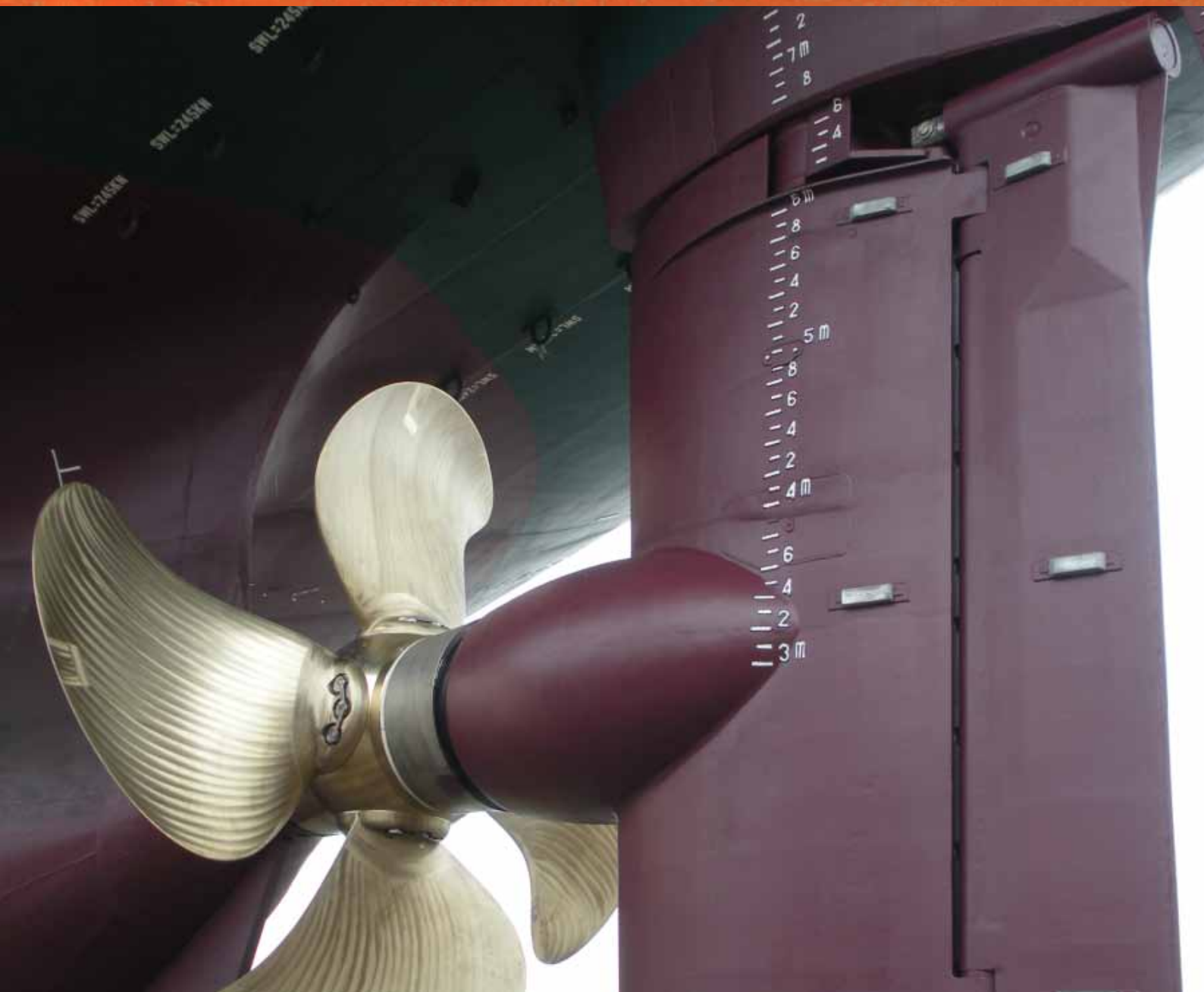
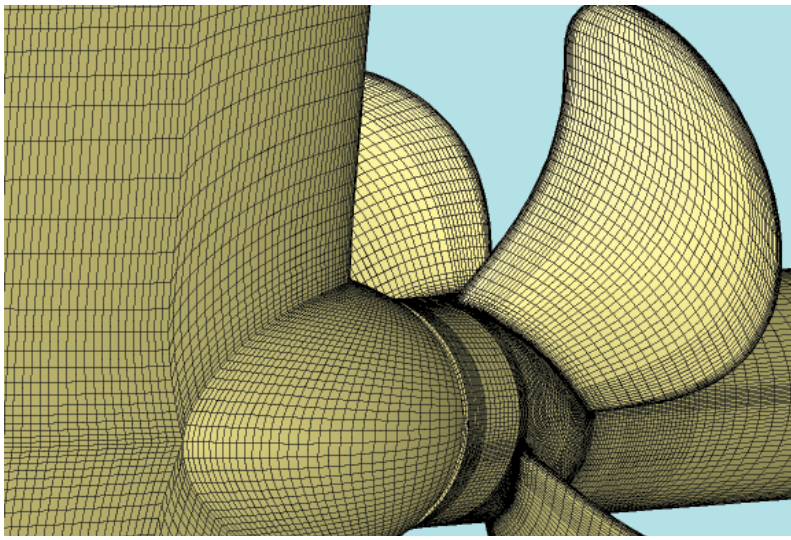
WÄRTSILÄ

