitive advantage, either on cost or on their environmental impact. As their Siem Offshore fixture above proves, a vessels competitive advantage is not always the daily hire rate, but it´s also the vessels expected environmental impact for a certain operation. So, how could the K-Line Offshore vessels gain a competitive advantage in a similar market situation as the above-described Lundin Energy Norway requirement? The K-Line Offshore vessels already have the largest capacity in the market and can conduct any operation in the North Sea. What factors can K-Line Offshore consider for outcompeting the Siem Offshore vessels? Based on Sigmund Hertzberg's decisive criteria, the K-Line vessels need to improve their environmental footprint.

Siem Offshore has implemented the UREA technology which was the decisive criteria for this fixture. This technology allows the vessel operator to control and reduce their NOx footprint (Yara, 2021). Can K-Line Offshore gain a larger competitive advantage by investing in a system that benefits both the charterer and the environment? Based on Sigmund Hertzberg´s future thoughts, this is the way to go (Hertzberg, 2021, Appendix 4). What systems allow a transition like this? In recent years, research has been conducted on alternative fuel types such as ammonia and hydrogen to replace the current MGO. But with the technology the branch has developed so far, there are challenges associated with these fuel types. One of the most challenging factors regarding ammonia onboard larger vessels is the lower energy density compared to MGO. For that reason, a vessel driven on ammonia only, requires larger fuel tanks which will increase the weight of the vessel itself, and reduce its loading capacity. Ammonia is also hazardous and requires different handling procedures. (Bjartnes & Michelsen, 2020). These types of transitions therefore demand a challenging conversion. Sigmund Hertzberg confirms that alternative fuel transitions for AHTS vessels will be challenging due to the vessels large fuel consumption (Hertzberg, 2021, Appendix 4).

The battery hybrid propulsion systems have already proven to reduce consumption cost and environmental impact on PSV vessels (Wartsila, 2018). A natural direction of change is therefore to investigate the potential benefits of installing these types of systems into the AHTS vessels. Lundin Energy Norway proves to benefit vessels that have a lower environmental impact (Hertzberg, 2021, Appendix 4). To discuss how charterers can benefit both the environment and their financial impact on a vessel charter, the thesis will further analyze different charter examples to clarify the potential benefits of installing battery hybrid propulsion systems.

4.2.1 - Fuel analysis for charters commercial gain

To analyze consumption emissions, the thesis will perform an analysis based on the Norwegian Environment Directorate´s calculator for measuring the effect of battery hybrid propulsion system onboard vessels. There are several factors to take into consideration during calculating emissions before and after hybrid conversion. There are three main emission products from AHTS vessels and other MGO going ships. These are, carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). For consumption of one liter MGO, the Norwegian Environmental Directorate has provided emission constants for every emission product and are together forming a CO_2 emission equivalent (The Norwegian Environment Directorate, Appendix 2). The calculator allows us to measure the effect of installing a battery hybrid propulsion system into AHTS vessels before a decision of investment is made.

For calculation purposes only the thesis will further be based on an fictious annual fuel consumption of 1000 metric tonnes MGO. With the basis of an average fuel price for November 2021 on 674 $/MT, the thesis will further analyze the results of battery hybrid propulsion system and compare the charterers total cost with or without the hybrid solution (Shipandbunker, 2021). To covert the fuel price of 674 $/MT to NOK, the conversion rate used is from the 24th of November 2021 at 8,92 NOK (DN Investor, 2021). The MGO fuel price in NOK is therefore:

674 $/MT x 8,92 NOK ≈ 6012,08 NOK/MT

How can we estimate the expected consumption reduction before any AHTS vessel have installed the system already? As some PSV´s and tugs in the North Sea already have got their proved results after installation of these systems, the thesis will compare all public available data from suppliers and owners. For calculation purposes, all gathered data will be used to calculate an expected average fuel percentage reduction after installation, as the system is likely to be used under the approximate same load of thrust. As the Appendix 3 shows, Wartsila has a proven fuel reduction of 15% on the system installed on the Viking Lady and the same numbers are expected for the Maersk Minder. As well as the Kongsberg and Wartsila systems are claiming a general fuel reduction at 20%, the total estimated average fuel reduction after installation states 17,5% (Appendix 3), (Kongsberg, 2021), (Wartsila, 2018). The general average of 17,5% annual fuel reduction will be used for the below Charter Party analysis.

4.2.2 - Charter Party 1: 14 Days Firm

Metric Tonnes MGO to Liters
MGO Density: 0,89013 MT / M³ (Thecalculatorsite, 2021)

1000 MT / 0,8913 MT/M3 ≈ 1123 M3

Daily M3 MGO Consumption
1123 M3 / 365 Days ≈ 3,08 M3 MGO / DAY

M3 MGO Consumption over 14 Days
3,08 M3 MGO / Day * 14 Days = 42,98 M3 MGO over 14 Days

M3 MGO to Liters
42,98 M3 MGO over 14 Days * 1000 Liters = 42 980 Liters MGO over 14 Days operation

Emission Factors (kg CO2-eqv./liter)				
Energy Product	CO2	CH4	N2O	CO2-eqv
Marine Gas Oil (MGO)	2,6628	0,00483	0,02003	2,6877

GAS	GWP Values
CO2	1
N2O	298
CH4	25

Todays Consumption	
42 980	Liters Marine Gas Oil/ 14 Days
115,52	Tonnes CO2 eqv

Total MGO Consumption After Electrical Compensation (-17,5%)	
35 459	Liters Marine Gas Oil/Year

