Workboat design and optimization based on operational profile

VICUS DESARROLLOS TECNOLÓGICOS S.L.
VIGO

INTRODUCTION

Practical case demonstration of the state of the art tools applied for a ship design optimized for operation.

-Introduction
-Company
-Traditional vs optimized approach
-Points of view: Owner, supplier, yard
-Sample case
-Ship type and mission
-Operational profile
-Scenario. video
-Optimized approach
-Methodology: resistance, seakeeping, propulsion, machinery
-How is this linked?
-Configurations
-Results
-What else can be done?

INTRO

DEFINE

METHOD

RESULTS

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COMPANY

- Strategically located in Vigo, NW of Spain, important shipbuilding area
- Technological and innovative company
- Committed with research and technology development
- Sectors: shipbuilding and renewable energy
- Very active in R&D. Participating on 3 R&D projects from the 7th Framework program of the EU

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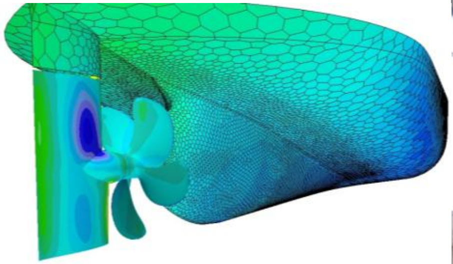
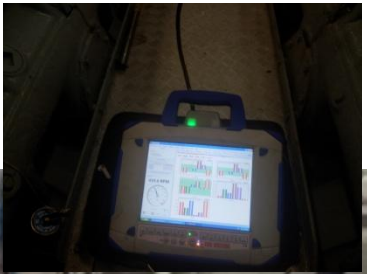
WHAT WE DO

SERVICES

-Ship hydrodynamics
-Propeller design
-Maneuvering – seakeeping analysis
-Performance analysis
-Sea trials





TOOLS

Analysis – prediction software: HydroComp
CFD Potential & Ranse
Simulink- tailor made tool for Ship analysis
Sea trials- Measurement, post processing and analysis of sea trials

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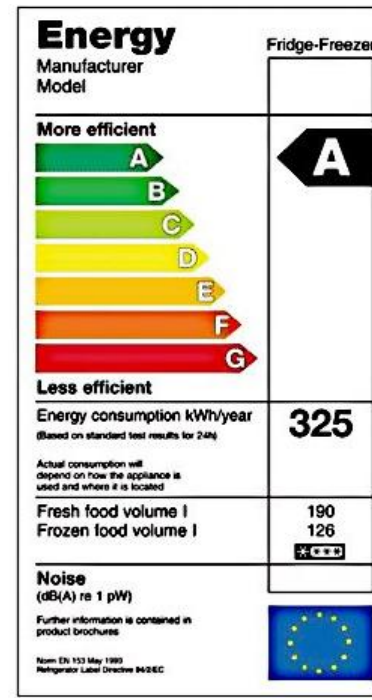
INTRODUCTION

Insanity: doing the same thing over and over again and expecting different results.
[Albert Einstein]

DIFFERENT CHALLENGES MUST BE SOLVED IN A DIFFERENT WAY



-New technologies changing very fast
-Environmental footprint
-Changing operational scenarios
-New market demands
-New regulations
-Price of energy

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SHIPYARD - DESIGNER

The yard looks for the most cost effective ship from the shipbuilding point of view. The ship is built for a single purpose, DELIVERY.

-Want it fast
-Want it on budget
-No problems affecting cost or delivery time
-Only matter what is in the contract specification and signed
-They will not run the ship nor pay the bills

QUESTIONS

-Do the yard investigate how past projects perform?
-Do the yard knows the real performance of a certain type of ships on a certain scenario?
-How is a certain yard positioned on a changing and demanding market?
-Can the yard offer something new in terms of performance guarantee in service?
-Taylor made ship?

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OWNER

Wants an efficient ship for an specific purpose but during the design stage, he only demands constraints for a few conditions only.

-Want it fast
-Want it on budget
-Affected from similar projects from competitors
-Contract specification is a standard document with lots of details but missing critical issues
-Technical configuration affected from what is known and what the suppliers provide.

QUESTIONS

-Do the owner investigate how really their current ships perform?
-Do the owner knows the real performance of a certain type of ships on certain scenarios?
-Is a good idea to ask the yard for a performance analysis and guarantees?
-Can the owner asses or predict future/probable scenarios?
-Shall I take into account future and current technology alternatives? How many?

CHARTERER

Wants a good transport efficiency. This means having the required capacity or features at lowest operational cost (fuel consumption mainly).

-Ask for details before chartering, “he wants to know”
-Interested on more than one scenario.
-Charter – owner relationship blocks certain investments
-Might want a more optimized (“greener”) ship if their customers demand it.