WÄRTSILÄ Rudders



Courtesy of Finnlines Oy, photographed by Hannu Laakso.

Energopac incorporated in model tests, photographed by HSVA.



CFD capabilities within Wärtsilä are state-of-the-art.

OPTIMIZING ENERGY EFFICIENCY

Wärtsilä is continuously looking to improve the energy efficiency of its propulsion solutions. In so doing, we aim to reduce fuel consumption, lower the operational costs of seagoing vessels, and, of course, cut back on emissions. We design our solutions to meet specific customer requirements, utilizing our extensive marine industry experience and state-of-the-art, modern techniques, such as CFD (Computational Fluid Dynamics).

Our high efficiency rudder technology dates back to the 1990s when Wärtsilä started making energy-saving rudders. Since then more than 30 vessels have been equipped with our energy-saving rudders, and all of them have proven to be very successful in saving fuel. For example, the fuel consumption of a series of chemical tankers has been reduced by 5% sailing at 17 knots. Another example is a series of general cargo vessels, with fuel savings of 4% at 23 knots.

In 2009, two Energopac systems were delivered to a newbuilding project, and in early 2010 the first Energopac retrofit was successfully installed. Another 12 Energopac systems are currently on order for delivery in 2010 and 2011.

The Wärtsilä Propeller-Rudder System, Energopac has been designed to include the following benefits:

- improved energy efficiency and reduced fuel consumption, thanks to integrated propeller and rudder design
- excellent manoeuvrability
- lower vibration levels and higher comfort onboard
- reduced levels of emissions