Total Emission After Implementation of Measure	
95,30	Tonnes CO2 eqv

	Total Greenhouse Gasses	CO2	CH4	N2O
Total Emission Pre Hybrid Implementation (CO2 Eqv.)	115,52	114,45	0,21	0,86
Total Emission Post Hybrid Implementation (CO2 Eqv.)	95,30	94,42	0,17	0,71
Hybrid Implementation Total Effect (CO2 Eqv.)	20,22	20,03	0,04	0,15

Table 1.1: Charter Party 1 analysis (Charter Party Analysis, Appendix 7) ((Miljødirektoratet, 2020)

4.2.3 - Charter Party 2: 3 Months / 90 days Firm

Metric Tonnes MGO to Liters

MGO Density: 0,89013 MT / M^3 (Thecalculatorsite, 2021)

1000 MT / 0,8913 MT/M3 ≈ 1123 M3

Daily M3 MGO Consumption

1123 M3 / 365 Days ≈ 3,08 M3 MGO / DAY

M3 MGO Consumption over 90 Days

3,08 M3 MGO / Day * 90 Days = 277,2 M3 MGO over 14 Days

M3 MGO to Liters

277,2 M3 MGO over 90 Days * 1000 Liters = 277 200 Liters MGO over 90 Days operation

Emission Factors (kg CO2-eqv./liter)				
Energy Product	CO2	CH4	N2O	CO2-eqv
Marine Gas Oil (MGO)	2,6628	0,00483	0,02003	2,6877

GAS	GWP Values
CO2	1
N2O	298
CH4	25

Todays Consumption	
277 200	Liters Marine Gas Oil/ 90 Days
745,02	Tonnes CO2 eqv

Total MGO Consumption After Electrical Compensation (-17,5%)	
228 690	Liters Marine Gas Oil/Year

Total Emission After Implementation Of Measure	
614,64	Tonnes CO2 eqv

	Total Greenhouse Gases	CO2	CH4	N2O
Total Emission Pre Hybrid Implementation (CO2 Eqv.)	745,02	738,13	1,34	5,55
Total Emission Post Hybrid Implementation (CO2 Eqv.)	614,64	608,96	1,10	4,58
Hybrid Implementation Total Effect (CO2 Eqv.)	130,38	129,17	0,23	0,97

Table 1.2: Charter Party 2 analysis (Charter Party Analysis, Appendix 7) ((Miljødirektoratet, 2020)

4.2.4 - Charter Party 3: 3 Years / 1095 Days Firm

Metric Tonnes MGO to Liters
MGO Density: 0,89013 MT / M^3 (Thecalculatorsite, 2021)

1000 MT / 0,8913 MT/M3 ≈ 1123 M3

Daily M3 MGO Consumption
1123 M3 / 365 Days ≈ 3,08 M3 MGO / DAY

M3 MGO Consumption over 1095 Days
3,08 M3 MGO / Day * (365*3) Days = 3372,6 M3 MGO over 1095 Days

M3 MGO to Liters
3372,6 M3 MGO over 1095 Days * 1000 Liters = 3 372 600 Liters MGO/3 Year's operation

Emission Factors (kg CO2-eqv./liter)				
Energy Product	CO2	CH4	N2O	CO2-eqv
Marine Gas Oil (MGO)	2,6628	0,00483	0,02003	2,6877

GAS	GWP Values
CO2	1
N2O	298
CH4	25

Todays Consumption	
3 372 600	Liters Marine Gas Oil/ 1095 Days
9064,40	Tonnes CO2 eqv

Total MGO Consumption After Electrical Compensation (-17,5%)	
2 782 395	Liters Marine Gas Oil/Year

Total Emission After Implementation Of Measure	
7478,13	Tonnes CO2 eqv

	Total Greenhouse Gases	CO2	CH4	N2O
Total Emission Pre Hybrid Implementation (CO2 Eqv.)	9 064,40	8 980,56	16,29	67,55
Total Emission Post Hybrid Implementation (CO2 Eqv.)	7 478,13	7 408,96	13,44	55,73
Hybrid Implementation Total Effect (CO2 Eqv.)	1 586,27	1 571,60	2,85	11,82

Table 1.3: Charter Party 3 analysis (Charter Party Analysis, Appendix 7) ((Miljødirektoratet, 2020)

4.2.5 - Analysis results

Analysis inputs:

Annual consumption: 1000 MT/Year

Fuel price: 674 $/MT x 8,92 NOK ≈ 6012,08 NOK/MT, (DN Investor, 2021)

Estimated average consumption reduction: -17,5%, (Wartsila, 2018) (Kongsberg, 2021)

Charter Party 1: 14 Days Firm			
Propulsion System	**14 Days Consumption MT**	**Fuel Price NOK/MT**	**Total Fuel Cost NOK**
Non-Hybrid System Consumption	38,36	6012,08	kr 230 600,33
Hybrid System Consumption	31,64	6012,08	kr 190 245,27
Total Effect	6,71		**kr 40 355,06**

Table 1.4: Charter Party 1 analysis (Charter Party Analysis, Appendix 7) ((Miljødirektoratet, 2020)

