

Contact us

ABB Oy

Marine and Cranes

Merenkulkijankatu 1
P.O. Box 185
FI-00981 Helsinki
Finland
Phone: +358 10 2211
Fax: +358 10 222 2350

ABB AS

Marine and Cranes

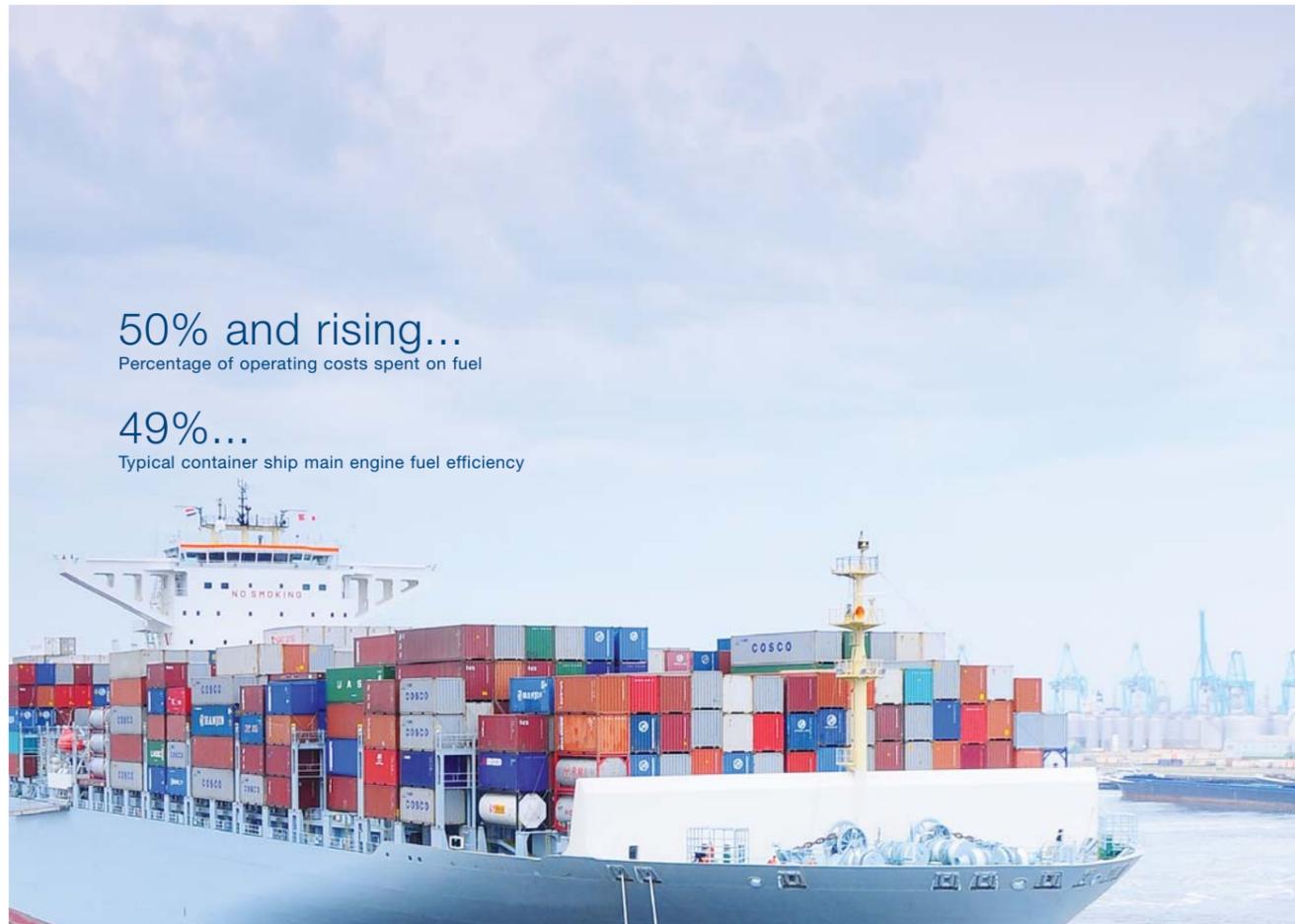
Bergerveien 12
P.O. Box 94
NO-1375 Billingstad
Norway
Phone: +47 22 87 20 00
Fax: +47 22 35 36 80

www.abb.com/marine

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Container vessels
Energy-smart integrated power solutions



50% and rising...