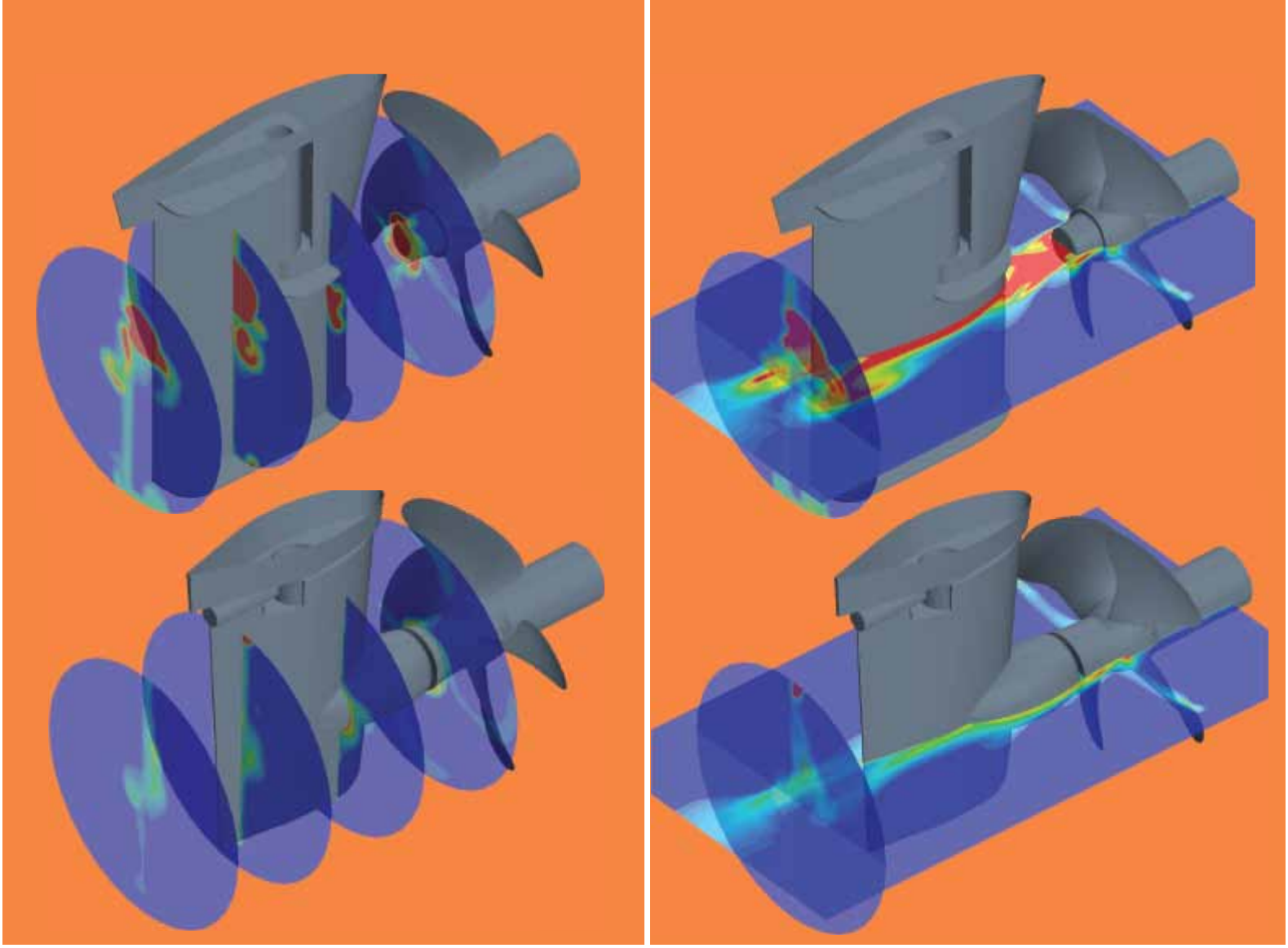
ENERGOPAC INTEGRATED PROPULSION AND MANOEUVRING PERFORMANCE

A vessel's power efficiency level is dependent upon interaction between all the main components. To achieve optimal performance, these need to form a single integrated design. This also holds true for the interaction between the vessel's propeller and rudder.

Energopac is an optimized propulsion and manoeuvring solution for coastal and seagoing vessels. Its key objective is to reduce a vessel's fuel consumption and CO_2 emissions through integrating the propeller and rudder design. Energopac is tailored for each and every vessel to meet the customer's specific requirements, and can thus be optimized for energy efficiency, without compromising manoeuvrability or comfort.

DESIGNED FOR PERFECTION

Energopac was developed through co-operation between Wärtsilä's propulsion specialists, and the rudder experts at Becker Marine Systems. The combined experience and track record of these companies in optimizing ship efficiency is extensive, and is widely appreciated throughout the industry.



CFD images show that streamlining the flow significantly reduces separation losses from the propeller hub.

The combination of propulsion expertise and vessel manoeuvring know-how forms the backbone of this co-operation. The result is a sophisticated propulsion and manoeuvring solution, designed and optimized for energy efficiency.

The amount of fuel savings, when applying Energopac, depends very much on the vessel type, its operational profile, and on the reference propeller and rudder. We can give a good estimation of the potential annual fuel savings after having examined the vessel's design, together with alternative propulsion solutions, in detail.

Energopac is then optimized according to the specifics of the vessel. In-house, state-of-the-art CFD (Computational Fluid Dynamics) capabilities are used for the engineering. CFD makes it possible to customize the equipment for any vessel, and to tailor it to match the vessel's operational profile and other specific needs.