Charter Party 2: 3 Months / 90 Days Firm			
Propulsion System	**3 Months Consumption MT**	**Fuel Price NOK/MT**	**Total Fuel Cost NOK**
Non-Hybrid System Consumption	250,00	6012,08	kr 1 503 020,00
Hybrid System Consumption	206,25	6012,08	kr 1 239 991,50
Total Effect	43,75		**kr 263 028,50**

Table 1.5: Charter Party 2 analysis (Charter Party Analysis, Appendix 7) ((Miljødirektoratet, 2020)

Charter Party 3: 3 Years / 1095 Days Firm			
Propulsion System	**3 Years Consumption MT**	**Fuel Price NOK/MT**	**Total Fuel Cost NOK**
Non-Hybrid System Consumtion	3000,00	6012,08	kr 18 036 240,00
Hybrid System Consumption	2475,00	6012,08	kr 14 879 898,00
Total Effect	525,00		**kr 3 156 342,00**

Table 1.6: Charter Party 3 analysis (Charter Party Analysis, Appendix 7) ((Miljødirektoratet, 2020)

The above analysis proves that the battery hybrid propulsion systems will affect the total charter cost significantly. With an estimated fuel reduction of 17,5%, the charterer can conduct a potential gain or loss analysis for the given vessel. As the analysis shows, the total financial gain over a shorter period such as the Charter Party 1, will be of lower values than the longer charters. The duration of the planned work scope will, for that reason, impact the charterers need for analyzing the fuel consumption difference. For the longer work scopes such as Charter Party 2 & 3, where the fuel cost difference increases, charterers will conduct a more thorough analysis.

Will the chances of being selected in a charterers requirement increase after an owner's potential investment in such systems? The analysis shows significant reduction in fuel consumption that would financially benefit the charterer as well as emissions decrease. These are all factors that Lundin Energy Norway is proving to valuate during a vessel selection procedure.

Lundin Energy Norway have the latest years had three Island Offshore PSV vessels on longer charters with over 600 days firm (Seabrokers, 2021). Hertzberg states that these vessels are fixed at a higher daily rate than the market level was at the time of fixing (Hertzberg, 2021, Appendix 4). Why did Lundin Energy Norway choose these three vessels instead of other vessels according to the market level? The latest years, a battery hybrid propulsion system delivered by Kongsberg, was installed on all three of these vessels (Marinelink, 2020). According to Kongsberg, their systems will in general reduce fuel consumption by 20% (Kongsberg, 2021). Hertzberg states that their financial gain of the Island Offshore vessels has been greater than it would have been with a non-hybrid vessel on market-based rates (Hertzberg, 2021, Appendix 4).

For AHTS owners operating in the North Sea, there are several factors a charterer is taking into consideration. Lundin Energy Norway has the latest years been operating at Utsirahøyden west off Stavanger. This location is characterized by shallow waters and a substantial number of pipelines and seabed structures. Due to these conditions, Lundin Energy Norway isn´t allowed to utilize standard mooring chains. A fiber rope is therefore required to prevent wear on pipelines and structures (Hertzberg, 2021, Appendix 4). The current market consists of a few numbers of AHTS vessels with large enough fiber capacity. The K-Line Offshore fleet has therefore had a competitive advantage with the largest capacities in the market (Hertzberg, 202, Appendix 41), (K-Line, Appendix 1). Lundin Energy Norway is also operating in the Barents Sea with deeper waters and few seabed obstacles. The Barents Sea therefore allows charterers to utilize standard mooring chains, and the number of AHTS vessels capable of conducting the operation increases (Hertzberg, 2021, Appendix 4). It is during such requirements that the competition increases, and the vessels' other properties are crucial. Like the recent fixture of the two sister Siem Offshore vessels that benefited on reduced NOx emissions, AHTS owners need to investigate what systems their vessels would benefit of.

Will AHTS owners gain a competitive advantage by reducing charterers fuel cost and environmental impact? Based on Sigmund Hertzberg and Lundin Energy Norway´s prior vessel selections and their alleged criteria's, a battery hybrid propulsion system will benefit all parties involved (Hertzberg, 2021).

Figure 26: Siem Diamond/Pearl/Opal (Van Aalst Group, 2021)

Figure 27: KL Sandefjord (Vesselfinder, 2021)

5 - Discussion and future work

During my work on this thesis, I´ve been made aware of the many challenges the offshore industry faces. The volatility in the market is directly affected by decisions and legislations given by the government. With discussions regarding decrease of oil production and shutdown, owners and their banks are operating with an uncertainty regarding future investments. How can the government demand a greener offshore sector without giving direct financial support for vessel upgrades?

During my intern at Seabrokers Chartering AS, I have witnessed vessel owners in panic only for finding capital to finance their next vessel classification. For an owner that´s already struggling with liquidity, expenses like these are a great threat to the company. In a case where a vessel has a daily capital and operational expense of 140.000 NOK and holds a longer charter with 100.000NOK in daily income, the owner will lose 40.000 NOK every day. Number like the above, is not unusual in the North Sea market and will not be sustainable over time for further operation.

Enova has been giving financial support for some vessel owners until April 2018. However, this scheme didn´t support owners that were in financial difficulties. For instance, owners with older vessels and outdated technology, will not be as competitive as vessels with a battery hybrid propulsion system and may not have a stable capital income. With the latest years lower income in general, the majority of vessel owners can´t finance vessel upgrades with their own capital only. Enova´s financing scheme therefore allowed some owners to gain enough capital to carry out the required upgrades. In 2018, Enova saw a sudden increase of support applications and decided to downgrade and cease the financial support of battery hybrid propulsion systems (Enova, 2021).