Percentage of operating costs spent on fuel

49%...

Typical container ship main engine fuel efficiency

The figures above illustrate a major challenge - and an opportunity - facing vessel operators in the highly competitive container business. We at ABB cannot do anything about fuel prices, but we can definitely help you improve energy efficiency – that's our business.

The traditional approach to energy optimization has been to focus on each separate sub-system in isolation. By focusing and controlling the ship's total energy flow and the interaction between all producers and consumers, ABB helps you to reduce overall fuel consumption and emissions.

Combining world-leading technology

Our integrated container ship solution is a result of close collaboration between ABB, Turbo Systems and ABB, BU Marine and Cranes, together with selected external partners. By combining world-leading turbo and heat recovery technology with state-of-the-art electric power and control systems, we are able to deliver unique turn-key solutions which meet the most stringent demands for energy-efficiency and environmental compliance.

Single source after-sales services

ABB quality does not end with the installation of the systems. Our marine service network extends around the world, providing quality maintenance, repair, and upgrade solutions. By choosing a total integrated ABB solution you will reap the benefit of single-source service and support throughout the life of your vessel.

Energy-smart integrated power solutions
15% to 20% improvement in fuel efficiency

For container vessels, ABB offers two basic power concepts designed to maximize fuel-efficiency and reduce emissions - one aimed at large 8000+TEU vessels and the other for smaller feeder vessels in the 2000 TEU range.

As a total system integrator we take full responsibility throughout all project phases, and you benefit from single-supply efficiency and reliability.



Solutions for
8000+ TEU vessels...