THE OWNER NEEDS THE INFORMATION TO SELL HIS SERVICES TO THE MARKET

COMMON INTERESTS

Shipyard

Reasonable cost of building

Good performing ship for the service

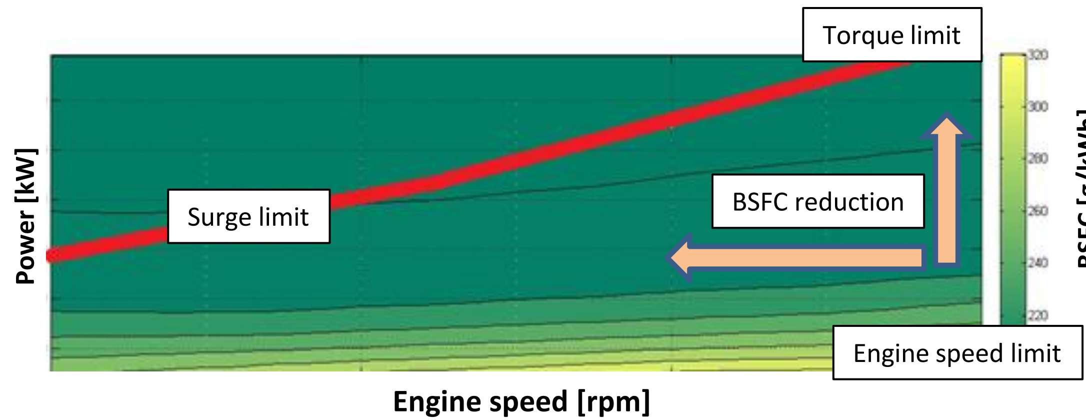
Optimised ship in terms of fuel consumption and emissions

Charterer/Owner

APPROACH

Ships are traditionally designed for a specific speed in a given condition. In the design stage ,Main engine/s are sized for that given condition.

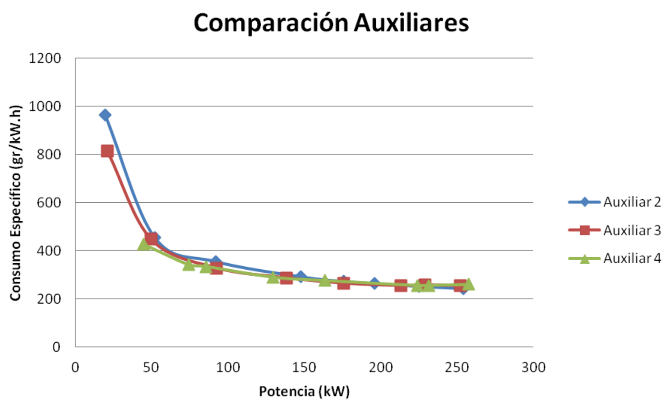
Worse performance in rest of conditions
(bad BSFC, higher maintenance,etc)



Ship hydrodynamics is also influenced by this design condition regardless to the true load conditions the ship is going to have in its operating life. This makes an efficient hull form for only one design condition

Ship propulsion is affected by the same design approach

Power demand increase for rest of conditions for both propellers and hull



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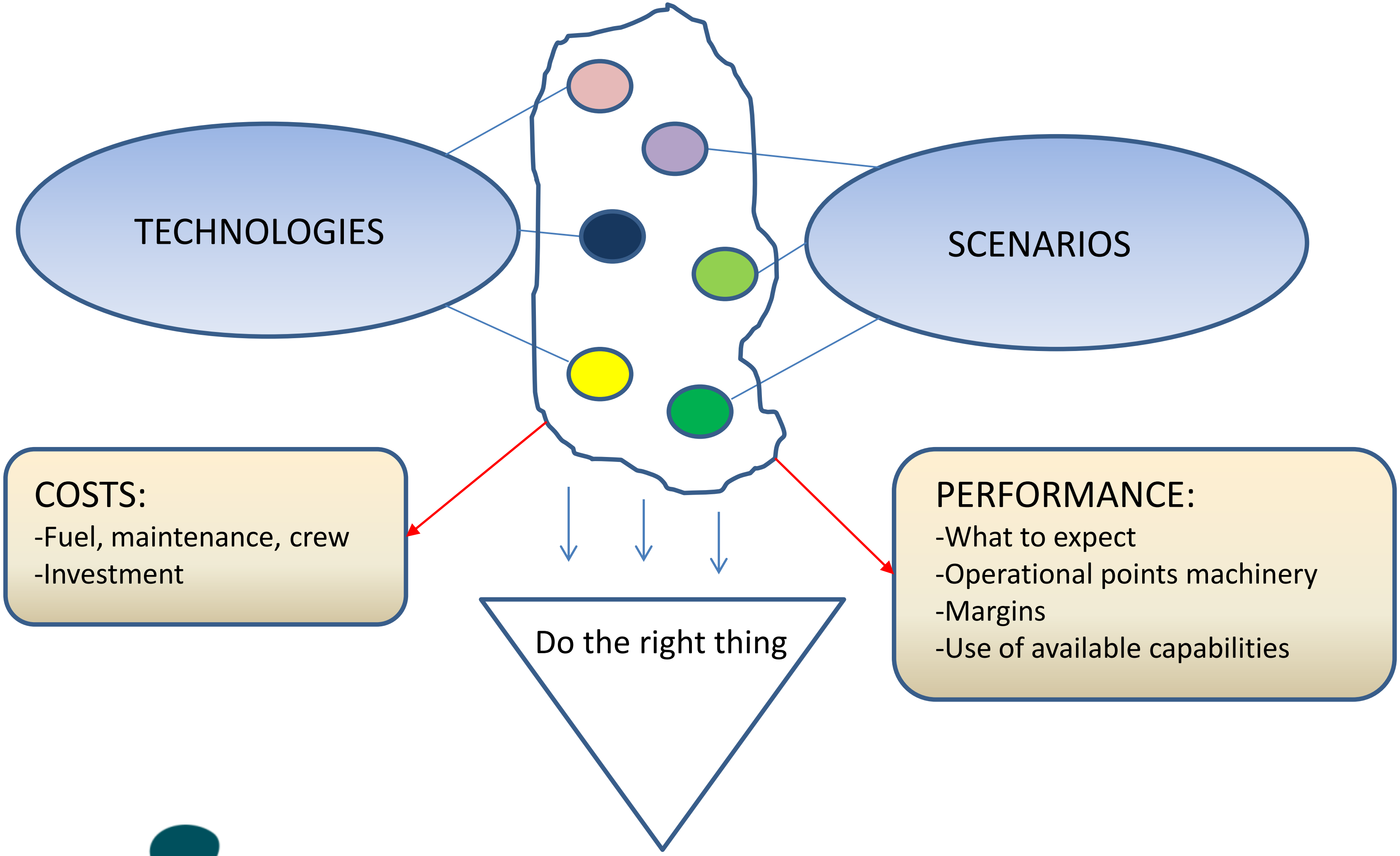
APPROACH