ENERGOPAC IN DETAIL

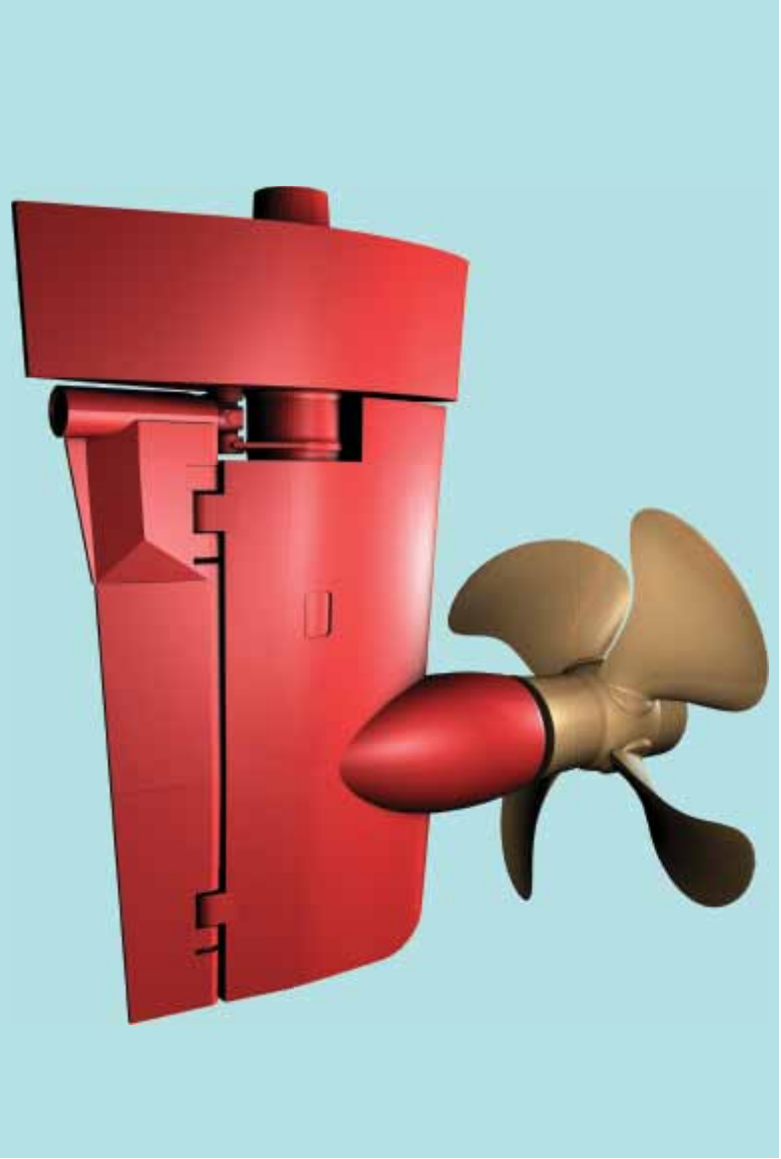
Energopac comprises several components, which vary in design and dimension, and which are modified to integrate with each other to serve the vessel in the most effective way possible. These include the propeller, a streamlined fairing cap, and a rudder system with a rudder bulb for efficiency. The interacting parts of the system are co-designed with Becker Marine Systems

Energopac includes a sophisticated full-spade flap rudder. Firstly, this provides excellent rudder balance and manoeuvring performance; and secondly it allows for a smaller overall rudder blade area, which results in lower rudder drag. Furthermore, it requires only relatively small steering angles to keep the vessel on course when in transit ensuring that the rudder bulb stays in the shadow of the fairing cap wake in steering condition.

