Green Skills I

Course description

Content

SKILLSEA	THE TOOLBOX GUIDE
Curriculum	
Learning objectives	A reduction of environmental impacts is a well-established goal of many national governments and international organisations. Carbon dioxide (CO_2) reduction has become one of the most important factors when combating global warming. On completion of Green Skills 1, the students shall obtain the necessary knowledge, skills, and competencies for operating a vessel in an environmentally friendly and sustainable way.
Target group	This course is designed for maritime professionals (at operational and management level) interested in energy-efficient and environmentally-friendly ship operations.
Entry requirement	The minimum competence requirement for students participating in this educational package is national equivalents of EQF level 4 and at least six months of seagoing experience or six months at a maritime academy.
Duration	The duration of this course is 100 hours, corresponding to 4 ETCS points. Duration of the full package is 12 lessons of 3 hours each, amounting to 36 guided learning hours and 64 self-study hours. The definition of guided learning hours, in this document, is 'the time a person spends': a) being taught or instructed by a lecturer, tutor, supervisor or another appropriate provider of education or training; or b) otherwise participating in education or training under guidance.

Assessment	The assessment of achieved learning outcomes will be based on a case from which the students produce a written report (see Appendix 2).

Course description

Course outline

The course consists of 12 lessons listed below. These lessons will enable the student to achieve the learning outcomes described below. Each lesson relates to the intended learning outcomes, as shown in the lesson plan: Appendix 1.

Lesson	Topic
1.	Alternative fuels*
2.	Green legislation in an operational context*
3.	Determining environmental impact
4.	Climate change and the adaptation of transport infrastructure
5.	Energy-efficient operation – power production*
6.	Energy-efficient operation – power consumption*
7.	Energy-efficient operation – energy efficiency awareness*
8.	Data collection and interpretation I
9.	Data collection and interpretation II
10.	Management of operation in a green context
11.	Improving green performance in an operational context
12.	Introduction to assessment case and methodology

*These lessons are included in Appendix 3 as examples.

Learning outcome	**Learning outcomes:** *Knowledge* 1. Demonstrate knowledge and understanding of international and EU legislation regulating maritime and related environmental pollution issues. 2. Demonstrate insight into current state-of-the-art alternatives to liquid fossil fuels, their characteristics and safe handling. 3. Exhibit knowledge and understanding of sustainable use of maritime resources and sustainability reporting. *Skills* 4. Interpret data collected onboard. 5. Calculate the environmental footprint of energy consumers onboard and primary emission consequences of energy-saving initiatives. 6. Operate vessels commercially and energy efficiently, in accordance with environmental regulations. 7. Manage the planning, implementation, monitoring and self-evaluation and improvement of energy-saving initiatives. 8. Evaluate energy-management alternatives. *Responsibility and autonomy* 9. Effectively comply with environmental regulation and ensure adherence to corporate governance principles. 10. Develop initiatives to improve the Ship Energy Efficiency Plan (SEEMP). 11. Demonstrate interdisciplinary expertise to understand and improve sustainability in a maritime context.

Teaching methods	The overarching principle for the course is based on the theory of constructive alignment devised by Professor John B. Biggs (Biggs & Tang, 2011). The main points are that learners construct meaning from what they do to learn. This means that there must be an alignment between learning activities, learning outcomes, and assessment. Based on the reality of a junior officer and the teamwork he or she will be part of, the assessment and learning activities should be group-centred. After each lesson topic has been delivered, a self-assessment quiz should be completed by the student. This is to ensure that the students are aware of their level of understanding and to motivate them to study. The questions should be constructed to cover the topic and reveal if any learning outcomes associated with the topic are not achieved. For methods used in the individual lessons, see lesson plan Appendix 1 and lesson examples Appendix 3.
Teaching material	Teaching materials are provided with each lesson example. (Appendix 3) In the lesson examples and the assessment case example, a simulator is used. (Appendix 2 and 4) Further readings are provided in Appendix 4
Assessment/exam	Each topic should be followed by a self-assessment quiz, as described under teaching methods. An example of such a quiz is provided for lesson 1 example in Appendix 3. The final assessment is the evaluation of a written report based on a case. An example of a case is provided in Appendix 2. It is possible to arrange for the casework to be done during the course or at the end.
Evaluation	

Course review	The students will complete the survey at the end of the course. Lecturers will review the outcomes of the survey and will provide their reflections, with possible actions for developers/deliverers to consider. Students will be provided with an opportunity to complete a short survey to evaluate the delivery and content of the package. After completing this evaluation, individual lecturers will carry out module reflection, also according to the template provided.