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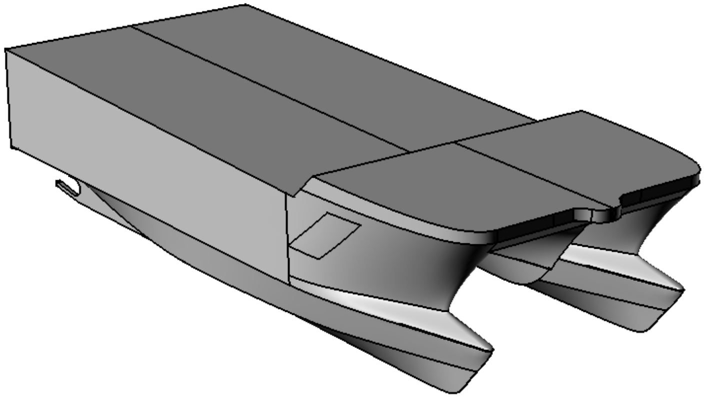
EXAMPLE

Ship type and mission:

Wind support vessel. Transfering technicians to wind farms and transporting small spares

Main particulars

Loa= 21m
Beam=7.5 m
Depth=2.8m



Propulsion

2x735 kW @ 2100 rpm
2x FP propeller
2x Aux. Gensets 11kW

OPERATIONAL PROFILE

Profile:

	time %	Average speed [kn]	amidships draught [m]	Power [kW]	Energy [kWh]
Leaving the port	0.67%	10	1.62	175	15
Trip to windfarm	7.35%	20	1.62	1401	1284
Arrival to windfarm	3.74%	10	1.62	175	81
Sailing in the windfarm	3.21%	10	1.62	175	70
Positioning	1.07%	5	1.62	22	3
Transfer to windmill	13.77%	0	1.62	1470	2524
Stopped	40.11%	0	1.62	0	0
Engine start	2.01%	0	1.62	0	0
Positioning	1.07%	5	1.62	20	3
Transfer to ship	14.71%	0	1.62	1470	2695
Sailing in the windfarm	4.28%	10	1.62	157	84
Return trip	7.35%	20	1.54	1260	1155
Entering the port	0.67%	10	1.54	157	13

Time		Gap [min]	v [kn]	% time
7:00	Leaving the port	5	10	0.7%
	Trip to windfarm	55	20	7.4%
8:00	Arrival at the windfarm	28	10	3.7%
	Positioning windmill 1	2	5	0.3%
8:30	Transfering to windmill 1	20	0	2.7%
	Sailing from windmill 1 to windmill 2	8	10	1.1%
9:00	Positioning windmill 2	2	5	0.3%
	Transfering to windmill 2	20	0	2.7%
	Sailing from windmill 2 to windmill 3	8	10	1.1%
9:30	Positioning windmill 3	2	5	0.3%
	Transfering to windmill 3	20	0	2.7%
	Sailing from windmill 3 to windmill 4	8	10	1.1%
10:00	Positioning windmill 4	2	5	0.3%
	Transfering to windmill 4	43	0	5.7%
10:45	Stopped	300	0	40.1%
15:45	Engine Start	15	0	2.0%
16:00	Positioning windmill 4	2	5	0.3%
	Transfering from windmill 4	50	0	6.7%
	Sailing from windmill 4 to windmill 3	8	10	1.1%
17:00	Positioning windmill 3	2	5	0.3%
	Transfering from windmill 3	20	0	2.7%
	Sailing from windmill 3 to windmill 2	8	10	1.1%
17:30	Positioning windmill 2	2	5	0.3%
	Transfering from windmill 2	20	0	2.7%
	Sailing from windmill 2 to windmill 1	8	10	1.1%
18:00	Positioning windmill 1	2	5	0.3%
	Transfering from windmill 1	20	0	2.7%
	Sailing in the windfarm	8	10	1.1%
18:30	Return trip	55	20	7.4%
	Entering the port	5	10	0.7%
				100.0%
	total [min]	748.00		
	total [h]	12.47		

Auxiliary plant load: 22 kW (Constantly)

