Energy efficiency in marine vessels

ALF KÅRE ÅDNANES – It is not many years ago that fuel efficiency was a minor or even neglected topic of many marine industrial conferences and journals. Today, together with safety and availability, it ranks at the top of the agenda of the marine community. So what happened to make such a dramatic change in awareness in such a short time?

The answer may be complex and the causes may be various. But above all, it is clearly a result of the dramatic variations and high level of fuel costs and income rates, leading to bleeding losses for those ship operators that are not prepared for the rapidly changing fuel costs and lack the ability to adjust vessel operation and operational expenses. Another factor is related to the increased public awareness of pollution and environmental emissions that leads to political decisions of global or local rules and regulations. These could be considered as a burden to ship operators, but could also create vast opportunities for the foresighted operators with long-term perspectives of their strategy.

This article will introduce some of the areas ABB works within in order to be able to offer solutions that help shipowners and operators reduce their fuel bills today and in the future and to support the yards in offering vessel designs for the future needs of the marine industry. Further and more detailed presentations of core technologies can be found in the subsequent articles in this magazine, contributed by internal, as well as guest writers from the industry.

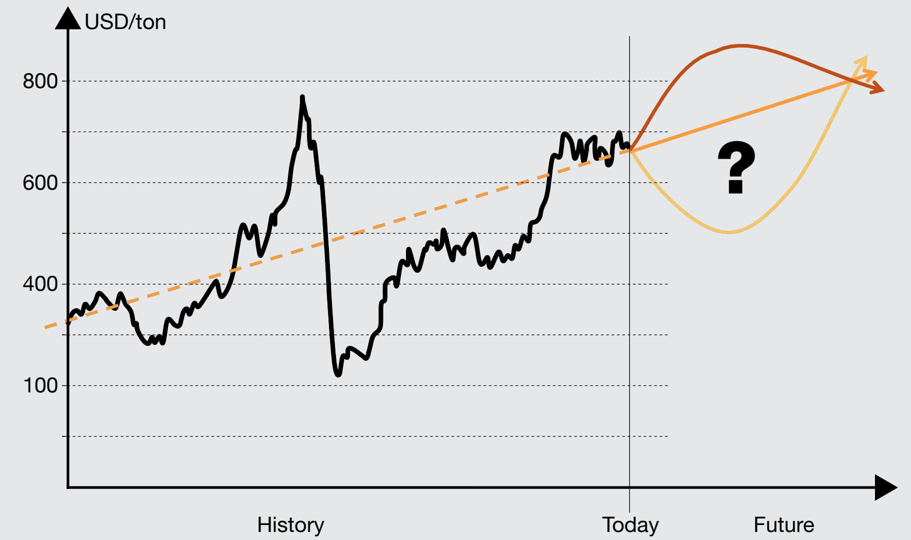
The fuel dilemma and opportunities

Global shipping consumes about 300 million metric tons of fuel annually, with heavy fuel oil (HFO) in transportation and larger ships and marine diesel oil (MDO) in the offshore and smaller near-shore vessels. As HFO is a residual oil product from refining, it is the fuel with lowest price and will not be replaced as a main source of fuel for shipping in the near future. However, the use of lower sulfur and cleaner fuels, such as MDO and liquefied natural gas (LNG), will take over parts of the HFO market as environmental regulations and local restrictions on emissions get strengthened.

During the last decade, the energy market has been turbulent, with increasing and changing fuel prices. There are few voices heard that predict this to be different in the next decade. Among shipowners and designers, there is a clear trend to increase the efforts in designing vessels for flexibility in fuel source and operational loading of the propulsion system.

The challenges of reaching the macro targets of stabilizing CO_2 emissions to reduce accelerated global warming will also, without a doubt, affect the shipping industry, although global rules and regulations are not in place yet. Such goals cannot be reached with the use of today's technologies alone, and will require new ways of designing and operating vessels and fleets, as well as further development in technologies and energy sources. While this is a challenge, there is a clear money driver for the long-term

1 Price of marine bunker oil, how will it develop through the lifetime of a new build vessel?



strategic players. While the HFO cost of today is above $600 per metric ton, the total fuel bill of the shipping industry is at an annual level of at least $200 billion. For the providers of energy-efficient solutions that reduce fuel consumption for environmental gains, there should be enormous funding opportunities only by sharing the reduced fuel bills.

Generations invited Det Norske Veritas (DNV) to make a summary and trends in development of rules and regulations. Their reports are presented in this issue of *Generations.*

Optimizing operations

With the means of communication and data transmission being installed to cover practically all oceans, there is no need to continue a tradition of running a fleet as independent ships with individual objectives. An enabler for the next generation, integrated systems are the introduction of IT networks extending the traditional integrated automation systems to tightly connect to the power and propulsion plant. High-speed networks with fault integrity and high reliability replace traditional hard-wired or serial communication links to provide easier installation and higher data transparency. IT and real-time data management that has revolutionized other industries is now entering the marine.

