Maritime Energy Management: The Journey Towards A Zero/Low Carbon and Energy Efficient Maritime Future

Prof. Dr. Aykut I. Ölçer

Director of Research

Nippon Foundation Professorial Chair in Marine Technology and Innovation

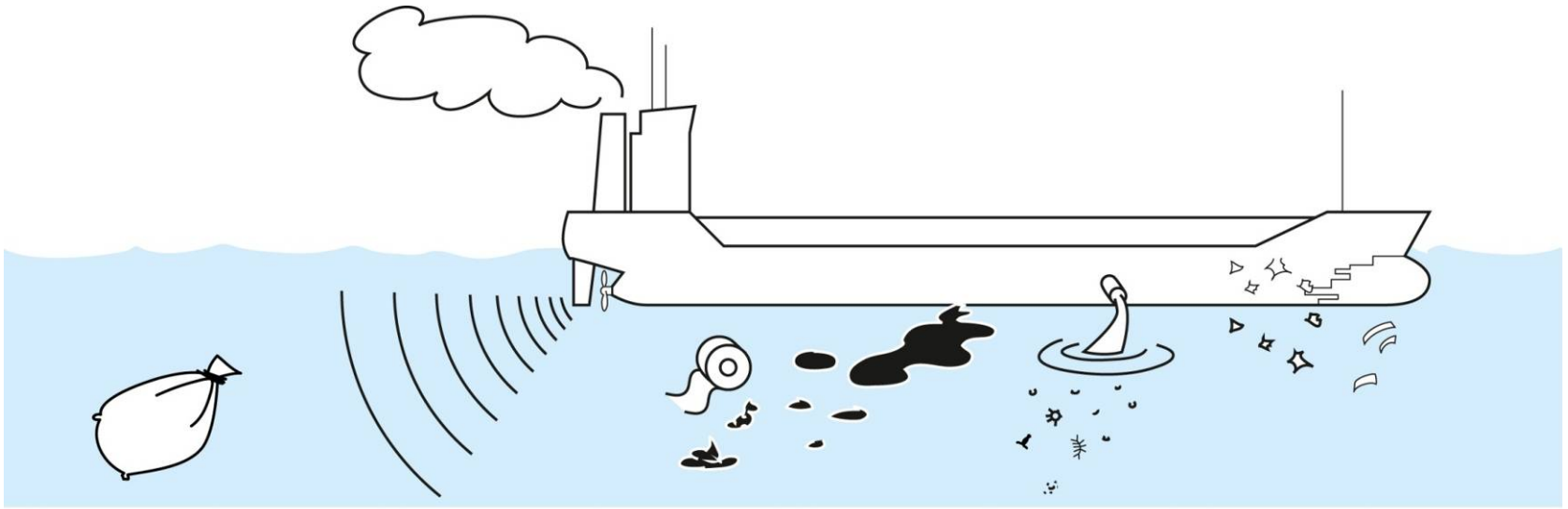
Head, Maritime Energy Management (MEM) Specialization

Prospects for Energy and Maritime Transport in the Nordic Region
26 February 2020

The Least (or Zero) Emission Ship?

(Source: WMU Maritime Energy Management Specialization EGY102 Lecture Notes)

Sustainable Shipping for a Sustainable Planet



Marine litter (solid waste) | Underwater noise | Air emissions | Sewage | Oil spillage | Invasive species (ballast water) | Chemicals | Antifouling

Source: (WMU Maritime Energy Management Specialization EGY102 Lecture Notes)

