



CHEK it out!

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

My [previous article](#) was about understanding the big picture and the future of heat processes in shipping. This time, we move from pure heat systems to ship machinery and energy system analysis, with some examples from our newly concluded EU-funded project CHEK (which will always have a special place in my heart, largely because of the people in our great 'CHEK family' and that it was also the first EU-project for me personally). I oversaw Deltamarin's part of the project from planning to execution, so I think that it deserves a moment of detailed reflection.

I may have sometimes mentioned in my writings that our sailing boat is the primary residence of our family during the summer, and we've just got back from this year's adventures. As I happen to have the strongest 'sea legs' in the crew, I usually spend a considerable amount of time inside the boat cooking for everyone, no matter the weather. This also inspired me to serve you this read as it is fresh from the development oven!

Can there be too many cooks in the galley?

The CHEK project was about decarbonising long-distance shipping. Together with 15 consortium partners, we had three years to develop and study two conceptual designs: a cruise ship and a bulk carrier. The goal was to reduce greenhouse gas emissions by 99%, plus achieve at least 50% energy savings compared to Energy Efficiency Design Index (EEDI) phase 2 requirements.

One of the most visible outcomes of the project to the public was probably the installation of two sails on board an existing bulker. In addition to this and many other milestones, the CHEK family managed to fulfil the key goals, and the project itself was listed by the European Commission as a Research and Innovation Project success story. Therefore, even if not every day of working on it could have been called pure pleasure, I have to say that the project was indeed a winner.

I think that the CHEK set-up resembled a typical ship design project: we had a wild mixture of various technical alternatives to be considered. In general, it seems like both the scientific community and the industry agree that there is no single best fuel or technology that would serve as a silver bullet for decarbonisation. Therefore, the new normal for any ship design project is that we have numerous fundamentally ship-changing alternatives on the table early during the

conceptual design that should be analysed.

To be more concrete, on top of the 'traditional design task,' each new ship design project is facing a new set of requirements. Three main questions arise at the very beginning. First, what is the fuel for the ship that will be considered at the start of its operation, and which fuels should the ship be ready to bunker in the future? Second, which major energy-saving or emission reduction-related technologies should be included in the ship? Third, what powertrain and machinery incorporate the previous two items, bringing the best performance out of the entire system?

One of the leading ideas in CHEK was to explore these three fundamentals as a synthesis, considering a typical operational pattern for the case ships. Without a doubt, multiple variations and complex modelling meant that our 'decarbonisation kitchen' started to get very crowded. Our role in the project was thus very central since it included orchestrating the various solutions in the conceptual designs.

The taste of synergy

Our bulk carrier concept reached almost 50% digital energy saving vs a state-of-the-art sailing vessel of a similar size. The result was reached as a true symbiosis of technologies and design. The illustration on the next page details one of the comparisons of the propulsion and main engine power in two cases. The figures on the left side are related to a 'baseline' ship simulation with heavy fuel oil (HFO) as bunker, while those on the right side illustrate the results of a vessel with a combination of a new hull and energy-saving technologies (the results are illustrated on all global routes that were analysed in the project).

The figures show how the ship propulsion power requirements are reduced from around 6.0 megawatts (MW) to 3.0MW with the combination of various drag reduction

technologies and wind power. Consequently, various hypothetical engine configurations were studied, including a considerably reduced main engine size and a hybrid powertrain. The machinery parameter optimisation contributed to further energy savings.

When modelling the cruise ship energy system, we made interesting findings especially in hydrogen-fuelled machinery. The cruiser was 'put' on a Mediterranean route, and the first of the results included simulating the ship with HFO as the main fuel. Setting aside the EEDI-derived energy consumption scaling, the results were approximately 21% fuel saving with a combination of various technologies. When modelling machinery operated with pure hydrogen but otherwise a similar technology set available for the ship, the results showed 27.5% less fuel energy consumption than a baseline vessel. Several factors in the energy system contributed to this: improvements in the ship power plant efficiency alongside lower heating requirements for a hydrogen-fuelled vessel (leading to lower boiler utilisation and the release of more waste heat for heat-to-electricity conversion).

One generic discovery in CHEK (and in many other projects we have carried out) is that a ship's true power requirements en route are often considerably below its installed capacity. With the CHEK bulker, for instance, the reference main engine size was 9.5MW. The results illustrate how increased energy efficiency will push down the power requirements even further compared to a standard ship. Moreover, the example simulations did not even consider the impact of weather routing or other voyage optimisation possibilities, which can further contribute to fuel savings.

Let's have the cake!

