

SERVOGEAR



**PROPULSION EFFICIENCY
BEYOND BELIEF**



Workboats



Fast Ferries

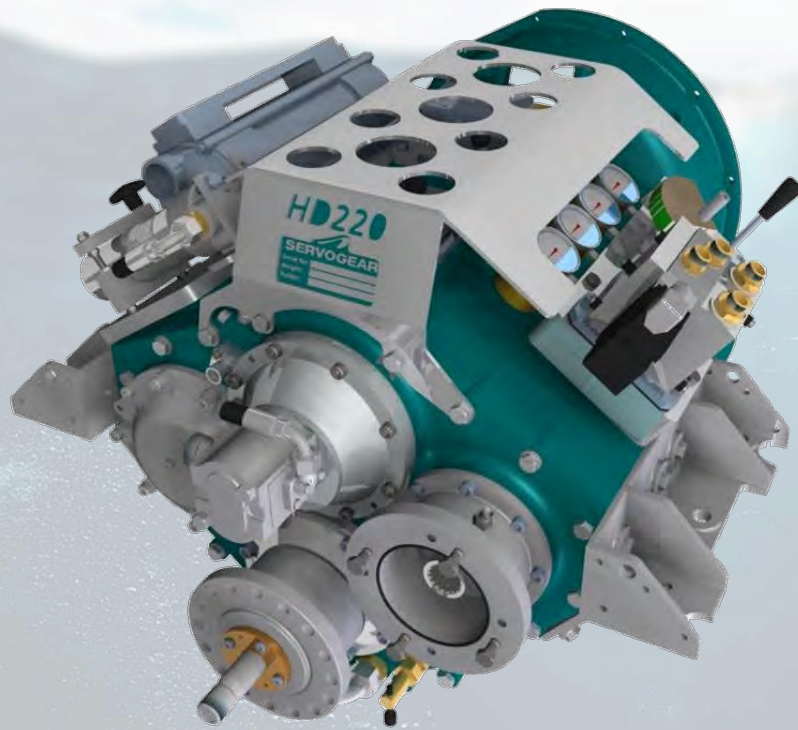


Offshore



Yachts

Propulsion efficiency **beyond belief!**



" ... Mechanical design should be as thoughtful and elegant as the hydrodynamic ..."



The unique brand of Servogear

Servogear Ecoflow Propulsor™

The most versatile propulsion you can get ...

... gives you the strongest combination of these facts

- High speed operation
- High bollard pull forces
- Less operational fuel cost
- Wider operational range
- Made for DP Operations
- Improved operational flexibility
- Environmental friendly
- High acceleration and maneuverability



RESULT: Unbeatable combination of speed and thrust

More than 1600 gears and propulsion systems delivered world wide

... from fishery in the Fjords of Norway, 1973



VD 60 C-gear
1973-1985
Maks 300 hp



VD 760 Propell
1973-1985
Dia: 520-690 mm



M/S Siv Hege, the first Vessel with Servogear

... to Superyachts in Miami, 2015

Palmer Johnson's Super Sport 48 meter, carbon-fibre motor yacht



... And World Wide «Offshore»,

Fast offshore and windfarm vessels, with high speed and high bollard pull for multi purpose operations, in all weather conditions



Servogear Ecoflow Propulsor™ - The Concept


THE CONCEPT

CP Propeller, in unique Propeller Tunnel



Range: 300 – 4000 kW (per shaft)

Speed: Up to 50 knots

PROPELLER TUNNEL

Servogear's unique propeller tunnel designs ensure optimal performance for the propulsor.

EFFECT RUDDER

Asymmetric airfoil design rudders combine minimal drag with the creation of forward thrust.

CONTROLLABLE PITCH PROPELLER

Servogear's unique, well-known and proven CPP design ensures a number of benefits compared to fixed pitch propellers and water jets.

SHAFT BRACKETS

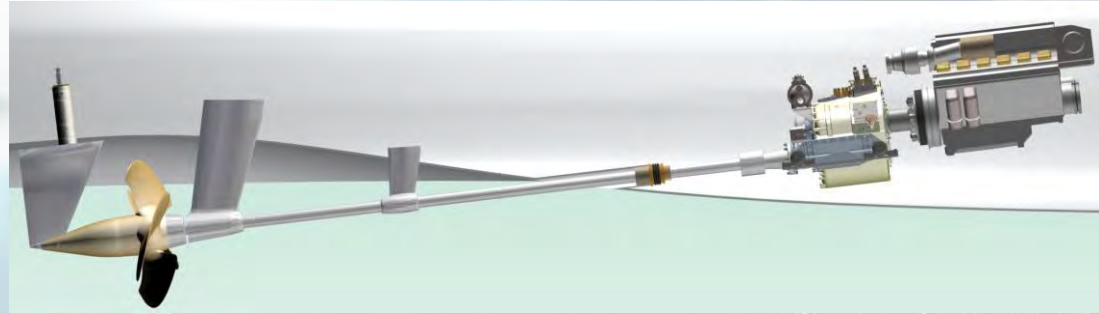
The slim design reduces drag for high speed operations up to 50 knots.

GEARBOX

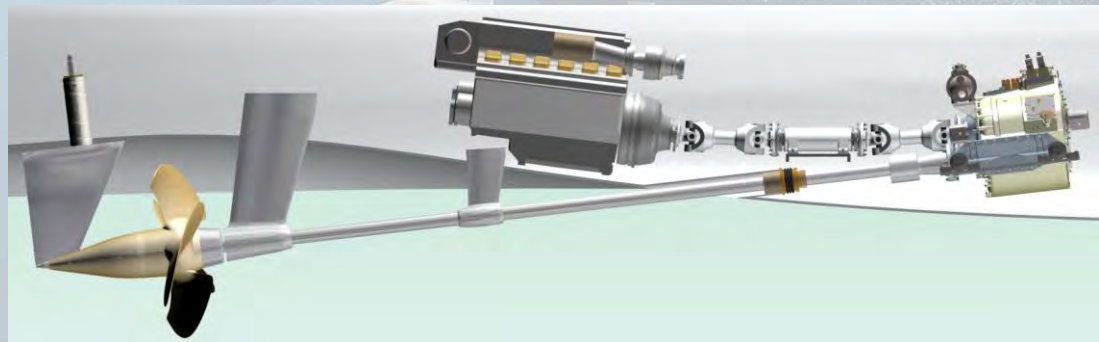
Reduction gearboxes are part of the Servogear Ecoflow Propulsor™ solution. The special design offers advantages and possibilities for versatile configurations, with built in PTO's for auxiliary equipment.

