Know thy ship

by Mia Elg, *R&D Manager, Deltamarin*

Shipowners and operators should be well into planning for the Energy Efficiency Existing Ship Index (EEXI) and Carbon Intensity Indicator (CII) regulations coming in from 2023 and what improvements they should make so their vessels comply. The best future-proof path is to base investment decisions on an analysis of a ship’s actual carbon footprint.

Energy-efficiency rules under EEXI and CII are being extended to cover practically all tonnage, old and new. Given that we will potentially move towards even tighter emission targets – in addition, faster than expected – I recommend that owners and operators first perform a preliminary analysis of their existing fleet’s status to give a basic understanding of the compliance challenge, then ensure their ships pass the EEXI requirements. Many will have already done this simply as a ticket to operate.

Working with what you have

The first, and in my experience, the most popular option is to implement engine power limitation (EPL): fully possible for many standard bulkers and tankers because it seems their typical operative load is relatively low (between 50-70%), mainly due to higher design speeds versus how fast they usually sail today.

A few years back, we produced, with our digital design tools, an artificial model of our latest Aframax tanker (including its key operational characteristics). The ship has a design service speed of 14.5 knots and 11MW of main engine installed power. We chose several typical trade lanes the ship could encounter with standard current operational average speeds (12kn and 12.5kn). Secondly, we estimated the propulsion power on the route with our DeltaSeas method, combining the route’s statistical (or measured) wind and wave conditions with the ship’s calm water hull performance. The result is a realistic, ‘dynamic sea margin’ for the vessel. Figure 1 illustrates the propulsion power scatter (together with certain other ship parameters). In this case, we can observe typically less than 60% main engine loading expected for the vessel.

We generally collect data from operating ships as a starting point for design optimisation in our newbuilding or retrofit projects. As such, we are able to observe similar patterns for engine loading in the majority of cargo vessel segments. Therefore, EPL due to EEXI might not significantly impact many ships’ operations. As a result, the motivation to improve EEXI by any means other than EPL typically comes from searching for monetary savings or the need to reduce the CII. This is when energy saving comes into the picture.

A complex question

If EPL isn’t an option, you can move on to assessing technologies that improve engine and propulsion performance alongside energy-saving devices (ESDs). Various individual ESDs can reduce EEXI value marginally (2-5%); these include shaft generators, devices for improving hydrodynamic performance, and waste-heat recovery.

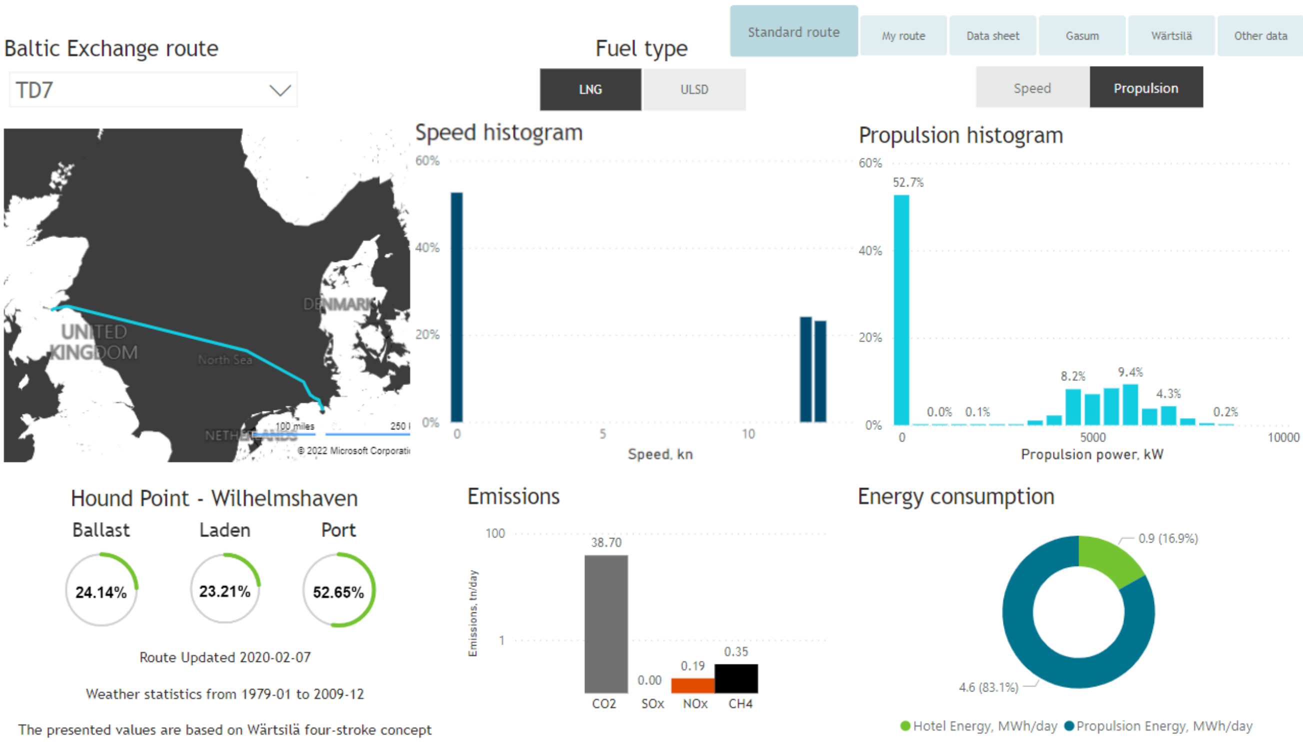
One attractive alternative that may reduce EEXI values considerably is wind-assisted propulsion; our research shows that even moderate wind-assisted propulsion combined with several other technologies could reduce EEXI values by 10-15%.