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2 The EMMA™ suite of solutions for energy management and fleet optimization; next generation advisory systems entering the marine industry

EMMA™ Fleet Control
Business intelligence data discovery to complete fleet management

EMMA™ Onboard Tracker
Onboard energy, fuel and process data and monitoring

EMMA™ Advanced Optimizer
Easy to use optimization modules for even the most complex onboard processes

There is an increasing interest in gaining benefits of electric propulsion in new vessel segments, in particular in hybrid propulsion concepts.

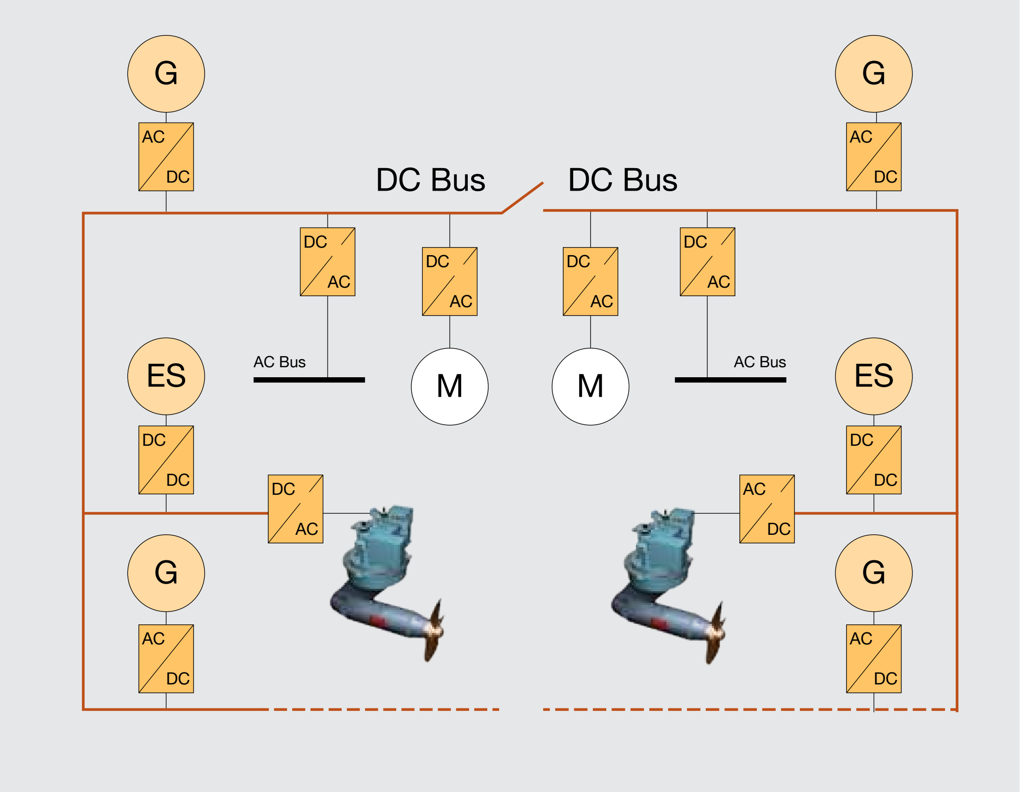
In order to support the optimization of vessel and fleet management, ABB has launched the EMMA™ suite of solutions for ship operators and owners. While being a solution package that can be adjusted to many ship types and equipment solutions, it also provides integrated information sharing with the onboard propulsion and control systems from ABB to take advantage of the large data that inherently are available in an integrated system. Features of EMMA are presented in the article on page 97.

Advances in electric propulsion

Electric propulsion has been applied in marine vessels over many decades, while the real expansion and wider use started in the 1990s. With exceptions of introducing Azipod® propulsion and the developments within variable speed drives technologies, one could say that the electric propulsion has evolved in a step-wise manner. Technologies from other industries have gradually found their ways into marine applications.

There is a clear shift in focus in the way marine society of designers, operators, and technology providers approach electric propulsion design. The shift is from adapting to marine to designing for marine. As the marine industry is small, compared with the total industry in terms of numbers of vessels and size of markets, the basic technology and product development efforts will still vastly be carried out by land-based industries. However, the solutions and systems for the marine industry are being reshaped to support energy efficiency of the vessel processes, including propulsion.