Appendix 1 – Table of constructive alignment

№	Lesson	Learning outcome (Numerated as per toolbox guide)	Teaching method(s)	Assessment case opportunity (see Appendix 2)
1	Alternative fuels	Primary: 2	Group presentations about alternative fuels. Individual preparation, presentation in break-out groups. Presentation to be followed by a discussion in break-out groups. Follow-up in the classroom afterwards.	Master's request of the possibility of an Energy Storage System (ESS) battery pack
2	Green legislation in an operational context	Primary: 6 Also contributing to: 1, 3, 9	Teacher's presentation on the basics of maritime environmental law. Study questions getting the student to use MARPOL as reference work to determine requirements, limit values, etc. through look-up in environmental legislation.	Ship's position, together with MARPOL and fuel grade.
3	Determining environmental impact	Primary: 5 Also contributing to: 3	Teacher presentation on environmental calculations. Calculation exercises in study groups.	Calculation of diesel generator replacement impact
4	Climate change and the adaption of transport infrastructure	Primary: 5	Teacher presentation on environmental calculations. Calculation exercises in study groups.	Determining the impact of replacing a diesel generator with an ESS battery

5	Energy-efficient operation - power production	Primary: 6	Simulation, lecture, and group work Described in detail in the exemplary lesson (Appendix 3) Simulation, lecture, and group work	Simulator scenario has been set to: - Both Diesel Generators (DG) running low load - Wrong fuel grade (Running 0.5 % S instead of 0.1 %) - Selective Catalystic Reactor (SCR) not running - NO_X emissions too high. - Hull has increased resistance. Can be seen in simulator load diagram - Speed too high for ETA
6	Energy-efficient operation - power consumption	Primary: 6		
7	Energy-efficient operation - energy efficiency awareness	Primary: 6 Also contributing to: 2, 3		
8	Data collection and interpretation I	Primary: 4	Teacher presentation on data collection. Data interpretation exercises.	Viewing, retracting and working with data from the simulator
9	Data collection and interpretation II	Primary: 4	Teacher presentation on data analysis. Simulator-based exercises. Actions to be taken based upon data interpretation.	Viewing, retracting and working with data from the simulator
10	Management of operations in a green context	Primary: 7 Also contributing to: 2, 8, 9	Teacher presentation on maritime management. Group work. Case-based exercise. Case separated into part tasks. Actions to be taken based on findings. Follow-up in the classroom after each part task of the case. Discussion on	Master's request to suggest initiatives.

			actions taken, why, and what could have been done differently.	
11	Improving green performance in an operational context	Primary: 10 Also contributing to: 2		Sample SEEMP to be included, to show a case in which initiatives can be implemented.
12	Introduction to assessment case and methodology	Primary: 11		N/A

Appendix 2 – Example assessment case

Case construction (teacher)

The case can be authentic, fictional or a mix. The case should be based on a seagoing vessel and a description of its current situation. Several challenges and problems should be described. The students will analyse and/or solve these, through use of the knowledge, skills and competences described in the learning outcomes. It is therefore important that the challenges and problems described lead to a demonstration of course learning outcomes, see Appendix 1.

It is very important to make sure that students are aware of the learning outcomes they are expected to demonstrate in the written report. This can be done by including learning outcomes in the case description.

Apart from the description and challenges, the case should contain appendices with relevant data. Relevant data can be in the form of a simulator scenario, an Excel file or text documents.

The case should be different each time the course is run, to minimise plagiarism.

An example of a case is given below, to – hopefully – serve as inspiration.

The case is based on the use of Kongsberg's K-Sim Engine MAN B&W 5L90MC VLCC 11-V simulator. The simulator scenario is a 'full ahead loaded' scenario that has been modified to provide opportunities for optimisation.

Example case for Green Skills 1

The following text is an example of the exam case the students receive.

