

Improving energy efficiency in the cruise and ferry industry

BUSINESS WHITE PAPER



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The overall energy efficiency of a vessel is determined by choices made throughout its lifecycle. Improvements in energy efficiency lead to increased profitability, reduced emissions and a more sustainable brand image. When looking for ways to improve the energy efficiency of a vessel, optimising its operation and engine and propulsion systems can offer significant opportunities for savings. Utilisation of the latest digital technologies and data intelligence enable continuous monitoring and optimisation of the operations of the entire fleet.

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Introduction

— Investing in greener solutions is good business.

Cruise shipping is currently one of the fastest growing sectors in tourism. According to Cruise Market Watch the industry attracted globally more than 22 million passengers in 2015. In the last fifteen years the amount of cruise customers has grown at an annual rate of 8%. As the number of passengers continues to grow, so do their expectations regarding the sustainability of cruise lines.

In the ferry market the global outlook for passenger volumes remains positive*. Also, positive signals in cargo volumes in the Ro-Ro market were seen in 2015 due to improving economic conditions in selected Northern European markets, and also due to the declining oil price.

The industry frontrunners are focused on improving guest experience, safety and energy efficiency, and subsequently minimising their impact on the environment. Environmentally responsible operations are expected by customers who want to cruise on a clean ocean. This makes investing in greener solutions good business.

Although the cruise industry has been striving for a green image as well as better fuel efficiency for decades already, recently introduced maritime regulations are driving the whole shipping industry towards significant improvements in vessels' total energy efficiency. In 2013 the IMO introduced Maritime Energy Efficiency Regulations in order to increase the energy efficiency of new ship designs and to create a framework for the management of energy efficient ship operations for all new and existing ships. For example, the Energy Efficiency Design Index (EEDI) for new builds mandates improvements for hull design and machinery. Likewise, the Ship Energy Efficiency Management Plan (SEEMP) requires ship owners to have a plan for improving the operational energy efficiency of each of the ships in their existing fleet.

The development regarding energy efficiency has been accelerating, and older vessels are not nearly as optimal as the latest ones. The development of new ship design is driving towards, for example, modern hull designs and economical coatings, the increased use of hybrid and diesel-electric propulsion, and waste heat recovery systems. It is, however, also possible to achieve technically and economically rational improvements to an existing fleet by upgrading the vessels and optimising its operations and maintenance.

Investing in improved energy efficiency increases profitability and creates a more sustainable brand image which, in turn, leads to a higher utilisation rate. This document provides an overview of energy efficiency improvement areas throughout the lifecycle of a vessel, with a particular focus on operation and maintenance.

* Source: Clarksons Research

Energy efficiency throughout the lifecycle



A vessel's energy efficiency is determined by the total amount of energy it consumes during its entire lifecycle, from the new-build process to the final recycling phase. It is measured in relation to a specific output, e.g. the total energy or fuel consumed per sea mile. An operator wishing to optimise the energy efficiency of the entire fleet, and utilise the synergies between the vessels, should apply a holistic strategy. This is done by implementing comprehensive lifecycle solutions that take into consideration the vessels' entire journey from business planning all the way to the end of its lifecycle. Major improvements to energy efficiency can also be achieved through assessing a specific area and applying a customised solution to it.

Wärtsilä can develop a holistic optimising strategy that covers the entire lifecycle of a fleet, or provide a solution to a specific challenge.

BUSINESS PLANNING

Taking a holistic view on energy efficiency

Improving energy efficiency is among the strategic plans of many shipping companies. Key development areas should be identified and taken into account already in the business planning phase. Comparing performance benefits and lifetime costs of alternative investment opportunities can be a complex task, and decision makers face the challenge of finding technically and economically optimal improvements.

Wärtsilä as an expert partner can provide valuable analysis and consultancy for newbuilding as well as for the current fleet. Here vessel data analysis plays a key role in optimising the performance of the entire fleet. Building investment scenarios and setting smart KPIs to monitor the performance are key steps in this phase.

NEW BUILDING

Increasing energy efficiency by optimal selection and integration of equipment

Ship design is the art of choosing a vessel configuration that matches the mission, intended operational profile and route as well as the operator's requirements for performance. Achieving this requires a deep understanding of the vessel type, as well as new technologies and how they integrate into the vessel. A new design will usually offer better energy efficiency than similar older ones due to the optimisation of its hull lines and propulsion configuration for a particular operational profile and lifecycle.

