APS

«Alternative Propulsion System»

A new era for electric propulsion!

AUXILIA™
ELECTRIC PROPULSION

Power to improve life

APS

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Power to improve life

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Overview on electric propulsion

AUXILIA ELECTRIC PROPULSION

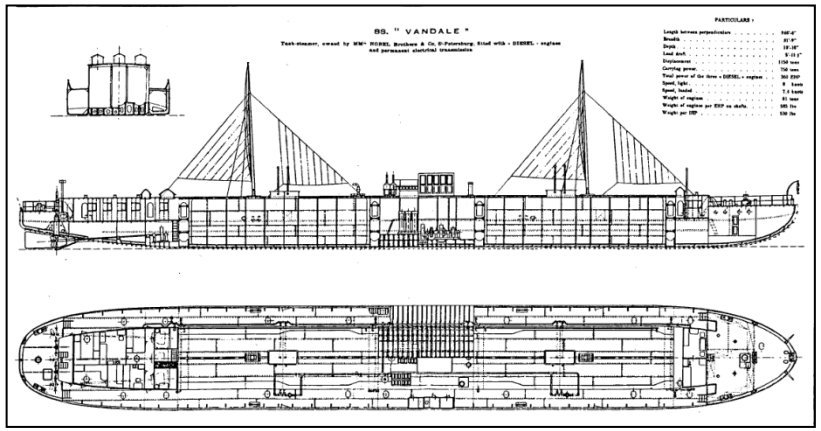
Power to improve life

... more than 100 years

When the early diesel engines were reliable enough to be used as ship propulsion, in 1903/1904, they were still non-reversible.

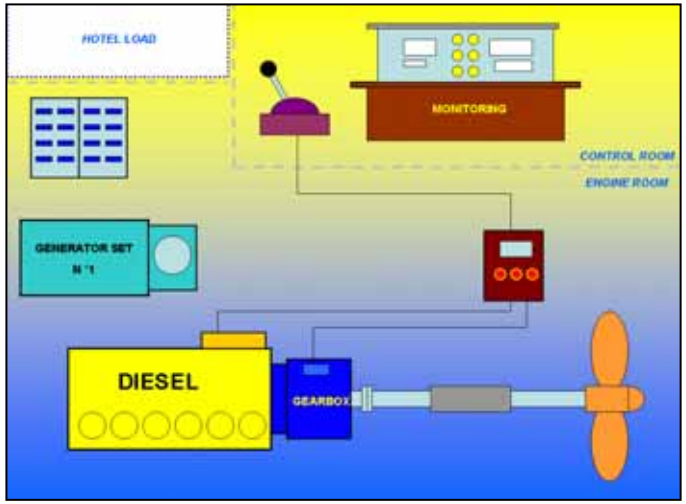
At that time, electric power transmission therefore was the only method to overcome this basic technical problem.

The first marine diesel-electric application worldwide was the Russian tanker «VANDAL», commissioned in spring 1903.

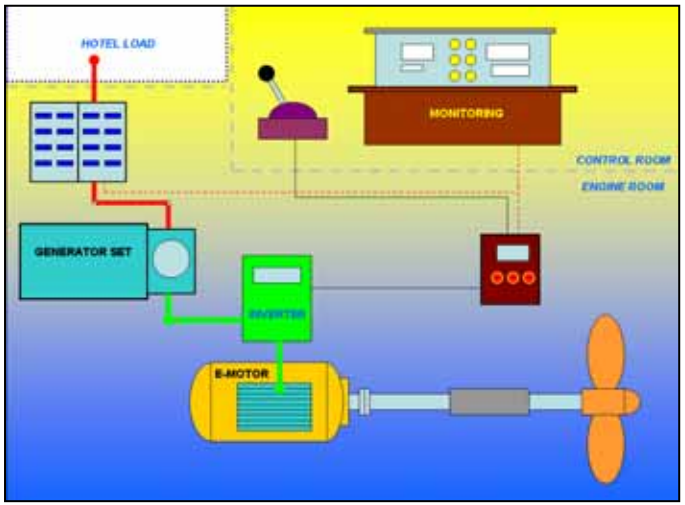


Overview on electric propulsion

CLASSIC PROPULSION



DIESEL ELECTRIC PROPULSION



Overview on electric propulsion

AUXILIA ELECTRIC PROPULSION

Power to improve life

Advantages

- Vibration reduction
- Comfort (noise reduction)
- Manoeuvrability
- Flexibility in space
- Redundancy
- Safety

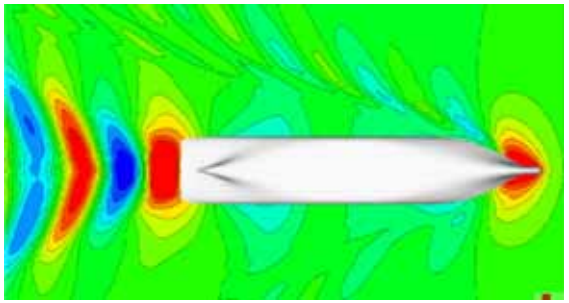
Disadvantages

- Price (expensive)
- Less efficiency
- Complexity (more equipment)