... Gear configurations

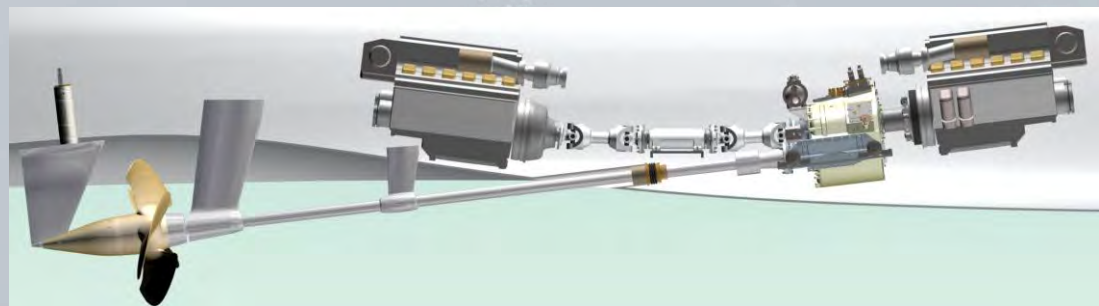
- H-gear configuration



- U-gear configuration



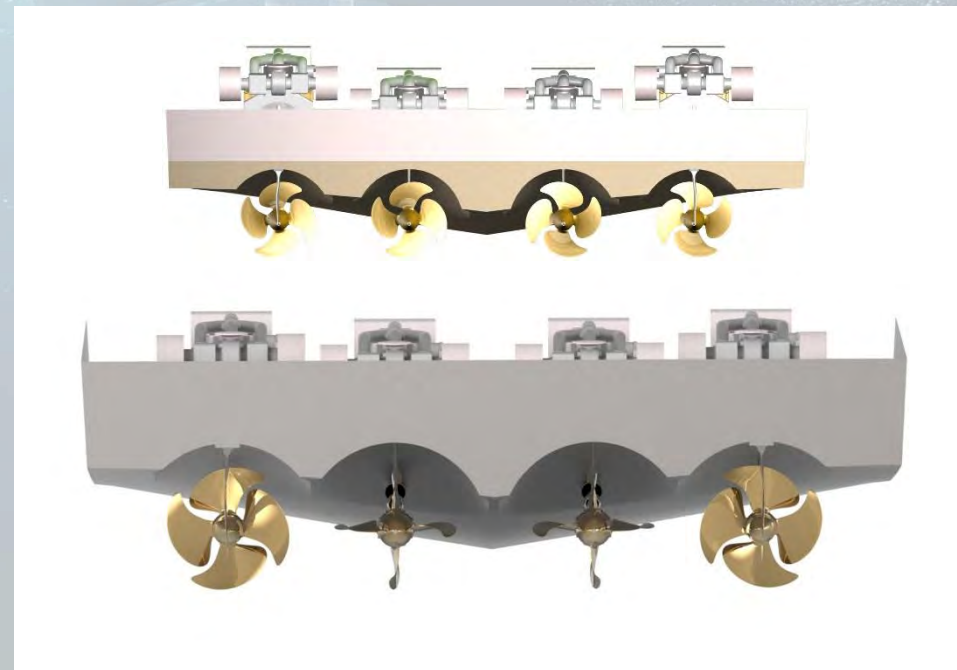
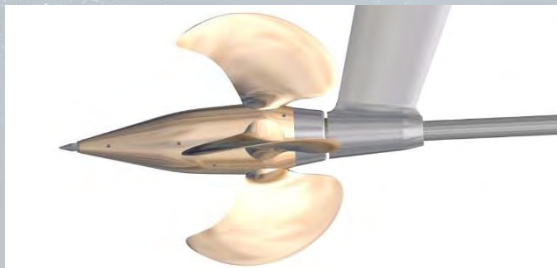
- PTI-gear configuration



... Full Feathering possibilities

- Minimum drag and resistance when sailing
- Minimum drag and resistance when running on single engine
- High fuel saving in transit voyages, steaming from A to B.

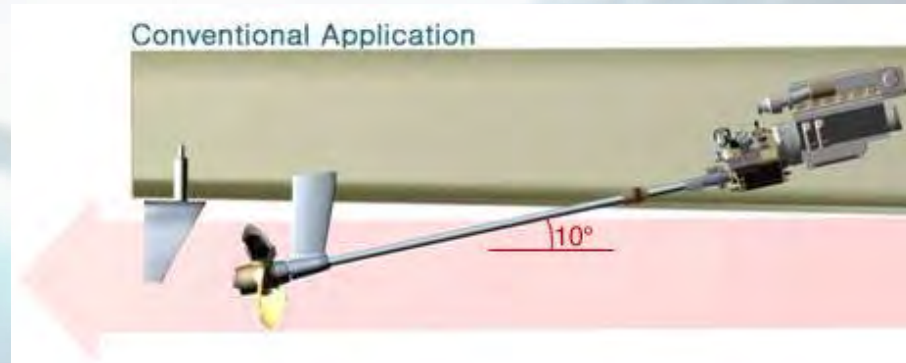
Typical installations are on single or twin engine sail yacht configuration, And multi engine configurations on Offshore MPV's and Windfarm vessels.



... Servogear propeller tunnels

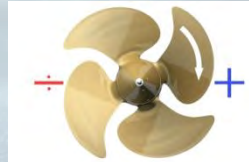
The Advantages:

- Less variation in thrust
- Slimmer design
- Less vibrations and noise
- Less drag and weight
- Reduced draft
- Reduced hull resistance



Typical angle between shaft and baseline: 10°.
Waterflow attack angle: 10°.