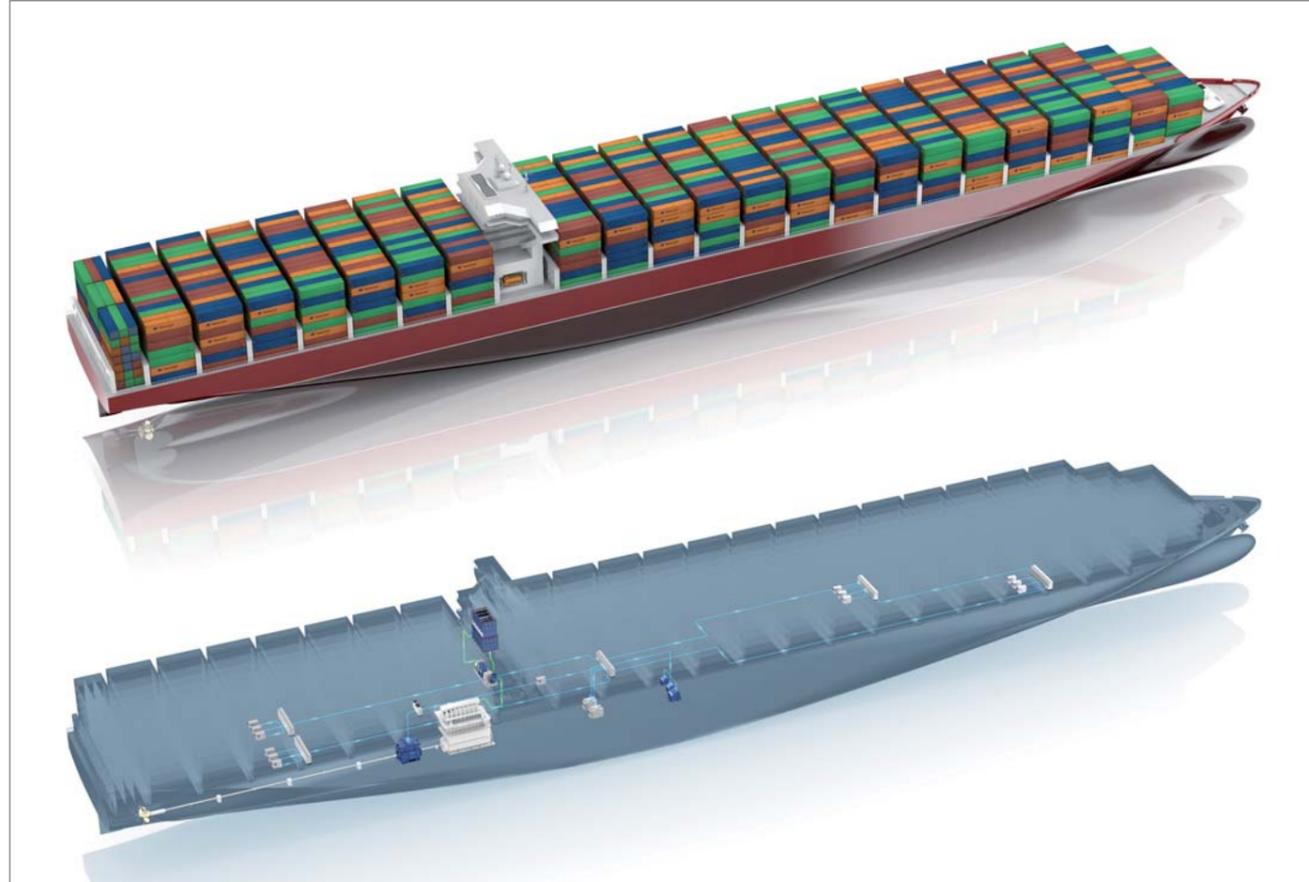
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Solutions for
2000 TEU vessels...

... page 10

Integrated power solutions for 8000+TEU vessels



For large intercontinental container vessels the trends are clear – a steady increase in the size of ships and an increasing focus on cost and the environment. Key issues are economy of scale, energy costs and $t_{fuel}/TEU/nm$.

The biggest marine engines ever built are found in today's large container vessels. Slow speed, two-stroke diesel engines are the propulsion of choice. Although they are the most energy-efficient propulsion engines on the market, their energy-efficiency is still only 50%.

In addition, modern container vessels have a growing number of reefer slots with a correspondingly high demand for electric power, usually produced by three to four powerful diesel generator sets.

Together, these present great opportunities for efficiency gains, and an energy-smart power solution from ABB can result in significant emission reductions and millions of dollars in annual fuel savings.

Spanning from advanced waste heat recovery technology to ship-wide and fleet-wide energy management and optimization systems

Turbochargers and Waste Heat Recovery Systems

High-efficiency ABB turbochargers and a WHR system which fully exploits the exhaust and heat losses from the main engine are an important part of our total concept. We deliver complete WHR packages with exhaust gas boilers, and a skid-mounted power turbine and steam turbine coupled to a common generator. Electricity from this unit significantly increases fuel efficiency, saving tons of CO₂ emissions.



Shaft generator/motor – hybrid propulsion

Our AMG/AMZ shaft generator/motor forms a vital part of the machinery onboard a modern container ship. It gives cost-effective, environmentally-neutral electric power to onboard services when required, and utilizes excess electric power to boost the propulsion system when available. ABB is the leading supplier of large electric machines and variable speed drives to the marine industry.



Electric power generation & distribution system

ABB has long experience supplying medium voltage power solutions to vessels with high electric power consumption. With an integrated electric system from ABB - including generators, switchboards, transformers and drives - you are guaranteed a functional and safe solution which is easy to operate and maintain. As part of the electric installation, we can also supply a complete shore-to-ship power solution.