Carbon capture is an additional future measure to reduce the ship’s footprint. Depending on a potential carbon tax introduced for fuels, we estimate a realistic payback time for carbon capture, with an emission reduction rate of 25-40%, of less than five years. However, it is yet unknown how it will be considered in the EEXI calculation or CII reporting.

For all ships, it is important to be aware that good EEXI performance doesn’t guarantee an acceptable CII result. In addition, EEXI is a ‘one-time’ check, whereas CII is the required level of ship ‘carbon performance’ that will be assessed continually.

Figure 2 shows certain selected results from an energy-saving project performed for a gas carrier. The outcomes of energy simulations of the ship, including the dynamic weather profile, are illustrated as the impact on the ship’s EEXI and CII. The example studied technologies included air lubrication,

Fig. 1. Propulsion power scatter



Source for all figs.: Deltamarin

specific hydrodynamic performance impacting devices, and Flettner rotors. Everything was compared against the baseline, which included a shaft generator (PTO) for the ship. The EEXI target line is presented as a solid black line, and we can see that only a vessel without any ESDs or a PTO wouldn't fulfil the EEXI requirements.

The ESDs' impact on a ship's CII is a much more complex question since the vessel's operating profile plays a crucial role here. The project included several operational strategies for the ship, including minimised time in port or high speed and average speed profiles. The results of the CII simulation are visualised in Figure 2 with the orange indicators. The performance is compared against the CII target baseline year 2019, 2026, and the estimated target for 2030 (if the vessel intends to remain in the target operational category). We can observe that a combination of ESDs and the most efficient operational strategy would likely keep the ship in the desired performance category long after 2030.

Members of Deltamarin's Energy Team performing energy flow measurements on board a ship (from left: Ville Valtanen, Bogdan Molchanov, Shqipe Buzuku, and Mia Elg); photos: Deltamarin

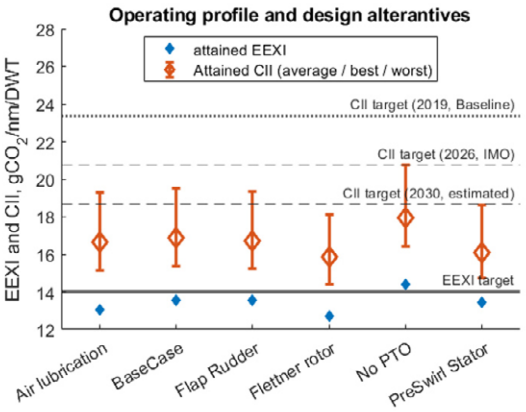
The optimal improvement mix

Calculating the CII rating is straightforward. All you need is the annual fuel consumption (converted to carbon emissions with a fuel-specific carbon factor), the distance the ship travelled, and its capacity. Any tonnage landing in the D-band for three consecutive years or getting an E-rating in a single year will need an improvement action plan.

I suggest that optimisation investment should focus more on CII but still keep the vessel's 'real' carbon/environmental footprint in mind. This is because the relationship between EEXI vs CII vs actual energy efficiency is not always linear. The rules are constantly developing and will be corrected towards real environmental impact.

Getting the optimal improvement mix requires 'energy modelling' that simulates the vessel's operational profile, pieces of

Fig. 2. Operating profile and design alternatives of a gas carrier



machinery, and available fuel options. Our research shows that energy modelling and related analysis can greatly impact CII performance and power consumption per mode.

For a newly built ship, it is clear that an energy model should be formed to simulate the impact of various design choices, technologies or fuels on both ship fuel consumption and CII. But this is the method also for retrofit projects. According to the earlier example, the operational profile has a massive CII impact. An energy model systematically represents the ship's energy consumers and producers (machinery), fuel qualities, and operational characteristics.

Typically, the energy-saving potential can be found in all ship parts. Still, to generate a considerable impact to vessel fuel consumption and CII, it is reasonable to focus firstly on the largest energy-consuming groups: propulsion in all ship categories generally. On the other hand, the propulsion-related improvements sometimes become so costly that the investment is not necessarily profitable or imposes too large of a risk for the shipowner considering the vessel's age and overall condition.

Nevertheless, Deltamarin has, during the past years, performed several retrofit projects to improve the hydrodynamic performance of ships with somewhat limited modification area to their hulls. In these cases, the energy savings have been close to, or exceeded, 10% of the yearly fuel consumption. These improvement types are possible, especially in vessels operating far from their design condition.

