Joint study to explore new cost-effective applications of hybrid power generation on larger ocean-going cargo ships

Acknowledgement

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The goal of this study is to explore new cost-effective applications of hybrid power generation on larger ocean-going cargo ships.

Background

Increased scrutiny is being put on shipping to reduce its environmental footprint. As such, the IMO has adopted an oil strategy aimed at reducing total GHG emissions from international shipping by at least 50% within 2050. The question to ship operators however remains; is it possible to reduce GHG emissions whilst staying profitable? Many studies suggest yes, and one of the more promising measures, are hybrid power solutions.

Vessel type selection

Hybrid power systems often achieve significant efficiency gains and cost reductions – both in terms of their power demand fluctuations, for example when drone energy consumers, such as fans or thrusters, are utilised. This typically happens in connection with port visits. A review of historical AIS data showed that container feeders are a ship type meeting this requirement, and thereby potentially being a good case for hybridisation.

Operational profile

A detailed analysis was carried out to generate a representative vessel operational profile for a container feeder operating on a European trade route. Furthermore, modeling was carried out to estimate both the propulsion and electric power demand for the given operation modes, and create an artificial time-based load profile as shown figure 4.

The results of the study are presented in the form of two scenarios:

1. A new built hybrid vessel in 2020 using current battery technology, where a battery is applied for peak shaving and spinning reserve for the Diesel-Gensets.
2. A new built hybrid vessel in 2030 when batteries are applied for zero-emission manoeuvring in and out of ports.

Scenario 2020

Simulations showed that a battery size of 300 kWh would replace one generator. The resulting engine topology is shown in figure 5. For a container ship, the total number of reefer on board and the power they demand, will have a significant impact on the size of the battery, and thereby on the potential benefits of hybridisation. The spinning reserve capability achieved by installing wireless can provide substantial savings in case where startup of additional generators can be avoided or delayed.

Figure 6, with 150 reefer active, shows that the battery is able to cover peaks during loading and port stop. It is then possible to run just one generator at a high optimum load point, instead of two. In the case where no reefer are active (figure 7), at least one generator is running during port stop in the conventional as well as in the hybrid case. Hence, most of the savings are attributed to the on-board crane during cargo operation and the thruster during manoeuvring.

Scenario 2030

For a zero-emission port entry only application, the size of the battery is solely determined by the power demand and duration of manoeuvring. For this reason, a total installed capacity of 114 kWh is needed to meet the requirements. The engine topology is shown in figure 8.

The zero-emission mode locks economically only if battery system costs are lower than today, fuel prices are higher, and incentive schemes or stricter emission regulations are in place, all of which may well be the case by 2030. However, assuming that by 2030, fuel costs would be 1000 $/t and battery costs were 550 $/kWh, the NPV would become positive, as seen in figure 9.