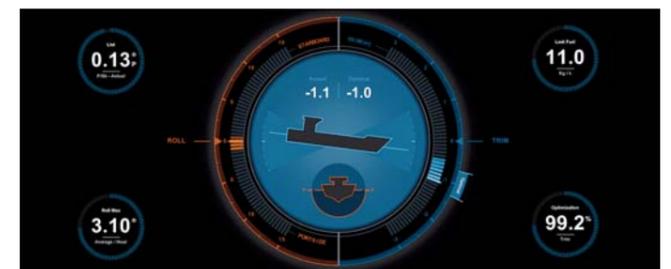
Integrated Automation System - IAS and PMS

ABB's 800xA extended automations system facilitates a single-system approach to vessel automation. Seamless integration of all control and monitoring functions onboard, including power management and control of electrical systems, provides the basis for safe, rational and energy-efficient ship operations.

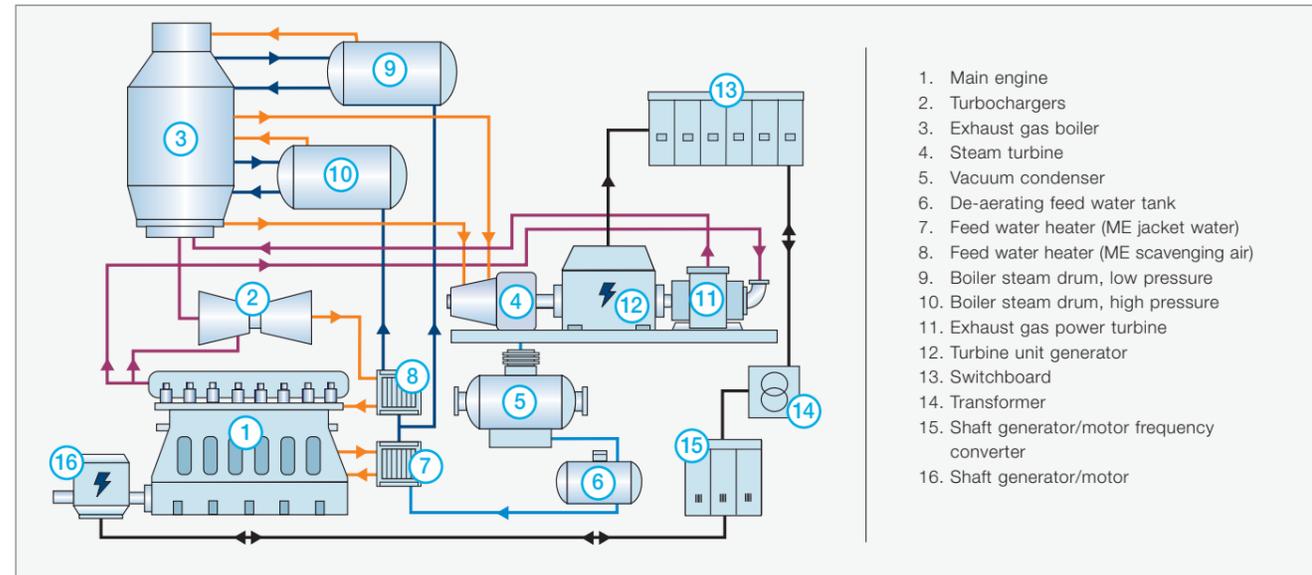


ABB's Advisory Suite – energy management

ABB Advisory Suite is a complete energy management and onboard decision support system. It makes it easy for the crew to work with day-to-day energy-efficiency onboard. Advisory Suite offers leading-edge optimization and forecasting tools; e.g, advanced trim optimization, model-based power plant optimization, RPM optimization and vessel motion prediction. The system can be extended to provide cloud-based, fleet-wide energy management and benchmarking.



Waste heat recovery and shaft generator/motor systems



ABB's power concept combines a waste heat recovery system with an efficient shaft generator/motor system.

