Hybridization of general cargo ships to meet the required EEDI

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Introduction

Shipping emits around 3% of the global greenhouse gas emissions; this is a relatively small number taking into account that the fleet transports approximately 90% of the world's trade volume [1]. Although shipping is the best alternative for transporting large quantities of goods, the shipping sector stands before large "forced" improvements in the years to come. According to Lloyd's the commercial shipping sector's volume will double from 2010 to 2030 [2]. The Energy Efficiency Design Index (EEDI) adopted by IMO in 2011 will affect most of these newbuildings, hence force a change in the future ship design.

The EEDI regulations will come in three phases: 2015, 2020 and 2025. It influences all new ships above 500 GT must comply with rising restrictions on how much CO_2 is emitted per tonne nautical mile. The required EEDI value is fixed for the major ship types and relies on the DWT. A very simplified attained EEDI equation is shown below:

$$EEDI = \frac{CO_2\text{-emission}}{\text{Benefit of ship (capacity} \cdot \text{speed)}}$$

General cargo ships will have problems complying with the required EEDI. The ship type has higher cargo flexibility that leads to lower dwt/displacement ratio and has higher installed engine power to serve the shipping route with minimum delays.

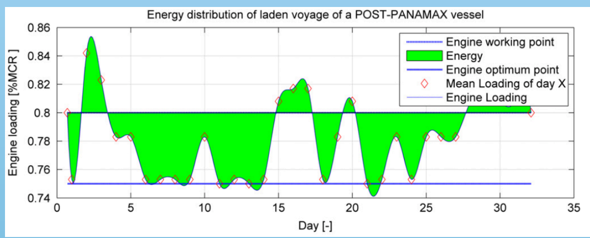
Objectives

A study shall be performed on installing a hybrid system with energy storage for general cargo ships and examine how it influences the EEDI.

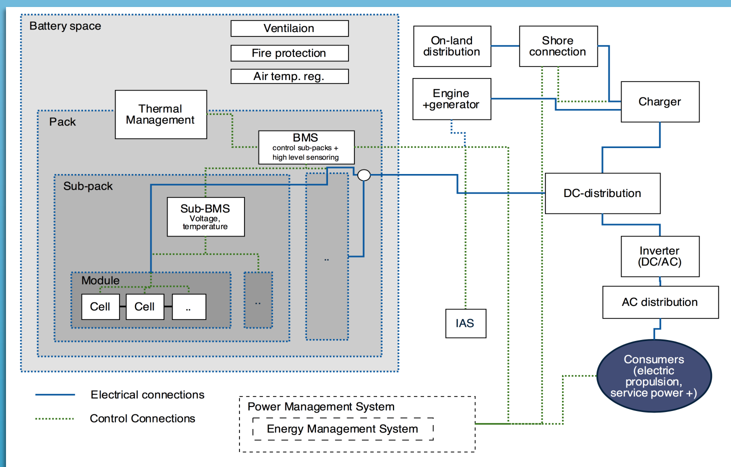
- Presenting the EEDI regulation.
- Technical and economical feasibility study.
- Evaluate the advantages and disadvantages of a battery hybrid system in a analytical model.
- Perform a case study.
- Discuss the results and conclude.

Results

Hybrid systems with lithium ion battery storage has been successfully installed in OSVs and ferries. For the merchant fleet it has not yet been an extensively proven technology. The study suggests that it is technically feasible to install a battery hybrid system in a general cargo system with the result that less installed main engine power is needed. The hybrid system is not taken account for in the calculation of the attained EEDI and can be seen as a reduction in installed power.



The graph [3] shows an engine loading curve for a ship in laden voyage. The green area indicates the fluctuations, day by day, from the engine optimum point. This can be served by a hybrid battery system and the engine can always work on optimum point. this results in less fuel consumption and hence less emissions from the engines.



The figure above [4] represents a battery system with the different elements and systems around. The suggested solution is to install a lithium ion battery pack with high energy. Such a battery pack can supply the various propulsion loads, meaning both exploit the superfluous energy production and supplement the engines when energy demand is high. Results from case study and the economical study will not be presented here, due to state of the work progress.

References

[1] IMO (2009). Second IMO GHG Study 2009. International Maritime Organization.
[2] Qinetiq,Lloyd's. (2013). Global Marine Trends 2030.
[3] Dedes, E. K., et al. (2011). "Assessing the potential of hybrid energy technology to reduce exhaust emissions from global shipping." Energy Policy.
[4] DNV-GL, et al. (2013). DNV GL guideline for large maritime battery systems.

Temporary conclusion

It has been stated that it is possible to install a hybrid system in a general cargo ship with the effect of lowering the EEDI. Further conclusions on the economy is not drawn.