IMO
World Maritime Theme for 2020

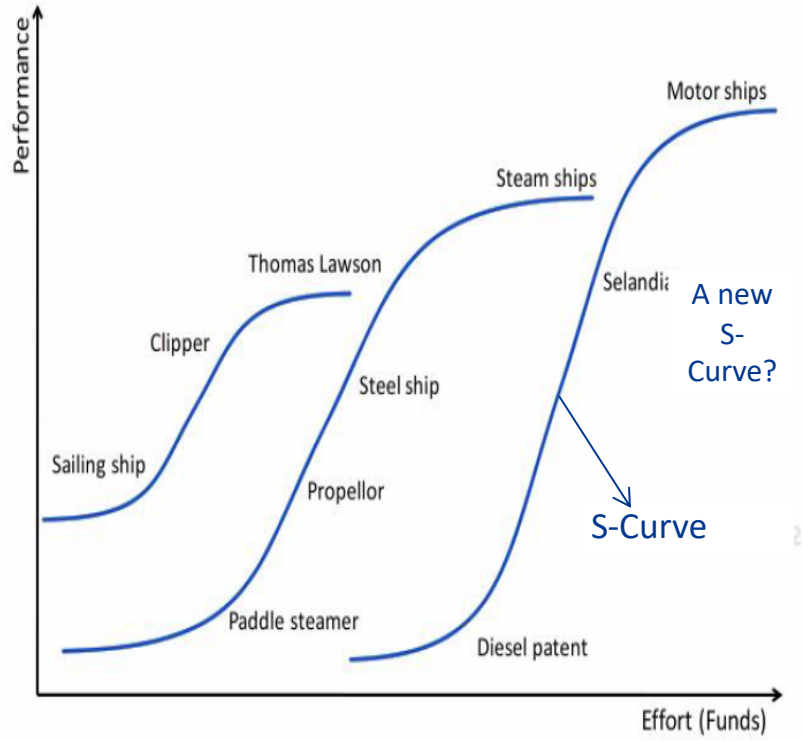
Air Pollution - Motivation and Drivers

- Environmental impact of Air Pollutants and GHGs (climate change, ..) and other externalities
- More stringent environmental regulations (MARPOL Annex VI Chapter 4), Kyoto to Paris Agreement and the latest IMO GHG Strategy
- Volatile fuel oil price
- World population, energy demand and prices
- Energy resources scarcity and Energy security
- UN2030 Agenda (SDGs 7 & 13 in particular)

Source: (Introduction Chapter, Trends and Challenges in Maritime Energy Management, Ölçer, A.I., Kitada, M., Dalaklis, D., Ballini, F. (Eds.), ISBN 978-3-319-74576-3, Springer)