Maximizing the use of green energy sources and minimizing emissions and fuel costs

In ABB's power concept for large container vessels there are, in addition to the main diesel engine, three different producers of energy: the power/steam turbine generator, the shaft generator/motor and the auxiliary power plant, normally consisting of three or four generator sets.

Depending on the ship's operating conditions, the electricity production from the different power sources will vary. The goal is always to maximize the use of the cost-effective green energy sources.

Shaft generator/motor

ABB delivers shaft generator/motor systems tailored and optimized for individual vessels. By installing a generator/motor on the shaft line between the main engine and the propeller you gain the following:

- a green power source that under most conditions produces much cheaper energy than the auxiliary diesel generator sets
- full use of the electric power produced by the WHR system
- a booster for the main engine when extra propulsion power is needed

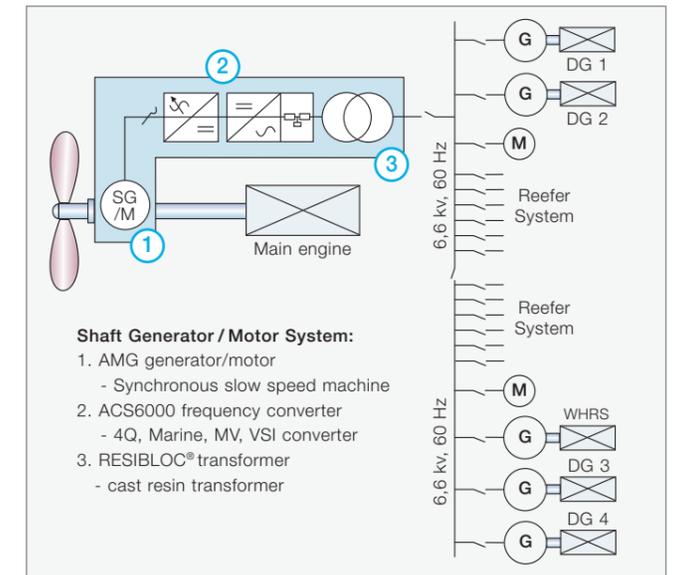
In addition to a shaft generator/motor, the complete system includes a transformer and a frequency converter for speed control and electric network compatibility.

Operating modes

The shaft generator/motor has two different operation modes. In PTI (power take-in) mode it is used as a propulsion motor boosting the main engine, and in PTO (power take-out) mode it is used as an electricity generator. Automatic switching between these modes maximizes the use of the green energy from the WHRS and shaft generator/motor system.

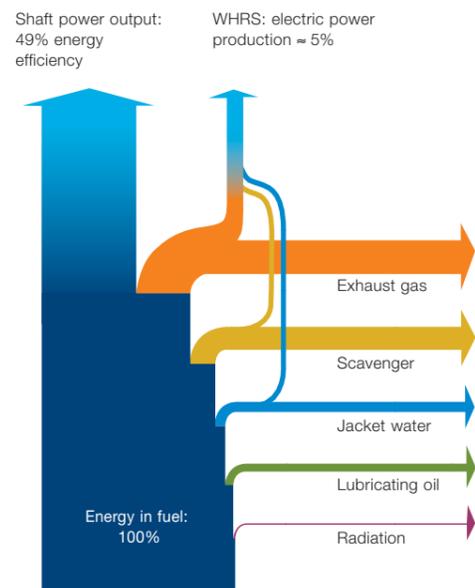
At times when the WHRS generates more electricity than the vessel can consume, or when the main engine requires extra power, the system operates in PTI mode feeding energy into the drive shaft of the vessel's propulsion system.

When demand for onboard electricity rises, the shaft generator/motor automatically switches to PTO mode, feeding power into the vessel's electricity grid. Power produced by this generator, which is already rotating on the main shaft, is much more energy-efficient than power generated by the auxiliary generator sets.



A typical system configuration for a container vessel with WHRS and a shaft generator/motor system.