THRUST



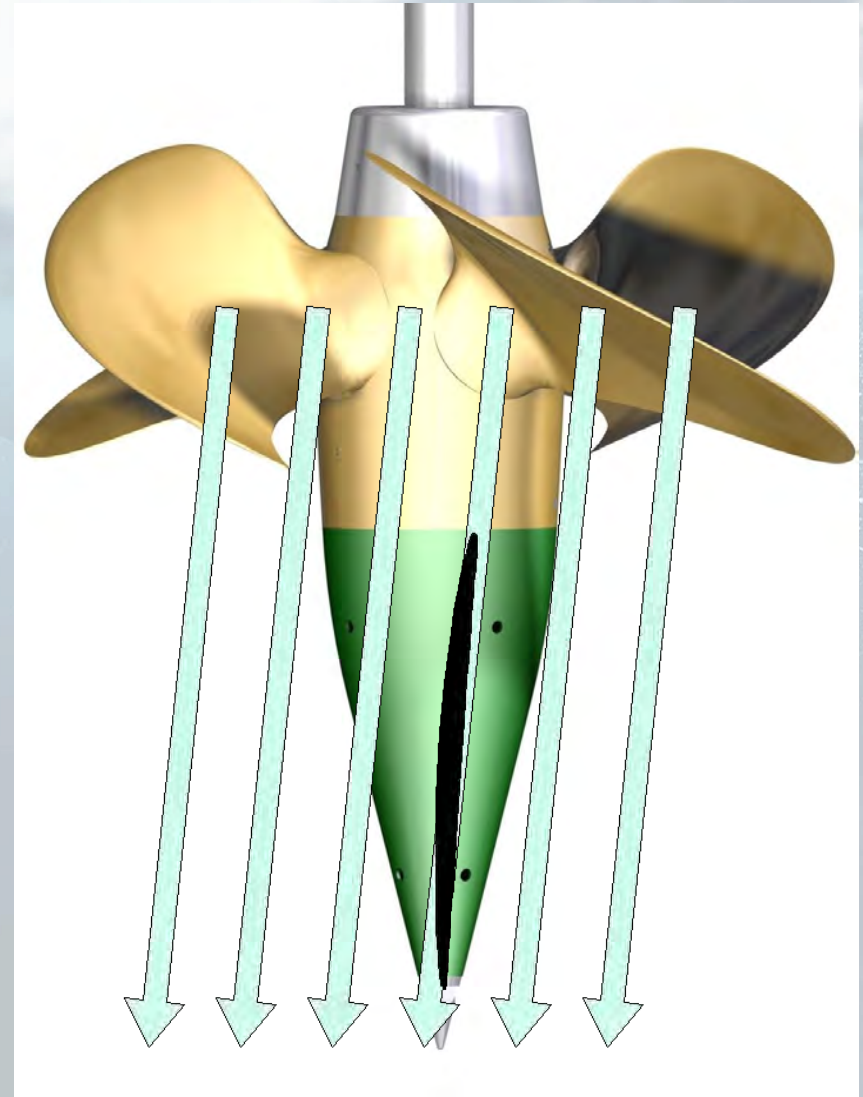
Typical angle between shaft and baseline: 4°.
Waterflow attack angle (catamarans): 3°.

THRUST



... Servogear Effect Rudders

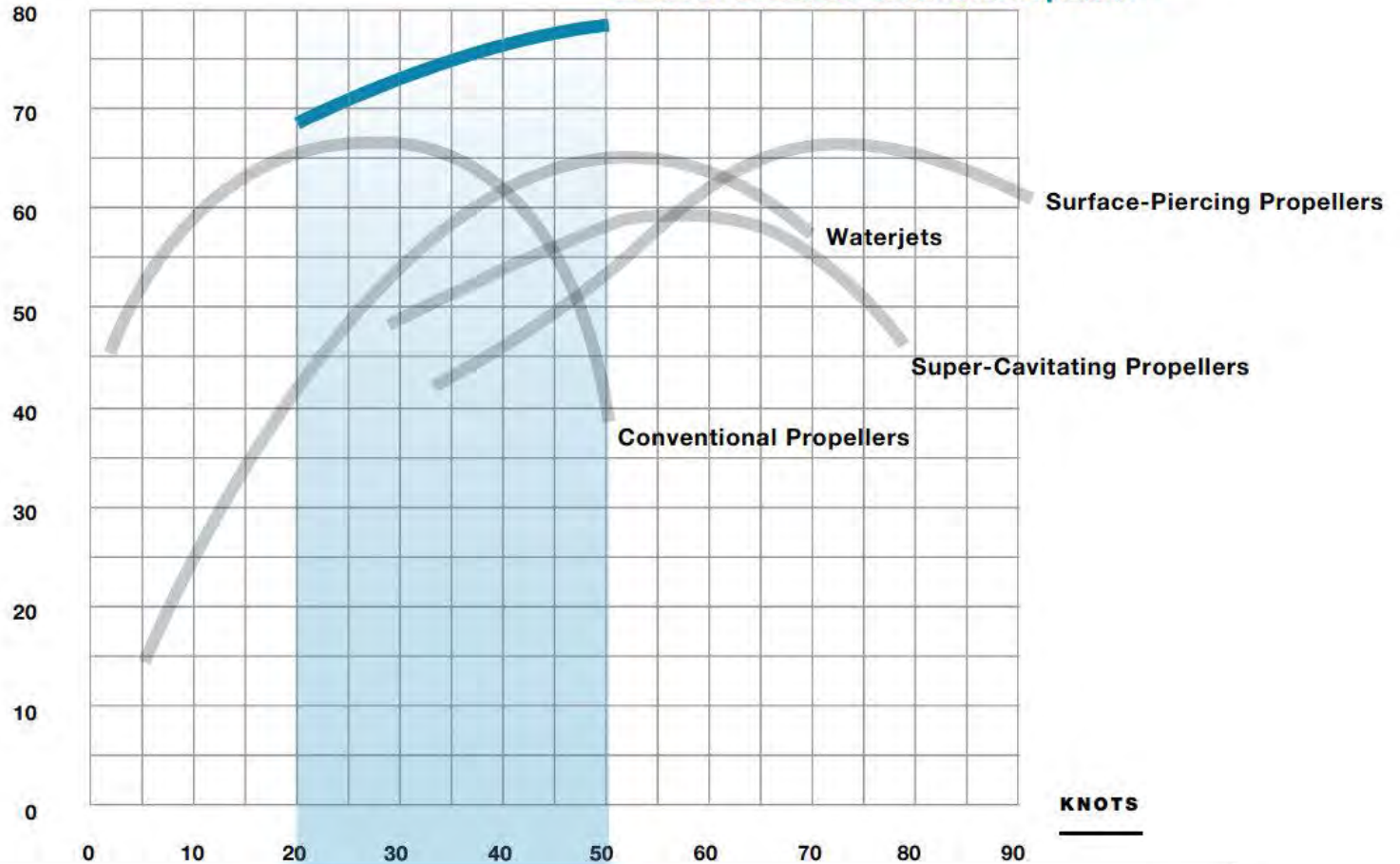
- One piece casting – slim design
- Asymmetric airfoil wing design
- Twisting reduces rotational losses
- Stainless steel or nickel aluminium bronze castings