Introduction

This case will be used throughout the course as a reference, and you will apply the knowledge and skills you acquire in each lesson to it. It is not possible to complete the report or respond to all the challenges until the end of the course – do not be discouraged or overwhelmed at the beginning!

Case description

Scenario

You are an officer onboard the merchant vessel 'MV Svendborg' (MC90) on a fully loaded voyage from Sture Terminal (Norway) to the port of Rotterdam (Netherlands).

MV Svendborg is a Very Large Crude Carrier (VLCC). Details can be found in the simulator manual. Ship's main particulars can be found below.

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The ship represents a VLCC with the following main data:
- Length OA 305 m
- Length bp 295 m
- Breadth moulded 47 m
- Depth moulded 30.40 m
- Summer draught 19.07 m
- CB 0.801
- Dead weight 187997 tons
- Speed 14 knots

Main Engine
- Type MAN B&W 5L90MC
- Continuous Service Rating ME 18 MW
- Corresponding Engine Speed 74 rpm

Propeller System
The propeller system is FPP.

Electrical power plant
two 900 kW/440 V/60Hz diesel engine driven synchronous generators
one 1200 kW/440 V/60Hz synchronous shaft driven generators
one 900 kw/440 V/60Hz steam turbine driven generator
one 250 kW/440 V/60Hz emergency generator

Thrusters
1 CPP Bow Thruster 750 kW
Steering Gear
Double acting, rotary vane type, IMO Model
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The vessel's position at the beginning of this case is 57°00'00"N, 004°00'00"E in the middle of the North Sea. You are expected to be at the pilot station at hh:mm:dd:mm:yyyy.

The master has received a message from the company in which they ask crews to come up with suggestions to optimise their vessel's operation and do some knowledge sharing with their sister ships. This knowledge-sharing programme is very important for the company's strategy to strengthen its green profile. The master is inspired by this message and asks you to go through the vessel and make sure everything is running as efficiently as possible, and that the vessel complies with all environmental regulations. The master also wants you to come up with some suggestions about what your vessel could do to contribute to the company's knowledge-sharing programme. The SEEMP onboard has not seen much use since it was implemented. However, considering the company's new green strategy, the master wants all the work to be in accordance with the SEEMP and also documented within it.
The master is very interested in the possibility of installing an ESS battery pack, since he has an idea that this might also improve safety if it could act as a UPS for propulsion. He would also like to see a calculation of the impact of replacing one of the older DGs.

Case report

A written report must be produced and handed in, according to the lesson plan. The written report should contain relevant answers to all the problems and challenges identified in the case description and the simulation. It is advised to run the simulation more than once. The report documents what problems you identify and how you solve them and demonstrate the learning outcomes.

Loading the scenario:

The scenario can be loaded by starting the VMware Horizon Client and choosing the MC90 simulator. When logged into the remote desktop, start the simulator by clicking the MC90 icon on the desktop. At the start screen, choose initial condition ‘green skills 1’ and press f1 to start the simulation.

Details about MV Svendborg

Details can be found in the Kongsberg Manual available.

Recommended areas to include in casework

The learning outcomes of the course should be demonstrated in the written report.

When writing the report, students should clearly state which learning outcome each of the answers or sections relate to.

Appendix 3 – Example lessons

Lesson 1 - Alternatives to fuel oil (one lesson)

1.0 Introduction

An effective way to eliminate or reduce CO_2 emissions is to use fuel without carbon content or fuel with less carbon content than traditional fuel. In seagoing vessels, the traditional fuel used is Heavy Fuel Oil (HFO), but many vessels have already changed to alternatives.

2.0 Learning outcomes.

Learning outcome 2 from toolbox guide

Demonstrate insight into current state-of-the-art alternatives to liquid fossil fuels, their characteristics and safe handling.

3.0 Teaching methods

The methods of this lesson are lectures and group work.