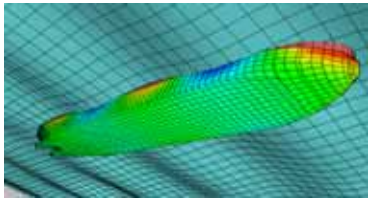
BENETTI «AMBROSIA»

Some power prediction concepts

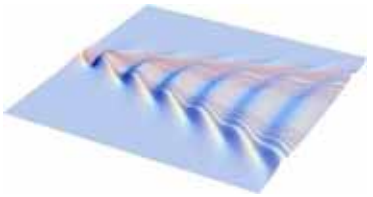
Power to improve life



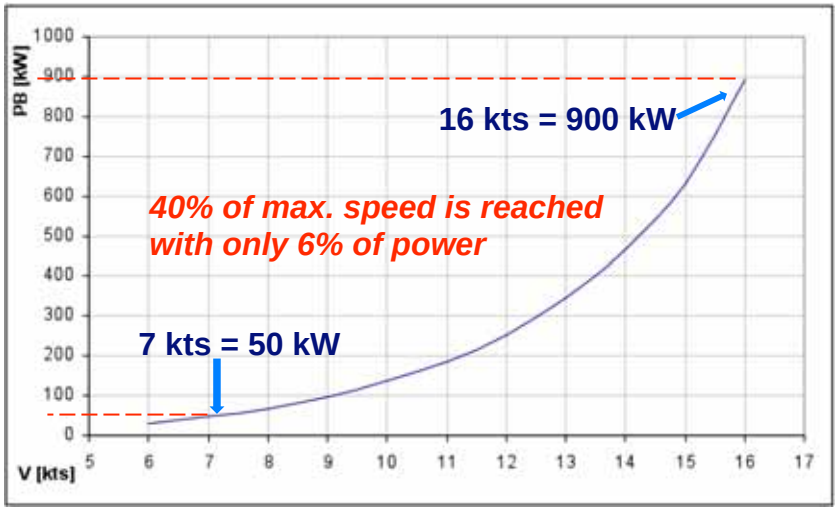
Ship resistance



Form resistance



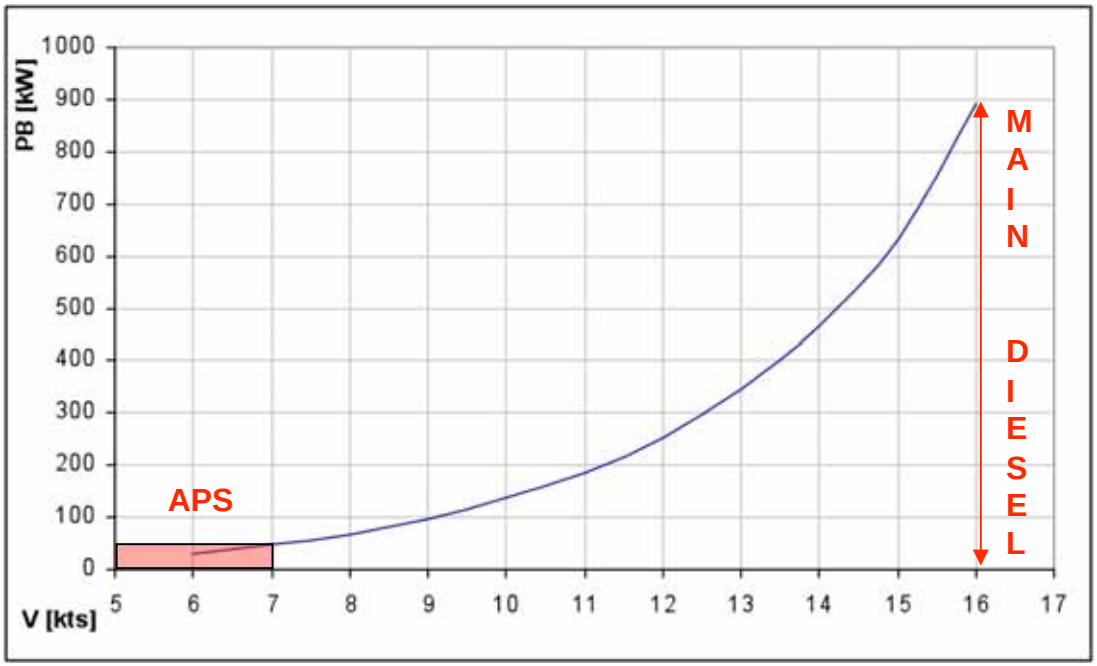
Wave resistance



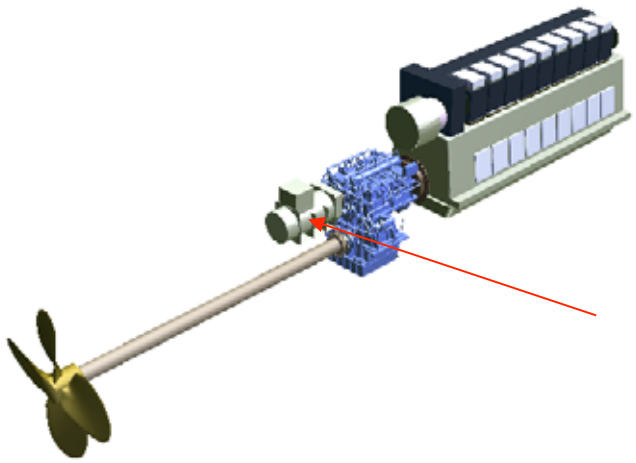
Some power prediction concepts

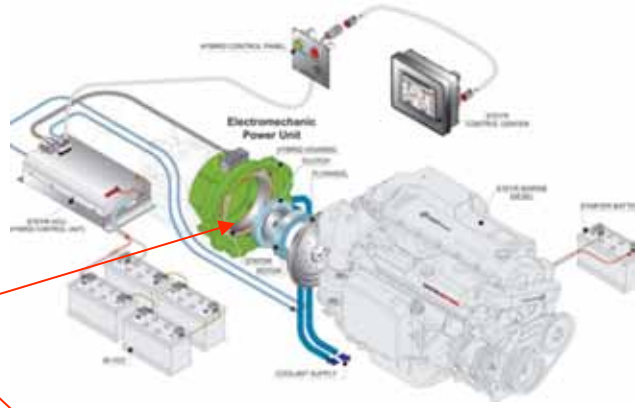
Power to improve life

Alternative propulsion system
Small power but excellent performances



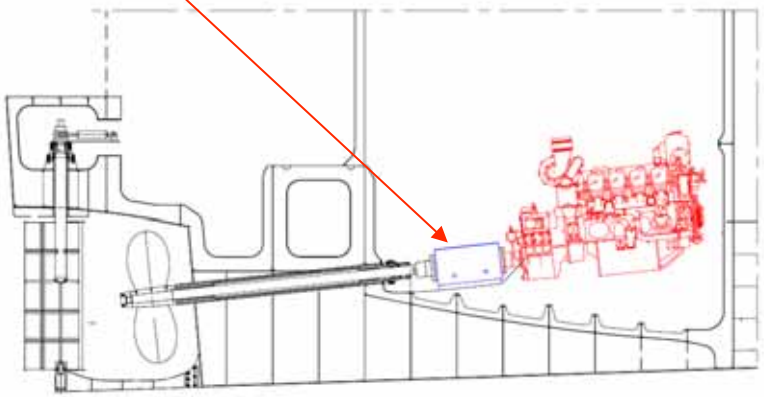