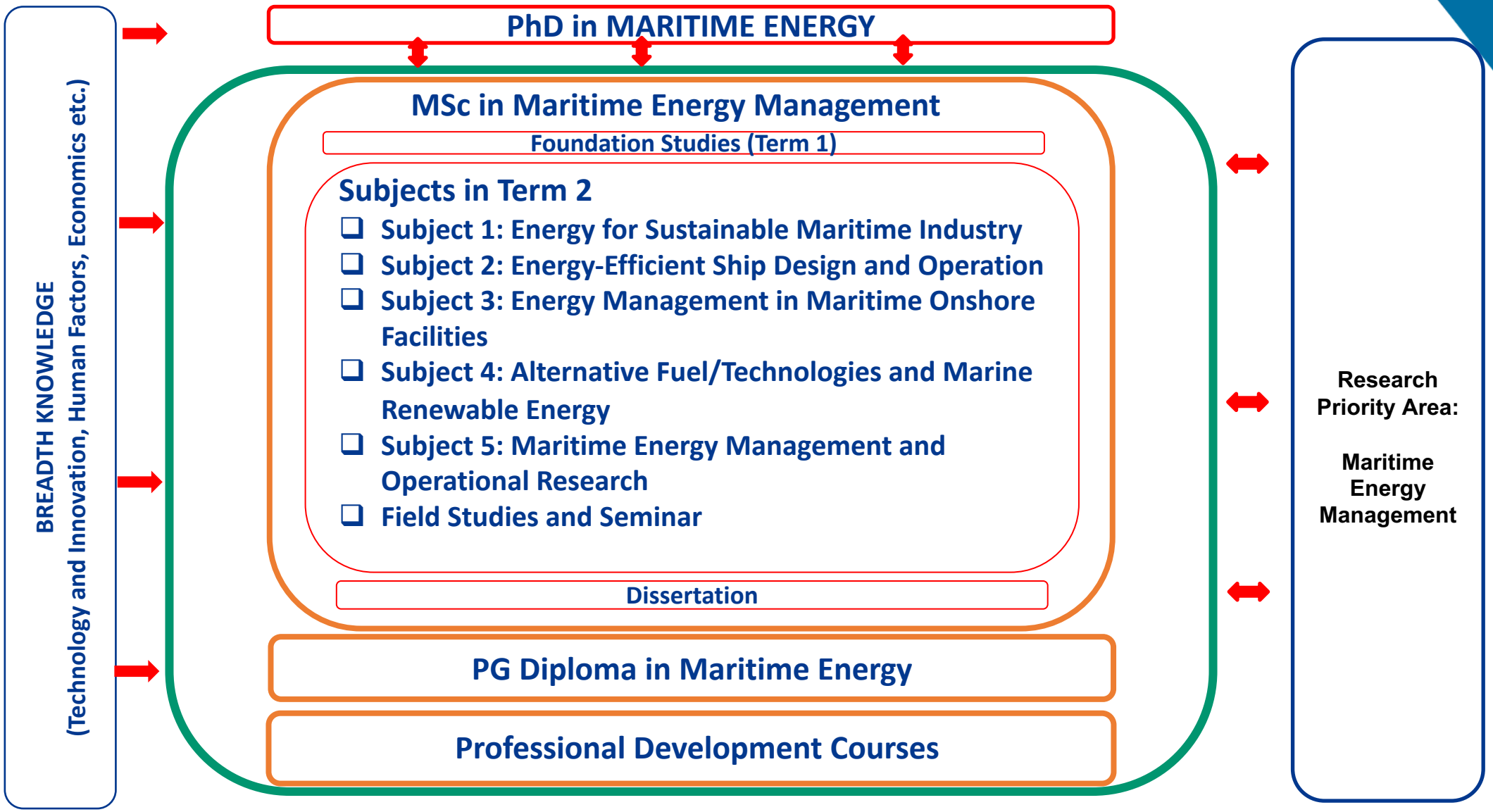
Future Ship Propulsion Technology

- From Human to Diesel Engines
- Fuel cells, batteries?
- Nuclear (or Thorium?)
- Alternative fuels and Renewables
- (Solar, Wind, LNG, biofuel, Methanol, ..)
- Hybrid (right mix?)



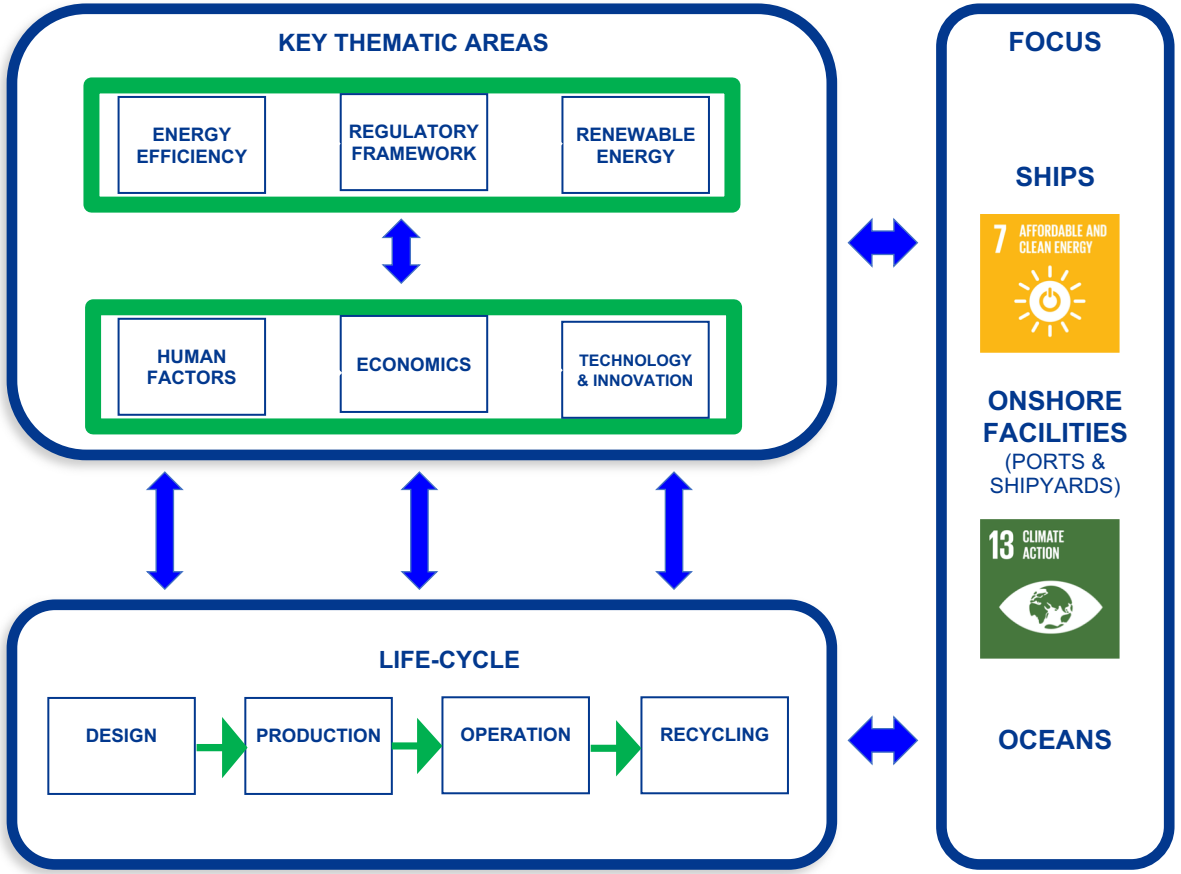
(Ref: Shipping innovation by Niko Wijnolst, Tor Wergeland, Figure 407, page 378)