In the CHEK project, our special focus was on ship energy systems and their modelling. Introducing single equipment or design

The decarbonisation recipe à la CHEK¹

Basic ingredients:

- Operational data from an existing Kamsarmax-sized bulk carrier and Meraviglia class cruise ship
- A future-proof ship design platform
- Ultrasound antifouling
- Air lubrication
- Waste heat recovery
- Shore power enabled at all ports

Bulker specialties:

- Fuel flexible hybrid machinery
- WindWing sails
- Gate rudder
- Solar panels on wings
- Liquid biogas as fuel

Cruise ship spices:

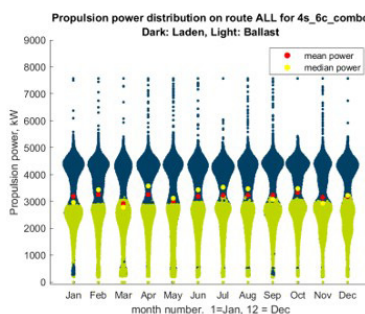
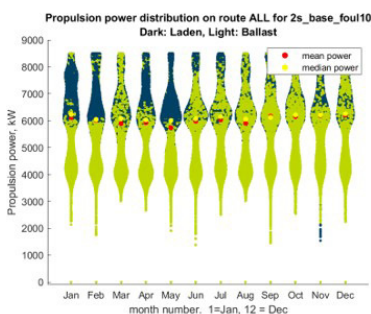
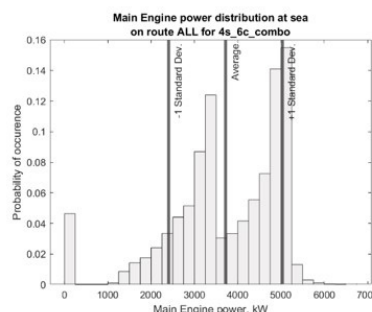
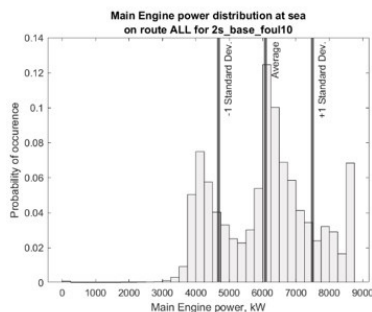
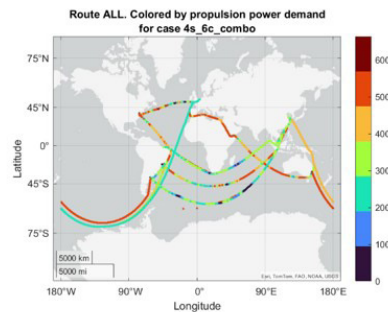
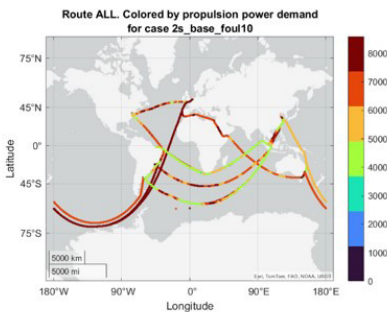
- Waste to power
- 10MWh battery pack
- Hydrogen engine

Instructions:

1. Create the necessary design basis and a new efficient hull for the ships
2. Develop a digital operational profile for the ships by combining historical weather data for a typical route of the ships
3. Test and collect performance data about energy saving technologies, either from a laboratory environment or from real-life demonstrations
4. Integrate the technologies at system level in a ship energy model in order to understand the combined effects and to find synergies between processes

Pro-tip: To ensure meeting the goals, the modelling should be performed in several generations, adding more data and improved models each time

¹ A longer version of the recipe with insightful pictures can be found in the notes from the 2023 & 2024 HIPER conferences ([training videos](#) are also available)



changes – especially a fuel switch – has a holistic impact on a ship's energy system. When integrating several onboard energy-saving technologies, there is an impact not only on the entire energy system but also between the new pieces of equipment. Since regulations are pushing for reduced emissions from ships, we will eventually have new clean fuels on board. These bunkers are more expensive – or alternatively, the ship operator or owner will pay for polluting. Either way, energy-saving is 'the' way to commercially survive and beat the competition.

When I entered this business, the energy system modelling was merely seen as the 'icing on the cake' rather than a game changer. Nevertheless, now amidst various decarbonisation solutions and developing legislation, ship energy system modelling and its related analysis should be seen as a new but important ship design discipline. The simulations can enable correct dimensioning of the equipment, such as ship machinery and fuel storage.

In my view, studying design variations on the energy system level, as we did in CHEK, is a highly useful screening step in any project. It is done to identify the solutions that we want to proceed with in a more holistic naval architectural analysis and ship design integration on all levels. The energy simulation also enables later comparison of expected performance with the measured data from the ships, providing a platform for design validation.

Finally, we simply cannot afford to skip the analysis of the combined effect of our design choices. Sticking to the traditional way of dimensioning vessel fuel storage and propulsion machinery with extensive design margins leads to continuously increasing costs for the ships. I believe that the winners of the future will be those who dare to take the next step in pushing for optimised operation and dimensioning the machinery to perform best under the most typical conditions. □



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