Introduction to APS (alternative propulsion)





Electric motor

Different solutions for alternative propulsion system.



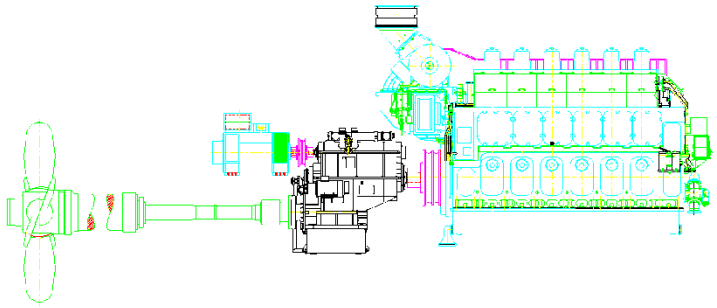
Alternative propulsion is very common for commercial vessels.

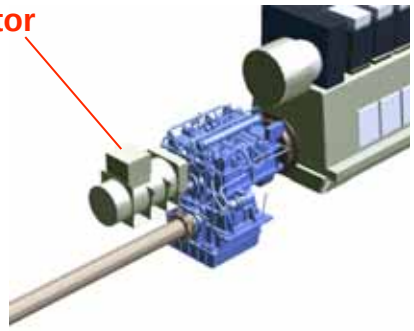
All classification societies (ABS, LRS, BV, RINA) have Additional Class Notation for APS.

An electric motor is connected through PTI to gearbox and propeller shaft.

It is possible to have a DIESEL ELECTRIC SYSTEM in alternative to CONVENTIONAL DIESEL SYSTEMS.

Introduction to APS (alternative propulsion)





