Chapter 18
Environmental Management at Fiskerstrand Verft AS: A 30 Year Journey

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Abstract Fiskerstrand Verft is a multipurpose shipyard with extensive expertise and activities in shipbuilding, maintenance, repair and conversion/modification of ships. The yard is exposed to a range of different environmental challenges related to its business which trigged the yard to develop and implement health and safety, and environmental management systems. This chapter gives an overview of environmental management at Fiskerstrand Verft over a 30-year period, written from the perspective of the first author as CEO. The activities from 1991–94 mainly considered Level 1 in the CapSEM Model with annual accounting of materials and wastes, emissions to air and discharges to ocean. The yard participated in various R & D environmental projects and during the period 1994–99 these were extended with activities corresponding to life cycle thinking according to Levels 2 and 3. In 1999, Fiskerstrand Verft was the first Norwegian shipyard that prepared and published an environmental report. The yard was certified as an environmental lighthouse company in 2000, the first in Norway. During the period 2004–2008, the yard further developed their systems and began to transition to Level 4. The life cycle perspective for ships and technology has been at the center of the development of green technologies for ships. This journey continues today, passing the 30 year mark, and has contributed invaluable knowledge about the CapSEM toolbox and how it can be applied to shipyard operations.

18.1 Introduction

Fiskerstrand Verft AS is a shipyard established in 1909, located in the municipality of Sula, Norway about 25 km from the center of Ålesund. More than 112 years later, Fiskerstrand Verft is a cornerstone company: a multipurpose shipyard with

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extensive expertise in shipbuilding, maintenance, repair and conversion/modification of ships. Our business has always been based on quality, expertise and reliability.

Since 1965, Fiskerstrand Verft has delivered more than 84 new ships. Over the years, Fiskerstrand Verft has also provided innovative and safe solutions for fishing vessels, and car and passenger ferries in order to achieve the best solutions for our clients. Fiskerstrand Verft has extensive experience in vessel modifications; its main focus is on using the latest knowledge, working methods and technology in modern facilities.

Over the years, we have also gained solid expertise in environmental technology and have, amongst other things, had a particular focus on liquefied natural gas (LNG) engines for ships, battery technology and on the potential for hydrogen-powered ships. In 2019, Fiskerstrand Verft invested in a new and larger floating dock and increased the docking capacity from 6000 tons to 12,000 tons. The dock opened the potential for new markets at the same time increasing efficiency: it has facilities that ensure the collection of wastewater, chemicals and oil which help the yard to better control waste which in turn helps to protect the environment.

The mother company, Fiskerstrand Holding AS, consists of three 100% owned companies Fiskerstrand Verft AS (shipyard), Fiskerstrand Eiendom AS (property company), and Multi Maritime AS (ship design, consultancy company). Our vision is to 'create sustainable maritime development'. This vision is underpinned by our values, of 'Quality, Reliability, Inclusivity and Innovation', and our business focus is primarily on European markets through projects based on green technology and sustainable solutions. Fiskerstrand Verft runs the entire business in an environmentally friendly way. The shipyard will always follow laws and regulations and strive to find new solutions in the fight to reduce emissions and waste, as long it is financially defensible. This, amongst other factors, requires a constructive companionship with our clients, suppliers, and business partners. We wish to prioritize and open channels of communication with our employees, local society, and national government regarding environmental issues.

18.2 Environmental Challenges

Fiskerstrand Verft is exposed to a range of different environmental challenges related to its business. It has a dynamic and thriving variety of activities in general and as a natural part of various ongoing projects. It generates large volumes of waste some of which are dangerous. There is significant time pressure while executing projects: particularly during the construction phase. All of this is accompanied by an increasing focus on the environmental impact of such projects and on requirements to resource efficiency in society.

The most significant environmental impacts result from outdoor repairs, maintenance and conversion work while the ships are in the dock or at the quay side. The environmental impacts discussed in our reports primarily affect local or regional areas. Fiskerstrand Veft has been producing annual 'Environmental reports' since 1999 that show, among other items, energy and water consumption, emissions to air, land and sea, amount of waste and materials to recovery and recycling.

18.3 Environmental Management at Fiskerstrand Verft

Fiskerstrand Verft intensified their work with managing health, safety and environment (HSE) in 1992 to improve their performance regarding procedures for working processes to HSE-issues. The text further gives a flavor for the work throughout the following years. Many of the results achieved in this time period were documented in internal reports and the following research reports for the projects conducted in cooperation with Møreforsking Ålesund (www.moreforsk.no/):

Rapport Å 9406, Prosjekt nr. 5707.
Rapport Å 9501, Prosjekt nr. 5713.
Rapport Å 9502, Prosjekt nr. 5706.
Rapport Å 9615, Prosjekt nr. 5734.
Rapport Å 9506, Prosjekt nr. 5707.
Rapport Å 9616, Prosjekt nr. 5734.