Module content

In this module, alternatives to HFO will be explored, and current pros and cons of the different fuels will be highlighted. Alternatives covered in this module:

Commercially available alternatives:

- Liquefied Natural Gas (LNG)
- Liquefied Biogas (LBG)
- Liquefied Petroleum Gas (LPG)
- Dimethyl Ether (DME)
- Energy Storage System (ESS)
- Biodiesel (various types)
- Methanol (Alcohol)
- Ethanol (Alcohol)

Not yet commercially available alternatives:

- Ammonia (NH_3)
- Hydrogen (H_2)

Lesson plan

A suggested lesson plan is listed below:

- The teacher presents a brief overview of all the alternative fuels and the challenges (see exemplar PowerPoint slide show)
- Group discussions of:
    - Pros and cons of alternative fuels
    - Best/worst fuel
    - What will be the fuel of the future?
    - The food, energy, and environment trilemma
- Group work creating a presentation of one of the alternative fuels
- Presentation of work for peers (whole class or another workgroup)
- The teacher presents one or more alternative fuels (if student presentations lack quality) and gathers important points from the session. (Teacher presentation of an alternative fuel must be prepared)

While the students discuss and develop their presentations, the teacher should act as a counsellor providing the students with directions and encouraging them to reflect upon the topic.

The activities outlined above can be done in a classroom setting, or as blended learning. The teacher presentation could be replaced with a video presentation. The group work and discussions could be done in an online environment such as MS Teams or Zoom. If done as an online class, it is even more important that the teacher facilitates the group work.

4.0 Teaching materials

PowerPoints

PowerPoint 1: [Title: Example presentation – Alternative Fuels]

Reports

DNV GL. (2019). *Maritime forecast to 2050 - Energy transition outlook 2019.* DNV GL - Maritime.

Books

Andersson, K., Brynolf, S., Lindgren, J. F., & Wilewska-Bien, M. (2016). *Shipping and the Environment.* Berlin Heidelberg: Springer.

Websites

DNV-GL Maritime
https://www.dnvgl.com/maritime/index.html

Transport and the Environment: shipping and climate change
https://www.transportenvironment.org/what-we-do/shipping-and-environment/shipping-and-climate-change

EMSA - European Maritime Safety Agency

http://www.emsa.europa.eu/implementation-tasks/environment.html

Marine Environment (IMO)
http://www.imo.org/en/OurWork/Environment/Pages/Default.aspx

UN & Sustainable Development Goals
https://sustainabledevelopment.un.org/

World Ocean Council
https://www.oceancouncil.org/

5.0 Socrative questioning.

These questions are provided as an appetiser for the students regarding this lesson. The answers should not be given to the students, but they should be encouraged to find them themselves. The questions can be used both for preparation for the lesson and reflection afterwards.

How much CO_2 does the combustion of fuel result in?

It depends entirely on the fuel and its carbon content. It also depends on how well the combustion is managed. If the combustion is considered stoichiometric, which means that there is exactly the right amount of oxygen present and that the reaction is complete, one mole of CO_2 will be created for each mole of C.

Is the usage of electricity or fuels with no carbon always CO_2 neutral?

No, it depends on how the electricity or the no-carbon fuel is produced. If the electricity is produced using renewable sources like wind turbines, hydro turbines, or solar cells, it is possible that the source is CO_2 neutral. The same goes for the production of carbon-free fuels – the production requires energy, and this energy source needs to be CO_2 neutral.

Can CO_2 be removed from the exhaust gas?

Yes, it is possible to remove CO_2 from the exhaust gas. This process, however, presents several challenges. The process requires energy, which lowers efficiency. The CO_2 that is removed from the exhaust needs to be collected and stored. The technology available today requires considerable space.

6.0 Self-assessment quiz for topic: alternatives to fuel oil.

This is a multiple-choice quiz. Questions, correct answer and wrong answers are provided. The correct answer is underlined.

1. Which of the following alternative fuels will result in zero carbon dioxide when combusted?
    a. <u>Ammonia</u>
    b. Liquified Natural Gas
    c. Bio Methanol
    d. Bio Diesel

2. When comparing alternative fuels to fuel oil, an important metric is energy density. Which of the following alternatives has the highest volumetric energy density?
    a. Ammonia
    b. Liquified Natural Gas
    c. Bio Methanol
    d. <u>Bio Diesel</u>

3. ESS batteries are considered an excellent alternative to fuel oil in some operation scenarios. Which type of vessel are the most common type using full electric propulsion?
    a. Container ship
    b. Tanker
    c. <u>Passenger ferry</u>
    d. Offshore supply vessel