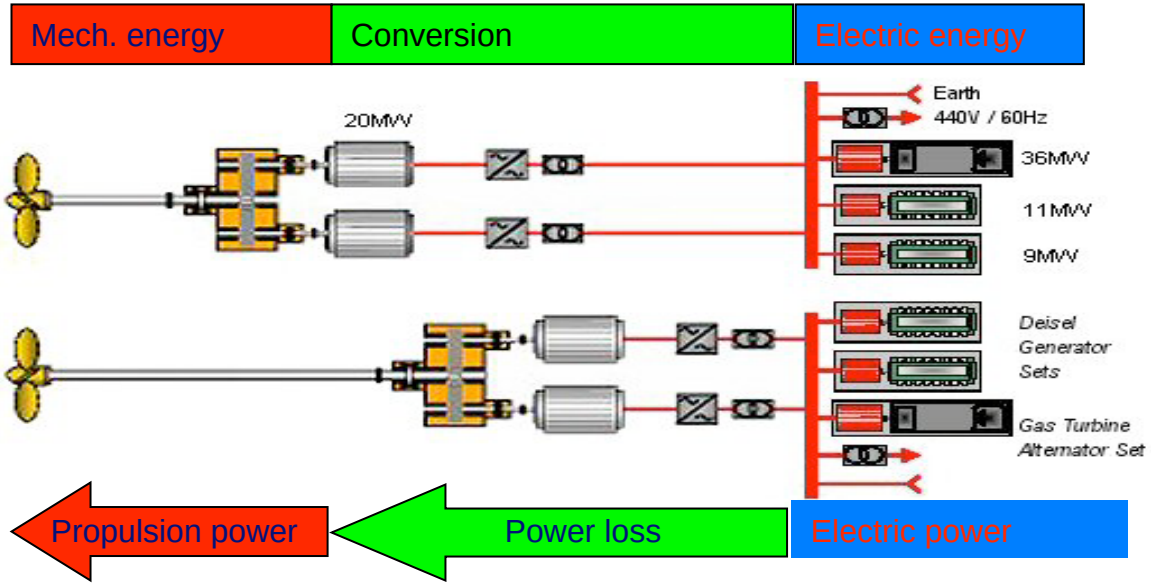
The APS system offers to the Owner the following advantages:

-Safety: redundancy of the propulsion system
-Shaft generator: electricity from the main diesel engine
-Economy: for some load conditions it is more convenient to use the electric motor
-Ecology: less emissions
-Comfort: reduction of noise and less vibrations
-Manoeuvrability: complete speed range (0-max) on the propeller shaft
-For safety reason the Owner saves money in insurance
-Save time: maintenance of diesel engine is made during navigation (without stopping the vessel)

APS – an open door for innovative energy sources

Power to improve life

Classic diesel electric propulsion



Electric power must be +5% of propulsion power:

The power is really high! (MW)