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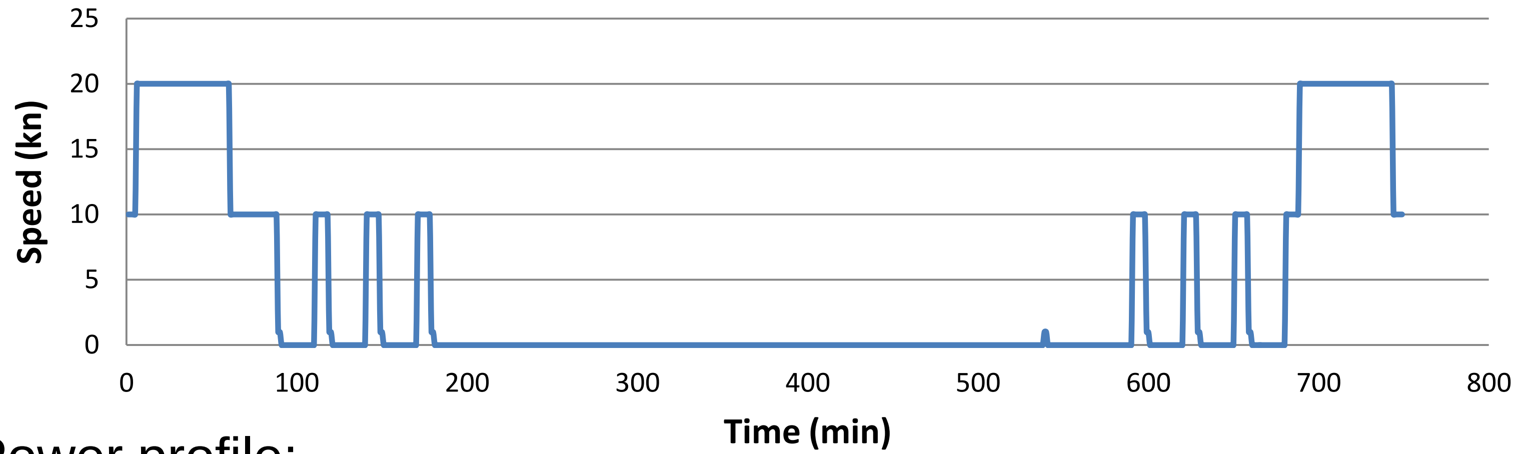
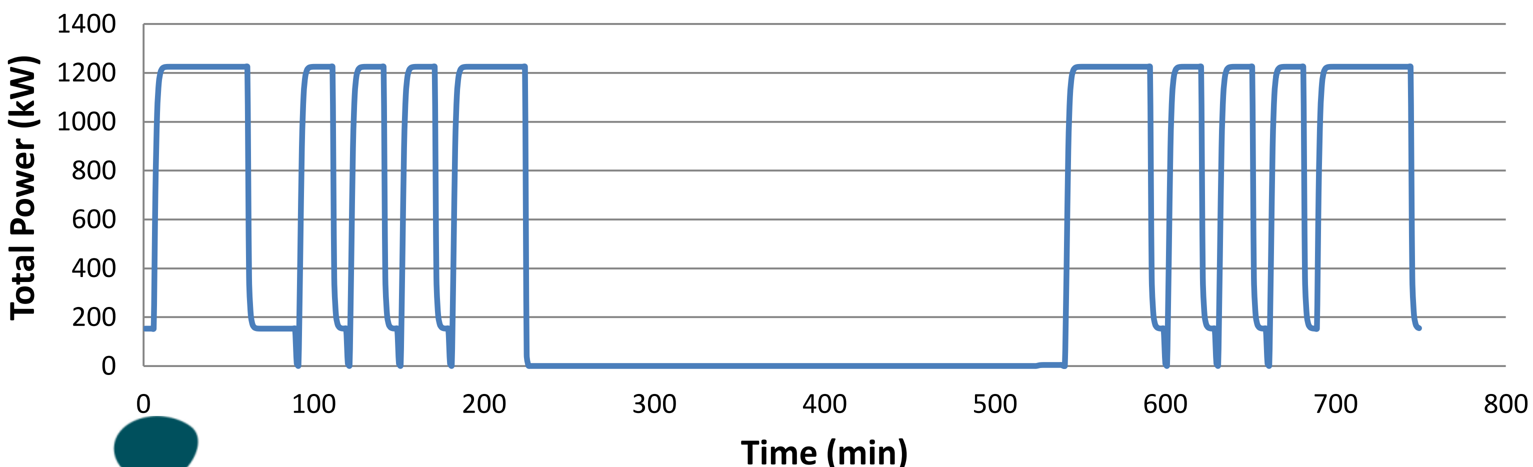
OPERATIONAL PROFILE

Speed profile:

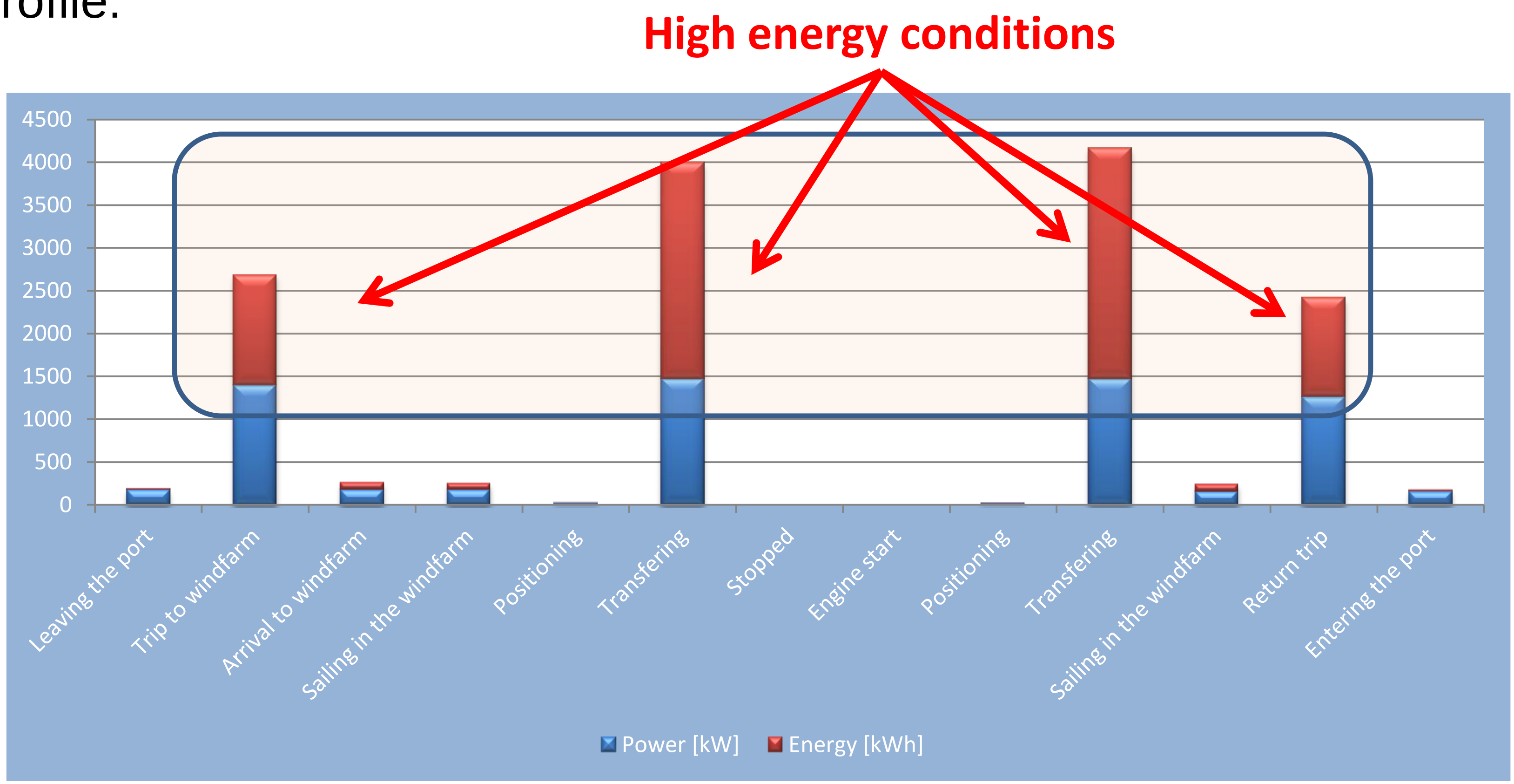


Power profile:

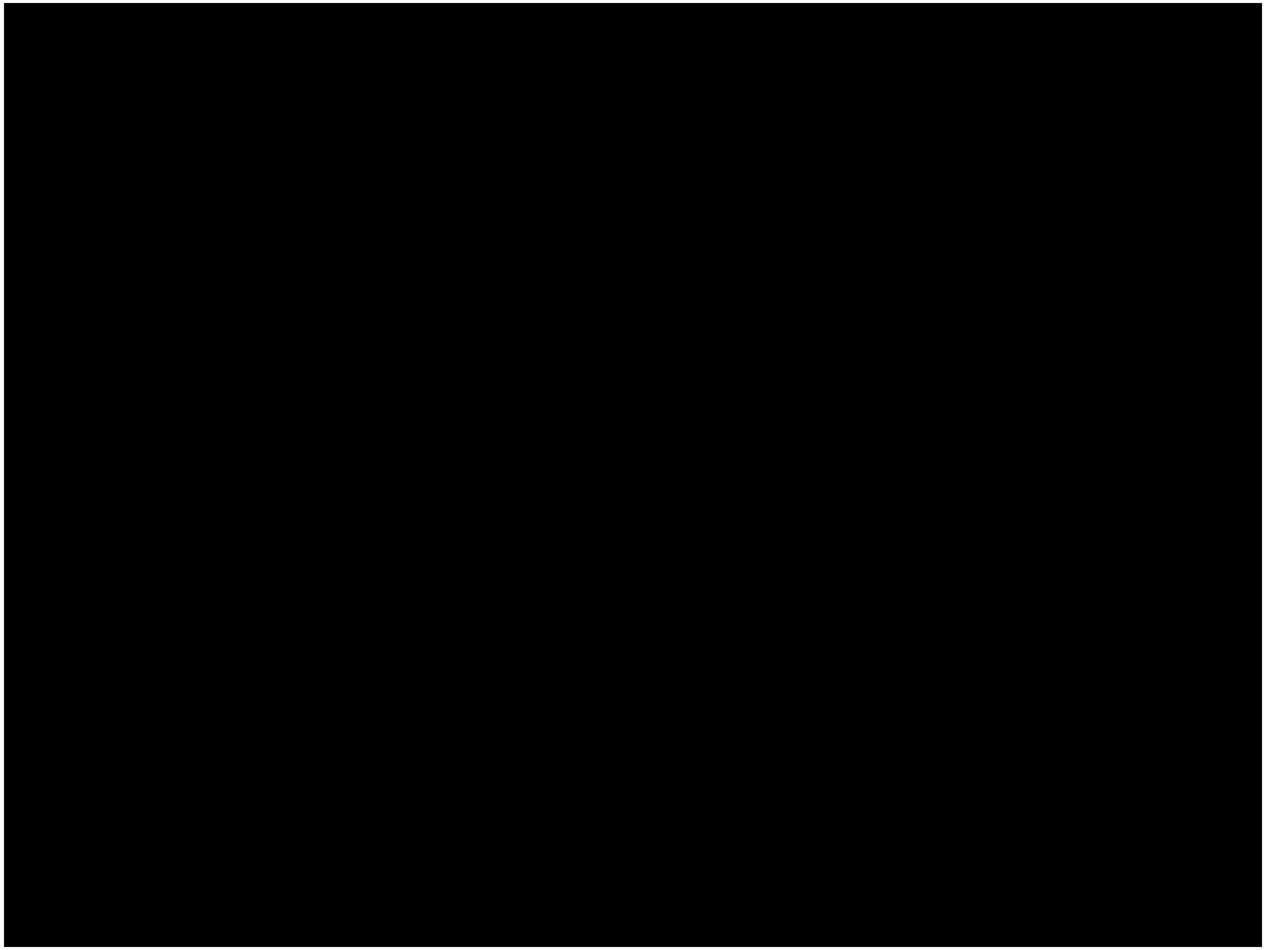


OPERATIONAL PROFILE

Profile:



VIDEO



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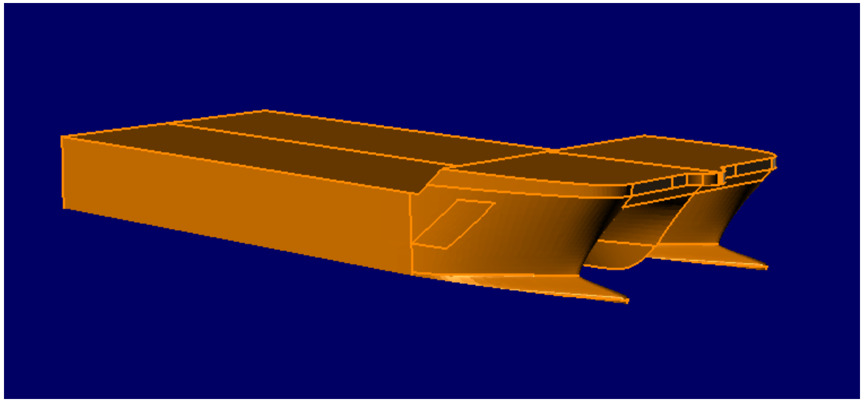
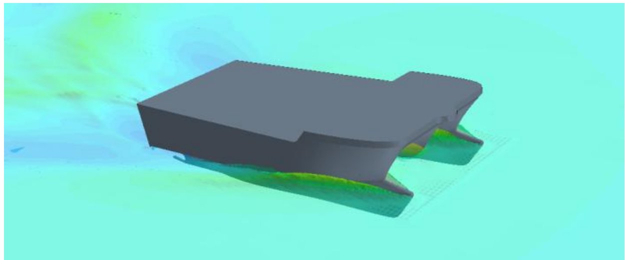
METHODOLOGY

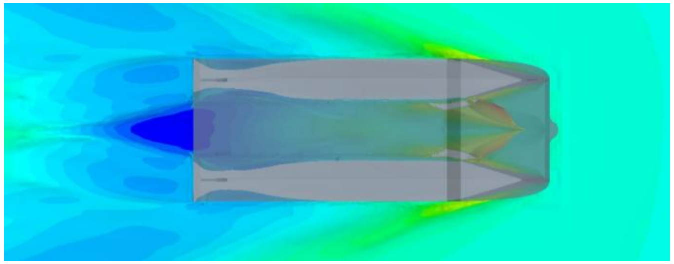
3D modelling

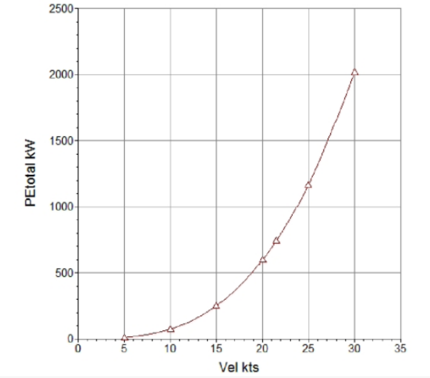


Ship Resistance

Calculations by means of Computational Fluid dynamics, both Potential (for initial analysis) and viscous codes