4. Internal combustion engines emit NO_x due to the high working temperature. Which of the following is an alternative that could eliminate NO_x emissions?
    a. Dual fuel engines
    b. <u>Fuel cells</u>
    c. Gas turbines
    d. Boiler and steam turbine

5. Which of the following alternative fuels eliminate the SO_x emission?
    a. Ammonia
    b. Bio Ethanol
    c. Liquified Petroleum Gas
    d. <u>All of the above</u>

6. The production of alternative fuels must be done with sustainable energy. What is the process that converts electrical energy and water to hydrogen?
    a. Haber-Bosch Process
    b. Electrolysis
    c. Nuclear fusion
    d. Fracking

7. Ammonia is considered a promising alternative to fuel oil. What is considered to be the largest safety hazard of ammonia?
    a. Flammability
    b. Corrosiveness
    c. Toxicity
    d. All of the above

8. Liquified Natural Gas is most commonly kept in a...?
    a. Normal tank
    b. Pressure vessel
    c. Refrigerated tank (auto-refrigeration or regasification)
    d. It cannot be stored

9. Avoiding emissions from converting fuel into energy is impossible. But they can be reduced to only H_2O. Which fuel will result in only H_2O if used in a low-temperature fuel cell?
    a. Hydrogen
    b. Helium-3
    c. Dimethyl ether
    d. Bio Ethanol

10. Hybrid vessels are mixing conventional fuel with an alternative to fuel. Which alternative?
    a. Ammonia
    b. Liquified Natural Gas
    c. Electric power (ESS)
    d. Hydrogen

Lesson 2 - Green legislation in an operational context (one lesson)

1.0 Introduction

Positive environmental changes can be achieved through application and enforcement of green legislation within the maritime sector.
This module aims to develop a better understanding of laws that regulate air emissions – one of the maritime industry's most significant environmental challenges – and how these laws are used in an operational context.

2.0 Learning outcomes.

Primary learning outcome 6 from toolbox guide

Operate vessels commercially and energy efficiently, in accordance with environmental regulations.

Also contributing to learning outcomes: 1, 3 and 9 from toolbox guide

Demonstrate knowledge and understanding of international and EU legislation regulating maritime and related environmental pollution issues.

Exhibit knowledge and understanding of sustainable use of maritime resources and sustainability reporting.

Effectively comply with environmental regulation and ensure adherence to corporate governance principles.

3.0 Teaching methods

The methods of this lesson are lectures and group work.

Module content

In this module, the student will be presented on ways in which environmental legislation is managed in an operational context.
Subjects covered in this module are:

- IMO Data Collection System (DCS)
- EU CO_2 monitoring (EU MRV)
- SO_x record-keeping
- Emission reporting onboard

Lesson plan

A suggested lesson plan is listed below:

- The teacher presents a brief overview of DCS and record-keeping (see exemplar PowerPoint slide show)

- Group discussions of the importance of record-keeping and evidence collection regarding:
  - Inspections and surveys
  - Seaworthiness of the vessel
  - Commercial obligations with partners
  - Marine insurance
- Group discussions on the negative impact of poor record-keeping.
- Follow-up in a class where groups present their findings.
- The teacher presents one or more points to discuss (if student presentations lack them) and gathers important points from the session. (Teacher presentation of key points regarding the group discussion subjects must be prepared)

While the students discuss and work creating their presentations, the teacher should act as a facilitator providing the students with directions and encouraging them to reflect upon the topic.

The activities outlined above can be done in a classroom setting, although it is also possible to do it as blended learning. The teacher presentation could be replaced with a video presentation. The group work and discussions could be done in an online environment such as MS Teams or Zoom. If done as an online class, it is even more important that the teacher facilitates the group work.

4.0 Teaching materials

PowerPoints

PowerPoint 1: [Title: Example presentation – DCS and Record Keeping]

Websites
DNV - GL Maritime

https://www.dnvgl.com/maritime/insights/topics/EU-MRV-and-IMO-DCS/index.html

ABS on Environmental Compliance

https://ww2.eagle.org/en/Products-and-Services/environmental-performance.html

5.0 Socrative questioning.

These questions are provided as an appetiser for the students regarding this lesson. The answers should not be given to the students, but they should be encouraged to find them themselves. The questions can be used both for preparation for the lesson and reflection afterwards.