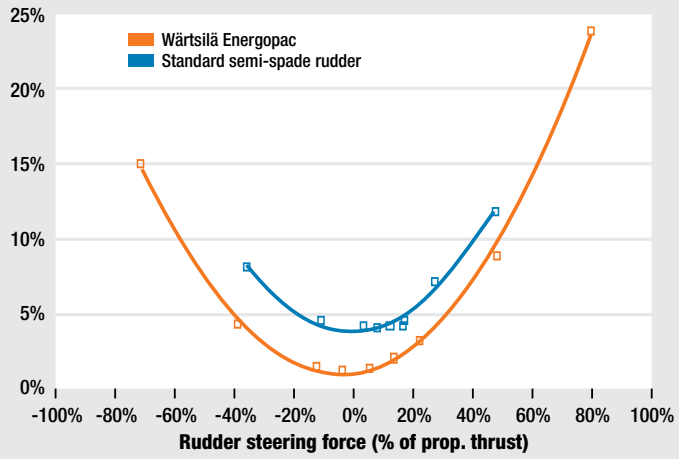
The KSR (King Support Rudder) system patented by Becker is used to construct a slim rudder profile, thereby minimizing resistance and providing a strong and stiff rudder support. The KSR support system enables the building of full spade rudders of any size, and to suit the highest ship speeds. This allows Energopac to be installed on any size vessel, even large or higher-speed vessels, which is truly unique. The asymmetric profile of the twisted leading edge rudder is aligned perfectly with the propeller's rotating slipstream. This results in less acceleration at the rudder leading edge, making the rudder less prone to propeller induced cavitation and recovering a part of the rotational energy of the slipstream, improving the propulsion efficiency of the propeller-rudder system.

The fairing cap and rudder bulb are specifically designed to reduce the separation losses behind the propeller hub, and to increase overall efficiency.

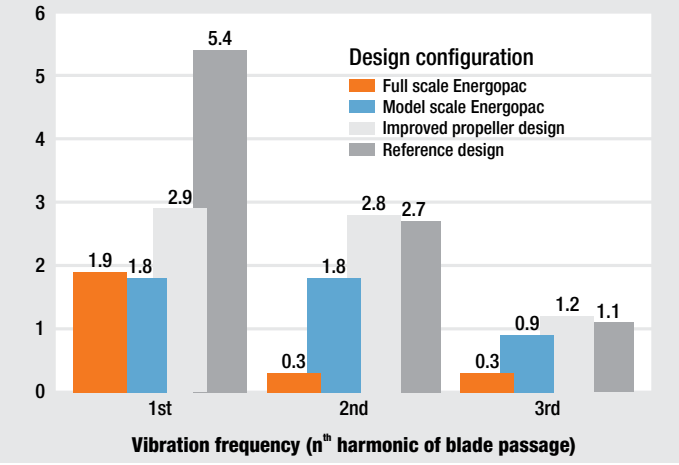
The propeller design is adapted to individual propulsion requirements. However, the design



Example arrangement of a typical Energopac solution, showing all the main components.



Energopac reduces flow separation behind the propeller hub and creates less drag than conventional rudder systems.



A standard propeller-rudder design compared with the improved design using Energopac. The reduction in pressure pulses, due to a more homogeneous water inflow into the propeller, results in lower vibration and increased comfort onboard the vessel.

is also optimized for both the rudder and the rudder bulb, thereby enabling even greater propeller efficiency when applying Energopac.

WORKING PRINCIPLES

By reducing the flow separation behind the propeller hub, Energopac effectively reduces the vessel's fuel consumption. Extended studies show that for the same course-keeping capabilities, Energopac creates less drag than conventional rudder systems.

The efficient design of the rudder bulb, particularly when integrated with the propeller and the rudder profile, streamlines the flow and significantly reduces separation losses from the propeller hub. The impact is most noticeable when a large part of the rudder bulb is behind the propeller hub. Thus, the highest fuel savings are achieved when the vessel is in transit, since the rudder angles required for maintaining course are minimal.

In course-keeping mode, Energopac has proven to save fuel more effectively than a conventional system. In particular, when using small forces for correction and steering to keep the vessel on course, the difference in rudder resistance is significant. The high-lift performance of Energopac requires smaller steering angles, and consequently reduces rudder resistance.

EFFIENCY AND COMFORT COMBINED

High performance propeller designs are often a compromise between increased efficiency and reduced vibration levels. The application of Energopac gives the vessel's designer or propulsion engineer greater freedom in optimizing opposing requirements. Energopac allows for a propeller design that meets both requirements! It will increase propulsion efficiency and/or reduce vibration levels, according to preference. At Wärtsilä we have the experience and know-how to advise our customers on the best solution for their specific combination of requirements.

