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New education tools for electro-technical officer (ETO)

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New education tools for Electro-Technical Officer (ETO).

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Abstract : Electrical systems in seagoing ships have been rapidly developed and changed over the last years. Not only in passenger ships large scale electrical drives have been implemented. The number and the complexity of electrical consumers has also increased significantly. Based on Manila amendment 2010 STCW focus is set on new developments on board and so influenced the newer education path for electro-technical officer (ETO). This paper should give ideas for useful experimental setups to prepare trainees for their future job onboard. Focus is set to laboratory, practical education to be defined more detailed.

Keywords: electro-technical officer ETO, education, laboratory

Introduction

Electrical systems in seagoing ships have been rapidly changed in the last years. Not only in passenger ships large scale electrical drives have been implemented. The number and the complexity of electrical consumers has also increased significantly.

Control systems have grown from a handful of sensors with local alarms to more than 10,000 sensors per ship with online connection to fleet monitoring centres. So the normal education path for ship operating officers is not sufficient any more. Even more green technology will not work without automation. According to this development, the Manila amendments to the STCW has defined a special training course for ships electrical engineers, the so called Electro-technical officer (ETO).

The paper is intended to provide a view of the development on board and the influence of these changes in technology that have to come into the current curriculum and the laboratory equipment. Here we want to show experiences after five years of educating ETO. Many of our finalists have been in contract with cruising companies like AIDA from Carnival corporation already at the beginning of their studies.

Definitions - Manila amendment 2010 STCW

Definitions for electrical training in the widely more general defined requirements of the Manila amendment 2010 STCW: when the company is requested to carry an electro-technical officer they should comply with the new competency requirements under A-III/6.

electrical equipment:

a) generator and distribution systems
b) preparing, starting, paralleling and changing over generators

c) electrical motors including starting methodologies
d) high-voltage installations
e) sequential control circuits and associated system devices, electronic equipment:
f) characteristics of basic electronic circuit elements
g) flowchart for automatic and control systems
h) functions, characteristics and features of control systems for machinery items, including main propulsion plant operation control and steam boiler automatic controls

control systems:
a) various automatic control methodologies and characteristics
b) Proportional–Integral– Derivative (PID) control characteristics and associated system devices for process control

Function and performance tests of equipment and their configuration:
1 monitoring systems
2 automatic control devices
3 protective devices
4 The interpretation of electrical and simple electronic diagrams

All this has been implemented into the original course set up at the UW right from the introduction of the ETO course five years ago. In order to take into account on the one hand the educational program of technicians for maritime ships operation and on the other hand the increasing number of electrical systems on board, the electrical content of the teaching plan has been widely expanded.

To ensure proper electrical knowledge of the ETOs, the first two years of the course are held in the faculty of electrical engineering in UW together with students of electrical engineering. The last two years of the ETO course will be completed in the department of maritime studies in Warnemünde. Due to the fact that marine industry and marine transportation is a worldwide business, many education centers offer maritime education and some of them also offer courses for ETO.

Some examples are here:
- Lithuania, Lithuanian Maritime Academy
  (https://ec.europa.eu/ploteus/en/content/marine-electrical-engineering)
- Southampton, The Corporation of Trinity House
- Greek Maritime Academies, Merchant Marine Academy of Makedonia,

Marine Engineering Department
- Ghent, Belgium, MSc in Electromechanical Engineering - Maritime Engineering (finished)
- Croatia Split: Croatia is the University of Split, Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture, MSc in Marine Electrical Engineering Technologies
  Master in Maritime Electrical Engineering and Communication Technologies
- Gdynia, Faculty of Electrical Engineering
- Paço de Arcos, Portugal, Bachelor Degree Maritime El. Engineering
- Further offers in EU here: https://www.marinetraining.eu/provideroverview

Training skills for the 21st-century in Marine Engineering Technology is not a closed process, it needs lifelong learning in the maritime context. This is also valid for teachers.The requirements for ETOs future knowledge also require Engine Room Simulator (ERS) training. This will need continuous development of ERS, which also allows application for research and development. The typical classroom for engine control rooms usually look like the following:

Figure 1: Gdynia Reproduced from Internet (https://umg.edu.pl/en/studies-faculty-electrical-engineering)