Main diesel engine with WHRS



The energy efficiency of a large two-stroke diesel engine can be increased by 10% using WHRS.

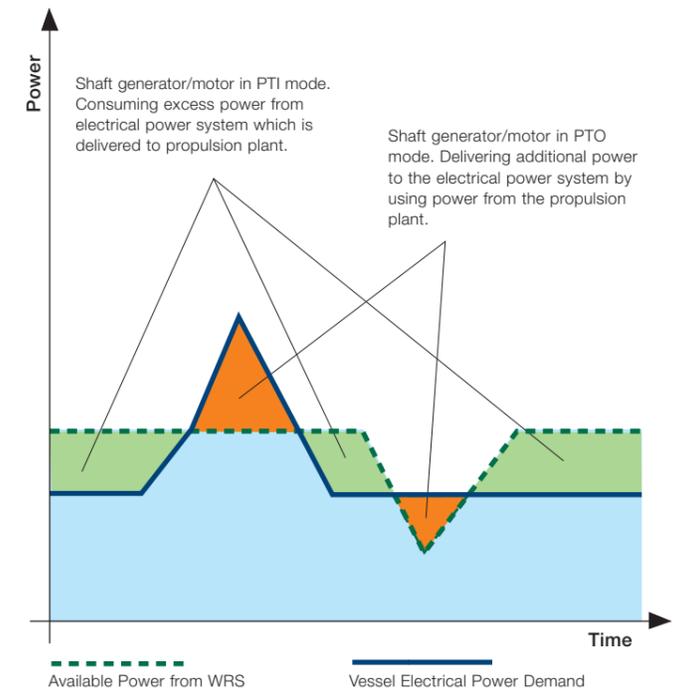
ABB Waste Heat Recovery System (WHRS)

On two-stroke engines used in large container vessels, a substantial proportion – about 25% - of fuel energy is lost through exhaust gas dissipation. The challenge for engineers has been to harvest this energy potential and convert it into usable power.

ABB's improvements in the efficiency of main engine turbochargers now allow a proportion of the exhaust gas to be diverted to a power turbine. The power turbine's rotational energy is used to produce extra electricity for the vessel via a reduction gearbox and generator, reducing fuel consumption and exhaust gas emissions by up to 4%.

After leaving the turbo units, the gasses are channeled into the exhaust gas boiler which uses this energy source to produce steam. The steam is fed into a steam turbine connected to the same generator as the power turbine. This more than doubles the output of electricity from this generator, which can then be fed into the vessel's electrical grid. The combined output of this recovery method adds at least 10% to the energy efficiency and thus decreases the overall fuel consumption onboard. The WHR system is delivered as a complete ABB package solution.

The operational modes of the shaft generator/motor

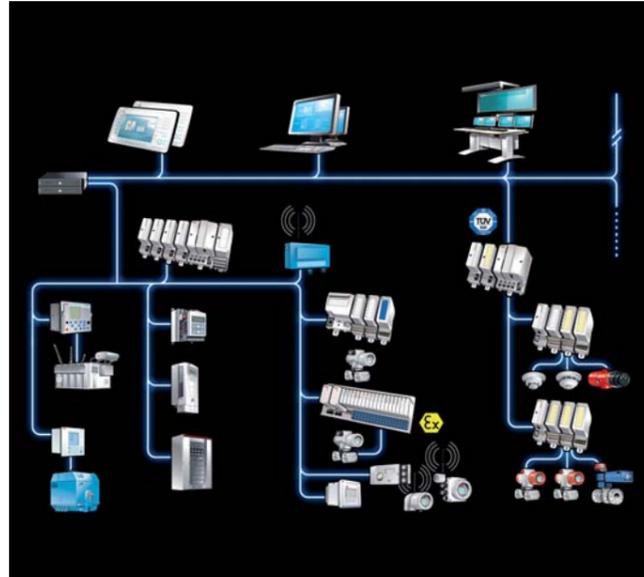


Vessel automation – IAS and PMS

Securing optimum fuel economy for all operating conditions



Edith Mærsk is one of the world's largest container vessels. It is equipped with an advanced ABB vessel automation system.



