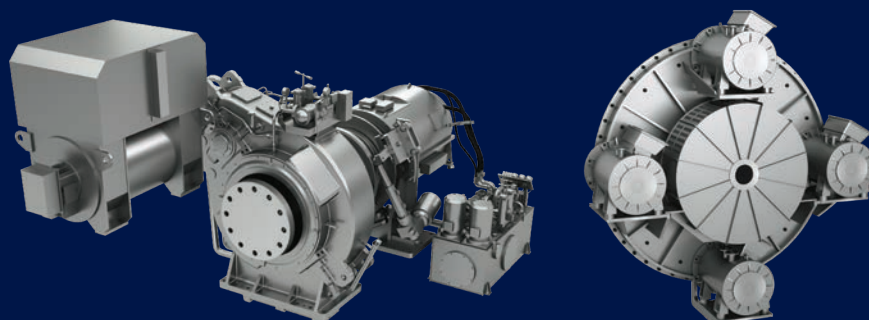




Innovative Power Transmission



PTO Solutions for low speed engines by RENK
MARHY-System | Integrated Front-end Power System (IFPS)

RENK is one of the world's leading manufacturers of single- and twin-engine gear units for marine and stationary applications, auxiliary marine drives, tunnel gear units, shaft generator drives and propeller shaft clutches.

Our commitment to minimizing fuel consumption while meeting even the most advanced emissions regulations plays a vital role in safeguarding the environment for future generations.

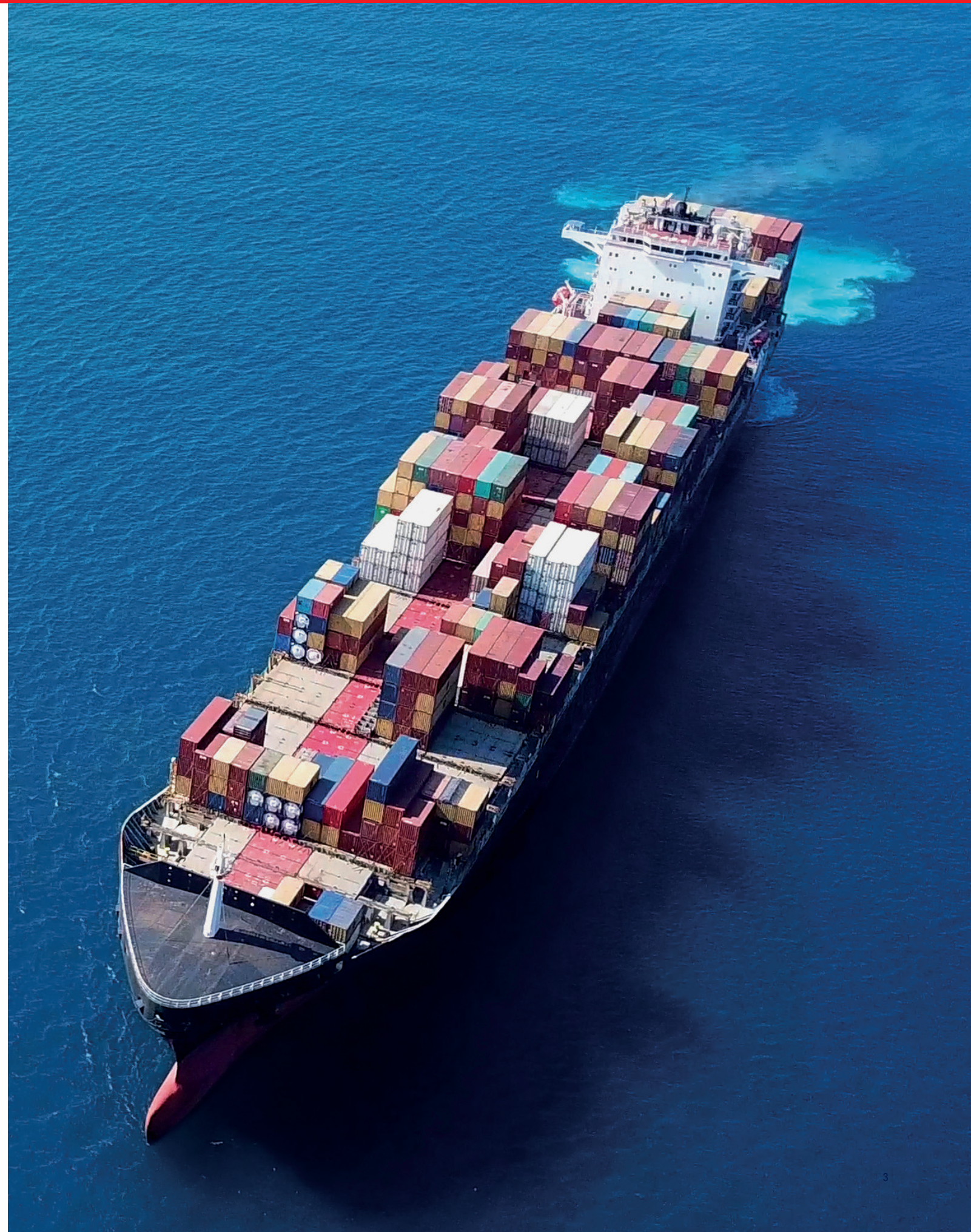
We are seeing unprecedented climate change threaten our vital, yet fragile ecosystems. The knock-on effects of rising temperatures caused by green-house gas emissions such as carbon dioxide (CO₂) could have disastrous effects on global agriculture and trade. That's why it has never been more important to limit the cause and effects for future generations.

