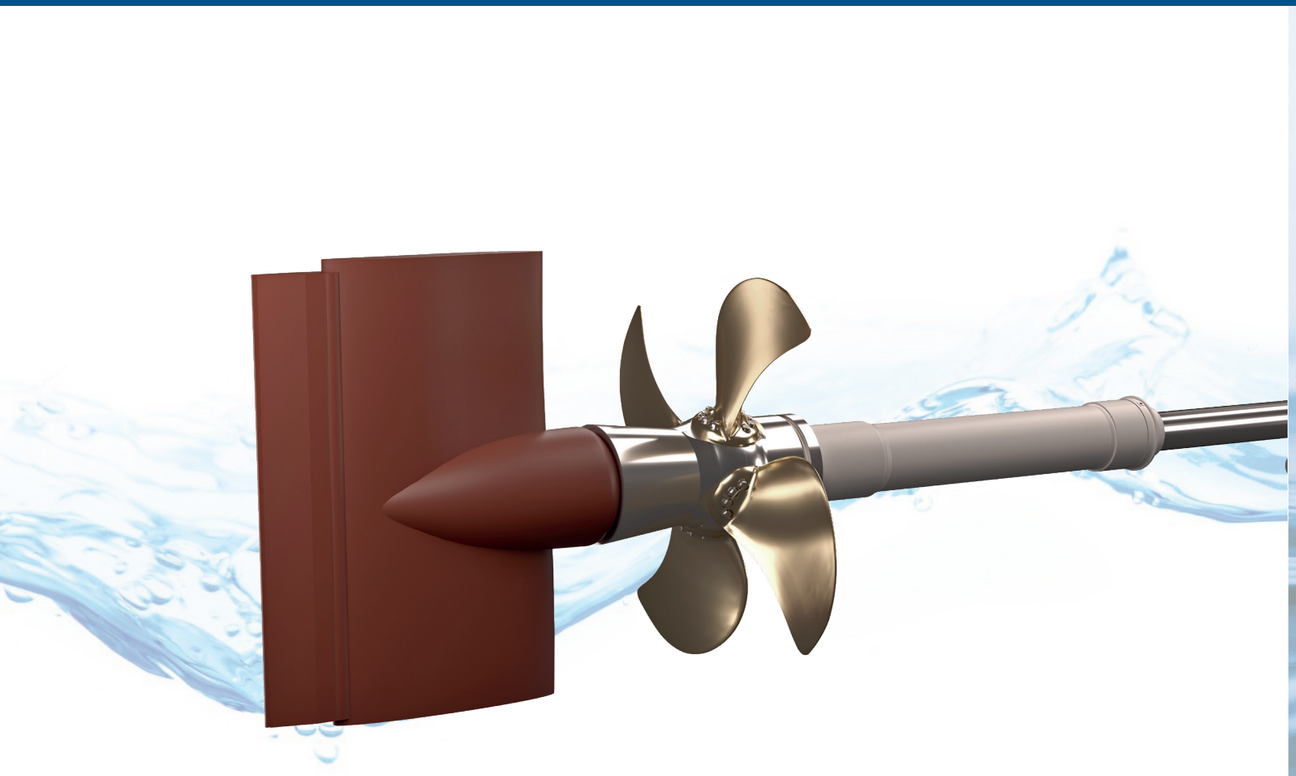
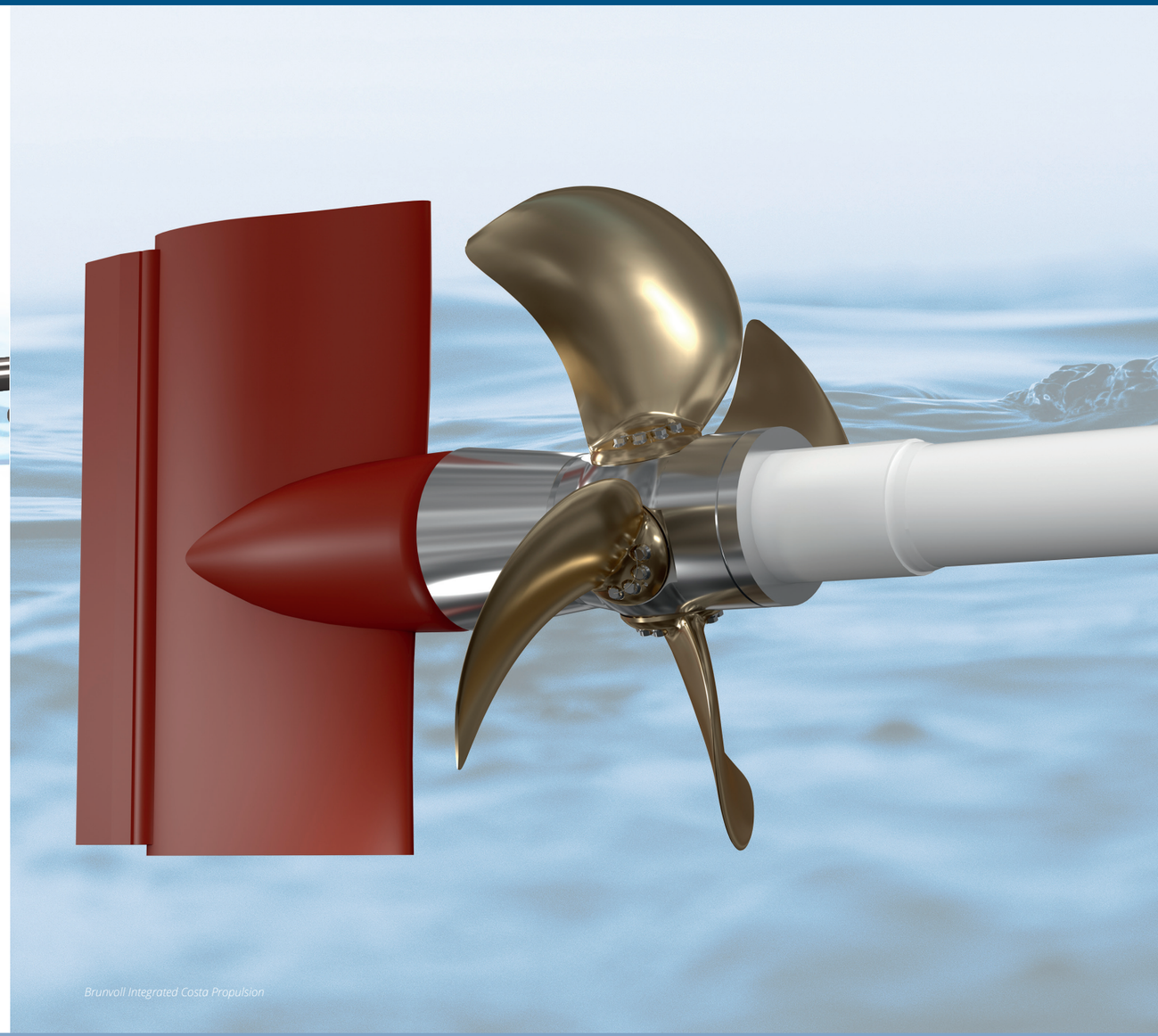