6.0 Self-assessment quiz for topic:

This is a multiple-choice quiz. Questions, correct answer and wrong answers should be provided below, underlining the correct answer as follows:

Lesson 5, 6 and 7 – Energy-efficient operations (three lessons)

1.0 Introduction

An effective way to reduce CO_2 emissions is to use less energy and thereby less fuel. To achieve this, it has become increasingly important to ensure that vessels are operated and manoeuvred in an energy-efficient manner.

Energy efficiency can be achieved by both technical and structural upgrades. However, the possibility of addressing the operating principles – which are closely related to energy efficiency awareness – is often missed. This human factor can often contribute significantly to energy efficiency with minimal investments.

2.0 Learning outcomes

6. Operate vessels commercially and energy efficiently, in accordance with environmental regulations.

Module content

Students have achieved the learning outcome when they are able to demonstrate the operation and optimisation of a vessel by performing actions in a simulation and making decisions based on performance data. Their actions and decisions should be explained and documented to display their theoretic understanding.

The module covers the following elements.

- Power production
    - Diesel engine efficiency
    - Specific fuel consumption
    - Electric generators
    - ESS battery
- Power consumption
    - Propulsion efficiency
        - Hull resistance
        - Propulsion chain
    - Auxiliary systems
    - Hotel load
    - ESS battery
- Energy efficiency awareness
    - Attitudes and perception towards energy efficiency
        - Importance
        - Current attitudes, perceptions, and opinions
        - Improvement considerations

3.0 Teaching methods

Based on the reality of a junior officer, and the teamwork he or she will be part of, both the assessment and learning activities should be group-centred.

Lesson plan

Power production

- The teacher presents the major topic Power Production (see exemplary PowerPoint slide show)
- Group discussions of:
    - Pros and cons of engine types
    - Energy conversion
    - What will be the power source in the future?
- Group work doing an exercise (see exemplary PowerPoint slide show)
- Discussion of exercise
- Teacher rounds off exercise by providing key insights that the student might have missed.

Power consumption

- The teacher presents the major topic Power Consumption (see exemplary PowerPoint slide show)
- Group exercises:
    - Hull resistance exercise (see exemplary PowerPoint slide show)
    - Propulsion chain efficiency exercise (see exemplary PowerPoint slide show)
- Group presentation of exercise to peers (whole class or another workgroup)
- Discussion of exercise
- Teacher rounds off exercise by providing key insights that the student might have missed.

Energy efficiency awareness

- The teacher presents the major topic Energy Efficiency Awareness (see exemplary PowerPoint slide show)
- Group discussions of:
    - Attitudes and perception towards energy efficiency
        - Importance
        - Current attitudes, perceptions, and opinions
        - Improvement considerations
- Group work doing an exercise (see exemplary PowerPoint slide show)
- Discussion of exercise

    - Teacher rounds off exercise by providing key insights that the student might have missed.

Energy-efficient operation workshop

- The teacher presents simulator or performance data. (A sample dataset is included but it is advised to create a custom data set or simulation.)
    - If a simulation exercise is chosen, then a scenario should be prepared with three to five items that can be optimised by the students. The students must identify and optimise as many as they can. During the workshop, they should take notes and write a report to be handed in later.
    - If a performance data exercise is chosen, then students should have already reached the learning outcome: *interpret data collected onboard.*

While the students discuss and do group work, the teacher should act as a facilitator providing the students with directions and encouraging them to reflect upon the topic.

The activities outlined above can be done in a classroom setting or as blended learning. The teacher presentation could be replaced with a video presentation. The group work and discussions could be done in an online environment such as MS Teams or Zoom. If done as an online class, it is even more important the teacher is proactive in facilitating the group work.

4.0 Teaching materials

PowerPoints

PowerPoint 1: [Title: Example presentation – power production]

PowerPoint 2: [Title: Example presentation – power consumption]

PowerPoint 3: [Title: Example presentation – energy efficiency awareness]

Data

A sample data set is made available for use on the learning management system. It is, however, preferable if the teacher customises data or simulation to make use of what is available and practice-oriented at the particular institution.

A file with sample data for use on the learning management system if no other better alternative is provided or available.