Shipping makes a difference

Maritime transport will continue to expand with increasing globalization, and although shipping already counts as the most efficient form of bulk transportation, the industry has recognized that more can be done. Optimized transmission solutions and improved designs lay the foundations for positive change. Working with key stakeholders, the International Maritime Organization (IMO) has outlined new standards for greater efficiency throughout all stages of a ship's lifecycle. One such measure, the Energy Efficiency Design Index (EEDI), is a perfect example of this ambitious goal.

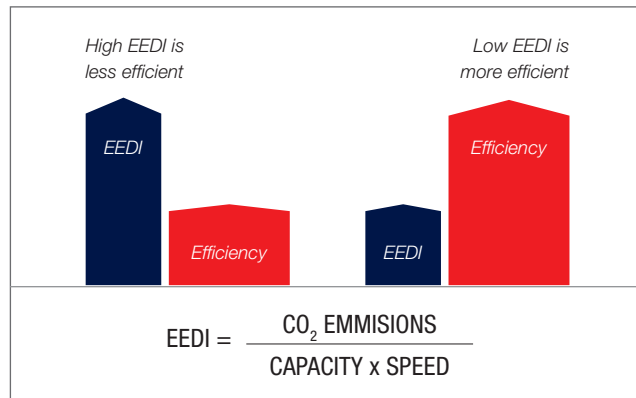
It pays to get on board

With the international shipping industry so committed to ensuring positive change, it will be crucial for individual ship owners and operators to move with the tide. Market-based measures such as levies or emissions trading are foreseeable in the future, and this will only create further incentives to invest in efficient ships. Though final decisions have not yet been made in this respect, the IMO is certainly considering the possibility. So now is the time to act.



Overview EEDI

High and low EEDI



No EEDI for:

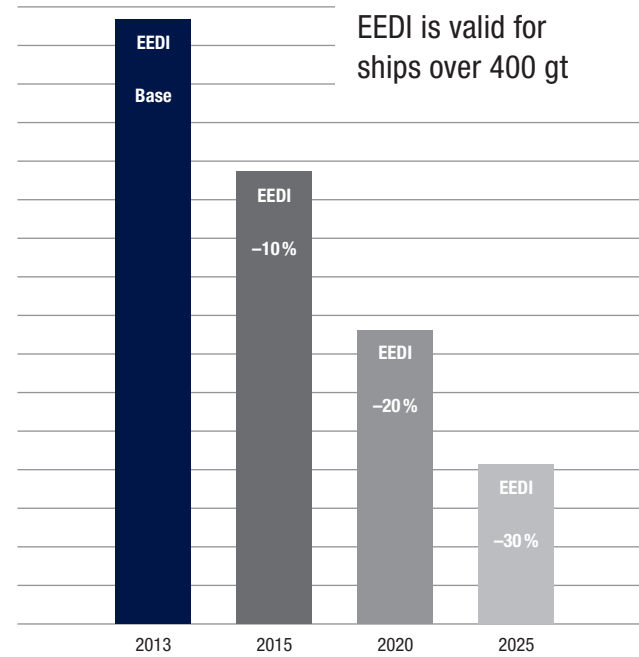
- Gas turbine
- Diesel-electric drive*
- Hybrid propulsion
- Offshore vessels

* except for Cruise Passenger Ships and LNG Carriers

What is it?