In 1992, a new '*Forskrift om internkontroll'* (Regulation for internal control) was introduced by the Norwegian government in order to improve companies' activities in relation to working environment and safety, protection concerning health and environmental damage from products and the protection of external environment against pollution and a better treatment of waste. The shipyard used the rebuilding/conversion of the car- and passenger ferry M/S 'Smørbukk' as the basis for the project. The work was carried out at the yard in 1992 and documented used materials, work activity for the rebuilding, quantity and type of waste. Material flowcharts then illustrated the total amount related to the rebuilding.

In 1993, based on this new regulation, Fiskerstrand Verft prioritized the work with the environmental management system (EMS). Whilst undertaking this work, we realized that assistance from experienced specialists was required.

In 1994, Fiskerstrand Verft was invited to participate in the project 'Cleaner production in the shipyard industry in the County of Møre og Romsdal', a collaboration between 5 shipyards in the region. This project looked at bottom hull treatment, paint and metallization of steel materials, waste disposal when rebuilding or converting vessels, sand blasting new steel materials, or painted steel materials.

The purpose of this project for Fiskerstrand Verft was to identify the potential for cost effective environmental improvement based on the introduction of cleaner production at the yard, as well as introducing improvements in the choice of materials and equipment to reduce waste and improve the impact on the environment. The project also investigated the possibility of reducing the amount of materials, result of dangerous waste and possible recycling of materials and waste. Fiskerstrand Verft was responsible for the work related to waste disposal when rebuilding vessels.

In 1994, as part of the project, Fiskerstrand Verft proposed the following improvements and rectifying actions:

1. Improved handling and labeling of waste, especially hazardous waste.
2. Recycling of thinners.

3. Source sorting of solid waste.
4. Development and implementation of computer programmes for substance indexes and environmental accounting.

The assumed environmental impact the individual rectifying actions might have on the amount of material, energy consumption, water consumption, construction activities, waste and contamination were all evaluated. The consequences related to economy, results, time and manhour consumption were also evaluated for the different proposed rectifying actions. Based on this, we commenced a thorough update of our environmental management system, environmental strategy, environmental mapping, goals and programmes.

The activities from1991–1994 mainly considered Level 1 in the CapSEM Model. All tools (I/O and Cleaner Production) were used to collect quantitative information. By developing this further, a database for the environmental aspects for shipyards was created. In 1994, a report was produced regarding the systematic assessment of environmental aspects for ships in the design, engineering, construction and operational phase seen in a cleaner production perspective. This system documentation identifies the limits of the total system and subsystems.

As a second step in the portfolio of projects that followed the cleaner production project in the period 1995–96, were the following projects: (i) "Waste minimization at shipyards," (ii) "Bottom hull cleaning water treatment at Liaaen Verft," (iii) "High pressure water blasting at Fiskerstrand Verft." and (iv) "Enclosed systems for sandblasting at Ulstein Verft (black steel) and at Søviknes Verft (painted steel)." These activities correspond to changes towards less polluting practices. One of the activities corresponding to Level 2 in the CapSEM model, was a project where the life cycle assessment (LCA) was tested by a simplified analysis. Life cycle screening (LCS) of the cruise ferry Color Festival was studied to look at how to bring the information about the environmental impacts of the different subsystems into the design specification of new ferries by the design for environment (DfE), or design for x-principles (DfX) in ship design. As part of the EMS-activities corresponding to Level 3 in the CapSEM Model (see Fig. 18.1), a set of environmental

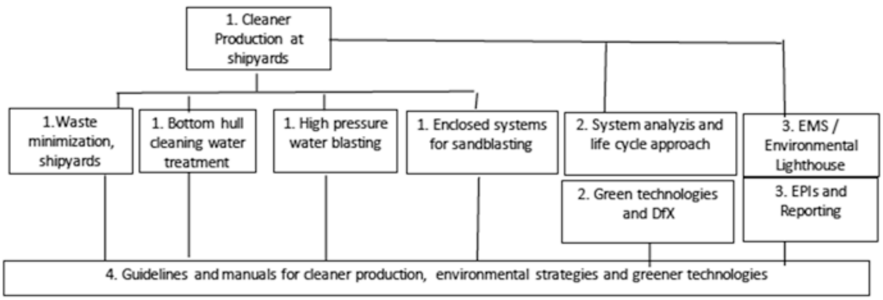

Fig. 18.1 Overview of activities resulting from the Cleaner Production project started in 1993. The numbers in the boxes reflect the Levels in the CapSEM model (modified from Fet 2002a, b)

performance indicators (EPIs) was developed and used to monitor and report the identified environmental impacts over time.