An increasingly important factor in a vessel's energy efficiency is the selection and integration of machinery. On modern vessels that are highly reliant on electrical and automation systems, power capacity and the reliability of these systems are also critical factors for vessel safety.

Hybrid power systems combine different power sources with energy storage devices. In conjunction with conventional diesel or dual-fuel engine generating sets they can improve efficiency by running the engines on optimal load and absorbing many of the load fluctuations through batteries.

OPERATION

Continuous performance monitoring for optimal operational energy efficiency

Small changes in operating conditions can lead to substantial changes in energy consumption, making it important to continuously monitor and optimise the operations of the entire fleet. It is critical to evaluate existing operational practises, and how they have changed and are expected to change over the years. Furthermore, current operational practices can be reviewed as part of a strategy to identify the best measures to improve operational energy efficiency.

Potential areas of efficiency improvements in ship operations are, for example, time spent in port, economical voyage planning, weather routing and active speed optimisation. Even small speed reductions can reduce energy consumption considerably. Also the choice of fuel matters, since there are big differences in the efficiencies achieved between different fuels. Such a wide range of variables to take in to account means that high performance in vessel operations can only be achieved through integrated and truly intelligent solutions.

Increasingly complex systems mean that technical knowledge by maintenance service providers is becoming critical to supplement ship crews' competences. Digital technologies make it possible for service providers to collect and analyse an installation's data and remotely monitor its performance. A system of remote monitoring and support enables immediate identification of operational issues and implementing corrective actions and adjustments.

Wärtsilä Optimised operations is a lifecycle solution that ensures energy efficient operations and that the Ship Energy Efficiency Management Plan (SEEMP) measures are in compliance with MARPOL regulation. The agreement-based service offers real-time monitoring and advisory services that maximise the efficiency of assets. Benefits accrue not only through condition based maintenance but also through operational decisions based on optimised fuel consumption.

A further step towards operational reliability is the **Wärtsilä Guaranteed asset performance** lifecycle solution, which guarantees that the agreed levels of performance will be reached and maintained. The business model is based on actual performance, and success is evaluated in quarterly performance reviews.

The **Wärtsilä Genius services** family of solutions utilises the benefits of real-time data and data analytics to improve the efficiency and predictability of operations. The services are suitable for setting up measuring routines as well as expert analysis of the systems.

— Changes in operating conditions can lead to substantial changes in energy consumption.

MAINTENANCE

Optimised maintenance increases cost predictability

In addition to fuel costs, maintenance costs play an important role in a vessel's total economics. Improved repair, replacements and maintenance to reduce wear and tear, as well as hull cleaning, propeller polishing, air removal from pipes and filter cleaning, all have a big impact on fuel costs. Maintenance tasks range from relatively easy-to-perform tasks to deep repair and modifications that require highly experienced personnel and may require special tooling.

Smart maintenance planning makes maintenance costs predictable. Furthermore, maintenance scheduled according to predicted needs instead of a fixed maintenance schedule optimises the balance between fuel economy and maintenance costs. Also, spare parts play an important part in optimising the overall efficiency. OEM-quality spare parts comply with the latest specifications and can have up to 50% longer service life compared to non-OEM parts. Combining OEM spare parts with smart maintenance planning can considerably enhance an installation's operation throughout its lifecycle.

The importance of competent personnel is high. In addition to technical and operational measures, awareness and engagement throughout the whole organisation is identified as one of the main success factors. The crew needs to have the right skills and competence level to operate and maintain modern systems and equipment.

Wärtsilä Optimised maintenance is a lifecycle solution that matches maintenance with a vessel's commercial operation and schedule, ensuring maximised uptime and long-term cost predictability. It is based on continuous engine and propulsion condition monitoring, Dynamic maintenance planning and periodical inspections. Predictive maintenance keeps installations running at optimal level.

Wärtsilä Land and Sea Academy provides solutions securing competent personnel for current and future needs. Assessment and a full spectrum of training methods are available, including practical, classroom, blended, on-site and simulated environment. For example, the Engine performance course emphasises the importance of efficient operation and maintenance of main and auxiliary engines as a means of effective energy and resource management.

UPGRADES

Opportunities to incrementally improve energy efficiency

A ship design is typically optimised for a limited range of operating conditions. However, a vessel only operates in its design conditions a small proportion of the time. The need to adjust to changing conditions often requires ship owners to consider a variety of upgrades and modernisations.