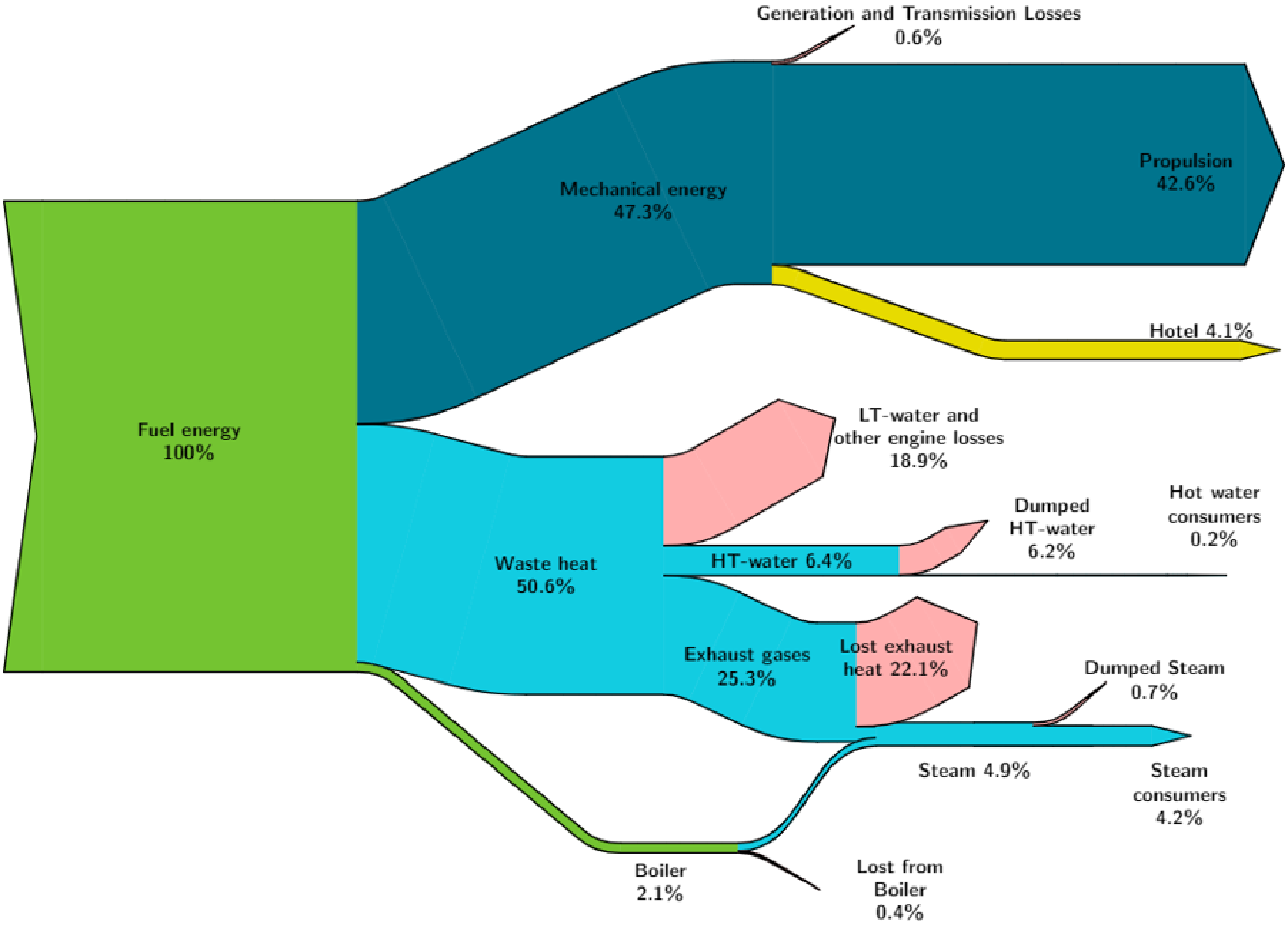
In addition to propulsion, Deltamarin's Energy Team has analysed various other improvements in ship machinery, such as converting their waste heat to electricity or cooling onboard. Especially with heat flow-related process modelling, it isn't easy to obtain reliable measurement data for the simulations from the ship. In this case, it is necessary to confirm the findings of the energy modelling during an onboard audit, where measurements in the heat systems are performed.

Any energy-saving method applied on a typical cargo ship will bring similar savings in the CII context. This is not always the case with a typical passenger ship because the calculation punishes vessels with large hotel-load and which spend considerable time in port (although shore power is a sound CII performance improvement method).

For the pocket and the environment

Since there is no guarantee that the CII correction factors under discussion, still after MEPC 78 on 6-10 June 2022, will be introduced in the final International Maritime Organization's rules, I recommend focusing on the ship's actual carbon footprint as the basis for investment decisions as the most future-proof way forward.

Fig. 3. Ship energy consumers



Additionally, while the regulation involves no hard punishment and owners will have several years to improve scores, the effective drivers for good CII performance will likely be commercial ratings. Being a low performer will be neither good PR nor business. In other words, the more energy saved in times of high fuel prices, the better – for your pocket and the environment. ■