On the other hand, Enova´s scheme never supported the AHTS segment. I have a hard time understanding why Enova didn´t include the AHTS vessels in the financing scheme of these systems. The AHTS vessels serve a central role in the North Sea operations and are the most expensive vessels to build and operate. For that reason, I´m critical and interested to investigate in my future work, what the underlying argumentations are for omitting AHTS vessels in a financial support scheme like Enova´s.

As my work on this thesis has progressed, I have been made aware of the political factors the market is dependent on. To gain a better overview and perspective of the research question for future work, I am interested in interviewing the supporting institutions such as Enova and the legislating governmental instances. I believe that with more proportionate information from the legislative organs, the thesis could discuss the decisive challenges and opportunities by giving the AHTS owners financial support for financing battery hybrid propulsion systems.

What are the possibilities for the future and are we still seeing vessel owners financially struggling day by day in 10 years' time? The government and the International Maritime Organization are legislating the shipping sector with challenging vessel requirements. With a cost overgoing the vessels income, some owners may not have the possibility to meet the given legislations over time.

Working with the thesis, I have become conscious that the vessel owner is responsible for the full cost of the required vessel upgrades. For the coming years, I believe that a shared cost solution will become more common. I have witnessed charterers requiring vessels with battery hybrid propulsion systems installed over a longer charter. At the time, the vessels bidding on the requirement was not equipped with these systems. The charterer agreed that they would take the cost of installment as the systems would most likely gain the charterer financially. To make the green transition more sustainable, I believe that the cost of modern technology that reduces the environmental impact, should be shared between owners, charterers, and governmental instances.

5.1 - Available data

The timing was an important factor when selecting my Bachelor´s thesis´ research question. I wanted to conduct my own analysis and research on a case where the market was in the consideration phase for future development. During my work on this thesis, important information has shown to be proportionate and difficult to provide. I have mainly had to base the analysis on publicly available data and compare the data with each other to argue for an estimated result. I believe that with more awareness of the above, I could have provided more exact numbers to gain a more realistic analysis. With that said, the battery hybrid propulsion transition for AHTS vessels is in the pioneer phase with no exact results to provide yet. It would have been interesting to investigate the same research question in two years' time to analyze the actual outcome of installing battery hybrid propulsion systems in AHTS vessels.

6 - Conclusion

The thesis has addressed the potential benefits and challenges related to the research question *"How can AHTS owners gain a competitive advantage by installing battery hybrid propulsion systems into their vessels"*. To enlighten the question of research, the thesis has utilized inductive qualitative methodology to present the charterer´s- and owner´s perspective. Through publicly available data from suppliers the thesis provides an analysis for the charterers commercial gain. By comparing the data, the thesis has discussed the direction of change within AHTS segment.

Governmental legislations, IMO regulations and charterers needs has shown to be the main driver for change. With environmental argumentations, the offshore industry is being pushed in a greener direction. Owners are therefore investigating solutions applicable to their vessels to meet the industry's requirements. Alternative fuel types such as ammonia and hydrogen involve risk and management challenges. Through interviews with charterer and owner, a battery hybrid propulsion system has proved to be the most suitable solution for AHTS vessels at the current stage of technology development.

The AHTS market is volatile due to the supply and demand mechanism. The markets activity depends on the oil companies' production levels, which the thesis has described as cyclic and varying. From the Norwegian Continental Shelfs´ production start in the 70´s, the AHTS market has seen both peaks and depression. Today's laid-up tonnage along the Norwegian coast is a result of the latest downturn in 2014 related to the oil price collapse. Owners that contracted vessels prior to this downturn has shown financial difficulties the latest years.

A total cost for a battery hybrid propulsion system has shown to be difficult to provide due to the suppliers´ competition sensitive market. Although, the thesis has enlightened the owners need for financial support to allow an investment in systems like these. Enova has been offering financial support schemes for these systems until 2018 but did never include AHTS vessels. The argumentation for omitting certain vessel types in a scheme like Enovas´, would have been an interesting research question going forward. The thesis has discussed potential financial solutions to justify a green transition period. With governmental support schemes and a shared-cost solutions between charterer and owner, the thesis has argued that a battery hybrid transition is possible for AHTS owners.

K-Line Offshore´s COO, Espen Sørensen, indicates that a battery hybrid propulsion system is applicable to the KL Sandefjord. There are however some challenges related to the installation of these systems onboard the AHTS vessels. Due to the vessels complex main deck, the battery module is required to be installed below deck. Sacrificing one of the vessels brine tanks has therefore shown to be the most suitable solution. Espen Sørensen states that their commercial pricing may increase after a system investment but appear to be confident that their market position would be strengthened.

To analyze the charterers commercial gain, the thesis has utilized the Norwegian Environmental Directorate´s calculator for measuring the effect of battery hybrid propulsion systems onboard vessels. The analysis is based on three fictious charter parties with an annual fuel consumption of 1000MT. By comparing expected and proven fuel reductions from the systems suppliers, the thesis has argued for an expected average fuel reduction of 17,5%. An estimated fuel cost reduction of over 3.000.000 NOK over a 3-year period of operations was proved. The interview with Lundin Energy Norway's Senior Marine Supervisor, Sigmund Hertzberg, confirms that charterers valuate the battery hybrid propulsion systems onboard vessels and serve as an elective factor during a vessel selection procedure.