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METHODOLOGY

Seakeeping

FEM and CFD tools

Propulsion

Propeller design, propeller analysis with CFD codes

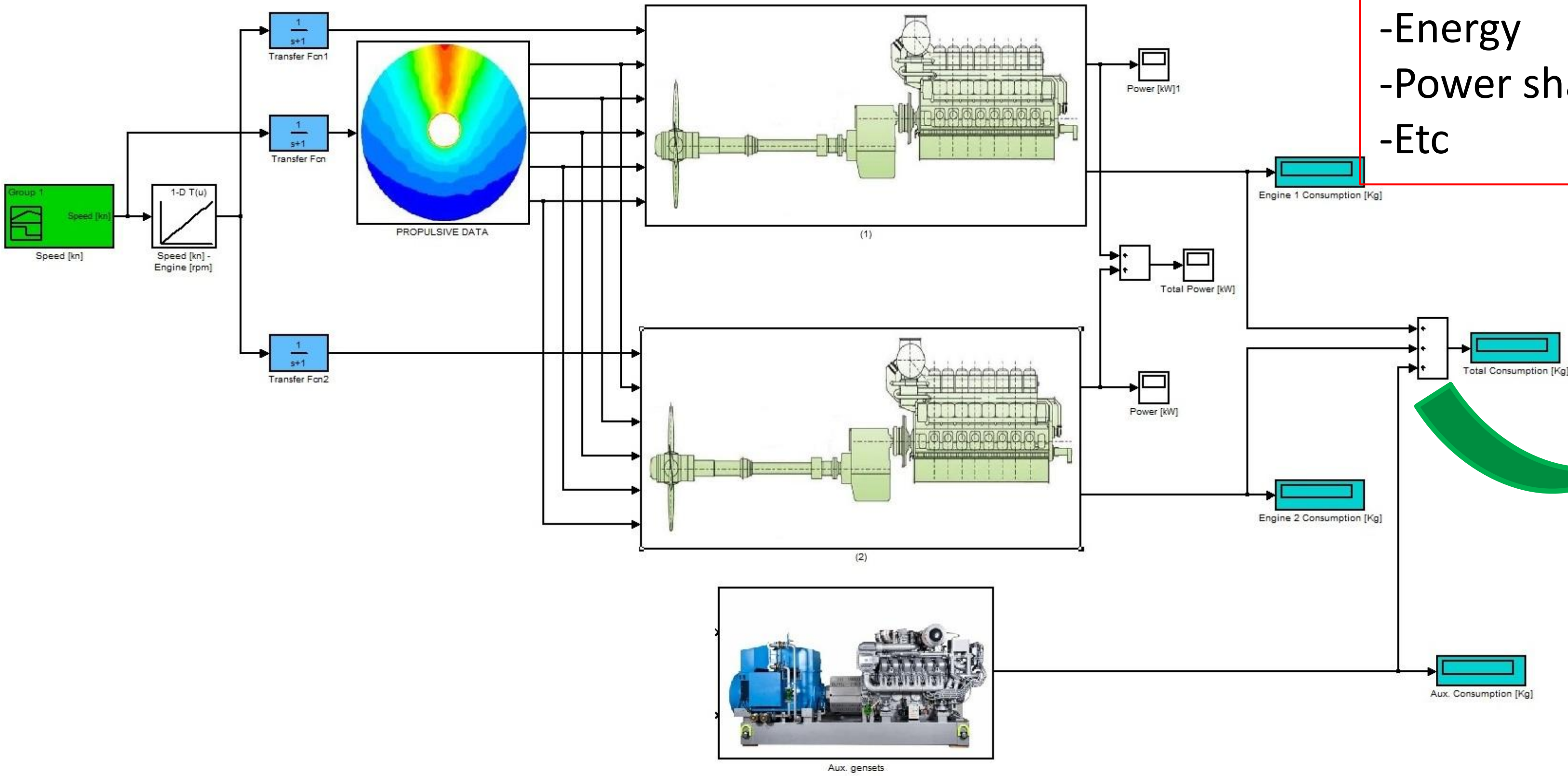
Machinery

Propulsion
Generation

Integration with Simulink to run the ship under a certain operation profile

HOW IS THIS LINKED?