As seen in Fig. 18.1, the results from the projects noted under the numbers 1, 2 and 3 were collected and modified into guidelines and manuals for cleaner production at shipyards, and other inputs to policy programmes for greening of the maritime industry (Angelfoss et al. 1998, Fet and Sørgård 1998, Hayman et al. 2000, Fet 2001, Fet 2002a, 2002b, Fet and Zhou 2002, Ellingsen, Fet and Aanondsen 2002, Zhou et al. 2003).

In 1997–98, in connection with the introduction of preventive environmental measures, internal investment was carried out on environmental management systems (EMS) with a strong emphasis on the process Plan-Do-Check-Act (PDCA). This was based on the most significant international environmental management standards in the ISO 14000 series. A special attention was given to the standards for Environmental Management System (EMS), Environmental Auditing (EA), Environmental Performance Evaluation (EPE) and Environmental Performance Indicators (EPI).

Measuring environmental performance provides a basis for how good or bad a company is in relation to the most important environmental aspects and evaluated according to EPIs mirroring the efforts of achieving the best improvement. It also bench-marked the company's performance against comparable businesses. EPIs are used to measure environmental performance for aspects as usage of materials and energy, emissions to air, discharges to water and soil pollution. Different waste indicators and accident indicators are among the EPIs recommended in the report.

The database from the mapping of waste generated by conversion of M/S "Smørbukk" at Fiskerstrand Verft was used in this report. It represented a step forward in assisting and improving environmental performance for yards in general. The report also presented indicators for bottom hull treatment as well as emissions to air caused by painting and mentalization. Fiskerstrand Verft has prioritized since the early nineties, reducing the impacts on the surrounding environment.

In 1998–99 the EMS was further developed. Routines for documentation and reporting were developed and formalized. In 1999, Fiskerstrand Verft was the first Norwegian shipyard that prepared and published an environmental report (https://www.fiskerstrand.no/). As a result of several years of work with environmental performance improvements, the company was certified as an environmental lighthouse company in 2000, the first in Norway. This means that the company's criteria for both new building of ships, conversion and repairing of ships at shipyards are fulfilled. Annual environmental reports have been produced since 1999 up to 2012. For the period 2013 to 2018 a report showing the development over the period of 6 years is published, and since 2019 the report has been adjusted to highlight the yards' responsibility with respect to the 17 sustainable development goals (SDGs).

From 2004–2008, the yard further improved the EMS Manual. The Manual describes and document the yards system and covers the legal basis, organization and responsibilities, working environment and environmental protection, fire, explosion hazards and accidents, product control, reporting, protection inspection and damage reporting risk assessments, action plans, EMS revision reports and plans and materials register.

The EMS was also included in the Quality Assurance Manual (QAM). Working with EMS requires involvement, patience, working step by step and gradually education all those involved. The benefits of so doing are clear. It results in a long process forward to a "self-propelled system" (Procedures, training, maturing, posture etc.) provides an improved and tidier working environment. It established an environmental protection system (external environment) with 13 new forms and 22 procedures, sourced and sored (18 types) to yield financial gain due to a differentiated tax system for waste collection. Not least, the crew on board ship often display a "hands off" self-waste approach, which is at times a challenge.

The continuing work with the EMS manual and the integration of procedures according to the environmental policy, has contributed to a set of KPIs and reporting practices in line with a few of the tools that are listed for Level 3 in the CapSEM-model. As a "front-runner" within the shipbuilding and ship repair industry, the actions also have given an impact on a broader societal system, meaning a move from Level 3 to Level 4 in the CapSEM-model.

18.3.1 Level 4: Activities

The work with the environmental management provides valuable statistics and experience data. Fiskerstrand Verft was ordered in 2009 by the County Governor of Møre og Romsdal to undertake environmental surveys of the shipyard area and at the seabed near the yard. Multiconsult was engaged to carry out environmental geological survey of the yard area, field survey, risk and action assessments. The business then turned its focus to Level 4 in the CapSEM model, looking into the sector's impacts on the society from a broader perspective. The emphasis was on marine pollution and possibilities for improvements.