The PG Pathway in MEM Stream



The Holistic View of MEM

- Regulatory framework
- Energy efficiency
- Renewable / Cleaner energy
- Technology and innovation
- Human element
- Economics of energy management



Source: Appendix I: Maritime Energy Management Research Strategy, Trends and Challenges in Maritime Energy Management, Ölçer, A.I., Kitada, M., Dalaklis, D., Ballini, F. (Eds.), ISBN 978-3-319-74576-3, Springer

WMU's Research – Two Main Pillars

As the International Maritime Organization's centre of excellence for postgraduate maritime education, WMU's mission is to be the world centre of excellence in postgraduate maritime and oceans education, professional training and research, while building global capacity and promoting sustainable development.

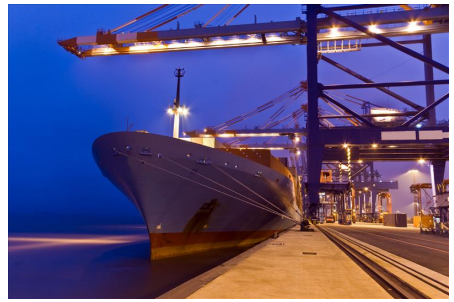
Maritime

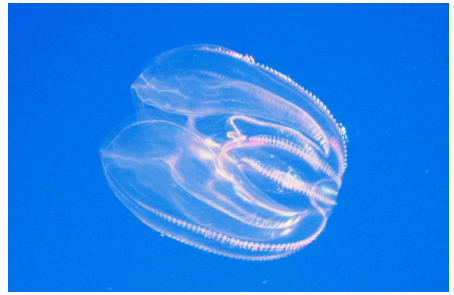
Ocean

Maritime Research Priority Areas (RPAs)

WMU's Mission: To be the world centre of excellence in postgraduate maritime and oceans education, professional training and research, while building global capacity and promoting sustainable development.

- Maritime Energy Management
- Maritime and Marine Technology and Innovation
- Maritime Economics and Business
- Maritime Social and Labour Governance
- Maritime Law, Policy and Governance
- Maritime Safety
- Environmental Impact of Maritime Activities

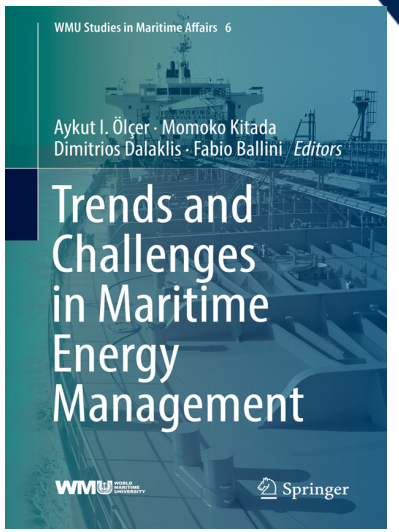


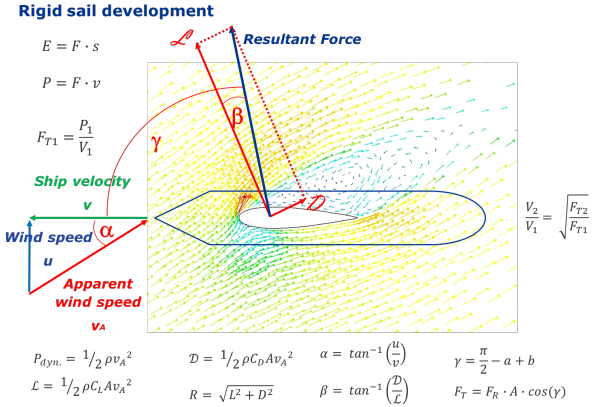


Maritime Energy Management (RPA1)

Key topic areas:

- Maritime energy policy and governance
- Economics and social dimensions of energy management
- Energy management over the life-cycle of ships and in maritime onshore facilities (ports, shipyards)
- Renewable energy including ocean energy applicable to the maritime industry
- Marine technology and innovation related to energy
- The circular economy from a waste reduction and renewable energy perspective





WMU MEM Research Strategy

Maritime Energy Management Research Strategy

OUR VISION

To become the world's leading University in the research field of maritime energy management and to play a vital role in transforming the maritime world to achieve a sustainable, low carbon and energy efficient future by delivering research of global excellence.