Based on the thesis results through interviews and analyzing publicly available data, AHTS owners will gain a competitive advantage by installing battery hybrid propulsion systems into their vessels. There are however central factors that make the transition challenging. With no financial support schemes for AHTS vessels, owners are forced to undertake the full cost of upgrade as of today.

The thesis has concluded that the battery hybrid propulsion system proves to be advantageous for both charterer and owner as well as the environmental footprint decreases. A battery hybrid propulsion system will therefore gain the owner a competitive advantage. The crucial factor, however, has proven to be the financial aspect of the system. What parties should be financially involved to justify a battery hybrid transition for AHTS vessels? In what way can the government support the industry for increased transition speed? These are the questions the thesis is left with and would be an interesting angle to investigate for future work.

7 - Bibliography

Andersen, I., 2018. *Nå har Aasta Hansteen startet den 900 kilometer lange reisen til Norskehavet.* [Internet] Available at: https://www.tu.no/artikler/na-har-aasta-hansteen-startet-den-900-kilometer-lange-reisen-til-norskehavet/434687
[Found 1 October 2021].

Bjartnes, A. & Michelsen, L.-H. P., 2020. Ammoniakk kan kutte store utslipp i skipsfart. [Internet] Available at: https://klimastiftelsen.no/publikasjoner/ammoniakk-kan-kutte-store-utslipp-i-skipsfart/
[Found 27 November 2021].

DN Investor, 2021. Amerikanske Dollar. [Internet]
Available at: https://investor.dn.no/#!/Valuta/Y9/Amerikanskedollar
[Found 24 November 2021].

DNV, 2021. GUIDELINES FOR MARINE TRANSPORTATIONS. [Internet]
Available at: https://rules.dnv.com/docs/pdf/gl/nobledenton/0030-nd%20rev%206.1%2028-jun-16%20guidelines%20for%20marine%20transportations.pdf
[Found 15 October 2021].

Enova, 2021. Enova justerer støttesatsene knyttet til sjøtransport. [Internet]
Available at: https://www.enova.no/bedrift/sjotransport/aktuelt/enova-justerer-stottesatsene-knyttet-til-sjotransport/
[Found 29 November 2021].

Equinor, 2016. Njord Stord. [Internet]
Available at: https://www.equinor.com/no/news/njord-stord.html
[Found 12 October 2021].

Giske, K. I., 2018. KL Sandefjord. [Internet]
Available at: https://maritimt.com/nb/batomtaler/kl-sandefjord-012011
[Found 7 October 2021].

Headtopics, 2019. Solstad Offshore i krise: 1 av 3 skip ligger i opplag uten arbeid. [Internet]
Available at: https://headtopics.com/no/solstad-offshore-i-krise-1-av-3-skip-ligger-i-opplag-uten-arbeid-8378384
[Found 20 October 2021].

Intermoor, 2021. Pre Lay and Rig Moves. [Internet]
Available at: https://intermoor.com/services/offshore-mooring/pre-lay-and-rig-moves/
[Found 15 October 2021].

International Maritime Organization, 2021. Global limit on sulphur in ships' fuel oil reduced from 01 January 2020.. [Internet]
Available at: https://www.imo.org/en/MediaCentre/PressBriefings/Pages/34-IMO-2020-sulphur-limit-.aspx
[Found 2 September 2021].

Kae, K., 2021. Pinterest. [Internet]
Available at: https://no.pinterest.com/pin/776167317006962839/
[Found 12 November 2021].

K-Line Offshore, 2021. K-Line Offshore Homepage. [Internet]
Available at: https://www.klineoffshore.no/company/category809.html
[Found 29 November 2021].

K-Line, 2021. K-Line. [Internet]
Available at: https://www.klineoffshore.no/
[Found 26 November 2021].

Kongsberg, 2021. DECK MACHINERY & CRANES. [Internet]
Available at: https://www.kongsberg.com/maritime/products/deck-machinery-and-cranes/
[Found 15 October 2021].

Kongsberg, 2021. Kongsberg, general average. [Internet]
Available at: https://www.kongsberg.com/no/maritime/campaign/Hybrid-Solutions/kongsberg-integrated-hybrid-power-propulsion-system/
[Found 20 November 2021].

Kongsberg, 2021. SHARK JAWS FOR ANCHOR HANDLING VESSEL. [Internet]
Available at: https://www.kongsberg.com/no/maritime/products/deck-machinery-and-cranes/deck-machinery/anchor-handling-vessels/shark-jaws-ahts/
[Found 28 October 2021].

Lundin Energy Norway, 2021. OM OSS. [Internet]
Available at: https://lundin-energy-norway.com/om-oss/
[Found 26 November 2021].

Macrotrends, 2021. Crude Oil Prices - 70 Year Historical Chart. [Internet]
Available at: https://www.macrotrends.net/1369/crude-oil-price-history-chart
[Found 4 September 2021].

Maersk Drilling, 2021. Maersk Invincible. [Internet]
Available at: https://www.maerskdrilling.com/what-we-do/rigs/jack-ups/maersk-invincible
[Found 5 September 2021].

Marinelink, 2020. Kongsberg Hybrid Power System for Island Offshore PSV Trio. [Internet]
Available at: https://www.marinelink.com/news/kongsberg-hybrid-power-system-island-481014
[Found 26 November 2021].