APS – an open door for innovative energy sources

Power to improve life

Fuel cells Hydrogen

Solar energy

Accumulators

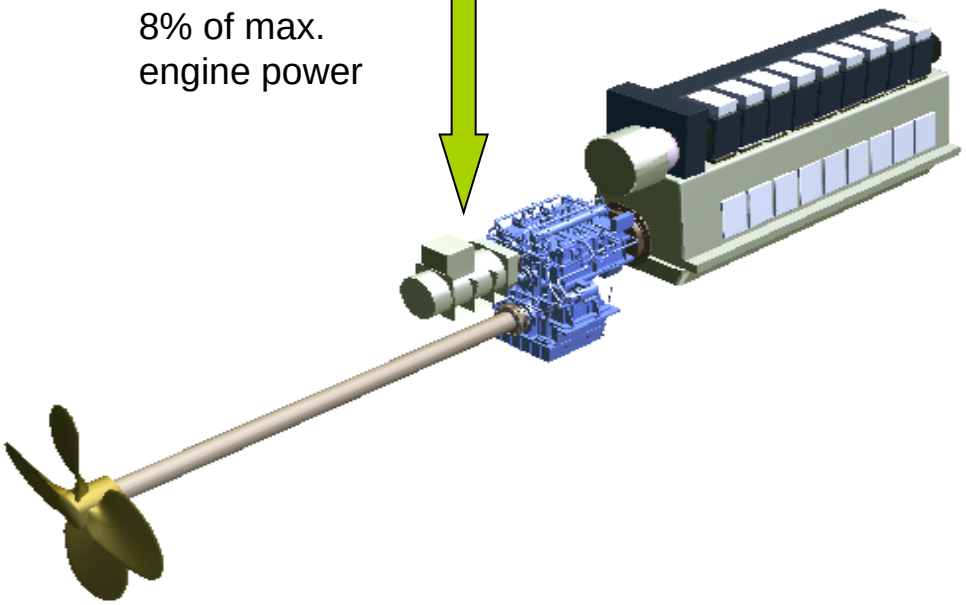
Wind energy

Natural gas gensets

Biogas gensets

Biodiesel gensets

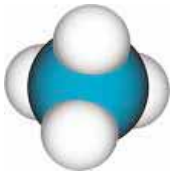
8% of max. engine power



APS, an open door for innovative energy sources

AUXILIA ELECTRIC PROPULSION

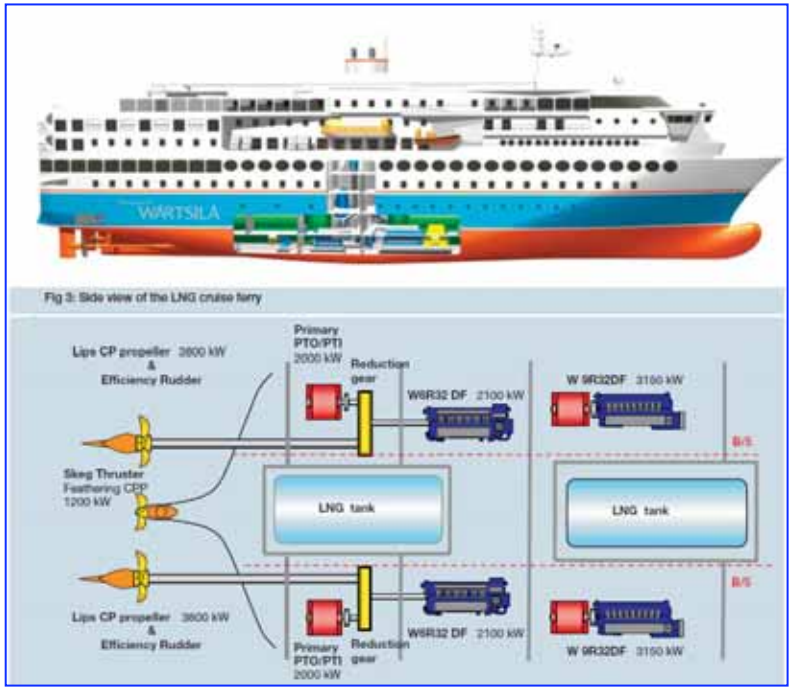
Power to improve life



CH_4 Natural gas – a concrete use of methane

- **The EU promotes and incentivizes natural gas as ecological fuel, with the aim to substitute the petroleum products within 2020.**
- **It's a safe (lighting at 595 °C) and volatile fuel.**
- **The use is authorized also with natural gas means on ferries.**
- **The natural gas gensets are normally used in the industrial sector, they are very reliable and produce less noise than the diesel ones.**
- **The refuelling is very simple: a pipe and a compressor are sufficient.**
- **The technology of bottles storage and its safety are highly tested and adopted with success in the public city transport.**
- **Economical fuel.**

EXAMPLE: Waertsilae natural gas Ferry (Viking Line)



Some new propulsion modes

Power to improve life

A) Silent mode (night mode)

Main diesel off - propulsion only with electric motor:
VERY HIGH COMFORT

B) Green mode

Main diesel off - propulsion only with electric motor - electric power from “green” generation or accumulators

C) Shaft generator mode

Example 1: one engine in propulsion, second engine in generation
Example 2: for sailing yacht, power from wind through propeller rotation

D) Diesel mode

Power from main diesel - APS off

E) Booster mode

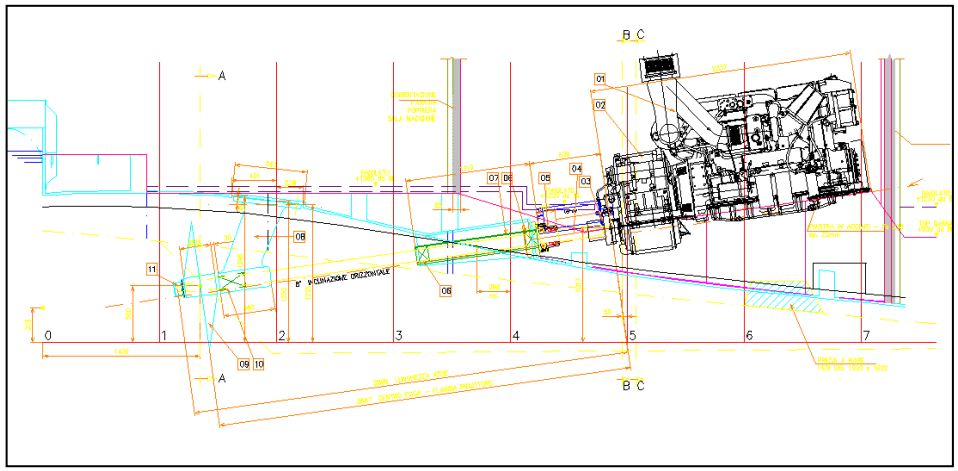
Main diesel and electric motor together for maximal power and ship speed

An example: Benetti 85

On 2008 we started a research project with Azimut|Benetti R&D with the aim to test an electric auxiliary propulsion system on Benetti 85 (BL001).

An example: Benetti 85

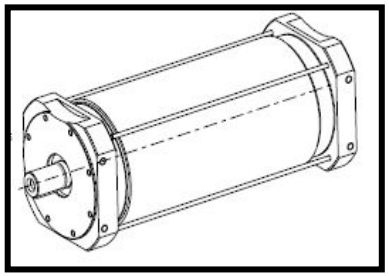
An electrical motor was connected through PTI (Power-Take-In) to the gearbox.

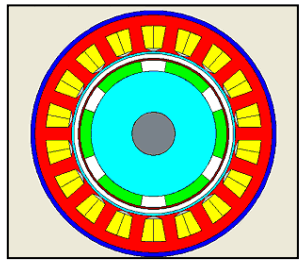


An example: Benetti 85

Power to improve life

The electric motor adopts permanent magnet type tecnology with very high power density (compact).