- Installation of Brunvoll - ICP improves propulsion efficiency and opex for the vessel
- Reduced fuel consumption
- Reduced emissions
- Low capex and installation time for retrofit
- Normally done in 4 -5 days during regular docking.



Brunvoll Integrated Costa Propulsion

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INTEGRATED COSTA PROPULSION

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BRUNVOLL ICP

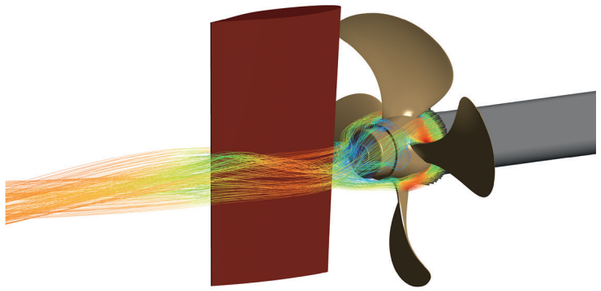
ICP Retrofit Solutions

BRUNVOLL Integrated Costa Propulsion

In a world where reducing costs and increased environmental impact are in focus, the continuous work for reduced fuel consumption is important.

Using modern hydrodynamic- and testing theory in practice have shown that the turbulent waterflow between a propeller and a rudder are actually more significant than one should firstly believe.

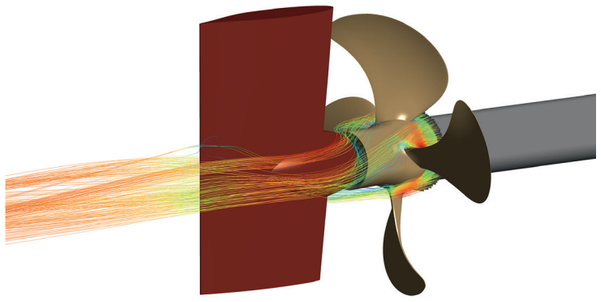
In particular for vessels with longer periods of transit condition the energy consumption can be improved by up to 7% - in average in the range from 1 – 5% depending on the vessel speed and amount of transit time. 7% are reached in combination with a twisted rudder profile



Traditional Propulsion System with Propeller and Rudder – without ICP System

Rudder with Costa bulb and CP-propeller with hub cap acting as one system

- Increased efficiency from 2-7% depending on time in transit condition and rudder design
- Reduced noise, pressure pulses and cavitation
- Robust and reliable construction
- Similar installation time as for conventional rudder and CP-propellers
- Improved low speed manoeuvrability
- Ideal for most ship types



Propulsion System with Brunvoll ICP System. Results, less noise, pressure pulses and cavitation.