Maslin, E., 2020. UUV Manipulators: Get a Grip. [Internet]
Available at: https://www.marinetechnologynews.com/news/manipulators-598684
[Found 15 October 2021].

Menon, A., 2021. What is Bollard Pull – Everything You Wanted To Know. [Internet]
Available at: https://www.marineinsight.com/naval-architecture/bollard-pull-everything-you-wanted-to-know/
[Found 27 October 2021].

Miljødirektoratet, 2020. Beregne effekt av ulike klimatiltak. [Internet]
Available at: https://www.miljodirektoratet.no/tjenester/klimagassutslipp-kommuner/beregne-effekt-av-ulike-klimatiltak/
[Found 27 November 2021].

Miljødirektoratet, 2020. Beregne effekt av ulike klimatiltak. [Internet]
Available at: https://www.miljodirektoratet.no/tjenester/klimagassutslipp-kommuner/beregne-effekt-av-ulike-klimatiltak/
[Found 27 November 2021].

Miljødirektoratet, 2020. Miljødirektoratet. [Internet]
Available at: https://www.miljodirektoratet.no/tjenester/klimagassutslipp-kommuner/beregne-effekt-av-ulike-klimatiltak/
[Found 27 November 2021].

Miljødirektoratet, 2020. Tiltaksberegning. [Internet]
Available at: https://www.miljodirektoratet.no/tjenester/klimagassutslipp-kommuner/beregne-effekt-av-ulike-klimatiltak/
[Found 21 November 2021].

Moharrami, M. J. & Shiri, H., 2018. Reliability assessment of drag embedment anchors in clay for catenary mooring systems. [Internet]
Available at: https://www.sciencedirect.com/science/article/abs/pii/S095183391730343X
[Found 2 October 2021].

Norcem, 2021. Troll A. [Internet]
Available at: https://www.norcem.no/no/Troll_A
[Found 2 September 2021].

Ocean Energy Recources, 2020. Borr Drilling sells Balder to BW Energy. [Internet]
Available at: https://ocean-energyresources.com/2020/11/03/borr-drilling-sells-balder-to-bw-energy/
[Found 5 October 2021].

Perrott, I. R., 2011. Offshore Support Industry. 1 red. 85 Gracechurch Street, London: Institute of Chartered Shipbrokers.

Repsol, 2021. Maersk Inspirer til Yme feltet. [Internet]
Available at: https://www.repsol.no/no/presse/annen-informasjon/2021/maersk-inspirer-til-yme-feltet.cshtml
[Found 5 September 2021].

Sandberg, F. & Smith-Solbakken, M., 2020. Norwegian Contractors. [Internet]
Available at: https://snl.no/Norwegian_Contractors
[Found 2 September 2021].

Seabrokers, 2021. TheSeabay. [Internet]
Available at: theseabay.com
[Found 23 October 2021].

Shipandbunker, 2021. Rotterdam Bunker Prices. [Internet]
Available at: https://shipandbunker.com/prices/emea/nwe/nl-rtm-rotterdam#MGO
[Found 24 November 2021].

Stopford, M., 2009. Maritime Economics. 3. issue red. 711 Thrird Avenue, New York: Routeledge.

Thecalculatorsite, 2021. Liters to metric tonnes. [Internet]
Available at: https://www.thecalculatorsite.com/conversions/common/liters-to-metric-tons.php
[Found 28 November 2021].

Tjora, A., 2017. Kvalitative Forskningsmetoder i praksis. 3. issue red. 0130 Oslo: Gyldendal Akademisk.

Tollaksen, T. G., 2020. Lundin. [Internet]
Available at: https://snl.no/Lundin
[Found 26 November 2021].

Van Aalst Group, 2021. Siem Diamond. [Internet]
Available at: https://www.vanaalstgroup.com/references/309
[Found 28 November 2021].

Vard, 2021. A containerized energy storage system. [Internet]
Available at: https://www.vard.com/products-and-services/seaq-power/seaq-energy-storage-systems/seaq-battery-on-board
[Found 20 October 2021].

Vesselfinder, 2021. KL Sandefjord. [Internet]
Available at: https://www.vesselfinder.com/vessels/KL-SANDEFJORD-IMO-9470466-MMSI-257576000
[Found 28 November 2021].

Waage, R., Myhre, R., Eijnatten, J. v. & Nones, C., 2018. Wartsila HY TUG propulsion system. [Internet]
Available at: https://www.wartsila.com/docs/default-source/marine-documents/business-white-papers/white-paper_wartsila-hy-tug-propulsion-system.pdf
[Found 29 October 2021].

Wartsila, 2018. Wartsila HY. [Internet]
Available at: https://www.wartsila.com/docs/default-source/product-files/hybrid/wartsila-hy-2018.pdf
[Found 5 November 2021].

Wartsila, 2021. Maersk selects Wärtsilä hybrid solution to support decarbonisation efforts. [Internet]
Available at: https://www.wartsila.com/media/news/28-05-2021-maersk-selects-wartsila-hybrid-solution-to-support-decarbonisation-efforts-2923832
[Found 20 November 2021].

Wartsila, 2021. Maersk valgte Wärtsiläs hybridløsning for å redusere karbonavtrykket. [Internet]
Available at: https://www.wartsila.com/nor/media/nyhet/16-06-2021-maersk-valgte-wärtsiläs-hybridløsning-for-å-redusere-karbonavtrykket
[Found 15 September 2021].