Figure 2: Lithuanian Maritime Academy Reproduced from Internet

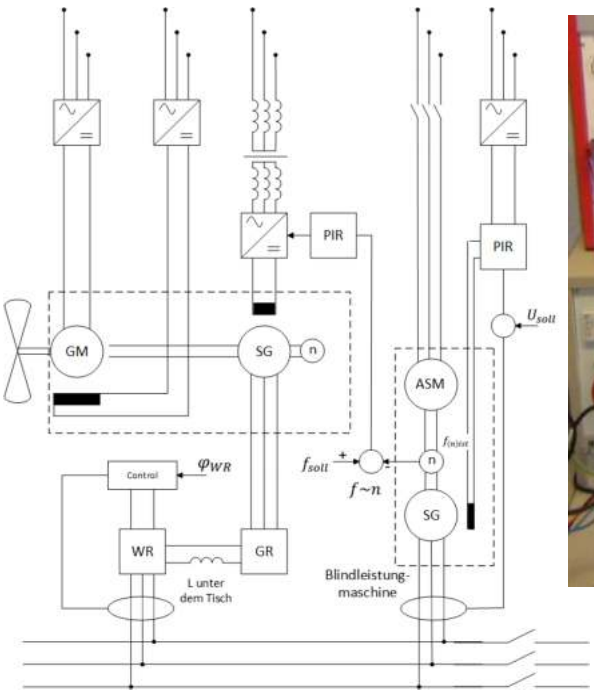
However, if we look into STCW/Manila we find here: "Manage operation of electrical and electronic control equipment" we find only general: "Marine electro technology, electronics, power electronics, automatic control engineering and safety devices". There is no list of components given. One of the most growing areas of technology is, in the eyes of UW, not covered: Power electronics and Power management as well; here a lot of new components enter the ships as:

- widely extended complex power management systems including automatic power recovery after Black Out
- large scale frequency converters in ships drives
- Frequency converter for auxiliary drives like any pumps or fans
- Exhaust gas scrubbers and washing systems and their controls,
- Batteries, power controllers and chargers for hybrid drives
- Electrical Starters for diesel Engines (e.g. Emergency generator)
- Ignition systems for LNG engines
- Automatic and manual operated electrical shore connection systems

To teach the required content practically it is very difficult to get access to proper experimental setups. Therefore, simulation is preferred.
This is valid for Power Systems as well as for all Automation Systems. UW and here MSL has invested in a number of modern experiments in recent years:

1 The first new setup is a frequency converter with an Asynchronous Motor and a load generator. Here the students get familiar with commissioning of FCs, the input of parameters and the definition of limitations and protection functions.
2 A current source converter (CSI) used in a shaft generator system has been available. Due to the fact that a cycle converter has the same structure, this has been adopted to simulate a drive system also.
3 One setup presents a ship's drive with a double winding motor, a second part simulates a POD drive.
4 One experiment on electrical starters including measurements at a real test setup
5 Ships Engine Simulator experiments with updated models for hybrid ships and on board Power Management Systems (PMS)
6 Regenerative systems consisting of solar cell, fuel cell, batteries, heat store and/or hydrogen storage experiment

CSI Drive (cycloconverter)
Synchronous generator = Drive, here active power can be taken out by windings (shaft generator operation) or taken out by Shaft (CSI electrical motor drive)



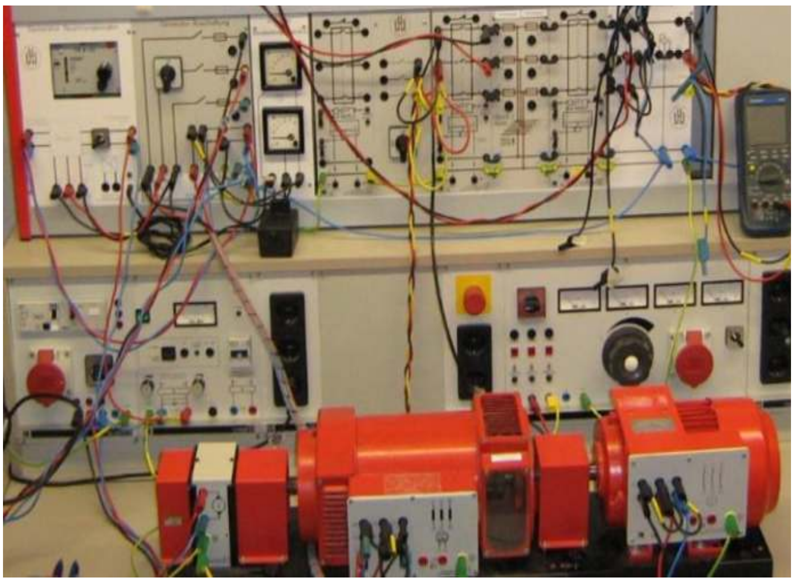


Figure 3: CSI drive/Shaft generator schematic

FC setup: frequency converter (ABB ACS 800) with an asynchronous motor and a load generator. Training content:

- Commissioning under aspect of cable routing, check lists (ABB manual),
- input of parameters, priority of limitations.
- Investigation of incremental encoder and its signals
- Parameter input for protection, functions, adaptation to process, soft starting drive.
- Showing electrical values from FC using digital storage oscilloscope


Figure 5: frequency converter (ACS 800) with Asynchronous Motor in Box

Ships drives
two Ships drives, controlled
locally or
remote (MKR), having ramps, and limitations, logging functions
a) tandem Siemens drive with supplying 3 winding transformer
b) ABB Azipod drive with ABB ACS 800 FC


Figure 6: Tandem drive

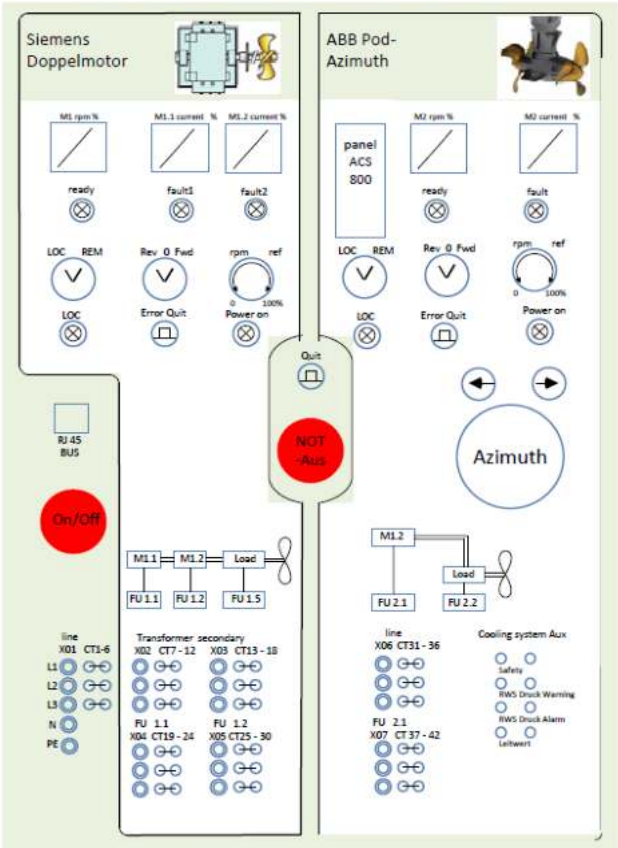


Figure 7: scheme panel

BUS controller of tandem Siemens drive

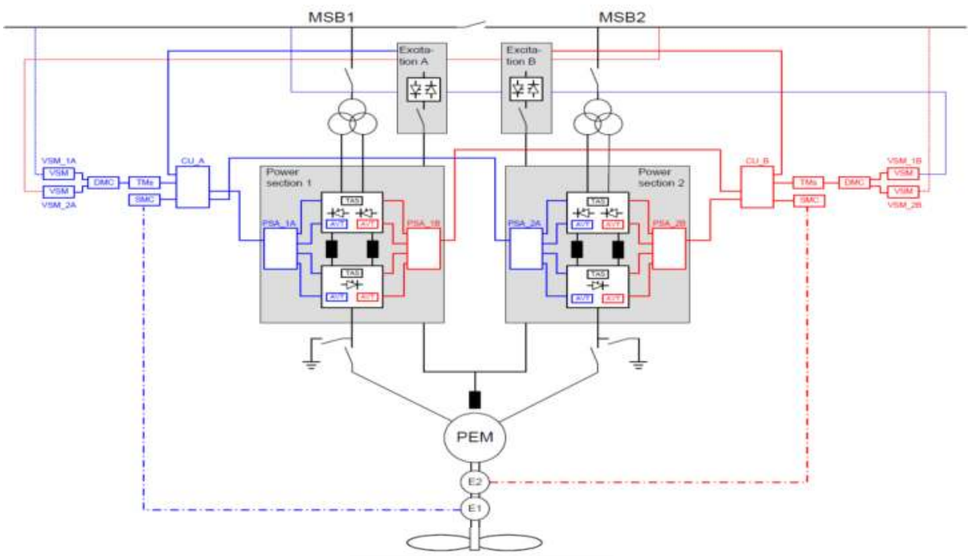