... Efficiency Servogear SSRP

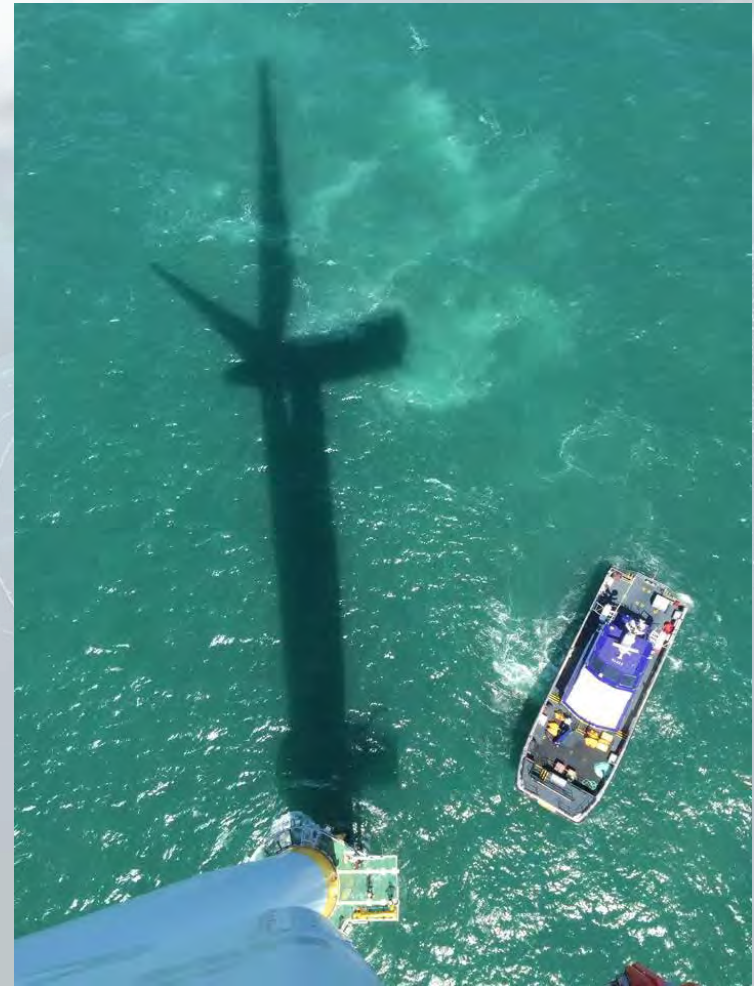
**PROPULSOR
EFFICIENCY (%)**

SERVOGEAR EcoflowPropulsor™



... Manoeuvrability with Servogear Ecoflow Propulsor

- Improved acceleration and retardation
- Short stopping length – important safety factor
- Very high bollard pull, compared to waterjet
- Smooth and precise maneuvering
- DP-mode operations
- Requires only net output from the engine



... Some markets we serve

Fast Ferries



Offshore



Workboats



Yachts

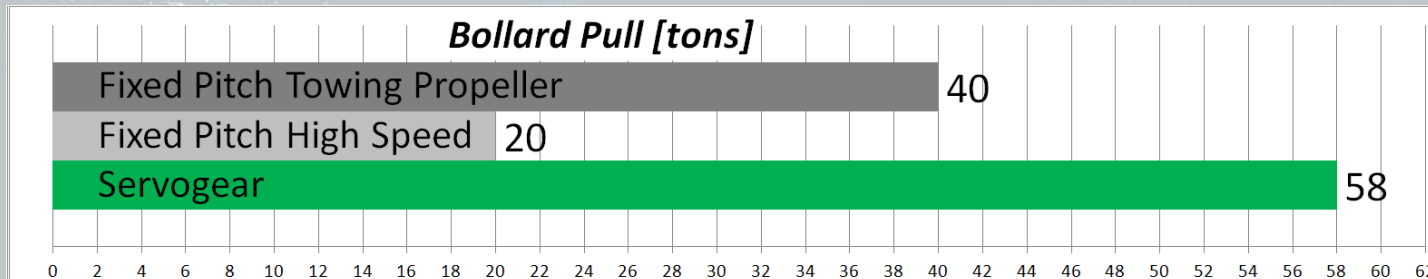
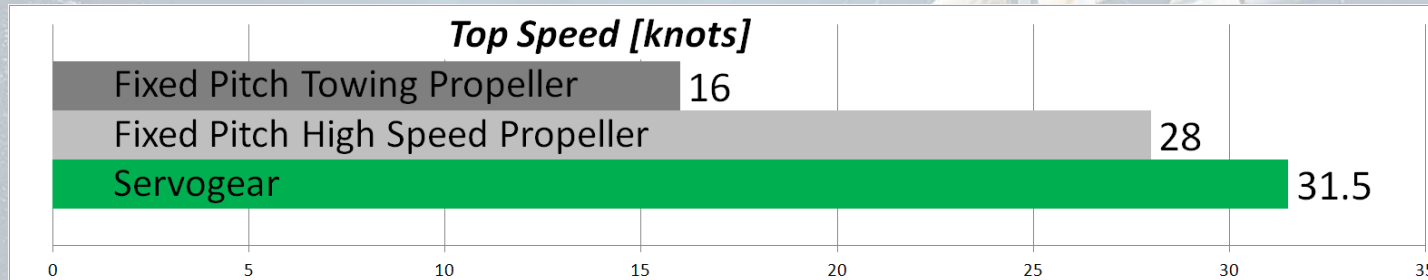