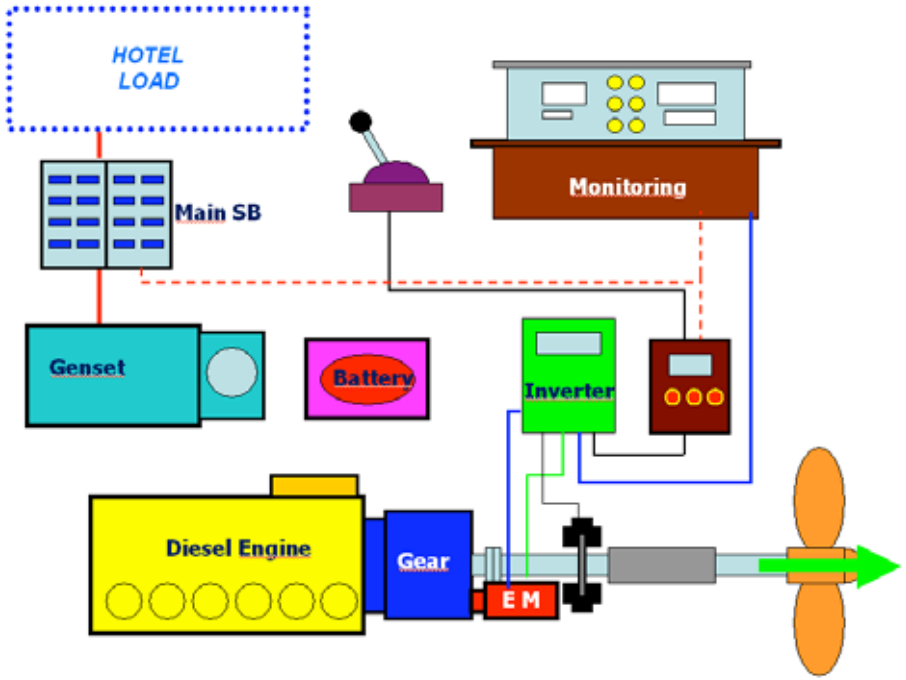


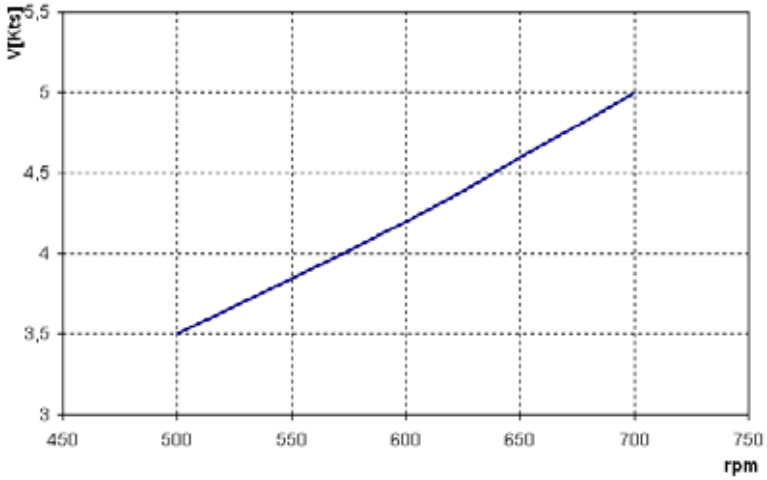
E- Motor

Power: 27 kW
Speed: 1000 rpm
Voltage: 400 V
Cooling: sea water
Service: S1 continuous operation
Weight: 120 kg
Dimension: 220 mm x 220 mm x 556 mm

An example: Benetti 85

Power to improve life





Architecture for diesel and auxiliary propulsion

The vessel can be managed in auxiliary mode like in classic diesel mode.

An example: Benetti 85

Power to improve life

SOUND LEVELS		
	Diesel mode	Electric mode
Rpm	750	675
Speed	5.3kn	5kn
	dBA	dBA
Saloon	61.5	50
Galley	63.8	44.3
Wheelhouse	56	45.5
Owner Cab	54	43.5
Vip Cab	60.1	45.5
Guest Cab S.	63.5	47.5
Guest Cab P.	62.5	48.5
Crew Mess	79.3	62.5
Crew Cab S.	72.7	55.5
Crew Cab P.	72	58
Engine room	101	83.2
Cockpit	73.7	67.5
Flybridge	61.7	55.5

Tests have reached the maximal satisfaction.

In Fort Lauderdale, during the sea tests, the Captain commented:

«*Excellent, I've never seen anything like it. 5-6 knots without noise or vibration!*»

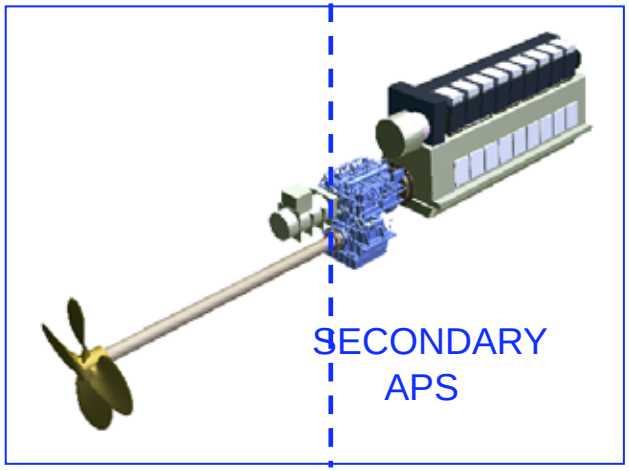
Technicians spoke in the engine room like in a tea room.