The EEDI is used to calculate a vessel's energy efficiency. This is based on a complex formula, taking the ship's emissions, capacity, and speed into account. The lower a ship's EEDI, the more energy – efficient it is and the lower its negative impact on the environment. IMO regulations stipulate that ships must meet a minimum energy efficiency requirement, so their EEDI must not exceed a given threshold.

New ships over 400 gt (keel-laying after July 2013)



Extension of regulated ship types

Although there were a lot of exemptions in the beginning, the number of ship types to which the EEDI does apply is steadily increasing. According to the latest updates, RoRo, RoPax, Cruise Ships with diesel-electric propulsion and LNG carriers with diesel-mechanic or diesel-electric propulsion have to meet the limits of the required EEDI. However, based on the results observed in the first phase of the initiative, the IMO intends to expand the EEDI to include additional types of ships in the future. Here too, it will be invaluable for ship operators to keep abreast of the changes.

Power Take Off (PTO) Solutions

Maritime PTO solutions for 2-Stroke diesel engines give a fast return of invest by reducing exhaust emissions and fuel consumption as well as optimizing the EEDI Index. These are important arguments for a new ship design.

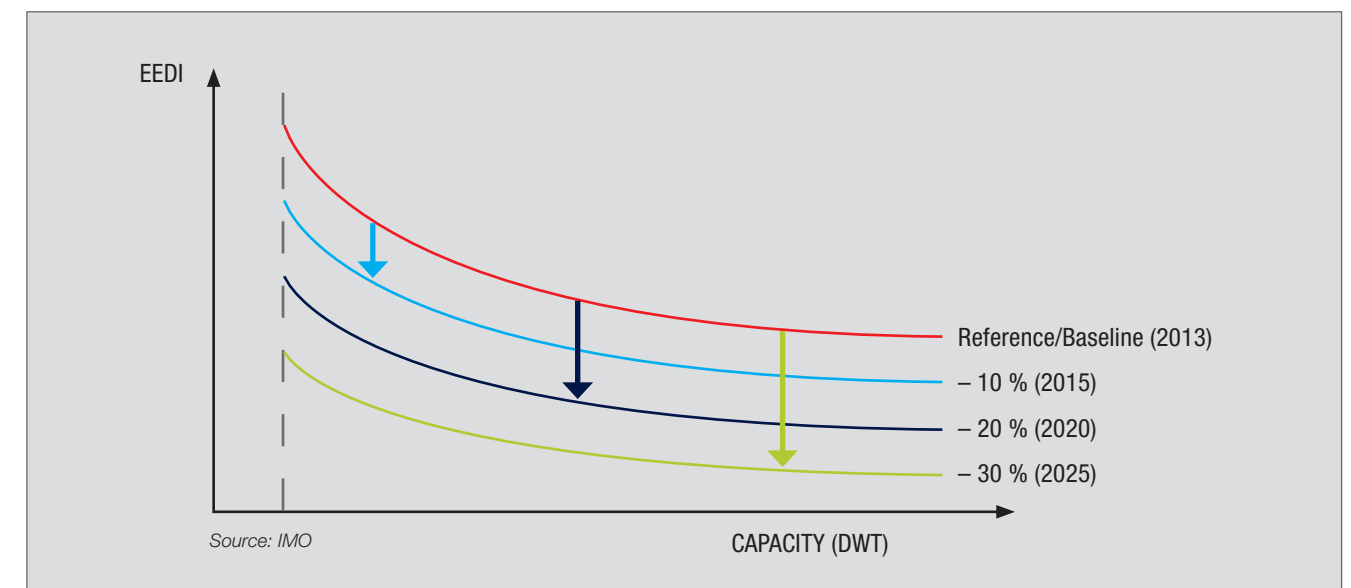
Compared with common gensets on board, PTO solutions can generate power more efficiently. The reason behind this fact is that the level of efficiency of the main drive engine amounts to approx. 53 %, whereas gensets only reach approx. 43 %.