... The real difference – Fast Offshore Supply



- 60 m Multi purpose vessel
- 4 x Caterpillar 3516B
- Fixed pitch propeller, ZF gearbox

- 60 m Multi purpose vessel
- 4 x Caterpillar 3516B
- Servogear Ecoflow Propulsor™



Re-Power Wall Street (New York), from Waterjet to Servogear Ecoflow Propulsion

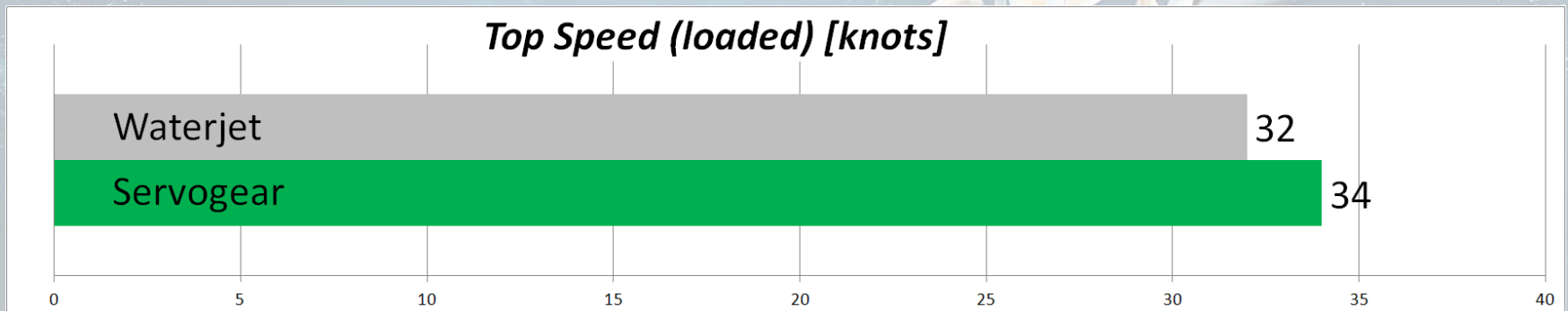
Launched 2003 , design by Incat Crowther



The real difference, 43 m fast ferry retrofit



- 4 x Cummins KTA50 (total 5696kW)
- 4 x KaMeWa A50
- 2 x MTU 16V4000M53 (total 3680 kW)
- 2 x Servogear Ecoflow Propulsor™



- With 2016 kW less power, the reduction in operational cost is significant
- Fuel saving 32% (USD 500 000 annually)
- CO₂ emissions per passenger halved

... Servogear innovation and development

- We are continuously developing the Servogear Ecoflow Propulsor system through theoretical and practical research
- Always working in close collaboration with our customers



... Advantages with Servogear Ecoflow Propulsor?

Running in service

- Significant better ability to keep up the speed in severe weather conditions
- Larger distance range due to improved efficiency
- Much higher efficiency at off-design conditions – heavy displacements
- Superior towing capabilities

Propeller Tunnels

- Reduced hull resistance
- Reduced noise and vibrations
- Reduced draft
- Reduced drag and weight
- Higher propeller thrust

Maintenance

- Very limited maintenance required
- Simple and robust design



... Manoeuvring controllers and automation



- Propulsion control systems
- Manoeuvring control systems
- Steering gears
- Joystick systems
- Modular and Rugged panels, several combination of panels possible
- Portable panel possible
- 3 axis Joystick
- Joystick interface to propulsion, rudder and bow thrusters

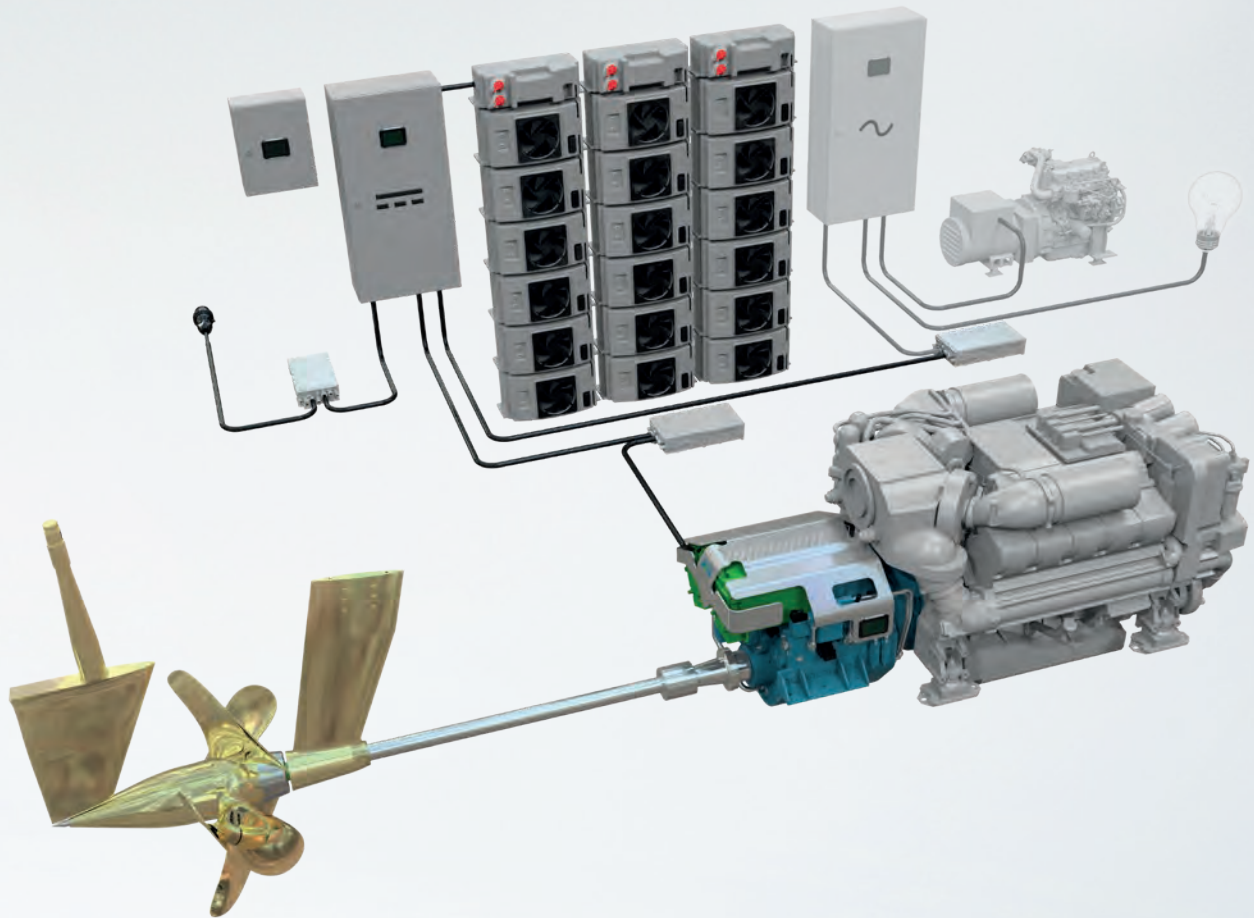
- Indication systems
- Back-up systems
- Automatic load control