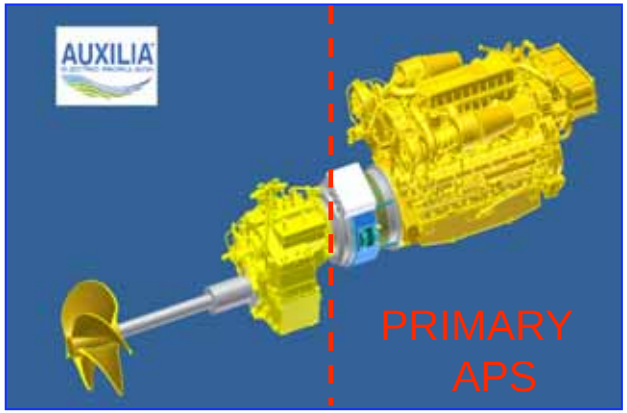
A new concept for APS – the «AUXILIA» way

Successfully completed the Benetti 85' tests, together with Azimut Benetti R&D, we made some considerations about the solution adopted.

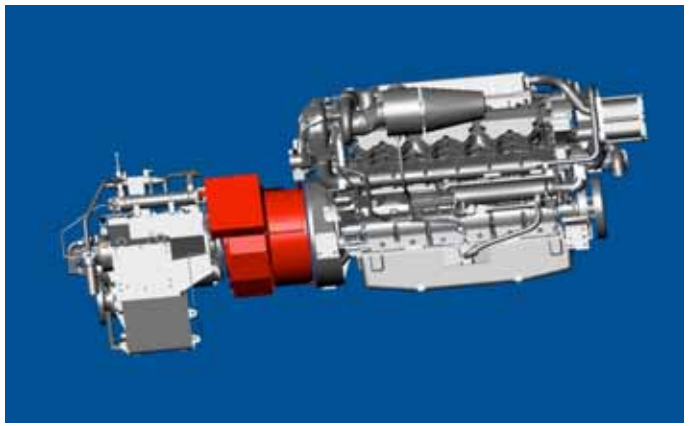
- The power is limited for geometrical problems (PTI has a fix position in the gearboxes).
- The torque requested on the motor is related with the ratio of the gearbox.
- The solution has to be «tailor made» for different gearbox manufacturers.

We have agreed to change from SECONDARY APS to PRIMARY APS.





A new concept for APS – the «AUXILIA» way



- It's possible to install big power (no space problem).
- The torque is not related with gearbox ratio or type of boat (planing, displacement, fast, slow etc.)
- The AUXILIA electric motor interfaces are the following:
  - ENGINE SIDE: standard SAE housing (SAE 1- SAE 0 and SAE 00)
    Connection possible with all diesel engines and types (CAT, MTU, MAN etc.)
  - GEARBOX SIDE: "free standing" connection with gearbox input shaft
    Connection possible with all gearbox types (REINTJES, ZF, TWINDISC etc.)

Retrofit is possible!
You need only approx. 50 cm space between engine and gearbox.

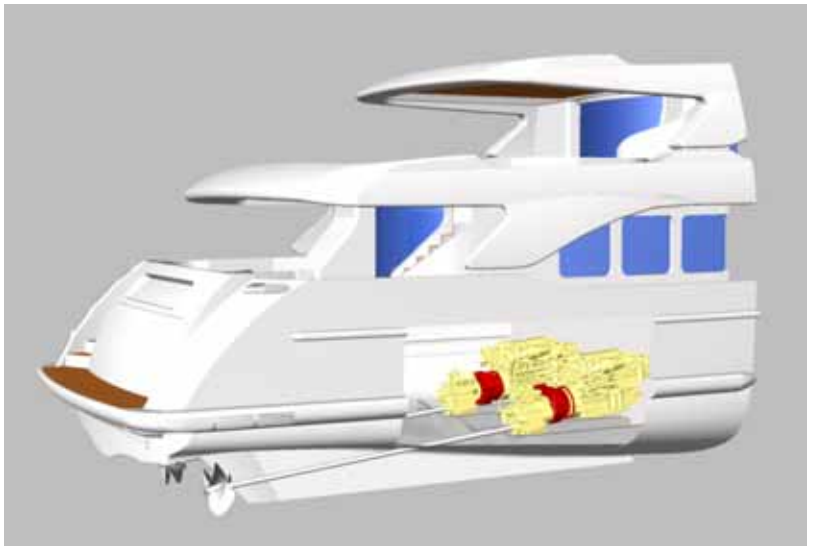
A new concept for APS – the «AUXILIA» way