A baseline is calculated based on a careful analysis of the current state of a vessel. On-board advisory services such as trim, hull performance, engine efficiency and condition monitoring combined with vessel audits and component condition evaluations enable the identification of potential areas for performance improvements. This approach establishes a holistic view of the current status and situation which acts as the base for an improvement plan. Changes in the vessel's operating profile and the availability of improved or innovative technologies can offer additional opportunities to incrementally improve a vessel's energy efficiency. Such solutions can be hull, propulsion and engine maintenance, machinery upgrades, or electrical and automation upgrades. Tuning the engine alone for lower speeds will not help to achieve complete energy efficiency of the ship, unless the propulsion is fully optimized to the required sailing speed and the hull configuration.

Engine performance can be optimised by upgrading the engine and propulsion components to newer technology that can offer efficiency and performance benefits that easily justify the investment. The main components having an effect on engine specific fuel oil consumption are the turbocharger, intake air filters, charge air coolers, injection pumps and nozzles and the exhaust gas pipe, which has an effect on exhaust gas back pressure. This causes the turbo charger speed to drop, leading to a lower power output, which is then compensated on the diesel engines by increased fuel feed.

Fuel quality and flow are also factors that have a significant effect on efficiency. Sometimes a conversion to another fuel type altogether, or to a multi-fuel solution, can be performed to improve the engine's fuel efficiency and flexibility.

— Fuel quality and flow have a significant effect on efficiency.

Wärtsilä has various propulsion upgrades, including energy saving devices and propeller and related machinery upgrades, offered individually or as a combined package with the engine upgrades and optimised hull.

Wärtsilä engine and turbocharger performance upgrades lower the specific fuel consumption of the engine and improve efficiency by reducing thermal loading. This results in lower lifecycle maintenance costs. The solutions are easy to install, with minimal downtime required.

Carrying out complex projects on existing installations requires excellent **project management** capabilities. Wärtsilä Services has professional project managers and project teams with the needed level of competences to run successful projects. Projects are managed on all aspects from feasibility studies, financing solutions, solution proposals, execution planning and implementation to full engineering, procurement and construction solutions.

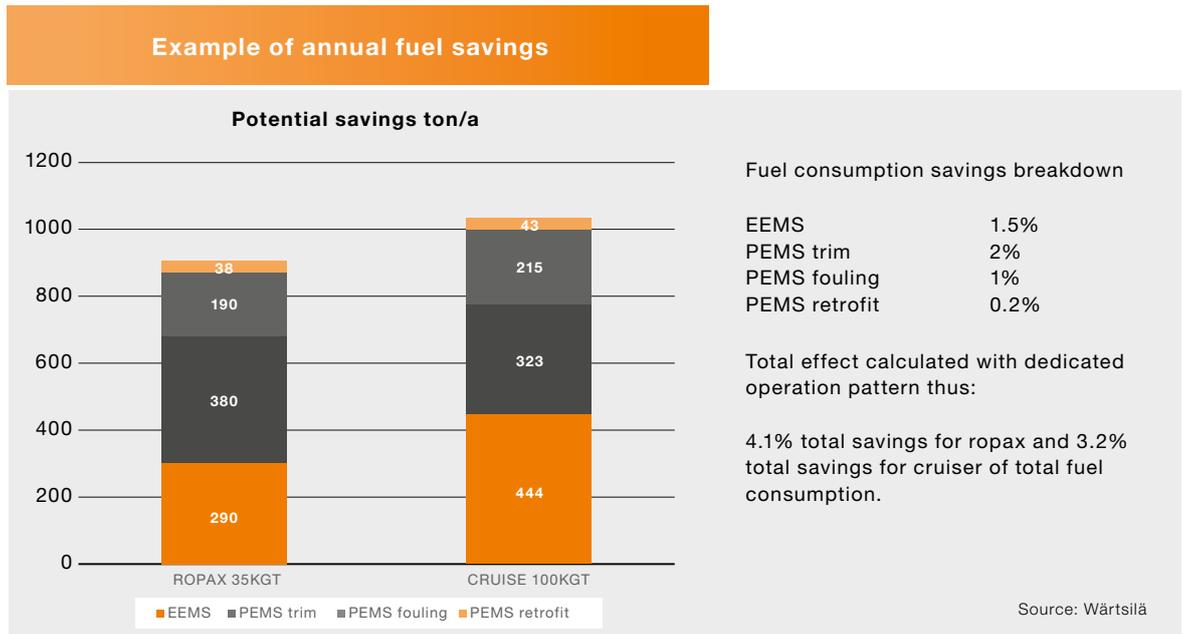
Using data intelligence for improving energy efficiency

Every ship has different potential for energy savings. Cruise ships and ro-paxes have different kinds of operation profiles, and typically cruisers use less power for propulsion than ro-paxes. The vast majority of fuel is burned by the main engines and used for the vessel's main propulsion. This makes the main propulsion train the priority when optimising the energy efficiency of any ship.