OUR STRATEGY

This vision will be reflected by MarEner (Maritime Energy Management and Marine Technology) Research Group's interdisciplinary research, whereby WMU will be appreciated for:

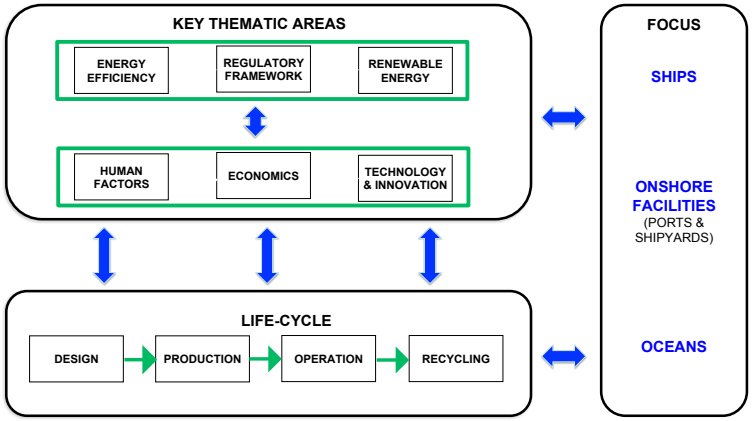
Advancing the knowledge in the maritime energy management field by conducting world-class fundamental and applied research in the thematic areas given below over a life-cycle perspective, from shipping to oceans, and from ports to shipyards;

Contributing to the capacity building and the goals of the IMO and its Member States and relevant UN bodies, in particular to UN SDGs 7, 12 & 13;

Fostering strategic relationships with other universities, governmental organizations, companies and other maritime stakeholders across the world to advance research;

Setting a global research agenda in the maritime energy management field through addressing maritime community's needs; and

Undertaking research of an international standard through scholarly publication.



WORLD MARITIME UNIVERSITY
Fiskehamnsgatan 1, 211 18
PO Box 500, SE-201 24
Malmö, Sweden
www.wmu.se/research

Recent Areas of Interest

- Ocean energy
- Renewable energy and alternative fuels and technologies
- Real-time decision support systems for energy efficient ship operations
- Climate change impact on port infrastructure and its adaptation
- Lean, energy efficient and green ports and shipyards
- Life cycle cost/environment impact models of green solutions for ships, ports and shipyards
- Decision making for trade-off situations of cleaner seaborne transportation

Source: Appendix I: Maritime Energy Management Research Strategy, Trends and Challenges in Maritime Energy Management, Ölçer, A.I., Kitada, M., Dalaklis, D., Ballini, F. (Eds.), ISBN 978-3-319-74576-3, Springer

Current Research Portfolio Examples

- ITF Transport 2040 Project: An assessment of the technological developments in the global transport sector and their implications on jobs and employment by 2040, with a budget of 1.2mUSD

- EU Horizon 2020 Projects

	Title of EU-H2020 Project	WMU Budget	Start date
1	CyberMAR (Cyber preparedness actions for a holistic approach and awareness raising in the Maritime logistics supply chain)	464,967 EUR (3 years)	1 September 2019
2	SAFEMODE (Strengthening synergies between Aviation and maritime in the area of human Factors towards achieving more Efficient and resilient MODE of transportation)	252,000 EUR (3 years)	1 June 2019

- EU Regional (Interreg):LNG Value Chain for Clean Shipping, Green Ports and Blue Growth in Baltic Sea Region (Go LNG)

- IMO: A research project intended to assess the impact of the human element on international shipping, with a budget of £500,000

- International Association of Maritime Universities (IAMU) and the Nippon Foundation: The work on skills for the future Global Maritime Professional (GMP) resulting in a Global Maritime Professional Body of Knowledge (GMP BoK)

Track Record of the MEM Publications

Transportation Research Part D 37 (2015) 150–170

Contents lists available at ScienceDirect

Transportation Research Part D

journal homepage: www.elsevier.com/locate/trd

The development of a decision making framework for evaluating the trade-off solutions of cleaner seaborne transportation

A. Ölçer *, F. Ballini

World Maritime University, P.O. Box 500, 201 24 Malmö, Sweden

ARTICLE INFO

Article history:

ABSTRACT

The general rise in marine fuel prices in combination with ever-more stringent environmental regulations resulting from IMO conventions and EU Directives have become the main industry drivers for seaborne transportation to become cleaner and more energy effi-

WMU Journal of Maritime Affairs (2019) 18:225–247
https://doi.org/10.1007/s13437-019-00170-2

ARTICLE

Circular economy approach to facilitate the transition of the port cities into self-sustainable energy ports—a case study in Copenhagen-Malmö Port (CMP)

Reza Karimpour [1] · Fabio Ballini [2] · Aykut I. Ölcer [2]