[sample data.csv]

DNV GL, Energy Management Study 2015, Technical report, www.dnvgl.com/maritime/energy-management-study-2015.html, 2015 (accessed 27th May 2019).

Books

Andersson, K., Brynolf, S., Lindgren, J. F., & Wilewska-Bien, M. (2016). Shipping and the Environment. Berlin Heidelberg: Springer.

Design of Propulsion and Electric Power Generation Systems. Hans K. Would and Douwe Stapersma. ISBN 1-902536-47-9

Websites

DNV-GL Maritime
https://www.dnvgl.com/maritime/index.html

Transport and the Environment: shipping and climate change
https://www.transportenvironment.org/what-we-do/shipping-and-environment/shipping-and-climate-change

EMSA - European Maritime Safety Agency
http://www.emsa.europa.eu/implementation-tasks/environment.html

UN & Sustainable Development Goals
https://sustainabledevelopment.un.org/

World Ocean Council
https://www.oceancouncil.org/

5.0 Socrative questioning

These questions are provided as an appetiser for the students regarding this lesson. The answers should not be given to the students, but they should be encouraged to find them themselves. The questions can be used both for preparation for the lesson and reflection afterwards.

Does it matter what we do as officers if the ship is not designed with high energy efficiency in mind?

Yes, it matters. A lot, actually. As DNV-GL conclude in their 2015 energy management study: ‘It’s all about the people.’ Several other studies also point toward the impact of the crews’ attitude and operational practices.

It is 2020, and energy efficiency has been a topic for many years now; isn't everything made as efficient as possible in the vessels?

Unfortunately no. There are still many areas on many vessels that can be optimised. There are a lot of opportunities out there both with regards to technical/structural upgrades, as well as improved operational practices.

Appendix 4 – Bibliography

Books:

Andersson, K., Brynolf, S., Lindgren, J. F., & Wilewska-Bien, M. (2016). Shipping and the Environment. Berlin Heidelberg: Springer.

Design of Propulsion and Electric Power Generation Systems. Hans K. Would and Douwe Stapersma. ISBN 1-902536-47-9

Pedagogical approach:

Biggs, J. B., & Tang, C. (2011). Teaching for quality learning at university: What the student does. Berkshire: Society for Research into Higher Education & Open University Press.

Websites:

DNV-GL Maritime https://www.dnvgl.com/maritime/index.html

EMSA - European Maritime Safety Agency
http://www.emsa.europa.eu/implementation- tasks/environment.html

Transport and the Environment: shipping and climate change
https://www.transportenvironment.org/what-we-do/shipping-and-environment/shipping-and-climate-change

UN & Sustainable Development Goals
https://sustainabledevelopment. un.org/

World Ocean Council
https://www.oceancouncil.org/

Online journal articles:

MAN Energy solutions – Marine Engines and Systems, *Basic Principles of Propulsion,* https://marine.man-es.com/propeller-aft-ship/basic-principles-of-propulsion, (Accessed 29. June 2020)

Inter Ferry, Ferry Industry Facts, *www.interferry.com/ferry-industry-facts/* (accessed

27. May 2019).

Eriksen, S., Lützen, M., Jensen, J. B., Sorensen, J. C., Improving the Energy Efficiency of Ferries by Optimising Operational Practices, *Proceedings of the Full-Scale Ship*

Performance Conference, The Royal Institution of Naval Architects, London, 2018, p. 101-111.

Jensen, S., Lützen, M., Mikkelsen, L. L., Rasmussen, H. B., Pedersen, P. V., Schamby, P., Energy-efficient Operational training in a Ship Bridge Simulator, *Journal of Cleaner Production*, 2018, 171, p. 175-183.

Rasmussen, H.B., Lützen, M., Jensen, S., Energy efficiency at sea: Knowledge, communication, and situational awareness at offshore oil supply and wind turbine vessels, *Energy Research & Social Science*, 2018, 44, p. 50-60.

Johnson, H., Styhre, L., Increased energy efficiency in short sea shipping through decreased time in port, *Transportation Research Part A: Policy and Practice*, 2015, 71, p. 167-178.

Banks, C., Operational Practices to Improve Ship Energy Efficiency, *PhD Thesis*, University of Strathclyde, Department of Naval Architecture, United Kingdom, 2015