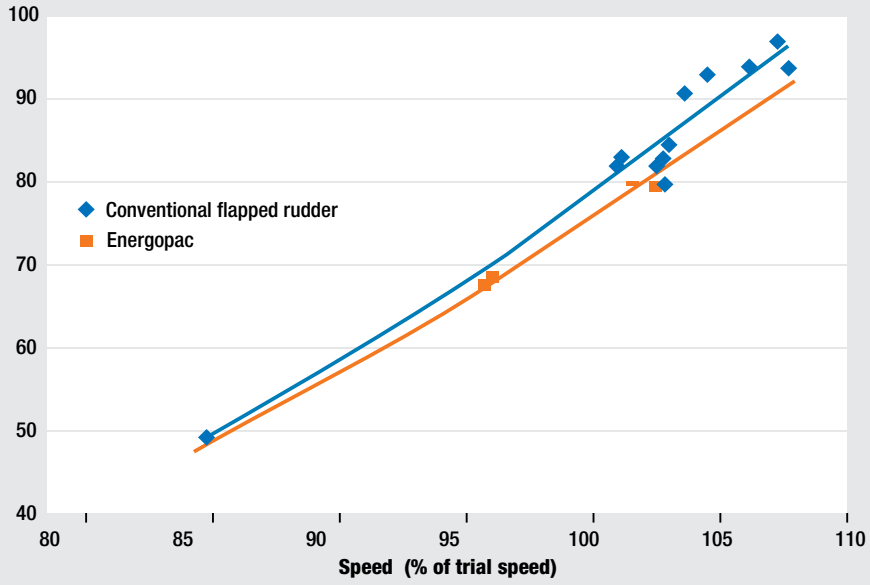
TYPICAL APPLICATIONS

Energopac will effectively reduce the operational costs for any vessel with a considerable share of free sailing time in its operational profile. It works very well for propellers with a relatively large propeller hub. The potential savings are largest for vessels having highly loaded controllable pitch propeller systems, such as RoRo-vessels, ferries, container / multipurpose vessels, and vessels with an ice class notation. On such ships with larger propeller hub diameters, the hub losses are significant with a conventional system. By applying Energopac, however, these losses can largely be avoided. Furthermore, Energopac will also show a favourable return on investment for any coastal or ocean-going vessels with considerable transit times.

SAVING WITH ENERGOPAC

Fuel savings with Energopac can be estimated for any application and are based on the vessel type, the operational profile of the vessel, and the reference propeller and rudder. Proven savings in the required power for a vessel's trial speed vary between 2% and 9%. As the actual reduction in power depends on the propulsion alternatives, the following examples give the annual savings in fuel costs for each percentage point in power reduction (based on fuel prices applicable in May 2010):

Case 1:
A 20,000 dwt cargo vessel with an 8000 kW main engine and a CPP installation will benefit greatly from Energopac in terms of power reduction. Depending on the operational profile of the vessel, the annual savings can be up to USD 35,000 for each percentage point reduction in power. In the figure above, a full scale comparison is made between standard Becker rudders and Energopac. In this figure results of speed trial measurements are shown for the same series of vessels, where 6 vessels have been equipped with standard Becker rudders and two with Energopac. As can be seen, the power savings vary from 0.5% at low speed up to 4% at maximum vessel speed. In design condition there is a 3.7% reduction in power, resulting in annual savings of more than USD 120,000.



Trial data General Cargo Vessels

Case 2:
A RoPax ferry typically has a high power density propulsion system with additional noise control requirements. This represents an excellent case for considering Energopac. With an installed power of around 25,000 kW and a twin screw CPP installation, Energopac can significantly reduce power requirements. The fuel cost savings can exceed USD 100,000 a year, per percentage point in power reduction.

Case 3:
LNG carriers sail long distances at relatively high speeds. A vessel with a capacity of 135,000 m^3 usually has 28,000 kW installed on a single fixed pitch propeller. Applying Energopac will save roughly USD 135,000 a year in fuel, for each percentage point in power reduction.

WÄRTSILÄ

Wärtsilä is a global leader in complete lifecycle power solutions for the marine and energy markets. By emphasising technological innovation and total efficiency, Wärtsilä maximises the environmental and economic performance of the vessels and power plants of its customers. Wärtsilä is listed on the NASDAQ OMX Helsinki, Finland.

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