Received: 15 April 2018 / Accepted: 23 May 2019 / Published online: 21 June 2019

Abstract
Sustainability has recently been one of the main focuses of developments in society and industry. In port cities, sustainable relation between ports and ships is one of the emerging factors of developments. Under the city-port umbrella, there are rarely mechanisms for ports sustainability independent from their cities. In the last years, the increasing negative externalities of the ships, in particular waste and emissions, have been among the priorities of the European ports. To address these issues, solutions like the circular economy in EU port cities has gained significant attention. This paper investigates the application of a waste-to-clean energy model for the Copenhagen-Malmö Port, as a case study. The innovative state-of-art model introduced in this research deals with the feasibility of a closed loop, based on the circular economy, to give added value to a large amount of the waste generated from shipping activities in the Copenhagen-Malmö Port. The proposed model includes key elements such as waste management, biogas plant and cold ironing. Two scenarios are compared, first is the current condition and the second one is assumed with the established circular economy model by the port authority. The scenarios are followed by cost-benefit analyses to show the feasibility of the proposed model.

Keywords Circular economy · Ship-port interaction · Waste management · Biogas plant · Cold-ironing

Research in Transportation Business & Management 17 (2015) 36–40

Contents lists available at ScienceDirect

Research in Transportation Business & Management

Managing people and technology: The challenges in CSR and energy efficient shipping

Momoko Kitada *, Aykut Ölçer

World Maritime University Fiskehamnsgatan 1, Malmö 211 18, Sweden

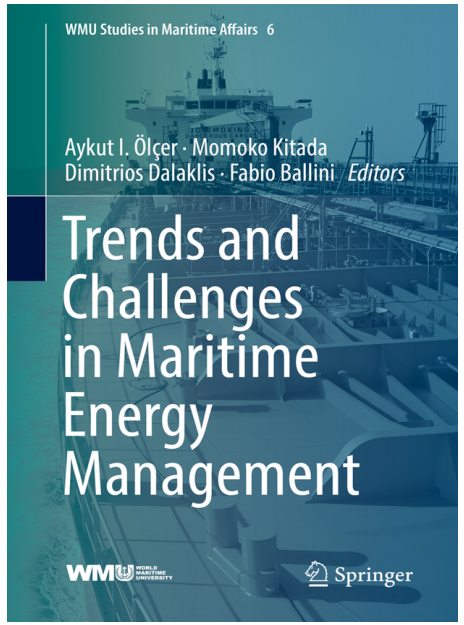
ARTICLE INFO

Article history:
Received 15 July 2015
Received in revised form 29 September 2015
Accepted 6 October 2015
Available online 16 October 2015

Keywords:
Energy efficiency
Shipping
CSR
Human element
Management
Technology

ABSTRACT

This paper addresses the challenges of managers in the shipping industry to implement energy efficient measures in ship operations and their roles of managing both people and technology under the fulfilment of their corporate social responsibility (CSR). An increasing pressure on shipping companies to concern about marine environment, including energy efficiency, has led managers to consider CSR as their ethical business practices. It is an accepted norm that shipping is generally the most environmentally friendly mode of transport in terms of CO_2 produced per ton nautical mile. Despite an extensive amount of research available to improve energy efficiency in shipping, the implementation of such measures has not been progressed by the industry as expected. This problem can be attributed to human element, which is connected to technology through designing and using it. In this context, it is problematic to understand that CSR is an inclusive set of corporate responsibilities in 'all-in-one' box. Hence, examining human element will help understanding the complexity of management in energy efficiency in shipping. The paper also identifies the limitations of CSR in business practices and the need of interdisciplinary research between people and technology in order to respond to managerial challenges in energy efficient shipping.



Ocean Engineering 198 (2020) 106972

Contents lists available at ScienceDirect

Ocean Engineering

journal homepage: www.elsevier.com/locate/oceaneng

The development of a ship performance model in varying operating conditions based on ANN and regression techniques

Yasser B.A. Farag [a,*], Aykut I. Ölçer [b]

[a] *Arab Academy for Science, Technology and Maritime Transport (AASTMT), Alexandria, Egypt*
[b] *World Maritime University (WMU), Malmö, Sweden*

ARTICLE INFO

Keywords:
Ship energy efficiency
Artificial neural network
Multiple regression analysis
Ship performance model
Ship power prediction
Just In Time

ABSTRACT

Maximizing the ship operational energy efficiency requires robust tools to monitor, estimate, and predict the ship's performance under dynamic sea environments. Knowledge of ships' fuel consumption using an appropriate prediction algorithm prior to (or during) a voyage can be a very important tool in reducing GHG emissions from international shipping. Classical methods for power estimation are approximate procedures that lack the required sensitivity to track sea environmental effects on ship performance. Meanwhile, Artificial Neural Network (ANN) as a computing system has proven its applicability in estimating its systems outputs. It also has the ability to capture, learn and adapt to the changes that may occur within the system's variables.