During 2007, Fiskerstrand Verft was invited to participate in the project "Opticap", a research project to increase knowledge about materials and practical methods suitable for capping contaminated marine sediments and to reduce spreading pollution. The project was a collaboration between NGI, NIVA, Agder Marine, Hustadmarmor, Secora, Fiskerstrand Verft and NOAH. Project management was driven by NGI. Fiskerstrand Verft supported the project financially with over one million NOK. The contract was between Opticap project group and Fiskerstrand Verft and Research Council of Norway. The project concentrated on investigating the development of fine-grained pumpable masses in moderate current-exposed seabed areas, measuring the effect of thin covering in relation to reductions in water concentration and pollution, measuring biota and recolonization after covering and documenting the effect of both passive and active covering of materials over time.

In this field test, a thin covering with suspended calc (biocalc) from Hustadmarmor and suspended calc mixed with activated charcoal (AC) on a heavily polluted area with among others Tributyltin (TBT) was employed. The test field, an of area

11000m^2 divided into two sub-areas, comprised one area of 9000m^2 covered with suspended biocalc alone, and one area of 2000m^2 covered with AC mixed with biocalc. The covering was carried out in September 2010. A total of 950 tons of biocalc and 5 tons of AC were used for the covering operation (Opticap 2012a). A final report "New materials and methods for laying out thin covering on contaminated seabed" was published in 2012 (Opticap 2012b).

Over the period of 2013–2021, Fiskerstrand Verft has also assisted other shipyards in developing their EMS as well as building competence in HSE. In addition, Fiskerstrand Verft has installed a number of electrical shore connections which provide an electrical power supply connection between the quay and/or the floating dock to the ships to ensure electrical supply onboard, thus preventing ships from using diesel engines with generators to obtain electricity onboard. The total shore connection capacity is 4000 kVA based on 400 V and 690 V, 50 Hz. From this capacity, 400 V and 690 V, 60 Hz can also be delivered, as required. Fiskerstrand Verft has been working with the Tafjord Energy Arena since 2015 on energy management (2015–2016) for industry and plant and energy savings (2016–2019) for buildings. Four main gauges on electrical intake, 2 sub gauges and 28 gauges for electrical consumptions were installed in 2020. The purpose is to monitor the electrical consumption to optimize and reduce peaks and thus, reduce both energy consumption and costs. The electrical grid rent is defined by the specific hour in a month with the highest power peak. It is therefore important to control power during any given period. The installed equipment is a good analytical tool to optimize control and thus reduce power peaks and costs.

18.4 Ship Building, Conversions and Repairs

The activities described in this section describe the use of the toolbox described for Level 2 in the CapSEM Model. During the period (2010–2021) the yard has focused on the development of green technologies, both to ensure a good practice in the organization, but also green technologies for ships. The life cycle perspective for ships and technology has been central, hereunder focusing on the suppliers for equipment to development of greener technologies. From this point on, the yard has been concentrating on product improvements according to Level 2 in the CapSEM Model. This work took a life cycle approach where both upstream and downstream activities were considered (use of materials, technologies in the building process and impacts from the operating vessels). One example from 2002 is the car- and passenger ferry "Nordfjord", which was the third ship in world history built under the environmental classification notation "Clean Design", which has strict requirements concerning safety and waste handling and promotes minimizing emissions to sea and air.

In March 2013, the LNG-bunkering vessel "Seagas" was delivered, the world's first dedicated LNG (liquified natural gas) bunkering vessel that can deliver LNG from ship to ship. It was based on a conversion of the car and passenger ferry

"Fjalir" to serve the Ropax ship "Viking Grace" for the line from Stockholm – Helsinki. Since 2010, six ships based on LNG-engines were delivered. This included one based on LNG hybrid battery and one based on biodiesel hybrid battery. Fiskerstrand Verft also delivered the conversion of a ferry from LNG to hybrid with battery, two ferries from diesel to battery and one from LNG to battery. Table 18.1 presents an overview of green technologies installed in vessels delivered by Fiskerstrand Verft.