System 800xA provides a common environment for vessel process control, safety supervision, PMS and propulsion control.

Our integrated marine automation solutions are based on ABB's 800xA system platform – recognized as one of the world's leading industrial automation platforms. It represents state-of-the-art control and integration technology, HMI solutions, and engineering and maintenance tools. Tight integration with ABB power solutions ensures optimal and safe operation of the complete power plant.

Integrated Vessel Automation - bringing it all together

Generally, we advise customers to select a fully integrated vessel automation system. This gives distinct advantages when it comes to information availability, user interface, reliability, and smarter functionality and operation of the whole ship. We also offer stand-alone automation systems for WHRS and power management.

A typical integrated solution from ABB includes:

- Power Management System
- Vessel Management, including HVAC, ballast, cargo, etc.
- Common alarm handling, history, trend and analysis tools
- Extension of information to crew cabins and offices
- Asset monitoring and asset management systems
- Integration with EMMA™ Advisory Suite
- 24 hrs remote diagnostics and support services
- Interface to company ERP system

Power Management - the brain behind

The PMS is the brain behind our energy-smart integrated power solution for container vessels. With several energy sources onboard, the PMS system will secure optimum fuel economy for all operating conditions. The PMS also takes green energy optimization into account at any given time.

The PMS facilitates close integration of the electrical equipment. With controllers located inside ABB's MV switchboards and the use of open field bus standards (IEC 61850), we provide reliable and cost-effective systems with advanced safety and blackout-prevention functions

PMS functionality includes:

- Power optimization and green energy utilization
- Supervision and control of electrical power plant
- Blackout prevention through load shedding and heavy consumer controls
- Active and reactive power control
- Synchronization
- Asymmetric load sharing
- Power factor compensation

ABB's Advisory Suite

Takes energy efficiency and decision support to a higher level

ABB's Advisory Suite is the most comprehensive energy management, optimization and decision support tool on the market. The overall energy cost savings, safety and availability increase from Advisory Suite is significant, and the system normally has a pay-back time of less than one year.

Advisory Suite consists of four main products:

EMMA™ Onboard Tracker

Continuously assesses the vessel's energy performance based on real-time energy, fuel and process data. By keeping power consumption within the recommended Key Performance Indicator limits, individual crew members can appreciate their own impact on the vessel's energy efficiency. All the EMMA KPIs are compared to adaptive limits for any operating condition, such as heavy weather, strong currents, etc.



Intuitive dashboard of EMMA™ Onboard Tracker

EMMA™ Fleet Control

All data from onboard EMMA products are synchronized to the EMMA Fleet Control cloud service for 24/7 access. This tool enables company headquarters to benchmark, set performance goals and manage fleet-wide energy optimization. Masters on board individual ships can easily compare their energy performance with others in the fleet.

EMMA™ Advanced Optimizer

This includes modules for optimization of Trim, Power Plant and Clean Hull management. Instant energy savings are achieved with self-learning models optimizing in real time. Power Plant optimization presents the optimum way of running the power plant. Trim module gives real-time decision support for optimizing the vessel's dynamic trim. With a few additional sensors and state-of-the-art statistical and learning algorithms, the optimum dynamic trim is calculated for any operating conditions. By following the extremely easy-to-use advice the crew can save a significant amount of energy.



EMMA™ model-based Power Plant optimization

Amarcon OCTOPUS-Onboard

OCTOPUS-Onboard helps you to get the maximum performance out of any vessel. The system has modules from motion monitoring and prediction, slamming and parametric roll warning, fleet fuel consumption monitoring, to ETA calculation with RPM advice. OCTOPUS-Onboard improves the efficiency and safety of container shipping.