Ocean Engineering 146 (2017) 477–485

Contents lists available at ScienceDirect

Ocean Engineering

journal homepage: www.elsevier.com/locate/oceaneng

Health costs and economic impact of wind assisted ship propulsion

Fabio Ballini [a,*], Aykut I. Ölçer [a], Jørgen Brandt [b], Daniel Neumann [c,d]

[a] *Maritime Energy (MarEner) Research Group, World Maritime University, Fiskehamnsgatan 1, 21118 Malmö, Sweden*
[b] *Department of Environmental Science, Faculty of Science and Technology, Aarhus University, Denmark*
[c] *Institute for Baltic Sea Research Warnemünde, Seestr. 15, 18119 Rostock, Germany*
[d] *Institute of Coastal Research, Helmholtz-Zentrum Geesthacht, Max-Planck-Str. 1, 21502 Geesthacht, Germany*

ARTICLE INFO

Keywords:
Wind assisted ship propulsion
Health economic externalities
Air pollution
EVA model

ABSTRACT

World seaborne transportation is crucial for world trade and global economic growth. Shipping has been increasing since 2009, including oil & gas, dry bulk and container freight, and is very likely to continue this trend in the near future. However, international shipping also produces 2.7% of the world's total CO2 emissions, and globally, air pollutants emitted from international shipping are increasing due to the rise in trade. It is a well-established fact that Greenhouse Gasses (GHGs) cause climate change and that air pollutants trigger a range of health issues for humans. To demonstrate the applicability of the proposed framework, this paper will focus on a general assessment of the health-related externality of air pollution emitted from wind-assisted hybrid ship

MSc in Maritime Energy Management

EGY 111	**Energy and Maritime Industry – Principles and Regulatory Framework** To apply system thinking; to define concepts related to energy and provide an appraisal of available energies; to discuss the predominance of fossil fuels; to examine the problems associated with air emissions; to explain local pollution and global climate impacts; to understand the international regulatory and institutional framework for air emissions; to compare energy security for private and public entities; to examine energy management in the shipping context	4 EC
EGY 102	**Energy-Efficient Ship Design and Operation** To understand MARPOL Annex VI including EEDI, SEEMP, MRV, DCS and technology transfer; to examine technological innovation related to energy management in the maritime industry; to explain the basic process of onboard power generation and describe principal energy consumers; to identify energy-saving measures in both ship design and operation; to discuss ship design and energy efficiency through ship resistance reduction means and propulsion efficiency improvement technologies; to discuss ship operation and energy efficiency through operational measures both at ship and fleet levels along with the integration of port/ship duo; to analyse the impact of technical and operational measures on fuel consumption of ships; to discuss machinery technologies including hull and propeller maintenance along with relevant ISO standards	8 EC
EGY 108	**Energy Management in Maritime Onshore Facilities** To discuss energy management in terms of its vision, planning and strategy in the context of ports/shipyards; to provide an overview of the ISO 50001 energy management system certification process and ISO 14001 environmental management systems; to explain energy auditing through real applications from ports/shipyards; to discuss the socio-economic benefits associated with abatement technologies adopted in response to international, European and regional port emissions regulations; to analyse the externalities in ports/shipyards; to apply the Circular Economy and industrial symbiosis approach within port/shipyard; to analyse the impact of climate change on port infrastructure and to discuss its adaptation	8 EC
EGY 112	**Alternative Fuels/Technologies and Marine Renewable Energy** To describe emission limits and technological options globally and within Emission Control Areas (ECAs); to examine emission abatement technologies and alternative fuels including LNG, LPG, biofuels, hydrogen and methanol; to discuss alternative future technologies including fuel cells and batteries; to demonstrate a systematic understanding of the application of life-cycle analysis on fuel cell concept; to discuss renewable energy for electricity generation and marine renewable energy including offshore wind and ocean energy (wave, ocean and tidal currents and tidal range, OTEC and salinity gradient) along with their environmental and social impacts including underwater noise; to examine solar and wind power applications onboard ships as well as in maritime onshore facilities	8 EC