Servogear and Scana Mar-EI have worked closely together for many years, offering turn-key propulsion packages to customers worldwide



SERVOGEAR

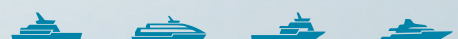
servogear.no



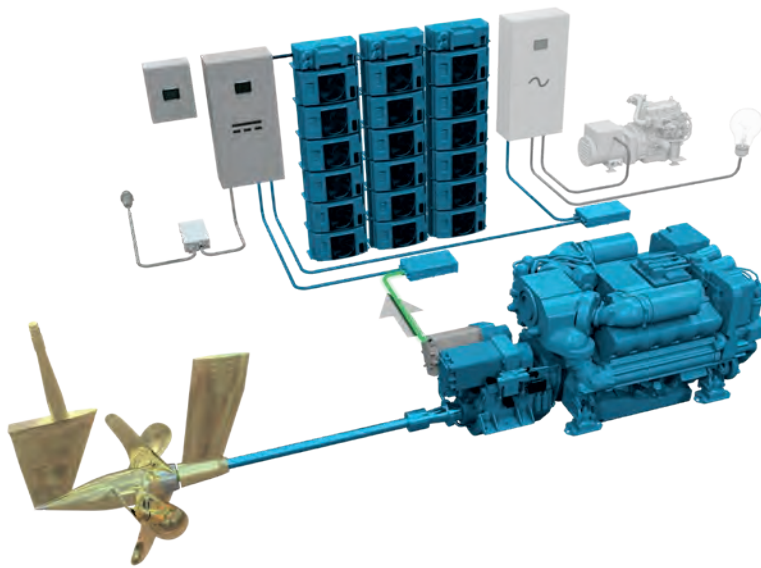
SERVOGEAR ECOFLOW PROPULSOR™ - HYBRID



A complete plug-in hybrid solution for high-speed vessels, including CP propeller(s), HDE220 hybrid gearbox, battery package and power controls.

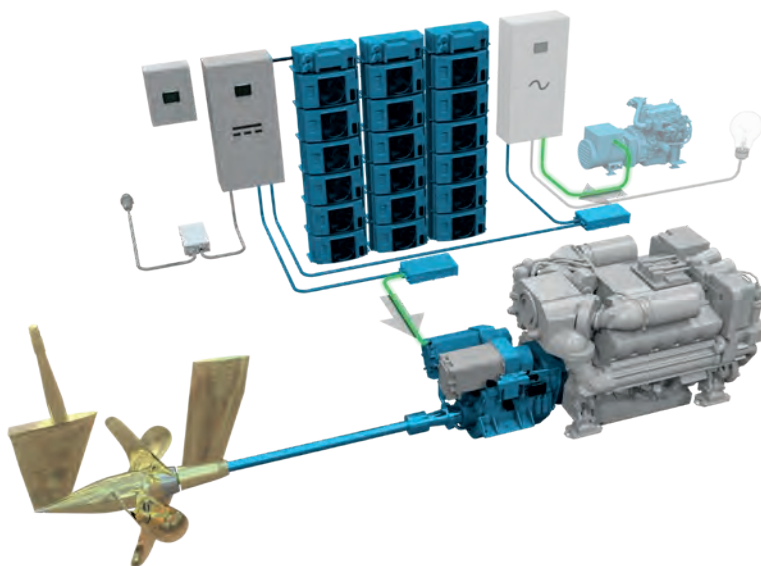


OPERATION MODES



DIESEL MECHANIC (DM) MODE **- Diesel Engine for Propulsion** **and PTO**

In DM mode the diesel engine is running the propeller and the PTO. Servogear's hybrid gearbox is equipped with two PTO connections: One connection for the dual function PM e-motor/generator, the other connection powers a hydraulic pump or an additional PM unit. The integrated PM generator feeds electric power into the vessel's grid assisting the existing generator sets or the remaining energy can be stored into batteries for later use.