The possibility of main engine power generation (PTO) is now playing an increasingly important role in the light of the stricter environmental legislation on emissions from ships coming into force in 2020. It states that emissions of nitrogen oxides (NOx) must be reduced by 80 %, sulphur oxides (SOx) must not exceed 0.5 % instead of 3.5 %, particulate matter (PM) by 90 %, and CO₂ by 20 % compared to emissions from ships currently in service. From 2050, the reduction of CO₂ emissions will be further tightened, which will then be 50 %.

In addition, there are other country-specific environmental regulations in coastal areas and many ports worldwide. This will make a PTO system indispensable in the future.

Benefits

- High efficiency for generating electric power
- Increased flexibility
- Low operation cost by using HFO or LNG
- Reduction of gen-sets in size or amount as well as maintenance cost
- Reduced CAPEX and OPEX
- PTO has a big influence to reach a low EEDI
- Suits FPP (Fixed Pitch Propeller) and CPP (Controllable Pitch Propeller) installations



RENK Power Take Off (PTO) – MARHY

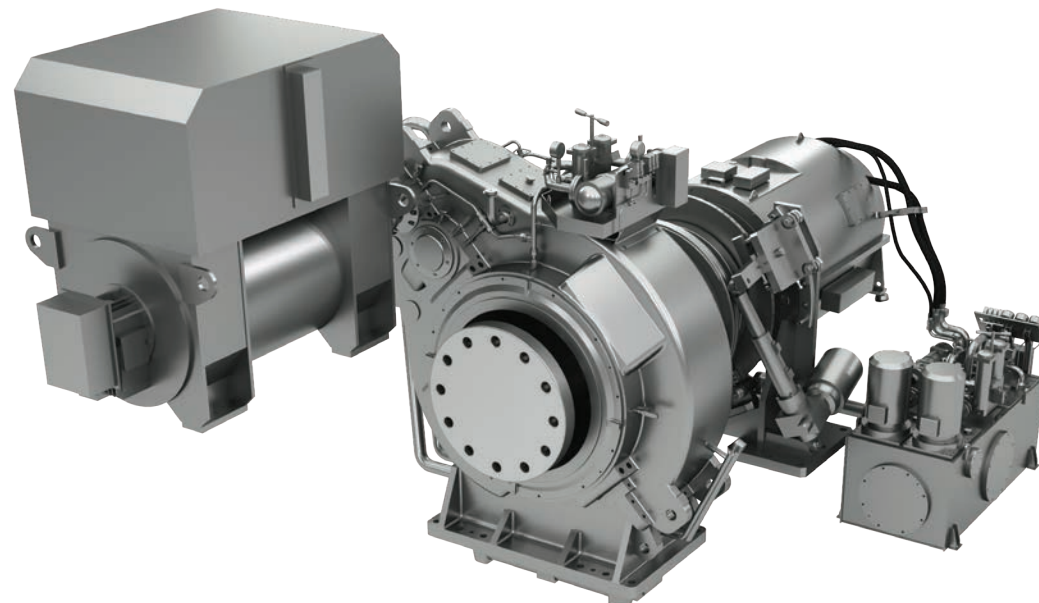
The RENK MARHY solution consists of well-known and proven standard components such as a tunnel gear unit, a propeller shaft clutch and electronic components which make the hybrid system payable and reliable for many applications.

Two-stroke diesel engines have a very high efficiency combined with a simple and reliable technique. These benefits make the engine still irreplaceable in the future. The MARHY package can be added to this propulsion system quite easy. It fulfils the classification requirements like Bureau Veritas AVM-APS, Lloyds Register PMRL and the “safe return to port” requirement for passenger vessels. Hazardous cargo in chemical tankers, container- or crude oil vessels can be transported in restricted areas.

Three propulsion modes are available:

- Propulsion mode and simultaneously production of electric current, power take off (PTO).
- Propulsion mode and simultaneously power boosting via electric motor, power take in (PTI).
- Electric propulsion mode, power take home (PTH)

RENK supplies the whole package consisting of tunnel gear-box, propeller shaft clutch (PSC), electric motor, frequency converter and couplings.