Technical considerations

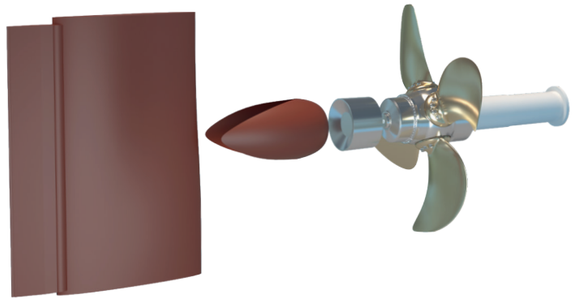
The retrofit of a Brunvoll ICP requires the following:

- Review of the operations profile
- Check of the strength of the rudder stock.
- A CFD analysis will determine the optimum design according to hull and vessel operations profile.

Normally it is beneficial to perform a model test as well.

The level of improvement is furthermore depending on the distance between the propeller cap and the rudder.

Brunvoll takes care of the entire retrofit project and performs the necessary evaluations and engineering in addition to the necessary cooperation with the rudder supplier to optimize the project.



ICP assembly consisting of rudder, bulb, cap, and propeller. Bulb and cap engineered for "plug and play"-installation.

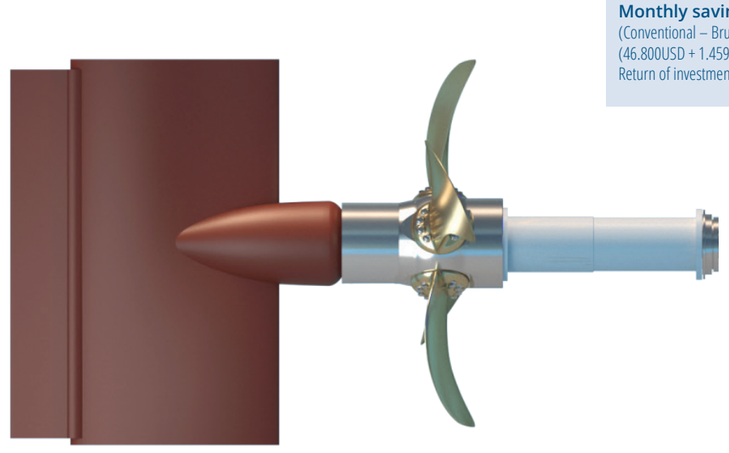
Calculated Reductions

ROI Calculation

The ICP solutions has a relatively low investment cost compared to other solutions that gives the same performance. The investment can be looked at as a one-time investment and not as an increase in assets.

The investment cost for retrofitting Brunvoll's ICP on a typical propeller plant of 2500kW is estimated to be around 50.000USD. One of the assumptions in this calculation is that the installation can be carried out during ordinary docking with a few days (4-5) days of work. This gives a ROI time less than 9 months according to investment cost and the potential fuel savings.

Given an unlikely low average energy saving of 1% - the return of investment timeline approximates 1.5 years. The reduction of fuel consumption and emissions can be observed from day one.



Calculations

Low speed operations (< 5kn):	100 days pr. year
Energy saving in low speed:	Up to 1%
Transit speed operations (> 5kn):	265 days pr. year
Energy saving in transit speed:	Up to 5%
MGO consumption:	0.20 kg pr. kwh (medium speed eng.)
Price for Marine Gas Oil (MGO):	0,540 USD pr. kg

How is it calculated?

Conventional

Duration x Effect x Consumption x Fuel cost x Load x Efficiency	= Cost
(100 days x 24 h) x 2500kw x 0,2 kg/kwh x 0,54 USD/kg x 10% load x 1	= 64.800 USD
(265 days x 24 h) x 2500kw x 0,2 kg/kwh x 0,54 USD/kg x 85% load x 1	=1.459.620 USD

Without Brunvoll ICP

(100 days x 24 h) x 2500kw x 0,2 kg/kwh x 0,54 USD/kg x 10% load x (1-0,01)	= 64.152 USD
(265 days x 24 h) x 2500kw x 0,2 kg/kwh x 0,54 USD/kg x 85% load x (1-0,05)	= 1.386.639 USD

Monthly savings and ROI time

(Conventional – Brunvoll ICP) /12 months	= monthly savings
(46.800USD + 1.459 620USD) - (25.695USD + 1 277 140USD) / 12 months	= 6.136 USD/Month
Return of investment, time = 50.000 USD / 6.135USD	= 8,15 monhts

Reduced fuel/energy consumption

Giving an impression of the scale of savings pr year – the next example shows a profile with the following conditions.

A vessel (typical cargo or fishing vessel) with 2500kW power to propeller with given operations profile, reduces the fuel cost with more than 73 629 USD pr year with this rebuild.

For a vessel with 8000 kW installed power (typical 20 000 dwt cargo vessel) and the above parameters, the reduction in fuel cost amounts to more than 200 - 250 000 USD pr year.

ICP Solution on the Plug-In hybrid Ro-Ro Passenger ship "Color Hybrid".