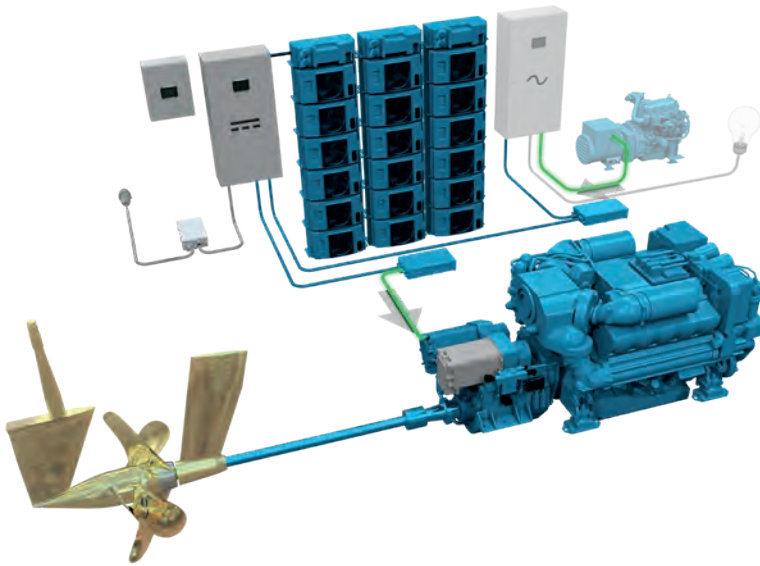


DIESEL ELECTRIC (DE) MODE

In DE mode the onboard generator is powering the integrated PM e-motors. This mode is ideal for long range slow steaming with a generator running at optimal speed. Fuel consumption is kept to a minimum while running hours on main engines are reduced significantly.

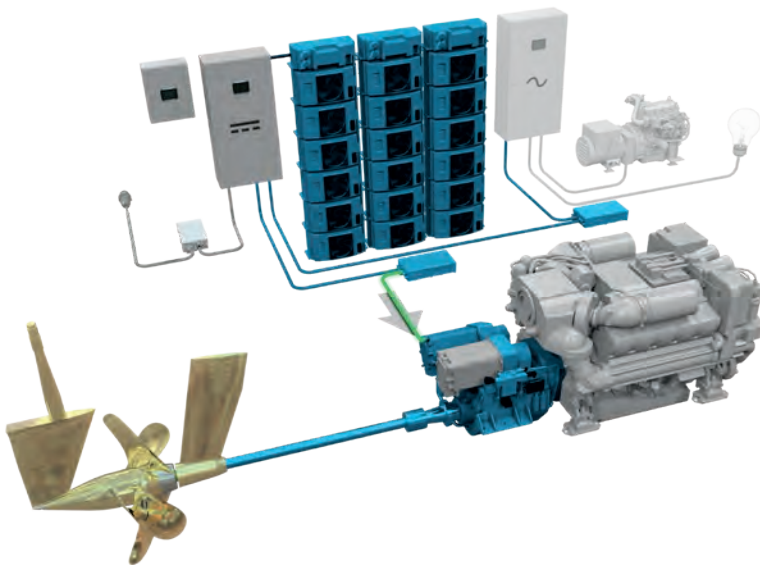
Best performance and highest versatility, the Servogear Ecoflow Propulsor™ - Hybrid system offers different operation modes.

Easy switching between diesel mechanic, diesel electric, boost- and electric mode addressing the subsequent main engine, generator, battery package or a combination of them, enabling the vessel to optimally use its power sources and take full advantage of the Servogear Ecoflow Propulsor™ - Hybrid system.



BOOST MODE – Combined power from Diesel Engine and Electric Motor

Operating profiles are vessel specific. The Servogear Ecoflow Propulsor™ - Hybrid solution offer the flexibility to select a smaller diesel engine supported with the additional power provided by the PM e-motor. When maximum propulsion power is only incidentally required this setup saves fuel consumption, engine room space, and CAPEX as a result of the smaller diesel engine.



ELECTRIC MODE

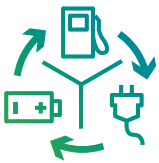
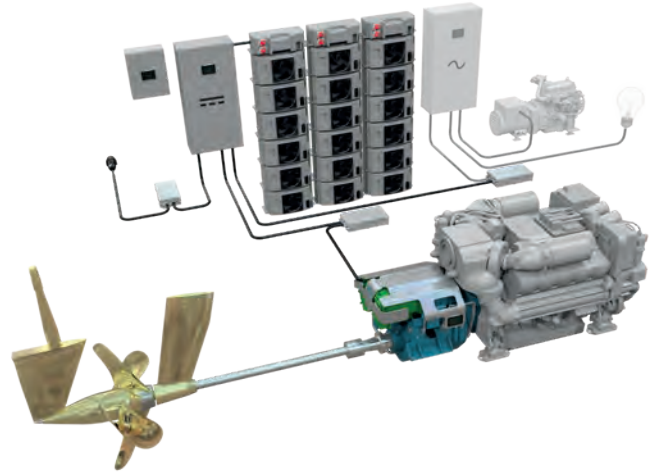
In electric mode the battery package is powering the integrated PM e-motors. This mode is meant for short range low speed operations with frequent manoeuvring in e.g. harbor areas OR for long range silent cruising while sightseeing. Range is depending on the size of the battery package. This size can be expanded easily by adding standardised modules. Modules are stackable, self-extinguishing, with integrated cooling and battery management.



SERVOGEAR ECOFLOW PROPULSOR™ - HYBRID



- Servogear Ecoflow Propulsor™ Hybrid system includes a new light weight HDE220 gearbox with integrated clutch(s), shaft line, brackets, and efficiency rudder
- Integrated permanent magnet (PM) e-motor / generator
- Integrated hydraulic pump
- Frequency converter / inverter
- Battery package including cooling and battery management
- Propulsion and power controls
- Shore connection, compatible with various electric grids



Operation Modes

- Diesel mechanic mode (DM). The classic propulsion system with power provided by the diesel engine
- Diesel electric mode (DE). Electric propulsion power provided by generator
- Boost mode. Diesel power + additional electric propulsion power provided by the generator and battery package
- Electric mode. Electric propulsion power provided by generator or battery package



Low Speed Operations

Using battery or genset power while:

- Position holding at e.g. windfarms
- Manoeuvring in harbour areas
- Sightseeing
- Long term loitering



Environment

- Diesel engines running at optimum speed
- Batteries charged overnight at quayside by green shore power
- Manoeuvring in harbours without emissions



Maintenance

- Reduced running hours on main engines
- Redundancy in propulsion power
- Worldwide service

GENERATION III BATTERY SYSTEM

Grenland Energy AS is proud to present their 3rd Generation of marine battery systems: “We are stretching the envelope of safe energy storage in all aspects! Both energy- and power density per litre are beyond current standards in the market. The weight reduction gives us a leading edge in high speed vessels.”

BATTERY ROOM WITHOUT WATER.