3 Onboard DC Grid with generators (G) and energy storage devices (ES)



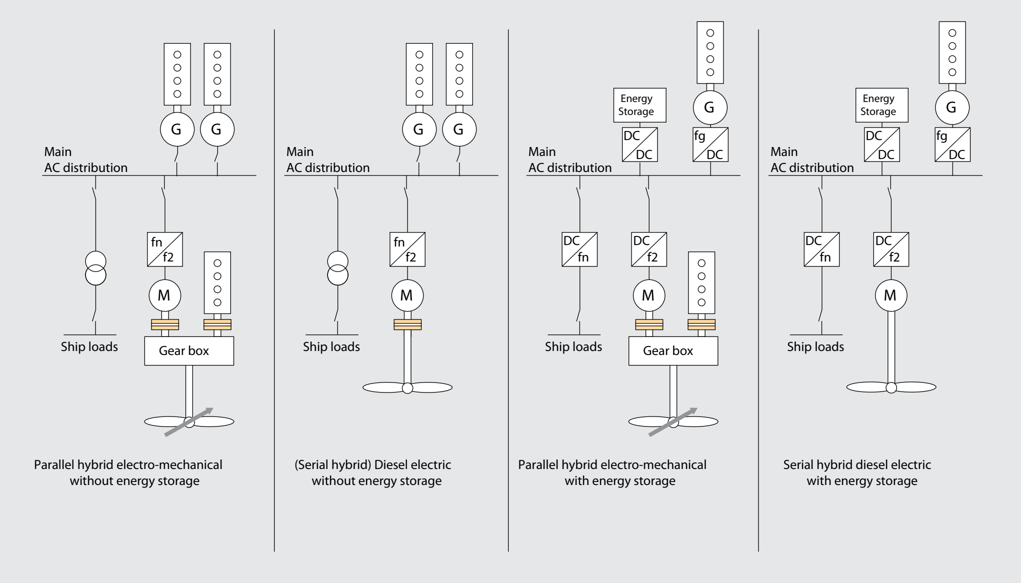
Electric propulsion is still a solution mainly used in passenger vessels, special vessels for ice-going or dynamic positioning, or in vessels powered by LNG. However, there is an increasing interest in gaining benefits of electric propulsion in new vessel segments, in particular in hybrid propulsion concepts, where the electric system either is parallel hybrid to a mechanical drive train, or the electric generation plant is supplemented with an energy storage system. Read more on the experience in hybrid propulsion systems for anchor handler vessels in the article on the recent technologies in gear drives for hybrid propulsion on page 136, contributed by guest authors from Scana Propulsion. *Generations* also presents thoughts on integrating battery and super-capacitor energy storage in electric systems for increased reliability and fuel efficiency, particularly suitable for the Onboard DC Grid concept. An article on trends in battery development is contributed by Corvus Energy.

ABB's product portfolio of Azipod® is going through an upgrade program, whith the new large size Azipod XO propulsor launched in the market recently to a very positive feedback from shipowners. The upgrades are described in detail in a paper in this magazine. The smaller Azipod CZ with nozzle has been expanded in power range to also fit the newer drillship designs. The article presenting that highlights the benefits for shipowners and ship designers by utilizing the simplicity of the thruster design, as well as increasing the awareness of the fuel and cost saving effects on the complete power plant by taking advantage of the high efficiency of the Azipod.

Hybrid propulsion

The term "hybrid propulsion" covers a variety of system designs and solutions. Many are already familiar with the concept of hybrid propulsion when it comes to cars, and the difference between series and parallel hybrid solutions there. For marine propulsion, hybrid propulsion has traditionally been used to describe a propulsion line where a mechanical prime mover is the main driver for the propeller, with a direct or geared electrical driven booster motor to supplement

4 Onboard DC Grid with generators (G) and energy storage devices (ES)



the prime mover, or to use in low load conditions for higher energy efficiency and redundancy.

With the introduction of energy storage to the propulsion system, hybrid propulsion is also used to describe that the diesel generators are supplemented with electric energy storage. As the similar terms are used in both automotive and marine industries, but with different tradition and meanings, a brief description of the various marine concepts are shown in Figure 4. It illustrates the differences between serial and parallel hybrids. In parallel hybrid, both a diesel engine and an electrical motor can be used, separately or together, to drive the propeller through a gear box as shown, or in line with a common shaft. In serial hybrid, the propeller shaft is driven solely by the electrical motor. The power plants can be equipped with or without energy storage. In this figure, only DC distribution is shown with energy storage devices as that is the most feasible solution, although it could be possible to integrate energy storage in AC distribution systems as well.

Waste heat recovery boiler systems are commonly used in ships, in particular with larger engines, to provide steam and electricity for the vessel. Today, there is a trend to increase the waste heat recovery capacity and produce more electrical energy. In order to utilize this energy, which can be substantially higher than the onboard processes demand, a hybrid propulsion line is needed to take advantage of the recovered energy from the engines. As the paper on this topic presents, the overall energy efficiency will increase by about 10 percent for such hybrid propulsion lines.

Summary

Historically, there have been a few big step changes in the design of the electric propulsion system, with continuous smaller steps of improvements in technology and system design. It is believed that during the next years there will be significant changes in such solutions becoming available for the market.

Generations collected a series of articles that show a selection of recent and ongoing development activities, with a belief that they give an indication of what the industry will be heading towards in terms of applied technologies. These changes should support ship yards, designers and shipowners to increase efficiency of energy consumption and reach target settings on operational flexibility, earnings and environmentally sustainable business.

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