Benefits
<ul style="list-style-type: none"> • Scalable PTO power • Simple and reliable solution • Reduced maintenance costs due to reduced operating hours of auxiliary generators • Redundancy for single screw vessels • Possibility to use as PTH or PTI • Either parallel operation with one or more gensets for peak loads or MARHY solution as single power source • Suits FPP and CPP installations • Fuel savings and CO₂ reduction – achieving EEDI goals

RENK Power Take Off (PTO) – Integrated Front-end Power System (IFPS)

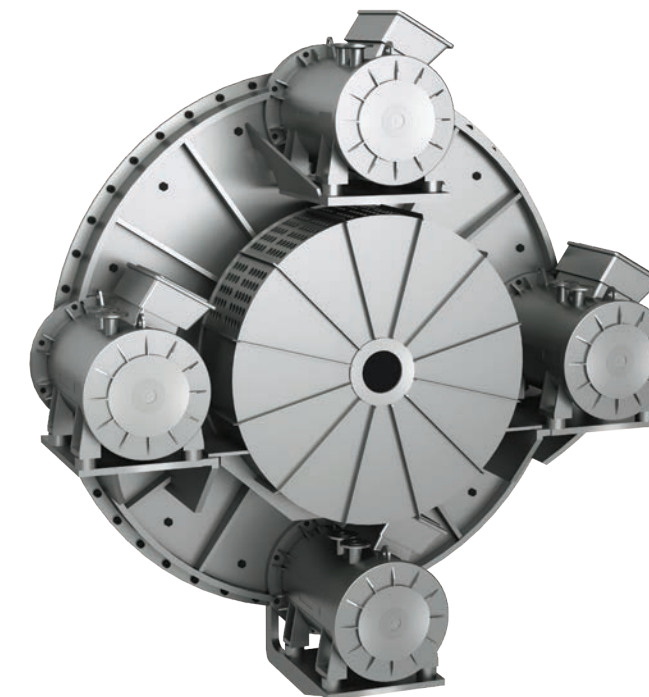
The Integrated Front-end Power System consists of a single-stage gearbox, one or multiple generators and associated frequency converters as well as the transformers for the connection to the ship's grid.

Developed for front-end mounting it can be applied where there is no space for other PTO solutions arranged between the main engine and the propeller. As the space on the front-end is in most cases also limited, the system features a flat gear unit design and specially designed short generators.

The gear unit is connected to the crankshaft via an intermediate central shaft and a highly elastic coupling. The angle encoder of the main engine is mounted to the coupling cover.

The installation of the Integrated Front-end Power System requires only a few simple alterations on the main engine housing and the crankshaft. Directly mounted on the engine's front-end, the system needs no additional foundation, thereby reducing the installation costs. The modular concept allows the adaption of multiple generators of the same size. The main advantage is that the system's power rating is scalable from 500 kW up to 2,000 kW without the demand of additional axial space.

A regenerative frequency converter with active infeed unit allows constant grid frequency at a variable main engine speed. The electrical design is intended for both paralleling with other gensets and island operation (Integrated Front-end Power System as sole source of electric power).



Benefits
<ul style="list-style-type: none"> • Scalable PTO power from 500 up to 2000 kW without the need of additional axial space • Space saving due to flat gear box design and short generators length <1600mm (equals 2 frames) • Reduced maintenance costs due to reduced operating hours of auxiliary generators • Simple and reliable solution: Front-end mounted PTO system for 2-stroke engines based on the well-proven RENK tunnel gearbox design • Either parallel operation with one or more gensets for peak loads or Front-end PTO solution as single power source • FPP and CPP installations • Fuel savings and CO₂ reduction – Achieving EEDI goals

We set the proof

TECHNOLOG Services has conducted a study on RENK PTO solutions in regards to fuel saving, efficiency, OPEX and EEDI.