18.5 Development of Green Ship Technology

In December 2016, Fiskerstrand Holding AS was granted support by the Pilot–E system to develop a conversion of a car- and passenger ferry from diesel engines to a hydrogen fuel cells hybrid battery system. Pilot-E is a financing scheme for Norwegian industry, established by the Research Council of Norway, Innovation Norway and ENOVA.[1] The project was named HYBRIDship (Cf https://www.sintef.no/prosjekter/2017/hybridskip/). The overall idea of the project is to realize zero emission propulsion systems for longer crossing/operation time and larger vessels in hybrid configurations based on battery and hydrogen technology. Based on this knowledge base a pilot project for a hybrid ferry (hydrogen/battery powered) was outlined and specified. Further, an existing car- and passenger ferry should be rebuilt and tested by end of 2020 as the first car- and passenger ferry in commercial operation in the world. Both DNV and Norwegian Maritime Authority were partners in the project for the purposes of approving/validating the process. The objective was a win-win situation for both the regulating authorities and the yard in order to ensure pioneering functions.

Unfortunately, the project was terminated due to lack of financing for the ferry conversion. Battery will become the main source for ferry fjord crossings of up to 45–50 minutes. Hybrid with hydrogen and battery are more appropriate for fjord crossings for longer distances. Hybrid with batteries and biodiesel/biogas could also be used. Hydrogen fuel cells hybrid battery are relevant for the aqua industry, short sea shipping–cargo, local cruise lines–fjord cruises, local fishing vessels, high speed catamarans and supply and service vessels for offshore industry and offshore windmills.

Fiskerstrand Verft has installed an advanced system for managing wastewater from the high-pressure bottom hull cleaning of ships in the dock. The flush-down-water contains paint residue like TBT, PCB, seaweed, seashells etc. The water cannot be pumped directly into the sea. Six compilation wells for wastewater have therefore been installed: - two in each end and two in the middle of the dock. Collection pipes are installed in the bottom of the dock leading up to four pumps which pump this through a pipe on the seabed to 3 large settling tanks on the quay.

[1]Enova SF is a Norwegian government enterprise responsible for promoting environmentally friendly energy production and consumption.

Table 18.1 Overview of green technologies installed in vessels delivered by Fiskerstrand Verft

Vessel type	Name	Power system	Description	Category	Year
Ferry	Selbjørnsfjord	LNG	A pioneering project, installing a gas electric system in a car ferry, replacing traditional diesel driven system significantly reducing NOx and CO2 emission.	New building	2010
Ferry	Boknafjord	LNG + diesel	At the time, the world largest LNG driven car ferries crossing Norwegian fjords. Modern LNG engines, combined with diesel and SCR cleaning, gives a significant NOx – CO2 and methane reduction.	New building	2011
Feed ship/ aquaculture	With harvest	LNG	Gas mechanical directly driven propulsion system, optimized for low resistance at sea and low emission.	New building	2014
Feed ship/ aquaculture	With marine	LNG	Gas mechanical directly driven propulsion system, optimized for low resistance at sea and low emission.	New building	2014
Ferry	Hasvik	LNG	Gas electric propulsion system, hull optimized for low resistance at sea and low energy consumption	New building	2015
Ferry	Bergsfjord	LNG	Gas electric propulsion system, hull optimized for low resistance at sea and low energy consumption	New building	2015
Ferry	Fannefjord	LNG/ battery hybrid	Car ferry, upgraded with batteries to handle load transients for reduced use of LNG engines.	Retrofit/ Conversion	2015
Ferry	Hornstind	Biodiesel/ battery hybrid	Car ferry with batteries installed to handle load transients by reduced use of diesel engines. Diesel engines can run 100% on biodiesel, including exhaust cleaning systems, Hornstind achieves significant reductions in CO2 and NOx emissions.	New building	2017

(continued)

Table 18.1 (continued)

Vessel type	Name	Power system	Description	Category	Year
Ferry	Årdal	From diesel to battery	Diesel electric ferry upgraded to 100% battery electric propulsion system. Ferry is adapted to charging systems from shore for fast charging and shore power for reduced use of diesel generators at rural locations.	Retrofit/ Conversion	2019
Ferry	Lærdal	From diesel to battery	Diesel mechanical ferry upgraded to 100% battery electric propulsion system. Ferry is adapted to charging systems from shore for fast charging and shore power for reduced use of diesel generators at rural locations.	Retrofit/ Conversion	2019
Ferry	Karlsøyfjord	From LNG to battery	Gas electric ferry converted to 100% battery electric propulsion system. Ferry is adapted to charging systems from shore for fast charging and shore power for reduced use of diesel generators at rural locations.	Retrofit/ Conversion	2022

Finally, the water on the upper part of the settling tank is then pumped to a purifier plant securing clean water. The dregs from the settling tank are taken out regularly and treated as contaminated substance. The upgrading of the dock represents an improvement on Level 1 in the CapSEM model by reducing discharges to the sea from one of the operation processes at a maintenance shipyard.