Figure 8:
Bus System in use adopted from Siemens

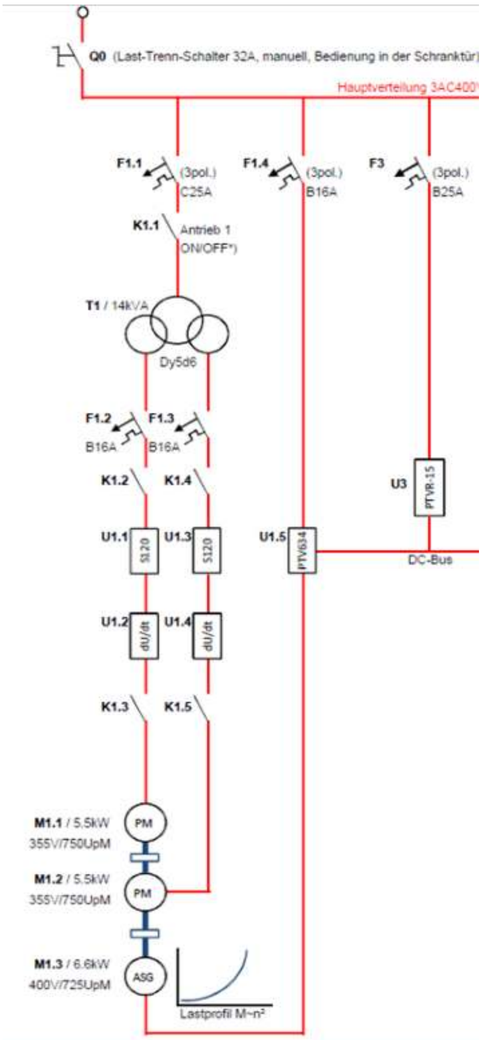


Figure 9: power diagram

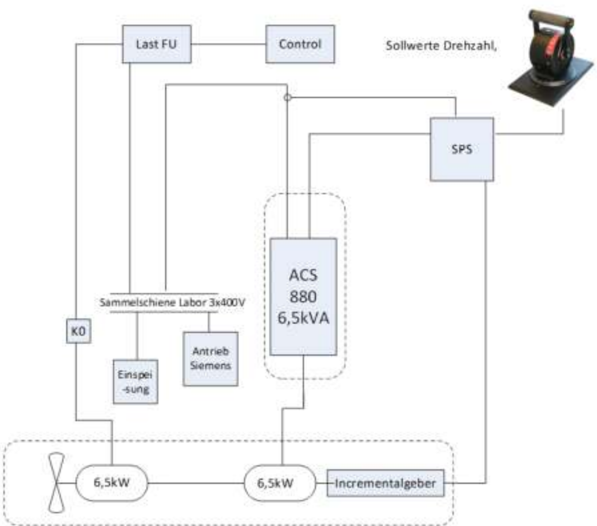


Figure 10: Drive overview

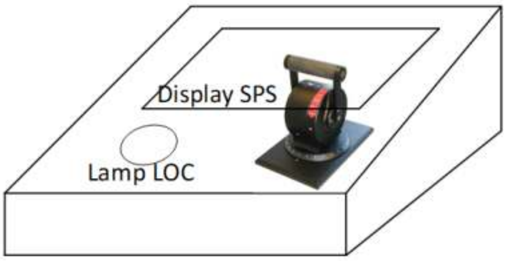


Figure 11: remote control panel

PMS model definition

Generators and E-motors are modelled by power balance (efficiency about 1) Diesel generators are already available in Ships engine simulator (SES). To model PMS under operation, they have to comprise power consumption of auxiliary systems like pups, fans, batteries, scrubbers etc.
Total accuracy is not the most important result, but tendency has to be right. So different scenarios can be compared. (e.g. shore power supply, sea mode, available power reserve as a parameter)