Wartsila, 2021. Wartsila Thrusters. [Internet]
Available at: https://www.wartsila.com/encyclopedia/term/thrusters
[Found 24 October 2021].

Yara, 2021. Reducing NOx emissions in Marine vessels. [Internet]
Available at: https://www.yara.us/chemical-and-environmental-solutions/reducing-nox-emissions-in-marine-vessels/
[Found 26 November 2021].

Attached appendixes

Appendix 1 – Vessel Spec KL Sandefjord

Appendix 2 – Norwegian Offshore Shipowners, Norwegian Shipowners association

Appendix 3 – Estimate of fuel reduction

Appendix 4 – Interview guide, Charterer

Appendix 5 – Interview guide, Owner

Appendix 6 – The Norwegian Environmental Directorate´s calculator

Appendix 7 – Consumption analysis

Appendix 8 – Charterers, Owners and Vessels overview

Consent confirmation - NSD

Vurdering

Skriv ut

Referansenummer
721151

Prosjekttittel
Bachelor Thesis - NTNU Ålesund

Behandlingsansvarlig institusjon
Norges teknisk-naturvitenskapelige universitet / Fakultet for ingeniørvitenskap / Institutt for havromsoperasjoner og byggteknikk

Prosjektansvarlig (vitenskapelig ansatt/veileder eller stipendiat)
Jan Emblemsvåg, jan.emblemsvag@ntnu.no, tlf: +4748264515

Type prosjekt
Studentprosjekt, bachelorstudium

Kontaktinformasjon, student
Thomas Ognedal, thomas.s.ognedal@lyse.net, tlf: 91618909

Prosjektperiode
16.08.2021 - 18.12.2021

Vurdering (1)

25.10.2021 - Vurdert
Det er vår vurdering at behandlingen av personopplysninger i prosjektet vil være i samsvar med personvernlovgivningen så fremt den gjennomføres i tråd med det som er dokumentert i meldeskjemaet 22.10.2021 med vedlegg. Behandlingen kan starte.

TYPE OPPLYSNINGER OG VARIGHET
Prosjektet vil behandle alminnelige kategorier av personopplysninger frem til 18.12.2021.

LOVLIG GRUNNLAG
Prosjektet vil innhente samtykke fra foresatte til behandlingen av personopplysninger om barna. Vår vurdering er at prosjektet legger opp til et samtykke i samsvar med kravene i art. 4 og 7, ved at det er en frivillig, spesifikk, informert og utvetydig bekreftelse som kan dokumenteres, og som den registrerte/foresatte kan trekke tilbake.

Lovlig grunnlag for behandlingen vil dermed være foresattes samtykke, jf. personvernforordningen art. 6 nr. 1 bokstav a.

PERSONVERNPRINSIPPER
NSD vurderer at den planlagte behandlingen av personopplysninger vil følge prinsippene i personvernforordningen om:
- lovlighet, rettferdighet og åpenhet (art. 5.1 a), ved at foresatte får tilfredsstillende informasjon om og samtykker til behandlingen
- formålsbegrensning (art. 5.1 b), ved at personopplysninger samles inn for spesifikke, uttrykkelig angitte og berettigede formål, og ikke viderebehandles til nye uforenlige formål
- dataminimering (art. 5.1 c), ved at det kun behandles opplysninger som er adekvate, relevante og nødvendige for formålet med prosjektet
- lagringsbegrensning (art. 5.1 e), ved at personopplysningene ikke lagres lengre enn nødvendig for å oppfylle formålet

DE REGISTRERTES RETTIGHETER
NSD vurderer at informasjonen om behandlingen som de registrerte og deres foresatte vil motta oppfyller lovens krav til form og innhold, jf. art. 12.1 og art. 13.

Så lenge de registrerte kan identifiseres i datamaterialet vil de ha følgende rettigheter: innsyn (art. 15), retting (art. 16), sletting (art. 17), begrensning (art. 18) og dataportabilitet (art. 20).

Vi minner om at hvis en registrert/foresatt tar kontakt om sine/barnets rettigheter, har behandlingsansvarlig institusjon plikt til å svare innen en måned.

FØLG DIN INSTITUSJONS RETNINGSLINJER
NSD legger til grunn at behandlingen oppfyller kravene i personvernforordningen om riktighet (art. 5.1 d), integritet og konfidensialitet (art. 5.1. f) og sikkerhet (art. 32).

For å forsikre dere om at kravene oppfylles, må dere følge interne retningslinjer og eventuelt rådføre dere med behandlingsansvarlig institusjon.

MELD VESENTLIGE ENDRINGER
Dersom det skjer vesentlige endringer i behandlingen av personopplysninger, kan det være nødvendig å melde dette til NSD ved å oppdatere meldeskjemaet. Før du melder inn en endring, oppfordrer vi deg til å lese om hvilke type endringer det er nødvendig å melde: https://www.nsd.no/personverntjenester/fylle-ut-meldeskjema-for-personopplysninger/melde-endringer-i-meldeskjema. Du må vente på svar fra NSD før endringen gjennomføres.

OPPFØLGING AV PROSJEKTET
NSD vil følge opp ved planlagt avslutning for å avklare om behandlingen av personopplysningene er avsluttet.

Kontaktperson hos NSD: Olav Rosness, rådgiver.

Lykke til med prosjektet!