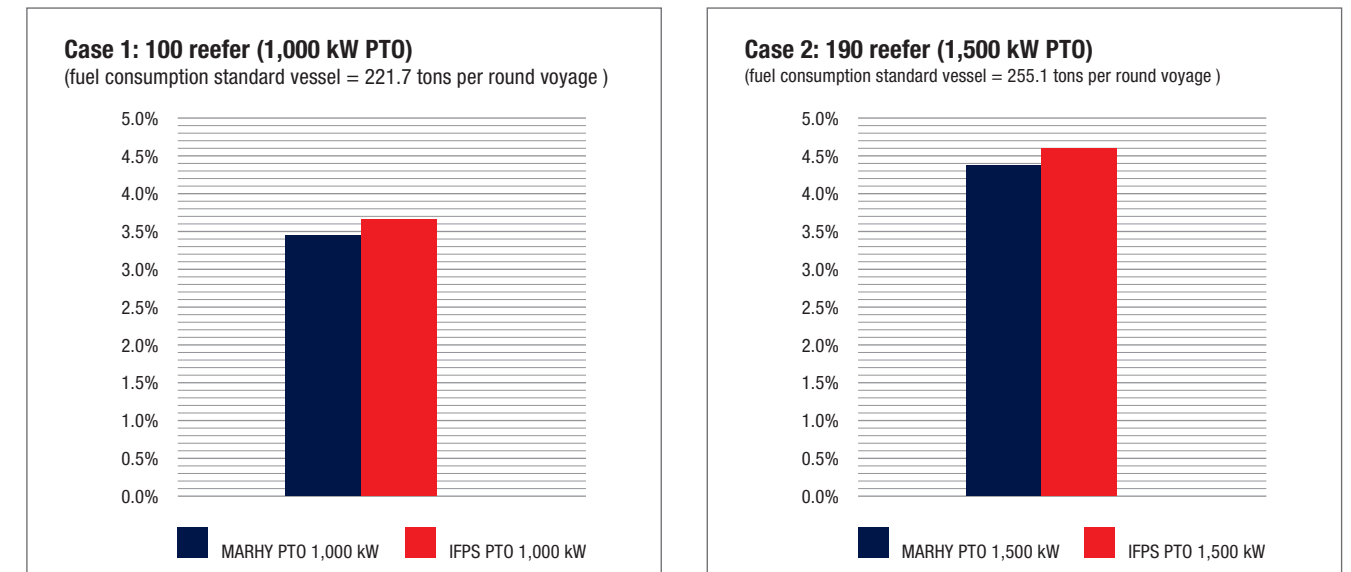
Basis for this study was the vessel STREAM 1400 shown below and a typical Northern European roundtrip voyage of 14 days, 13 ports and approximately 3,000 nm.

Vessel data:	
Length over all:	149.90 m
Deadweight:	15,500 dwt
De-rated Maximum Continuous Rating:	9,250 kW x 88.0 rpm
Power of Generator sets:	3 x 1,050 kW
Container Capacity:	1,400 TEU