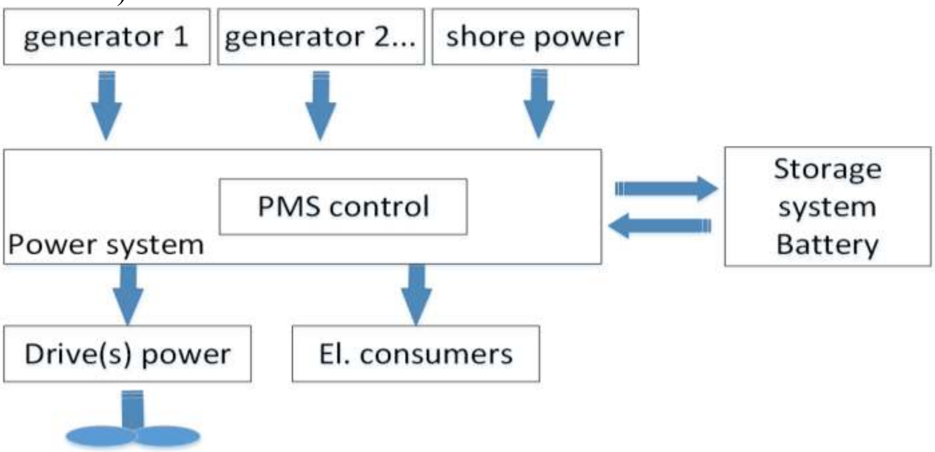


Figure 12: PMS model

System 2 Hybrid ship system

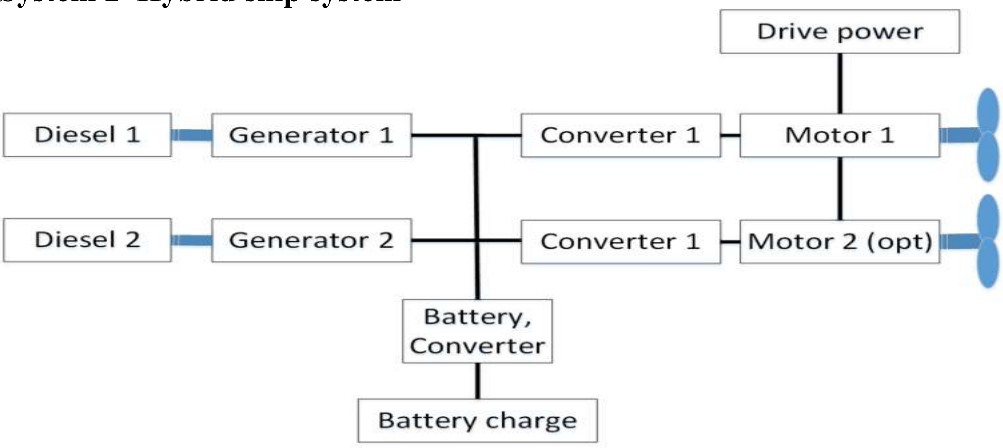


Figure 13: hybrid ships model

Influence of time table (ships speed) and route on charging cycles and thus battery aging can be estimated.

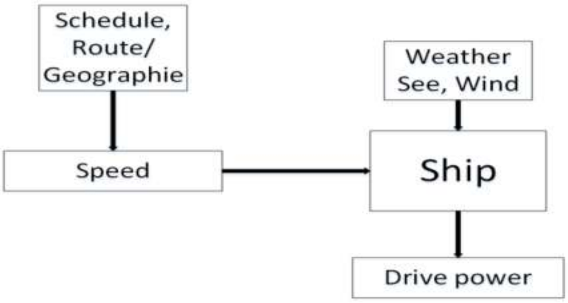


Figure 14: ships power definition system

Laboratory test - power recovery after Black Out

a) with PMS
b) without PMS

Ships engine simulator from Siemens is available for such tests.
So the automation system model is very close to reality due to the same human machine interface (HMI).
In preparation of this experiment/simulation students get familiar with generator protection functions including short circuit at a stand alone Stamford generator and control panel.