Letter of consent

Vil du delta i forskningsprosjektet

" Hvordan vil redere oppnå en konkurransefordel ved implementering av hybridsystemer ombord AHTS fartøy"?

Dette er et spørsmål til deg om å delta i et forskningsprosjekt hvor formålet er å undersøke hvorvidt redere kan oppnå et konkurransefortrinn ved å installere hybridløsninger ombord sine fartøy. I dette skrivet gir vi deg informasjon om målene for prosjektet og hva deltakelse vil innebære for deg.

Formål
Formålet med bachelor-oppgaven er å undersøke hvorvidt AHTS redere kan øke sin konkurransedyktighet ved å installere hybridsystemer i deres fartøy. Oppgaven vil ha en kommersiell, teknisk og økonomisk vinkling.

Hvem er ansvarlig for forskningsprosjektet?
Thomas Skogland Ognedal ved NTNU Ålesund er ansvarlig for prosjektet.

Hvorfor får du spørsmål om å delta?
Det aktuelle utvalget er trukket ut for å få informasjon fra de viktigste vinklingene av problemstillingen. Det vil bli spurt 3 personer om å delta for å dekke omfanget.

Hva innebærer det for deg å delta?
For den som deltar, vil intervjuobjektet bli spurt spørsmål gjennom et intervju eller spørreskjema.

- Hvis du velger å delta i prosjektet, innebærer det et møte over Teams/Zoom eller utfylling av spørreskjema. Det vil ta deg omtrent 20 minutter å gjennomføre, alt etter hvor detaljert vi går til verks. Jeg vil stille spørsmål om tekniske og kommersielle aspekter angående hybridsystemer i ankerhåndteringsskip. Dine svar blir registrert elektronisk eller på lyddopptak og slettet etter bruk.

Det er frivillig å delta
Det er frivillig å delta i prosjektet. Hvis du velger å delta, kan du når som helst trekke samtykket tilbake uten å oppgi noen grunn. Alle dine personopplysninger vil da bli slettet. Det vil ikke ha noen negative konsekvenser for deg hvis du ikke vil delta eller senere velger å trekke deg.

Ditt personvern – hvordan vi oppbevarer og bruker dine opplysninger
Vi vil bare bruke opplysningene om deg til formålene vi har fortalt om i dette skrivet. Vi behandler opplysningene konfidensielt og i samsvar med personvernregelverket.

- Det er jeg, Thomas Ognedal, som er behandlingsansvarlig for all informasjon som innhentes.
- *For å sikre innhentede personopplysninger, vil jeg lagre dette trygt på min lokale PC under en passord beskyttet mappe med forkortelser og koder for prosjektet, slik at ingen andre enn jeg kan oppdrive det.*

Dersom samtykke gis, vil jeg gjerne inkludere hvilket firma og eventuelt stilling intervjuobjektet er ansatt i. Navn vil ikke publiseres dersom dette er ønskelig.

Hva skjer med opplysningene dine når vi avslutter forskningsprosjektet?
Opplysningene anonymiseres når prosjektet avsluttes/oppgaven er godkjent, noe som etter planen er 18. desember.

Dine rettigheter
Så lenge du kan identifiseres i datamaterialet, har du rett til:
- innsyn i hvilke personopplysninger som er registrert om deg, og å få utlevert en kopi av opplysningene,
- å få rettet personopplysninger om deg,
- å få slettet personopplysninger om deg, og
- å sende klage til Datatilsynet om behandlingen av dine personopplysninger.

Hva gir oss rett til å behandle personopplysninger om deg?
Vi behandler opplysninger om deg basert på ditt samtykke.

På oppdrag fra *Thomas Ognedal ved NTNU* har NSD – Norsk senter for forskningsdata AS vurdert at behandlingen av personopplysninger i dette prosjektet er i samsvar med personvernregelverket.

Hvor kan jeg finne ut mer?
Hvis du har spørsmål til studien, eller ønsker å benytte deg av dine rettigheter, ta kontakt med:
- *NTNU Ålesund* ved Thomas Ognedal på +47 91 61 89 09 eller veileder Jan Emblemsvåg på +47 48 26 45 15.
- Vårt personvernombud: *NTNU ved Thomas Helgesen på +47 93 07 90 38*

Hvis du har spørsmål knyttet til NSD sin vurdering av prosjektet, kan du ta kontakt med:
- NSD – Norsk senter for forskningsdata AS på epost (personverntjenester@nsd.no) eller på telefon: 55 58 21 17.

Med vennlig hilsen

Veileder	*Student*
Jan Emblemsvåg	Thomas Skogland Ognedal

Samtykkeerklæring

Jeg har mottatt og forstått informasjon om prosjektet *[sett inn tittel]*, og har fått anledning til å stille spørsmål. Jeg samtykker til:

☐ å delta i *[sett inn aktuell metode, f.eks. intervju]*
☐ å delta i *[sett inn flere metoder, f.eks. spørreskjema] – hvis aktuelt*
☐ *at [oppgi hvem] kan gi opplysninger om meg til prosjektet – hvis aktuelt*
☐ *at opplysninger om meg publiseres slik at jeg kan gjenkjennes [beskriv nærmere] – hvis aktuelt*
☐ *at mine personopplysninger lagres etter prosjektslutt, til [beskriv formål] – hvis aktuelt*

Jeg samtykker til at mine opplysninger behandles frem til prosjektet er avsluttet

----
(Signert av prosjektdeltaker, dato)