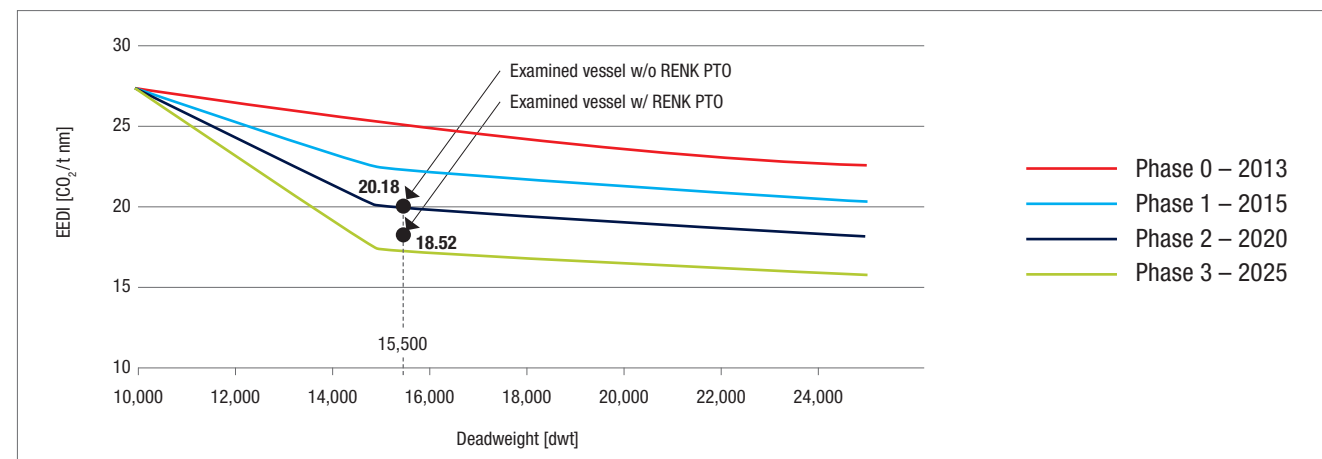
modern STREAM 1400 feeder vessel*

Fuel Cost Savings RENK PTO Solutions vs. Only Auxiliary Gensets



Relative saving potential compared to standard vessel*

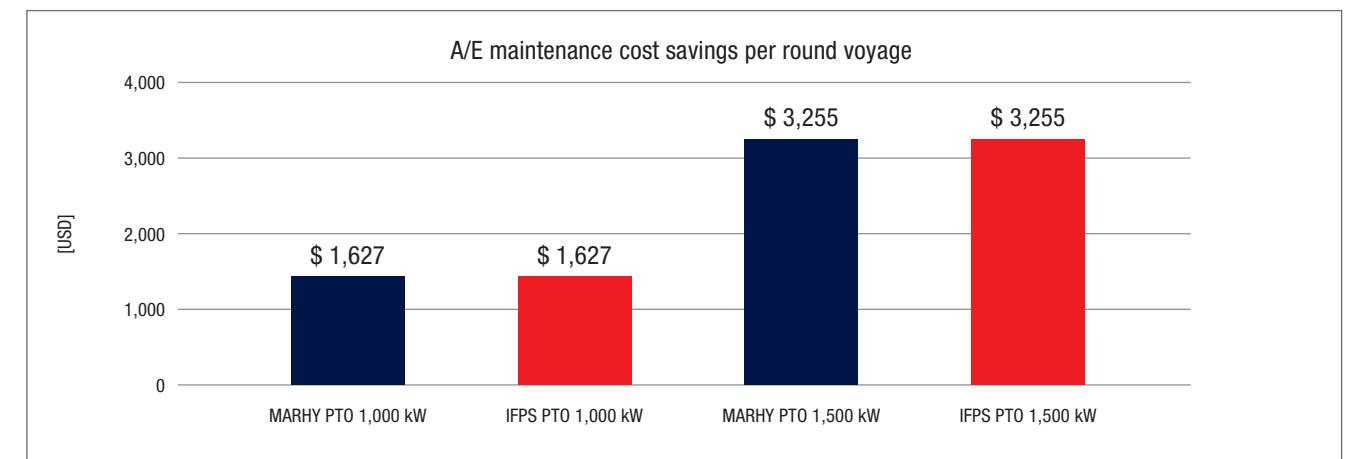
EEDI Calculation



EEDI reference curves as well as attained EEDI for STREAM 1400 vessel*

*Source: TECHNOLOG Services

Maintenance Cost Savings RENK PTO Solutions vs. Only Auxiliary Gensets

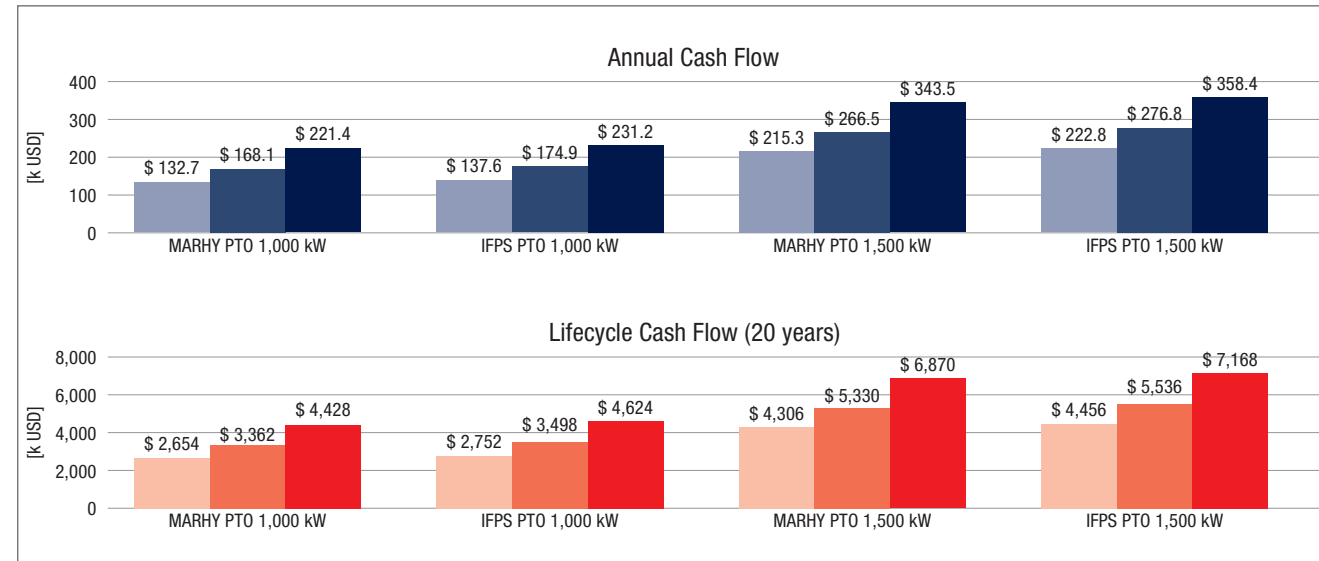


Absolute maintenance cost savings for auxiliary gensets (A/E) based on USD 10 per operating hour*