Power to improve life

Technical data SAE O:
Power: 150 kW
Speed: 0-1200 rpm
Voltage: 400 V
Cooling: water
Engine connection: SAE 0
Service: S1 continuous operation
Weight: 700 kg

A new concept for APS – the «AUXILIA» way

APS for Benetti Class		
7 Kts with electric propulsion	Propulsion power	Generators
DELFINO 90'	60 kW	2x50 kW
TRADITION 105'	65 kW	2x50 kW
CLASSIC 121'	80 kW	2x80 kW
CLASSIC SUPREME 131'	80 kW	2x80 kW
CRYSTAL 140'	90 kW	2x125 kW
VISION 145'	90 kW	2x125 kW
VISION SUPREME 164'	90 kW	2x125 kW



Benetti new models are designed with possibility to install the APS.

-Safety: redundancy of the propulsion system
-Shaft generator: electricity from the main diesel engine
-Economy: for some load conditions it is more convenient to use the electric motor
-Ecology: less emissions
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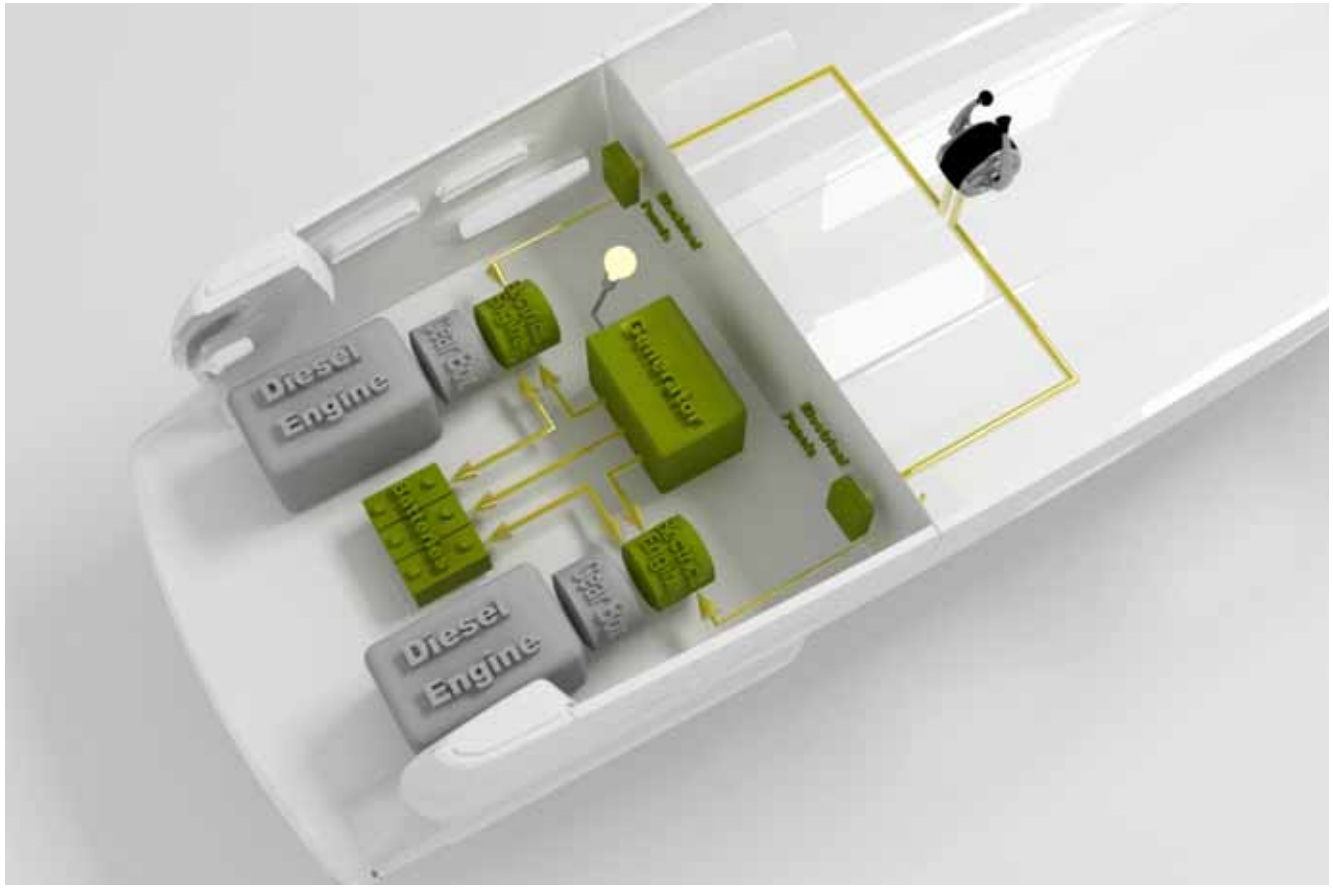
Diesel Engine
Diesel Engine

Thank you
for your kind attention!

Power to improve life

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