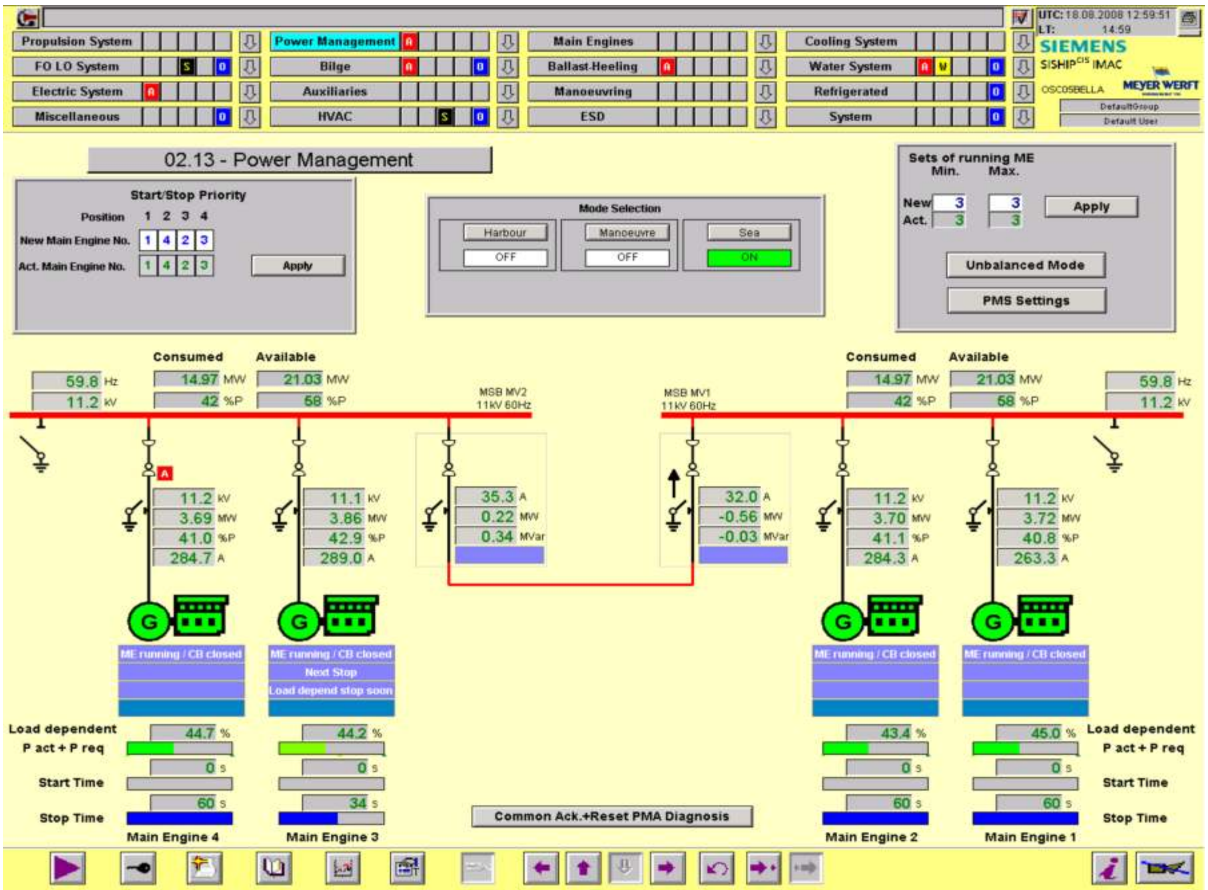


Figure 15: PMS picture Reproduced from Siemens Simulator Manual

Other aspect from industry:

At the time when a new ETO course at the UW was introduced surrounding shipyards like "MV-Werften" started to construct large passenger vessels. Due to the amount of electric and electronic equipment on board, the shipyards asked UW for highly qualified personnel able to commission these passenger vessels. Looking at that need, UW started to double, split of ETO course in higher semesters into two education paths

1. common ETO education (since 2014)
2. Ship electrical engineer without STCW,

by taking out all STCW material and focusing more on maritime and electrical technology (starting in 2020).

One more path has been introduced. Sometimes technical officers want to be educated to finish their studies as ETO. They already have extensive ship handling knowledge. Extended electrical aspects have to be trained. So UW in such a situation manages to conclude studies for such a person in one year. This is the minimum to get the required knowledge in automation, electrical and power systems. At the chair of Ships electrical engineering, research work is also done in the field of modelling for:

- Electrical properties of grids on board,
- Optimized use of batteries on bard of ships,
- optimized energy efficient power management systems on board of ships having electrical drive systems.
- Introducing Hydrogen into ships drives.

As a result, conference papers have been published on:
„Entwicklung von Modellen zur Simulation von (FU) Frequenzumrichter-Ableitströmen in IT Netzen" (methods of simulation of capacitive grid currents for frequency converters in IT power systems)
„Simulationsmodelle für Batterien und Dieselmotoren zur Bestimmung der Energieeffizienz auf Hybridschiffen" (Simulation models for batteries and diesel engines to calculate efficiency on hybrid ships)

Summary

- ETO course in Rostock is ongoing with about 8 students /year,
- Ships electrical experiments have been introduced into laboratory to keep course up to date
- Shipping Companies satisfied with "ETO results" as the finalists are.
- Surrounding shipyards and industry are interested in personal with special ships electrical knowledge.