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## Energy Efficient Design and Operation of Cruise Vessels

Carnival Maritime, founded in 2015, is the Marine Operations Unit for Costa Group, providing expertise on all technical and nautical aspects to 27 ships sailing under the brands of Costa Europe, Costa Asia and AIDA Cruises. From daily operations such as repair and maintenance, compliance and safe and efficient operations to complex technical retrofit projects, innovative solutions, dry docks and new build coordination, Carnival Maritime's primary focus is to ensure a safe and happy cruise experience to all passengers and crew onboard.

With new ships entering into service almost every year, each ship has been even more technically advanced than the one preceding. Following this trend are the latest announced new buildings Costa Smeralda and AIDAnova which are focusing on a drastic reduction of harmful emissions from power generation by utilizing LNG as the primary fuel source. Innovation, however, is not limited to new build concepts. Even the oldest ships in the fleet, for example AIDAcara and Costa neoRomantica, are receiving regular updates to increase energy efficiency as innovative technologies mature and become economically more feasible.

The road from invention to retrofit is often quite long, especially for the shipping industry where safety at sea and reliability of equipment are paramount. On many occasions innovation means the ability to implement a 100-year old technology onboard effectively (i.e. LNG, wet-scrubbing, battery packs). Other times, innovation to implementation can be fast, for example optimizing known onboard equipment to form a new system or function – such as the concept of hybrid water production. For a ship already in operation, innovation means retrofitting best known technologies at the highest quality and cost efficiency. This is often a very challenging task of prioritizing and funding the projects that have the biggest saving but the lowest investment cost and simplest integration.

Implementing energy efficient technologies onboard is only half of the journey. It is equally important and perhaps as challenging to ensure that the ship and its systems are operated efficiently. Shipyards design both beautiful and efficient ships, but in many geographic areas or slow speed itineraries, the ship and its systems are not able to operate efficiently. This is why any design choice, new build or retrofit, must be combined with a detailed analysis of the ship's operating profile with measured data.

Perhaps the best platform to access real life technical data from the ship is the onboard Energy Management System. In recent years we have seen a significant increase in the number of software solutions providing such functionality. This has led to a massive increase of available operating data, shifting the problem of 'where to get it' to 'what to do with it'. Although there is still much work to be done in the fields of measurement quality and accuracy, the recent availability and sheer volume of new information create new opportunities continuously.

Analyzing ship data, optimizing onboard systems, refitting new solutions and increasing crew awareness has never before been as easy and powerful as it is today. Having constant access to live data means that new innovative ideas that lack a positive business case do not need to be 'shelved' for a generation, but can be re-evaluated as often as needed to incorporate new developments in technology and pricing. Access to live data also means that a new level of support service to the ships is made possible through a centralized, 24/7 Fleet Operating Center. Concepts like Condition Based Monitoring, Efficiency Based Maintenance, Dynamic Trim Optimization, Speed and Engine Optimization and Water Management are making shipping significantly more reliable, environmentally friendly, energy efficient and safer.

Efficient new building concepts are mandatory, but there will be an even bigger reduction to global emissions by retrofitting innovative technologies on existing ships. The new build concepts we are working on today, will not be delivered until a few years – and even then their impact will be small when compared to the existing fleet. Future emphasis will be on further emission reduction in the forms of advanced power generation as well as maximizing zero emission operation and onboard heat recovery. Some remain possible only on new build designs, but many can be and will be retrofitted on ships already in service.