With the **Wärtsilä Engine efficiency monitoring service** you can minimise fuel consumption and optimise your operational practices. Fuel savings can be achieved by improved operation habits over installed engines, better fuel quality, correctly timed overhaul actions and operational focus on fuel consumption. The service monitors the efficiency of your engines in an ISO standardised way, and supports your overhaul and operational decision making based on actual real-time data. Through advanced follow-up and trend analysis you can improve the management of your power production and total fuel consumption can be improved.

The **Wärtsilä Propulsive efficiency monitoring service** is a comprehensive high-quality service for any ship with conventional shaft lines. It measures shaft power, thrust and various ship conditions such as different trim, fouling and ambient conditions. It is a self-learning system for all operating conditions which optimises the management of your vessels through continuous validation. The service optimises propeller and total cleaning intervals as well as the trim of the vessel. This leads to significant fuel savings. The cost savings can validate investments in retrofits such as the addition of nozzles, a new propeller design or an energy efficiency device. These services are available through a service agreement.

In the following example we are able to reach 3-4% savings on fuel consumption by monitoring the fuel consumption trend, drilling into the root causes, and taking corrective actions to ensure the most optimal trim, as well as doing hull and propeller cleaning and repairing activities.



The savings offered by the EEMS solution depicted above derive from improved operation habits, correctly timed overhaul actions, and new training for the crew to concentrate on fuel consumption.

The calculation of savings through trim management using the Propulsive efficiency monitoring service (PEMS) uses advanced information on trim effects to correct trim to suite various, and changing, operation weather conditions, speed and loading conditions. PEMS fouling refers to correctly timed cleaning actions for the propeller and the hull. Cost benefits can also be achieved through retrofitting the main engine and propellers, and by upgrading them to the latest technologies and matching them with new operational profiles.

Case study:

Cruise ship upgrade

A cruise ship equipped with 6 x Wärtsilä 46 engines and a CPP propulsion system achieved considerable savings by adopting a comprehensive approach to improving energy efficiency.

CHALLENGE

Built right after the turn of the millennium, the ship was originally designed for high-speed operations as was the norm at the time. However, the requirements have changed, and the ship is currently operated at a much lower speed. This created the need for adjusting and optimising the whole propulsion system.

SOLUTION

After a deep analysis of the condition of the equipment, the operating profile of the vessel and other key variables, as well as a full energy audit performed by Wärtsilä experts, a joint project by the cruise operator, Wärtsilä and a classification society was set up.

The project included several stages. First, Wärtsilä's team calculated new optimal engine operating profiles for different modes. As a result of the simulation, the operator decided to set one of the engines as standby to increase the redundancy and flexibility of engine deployment. Further, one of the engines was optimised for port operation by tuning the engine and the turbocharger for lower loads. This was done in conjunction with a major engine overhaul to ensure maximum cost efficiency. The EIAPP technical file was updated according to the new specification. Finally, the propellers were re-designed for optimal efficiency with the new operating profile and an energy-saving Energoprofin for the CP propeller on the post swirl side was installed.

RESULTS

Significant savings were achieved in energy consumption and maintenance costs, with the added benefit of a reduced environmental impact. The tuning of the engines, the new design for the propeller and the optimised operating profile resulted in fuel consumption savings of approximately 14%. In order to sustain a high level of performance the operator signed a service agreement with Wärtsilä guaranteeing a continual optimisation process and reducing the risk of future efficiency loss.

— Engine tuning, new propeller design and optimised operating profile resulted in fuel consumption savings of approx. 14%.

Wärtsilä believes that regulation and innovation will drive demand for expertise in optimising the lifecycle costs of fleets and the reliability of vessels. Cruise lines are benefitting from the lower fuel costs we see today, giving them a unique possibility to invest in energy efficiency and long-term profitability. As the cost of fuel is expected to increase in the future, now is a perfect time to invest in energy efficiency.

Please contact us: www.wartsila.com/services

Ensuring your lifecycle operations

Wärtsilä is an experienced lifecycle solution provider, with a proven track record in operation and maintenance services. Globally, more than 300 ships are covered by Wärtsilä service agreements.

Wärtsilä's extensive global service network and efficient spare parts logistics ensure that you can focus on your core business, resting assured that your maintenance needs can be optimally met, whenever and wherever.

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