18.6 Conclusion

This case study describes a transition toward sustainability that has taken place over a period of 30 years, beginning with the application of Level 1 of the CapSEM model, moving to Level 3 with implementation of EMS, KPIs and reporting. The understanding of the impact from shipyards on the environment matured over time, accompanied by a better comprehension of environmental impacts from each phase of the life cycle of the ship. When Level 3 in the CapSEM model was reached, a distinct and measurable shift in performance was demonstrated based upon results from environmental accounting obtained over a long period of time. This change is reflected and documented throughout the annual reports. The activities described for Level 4 illustrates further that Fiskerstrand Verft had gained valuable knowledge and experiences applicable to the entire the shipyard industry, e.g., as the pilot company developing the set of criteria for shipyards to become Environmental Lighthouse certified. The heavy involvement in the conversion to greener technologies also demonstrates how important the understanding of the life cycle performance of products is, both in the design of the technology and the impact it has over the life-time operation and maintenance of the vessel. A further attention to circular economy principles in the shipping industry, will gain more attention in the future. This requires close collaboration with the shipowner and the shipyard. This 30-years journey has also provided knowledge about the CapSEM toolbox and how the various methods can be used for different shipyard operations, as demonstrated by the example with the upgrade of the floating dock. The environmental accounting for this follows the input-output calculation method and the principles for cleaner production at Level 1.

In closing, this case is an example of how early environmental strategies, combined with practical work and visionary leadership, can lead to the greening of the shipyard industry.

References

Angelfoss A, Johnsen T, Fet AM, Karlsen H (1998) Life cycle evaluation of ship transportation–state of the art. Report (10/B101). Ålesund University College

Ellingsen H, Fet AM, Aanondsen S (2002) Tool for environmental efficient ship design. In Proceedings of the 39th Wegemt School, Marine Science and Technology for Environmental Sustainability, December 2002. University of Newcastle upon Tyne, UK. Available via https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.133.8031&rep=rep1&type=pdf. Accessed 14 September 2022

Fet AM (2001) Cleaner Production and Industrial Ecology. Nato/CCMS Pilot Study on Clean Products and Processes, Oviedo, Spain, May 6–11, 2001. Available via www.researchgate.net/profile/Annik-Fet/publication/242722329. Accessed 14 September 2022

Fet AM (2002a) Environmental management tools and their application - a review with references to case studies. In: Conceição P, Gibson DV, Heitor MV, Sirilli G, Veloso F (eds) Knowledge for inclusive development. Quorum Books, Westport, Connecticut, pp 451–464

Fet AM (2002b) Environmental reporting in marine transport. In proceeding of the Institute of Marine Engineering, science and technology. J Marine Design Operat Part B, 1:17–25, London, UK

Fet AM, Sørgård E (1998) Life Cycle Evaluation of Ship Transportation – Development of Methodology and Testing. Report 10/B101/R-98/008/00, Aalesund University College. 10.1.1.540.2851 & rep=rep1 & type=pdf

Fet AM, Zhou PL (2002) Environmental performance and eco-efficiency of using biodiesel in recreational boats. ENSUS 2002, Newcastle, UK, December 17.2002. Available via https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.568.2836&rep=rep1&type=pdf. Accessed 14 September 2022

Hayman B et al. (2000) Technologies for reduced environmental impact from ships-ship building, maintenance and dismantling aspects. In ENSUS-2000, Newcastle upon Tyne, UK, September 2000. Available via https://www.researchgate.net/profile/Brian-Hayman/publication/253362781._ Accessed 14 September 2022

Opticap (2012a) Evaluering av gjennomføring av testtildekking på TBT-forurenset sediment utenfor Fiskerstrand Verft i Sula kommune. NGI-rapport 20071139–00-123-R. Available via https://www.ngi.no/download/file/7620. Accessed 14 September 2022 [Norwegian]

Opticap (2012b) Utlegging av tynn tildekking på forurenset sjøbunn, sluttrapport. (OPTICAP - capping of contaminated sediments, final report) (NGI), September 2012. Available via https://www.ngi.no/download/file/7617. Accessed 14 September 2022 [Norwegian]

Zhou PL et al (2003) A feasibility study of the use of biodiesel in recreational boats in the United Kingdom. Procee Instit Mec Eng Part M-J Eng Marit Environ 217(3):149–158. https://doi.org/10.1243/147509003322255859