Screen shot from EMMA™ Trim optimization

Integrated power solutions for 2000 TEU container vessels



The strict emission regulations that are now in force in many ECA coastal areas present short sea shipping with a major challenge. For smaller container feeder vessels this means adapting to sharp increases in fuel prices and increasingly stringent environmental requirements.

ABB's integrated power solutions for feeder container vessels are based on a cutting edge electrical distribution concept - Onboard DC Grid. This new direct current system is designed for vessels with low-voltage power systems and produces clear energy savings through highly efficient electric power generation and distribution.

A total ABB power and control solution for a 2000 TEU container vessel will typically include:

- Main engine turbochargers
- Electric power generation systems including auxiliary generators and main engine shaft generator
- Onboard DC Grid electric power distribution system
- Integrated vessel automation – IAS and PMS
- ABB's Advisory Suite - energy management

Onboard DC Grid is a new innovative electric power distribution concept ideal for short sea shipping and feeder container vessels

Onboard DC Grid

The new Onboard DC Grid concept makes it possible to combine the advantage of AC components with smart DC distribution technology. It uses conventional AC generator sets, but the AC power is converted to DC immediately after the generators and is distributed efficiently throughout the vessel. Each consumer simply takes its energy from the common DC bus wherever the consumer is located. The result is a more energy-efficient distribution system with fewer and lighter components which are more straightforward to install.

Optimized electricity production with variable speed control of the diesel/gas engines

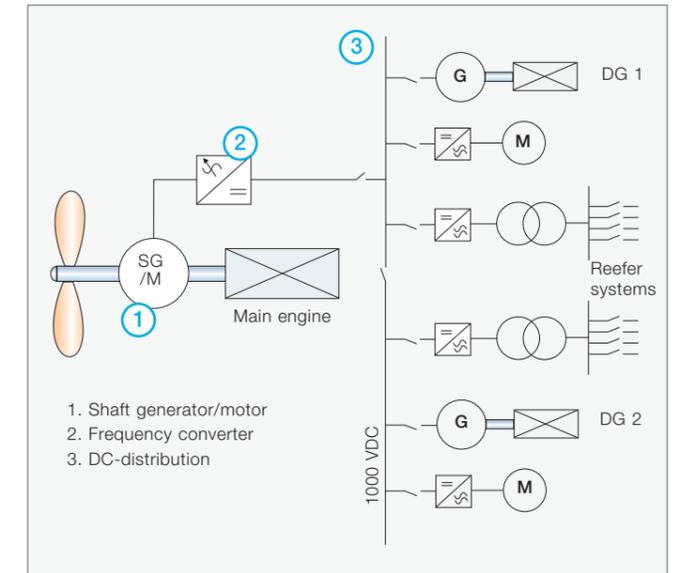
The main advantage of the Onboard DC Grid is that the generator sets no longer have to operate at a fixed speed, delivering 60 Hz current to the grid. The DC power system allows for variable speed control of the diesel engines which gives optimum fuel efficiency at every power level. This feature yields substantial annual fuel savings for a smaller container ship and reduces maintenance on the generator sets.

Main engine shaft generator/motor

Container vessels in the 2000 TEU range are not able to exploit exhaust gas from the main engine in a Waste Heat Recovery System (WHRS), as this energy source is fully utilized to provide maximum turbo efficiency.

However, as an important part of the integrated electric power concept, we employ a shaft generator/motor to fully utilize the effectiveness of the two-stroke main engine. The shaft motor provides "return-to-port" propulsion in case of main-engine failure. It also opens up the possibility of low and zero emission operations through the use of the auxiliary engines or energy storage units connected to the 1000 VDC. The shaft generator/motor system includes a rectifier for easy connection to the common DC bus.

Onboard DC Grid is an open power platform, and the system can easily be configured to combine and utilize any number and type of power sources that can be significant during the vessel's expected lifetime of 20+ years – fuel cells, solar power and batteries. This provides shipping companies with adaptable and competitive vessels with an extended working life.



A typical electric system configuration for 2000 TEU container vessel with Onboard DC Grid.