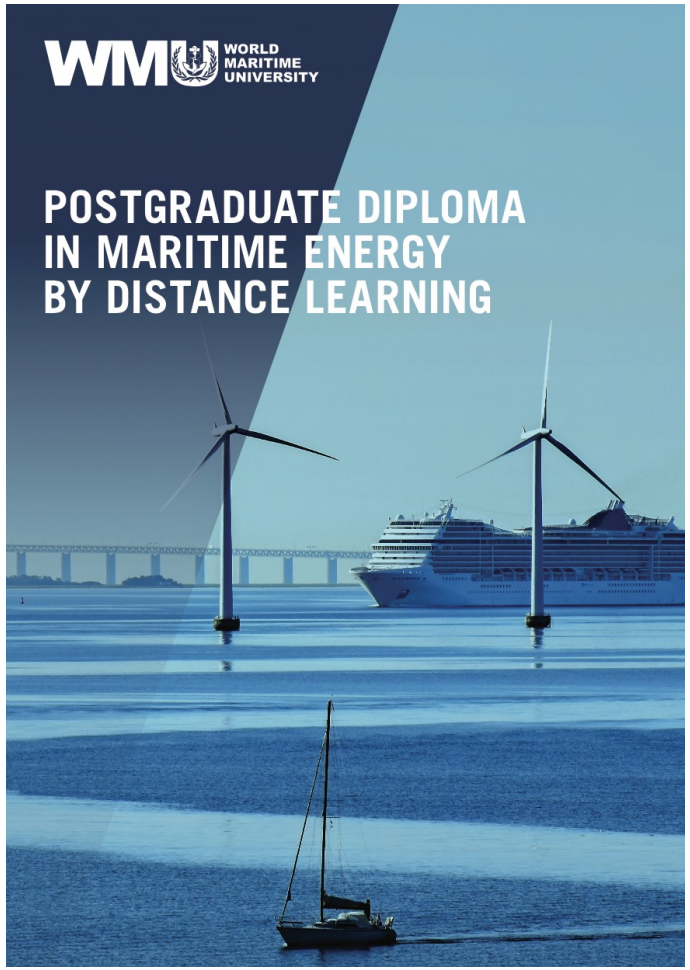
EGY 105	**Human Element and Economics of Energy Management** To discuss the social and human aspects of modern technology applications in maritime energy and the related IMO and ILO instruments; to analyse barriers to maritime energy management and discuss the roles of stakeholders and potential solutions; to discuss and analyse energy management systems including the cost, financing and economic evaluation; to analyse the demand and supply of energy, electricity markets, and climate change policy; to examine the evaluation of sustainable investment in ports and shipyards	4 EC
EGY 106	**Maritime Energy Management and Operational Research** To describe operational research (OR) techniques relevant to maritime energy management (MEM), in particular simulation, optimization and decision-making; to discuss the relation between MEM and operational research through mathematical modelling; to apply relevant OR techniques through OR software such as multi-criteria decision making, monte carlo simulation, externality modeling and speed optimization in ship design and ship/port operations; to analyse valuing of strategic investments and decisions through financial risk simulation; and to analyse the results of OR applications within the MEM context	4 EC
EGY 113	**Leadership in the Fourth Industrial Revolution** To examine technological innovation related to energy management in the maritime industry; to understand the impact of the fourth industrial revolution within the MEM context including autonomous ships, internet of things, cyber-physical systems, maritime digitalisation, big data and artificial intelligence; to understand science-policy-industry interface and the principle of science-based decision-making for future maritime energy leaders; to analyse the country needs and develop a practical plan of action for their country or region to achieve the UN's sustainable development goals	4 EC
FST 101	**Field Studies** To provide a range of field study opportunities to demonstrate the application of the theory taught in the specialization subjects. Students travel to major maritime destinations that offer valuable insights into organizational practices and networking opportunities with professionals around the world	4 EC
WMU 424	**Seminar on Maritime Transport Policy and Maritime Communications** To give students an opportunity to exchange ideas with each other and with maritime experts through presentations, debates and discussions. The seminars cover development of maritime transport policy as well as contemporary issues in information and communication technology	2 EC

Yaser Farag, Egypt

"WMU is the only place where you have a holistic view of the very specialized field of Maritime Affairs."

MSc in Maritime Affairs, specializing in Maritime Energy Management

PG Diploma in Maritime Energy (via DL)



Module 1	Maritime Energy and Sustainable Development
Module 2	Ships and Energy Efficiency
Module 3	Future Propulsion Technologies
Module 4	Energy Conservation in Ports and Shipyards
Module 5	Best Practices and Life-Cycle Perspectives

MTCC Seminar at WMU – October 2019

Title at IMO Website:
EU/IMO global project drives energy efficiency in the maritime sector

The Way Forward ?

- The Paradigm Shift?
- Mindset Change?
- Right Combination of thematic pillars
- Right combination of EE measures
- Collaboration amongst all stakeholders
- ….

☺ ZERO EMISSION SHIP ☺

Thank You For Your Attention

Aykut I. Ölçer

aio@wmu.se

SUSTAINABLE DEVELOPMENT GOALS