*Source: TECHNOLOG Services

OPEX Savings

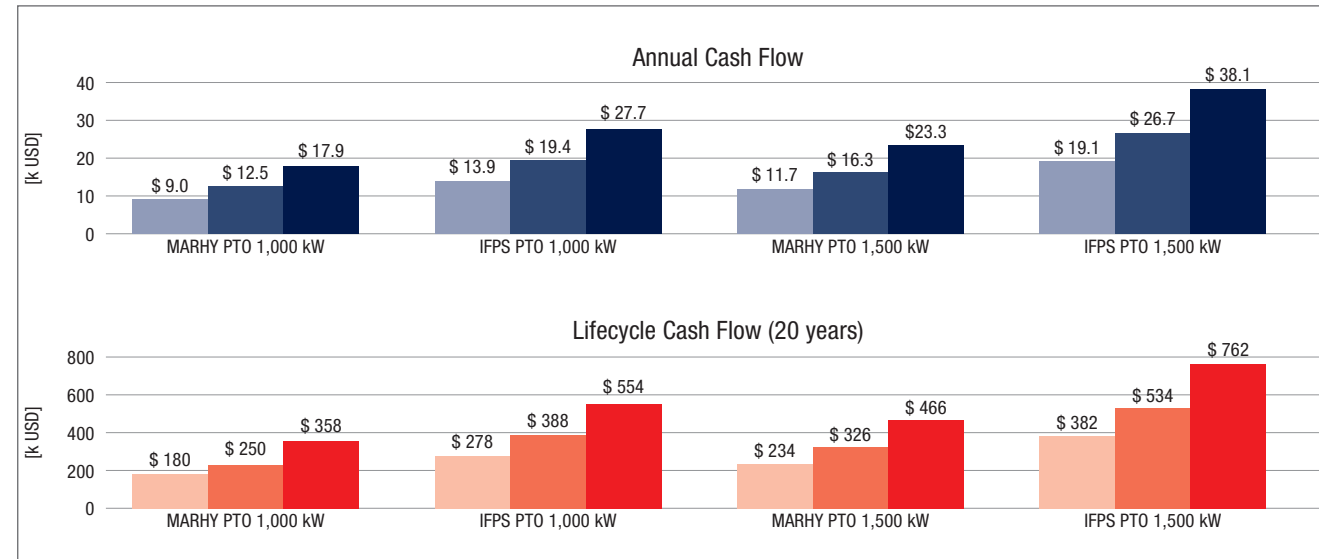
RENK PTO Solutions vs. Only Auxiliary Gensets



Total annual and lifecycle OPEX saving potential with RENK PTO solutions compared to auxiliary gensets*

OPEX Savings

RENK PTO Solutions vs. Inline Shaft Generators



Total annual and lifecycle OPEX saving potential with RENK PTO solutions compared to inline shaft generator PTO*

In order to show different case scenarios the study has used low, medium and high bunker prices. The calculations are based on 75% of the operating time with LSMGO (0.1% S).

low case mid case high case

	Bunker Price (\$/t)		
	low case	mid case	high case
Marine Diesel Oil (MDO 0.5% S)	421	589	842
Low Sulphur Marine Gas Oil (LSMGO 0.1% S)	450	630	900

*Source: TECHNOLOG Services

Benefits

- Fuel saving potential using PTO solutions up to 4,6%
- Maintenance cost savings potential up to USD 3,500 per roundtrip, amounting to up to USD 90,000 saving annually
- OPEX savings potential up to USD 360,000 annually, amounting to USD 7,200,000 savings per 20 year lifecycle
- Potential to achieve EEDI goals of phase 2 (2020) simply by using RENK PTO solutions
- Further potential to achieve even EEDI goals of phase 3 (2025) possible by simply adapting RENK PTO solutions (PTI drive mode is already available with MARHY solution)
- Potential of amortization within 3–4 years of operation





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