Electricity and water is rarely a good mix. Our experience is that forced air cooling gives the 18650 cells a uniform cooling without temperature shocks. Our 5 levels of failsafe design enables machine room installation in standard cabinets or battery room installation.



PROVEN TECHNOLOGY: 18650 BATTERY CELLS.

The 18650 battery cells provide an optimal way of storing a large amount of energy in a safe way. Used in Grenland Energy's design, a single cell failure is no risk to the surrounding cells. The only consequence is a 1/27 reduction of string capacity, and regular operation is maintained until serviced.

World Wide research & development on 18650 provides us with leading performance on Energy- and Power optimized batteries.

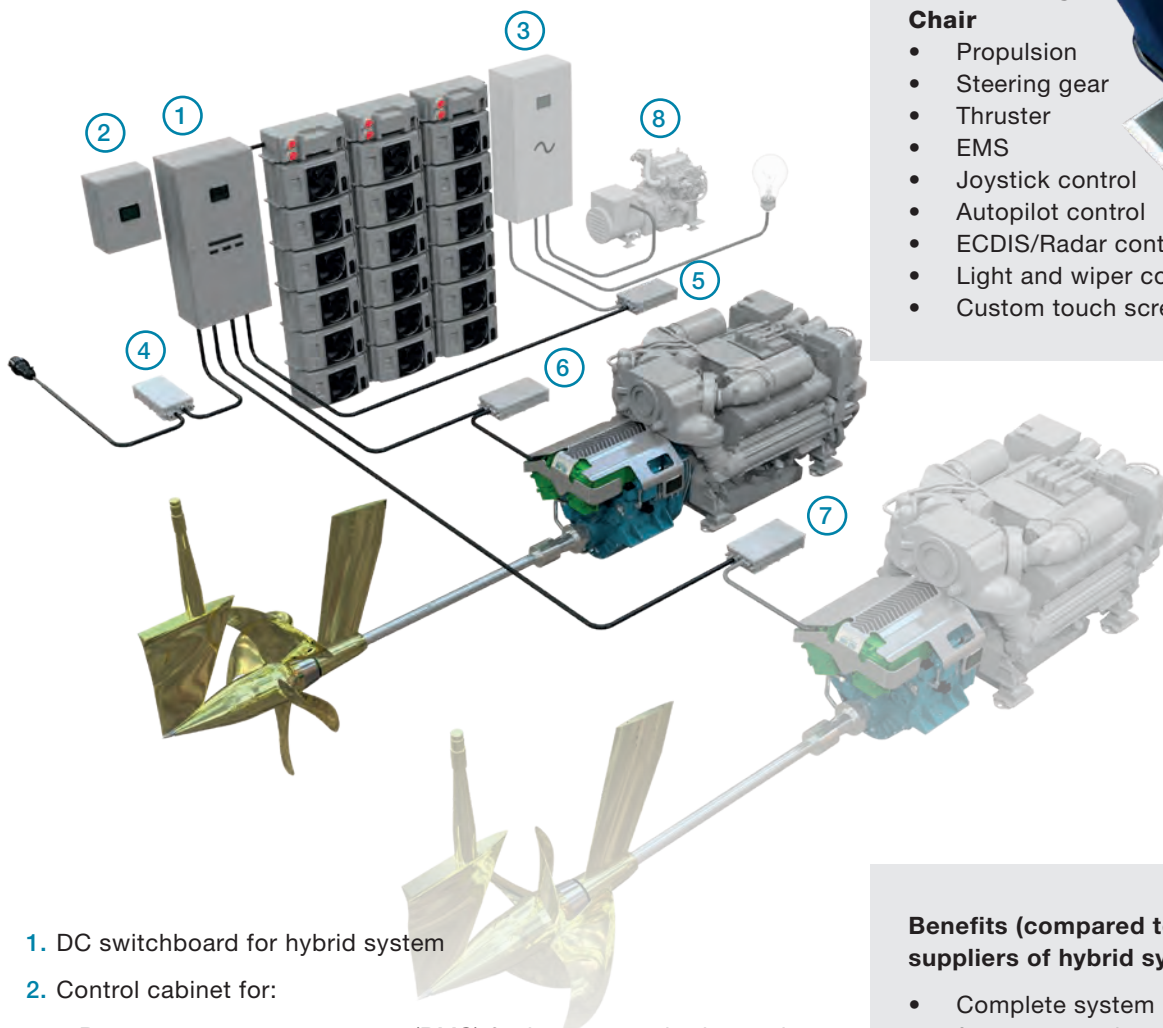


WE MAKE ENERGY DO MORE



BRUNVOLL

PRECISION IS OUR PASSION



1. DC switchboard for hybrid system
2. Control cabinet for:
 - Battery management system (BMS) for battery monitoring and safety control including local control display.
 - Energy management system (EMS) for charge- and discharge control, battery SOC/SOH monitoring and calculated available energy for electric voyage. Together with the control cabinet (3) is the display that is mounted in the manoeuvring station on the bridge.
3. Main switch board 230/400VAC for hotel load and other electric consumers (Not in Brunvoll scope)
4. DC/AC charge inverter for shore connection
5. DC/AC inverter for feeding main switchboard. May also be configured for charging battery from main switchboard, i.e. auxiliary generator
6. DC/AC inverter for control of PM machine, either as motor control or generator for battery charging, Port Side propeller
7. DC/AC inverter for control of PM machine, either as motor control or generator for battery charging, Starboard propeller (optional)
8. Auxiliary genset (Not in Brunvoll scope)

Brunvoll Manoeuvring Chair

- Propulsion
- Steering gear
- Thruster
- EMS
- Joystick control
- Autopilot control
- ECDIS/Radar control
- Light and wiper control
- Custom touch screen



Benefits (compared to other suppliers of hybrid systems):

- Complete system package from an experienced vendor of propulsion- and manoeuvring systems for high speed vessels.
- Integrated system design with focus on the control philosophy and ergonomics for both the electrical and mechanical solutions.
- Compact design with focus on weight and volume. Technical solutions and flexibility for installation in high speed vessels with limited space.
- Existing (proven) drive technology from automotive industry with references in marine vessels.

visit us at servogear.no

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