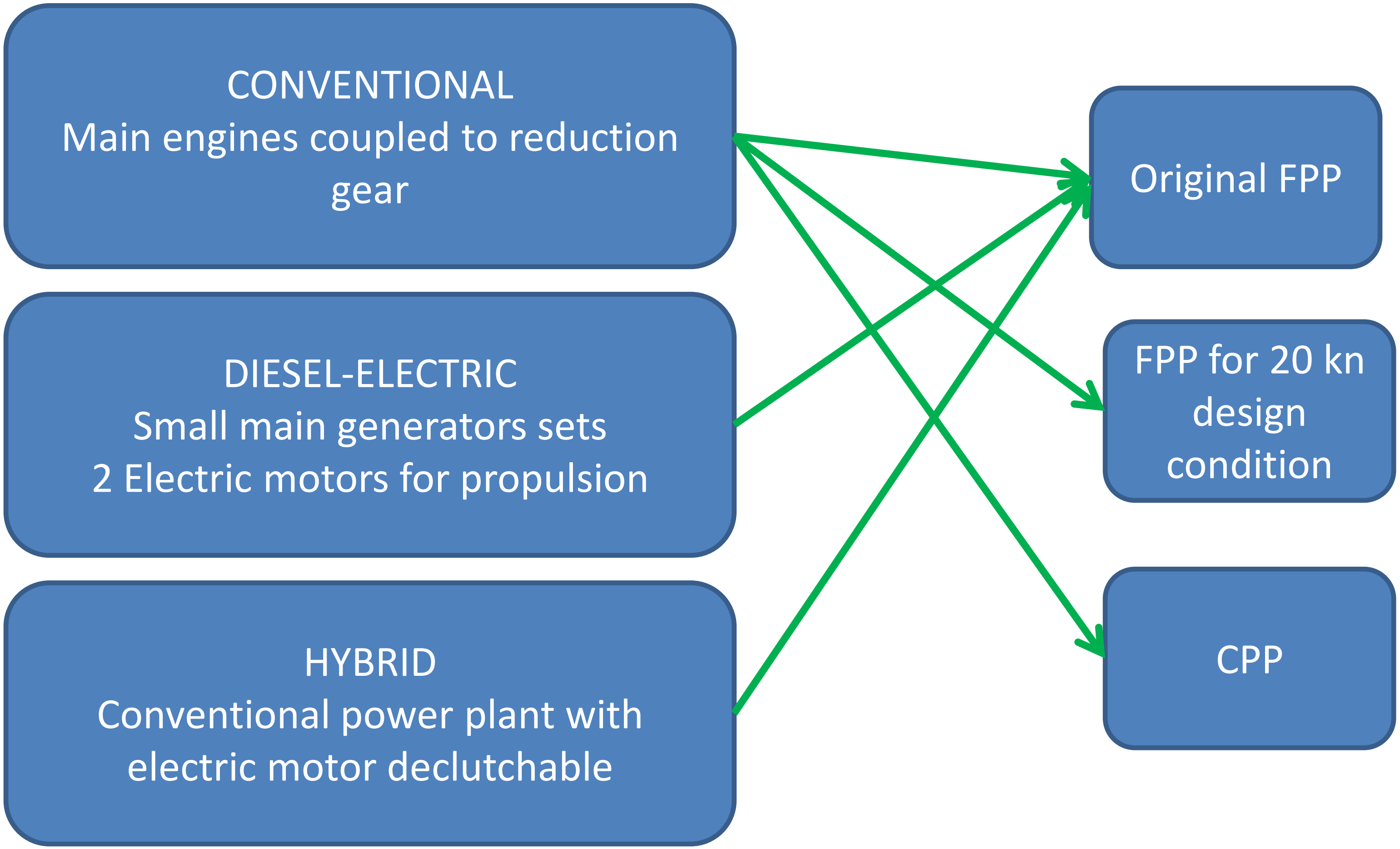
Simulink model



Additional Outputs

- Emissions
- Energy
- Power shares
- Etc

CONFIGURATIONS STUDIED



CONFIGURATIONS STUDIED

Propulsion

Two configurations of FP propellers have been studied

Original propellers

EAR=1.06 D=1.028m P=1.05m Z=5

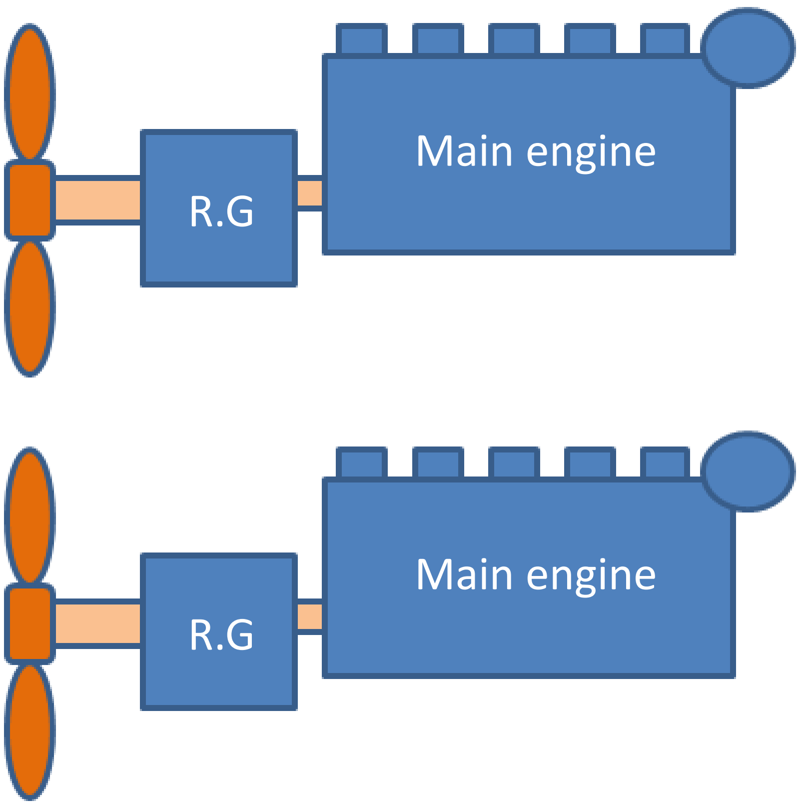
Modified propeller medium speed

(Higher Diameter→Less EAR→ Better efficiency)

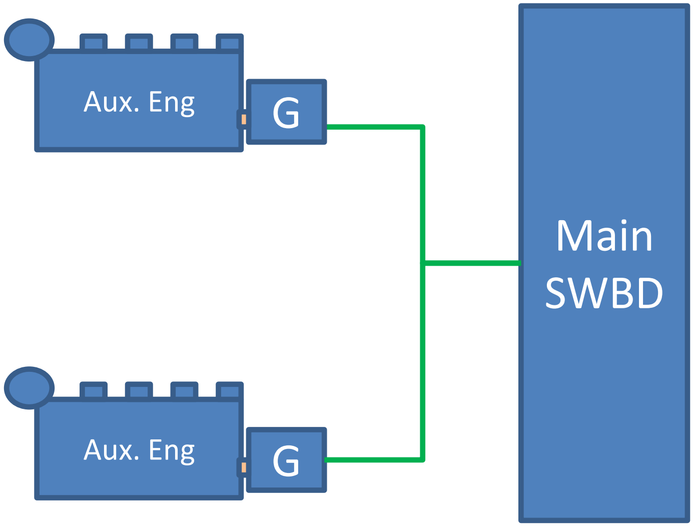
Both FPP and CPP

CONFIGURATIONS STUDIED

Conventional FPP



Aux. consumers



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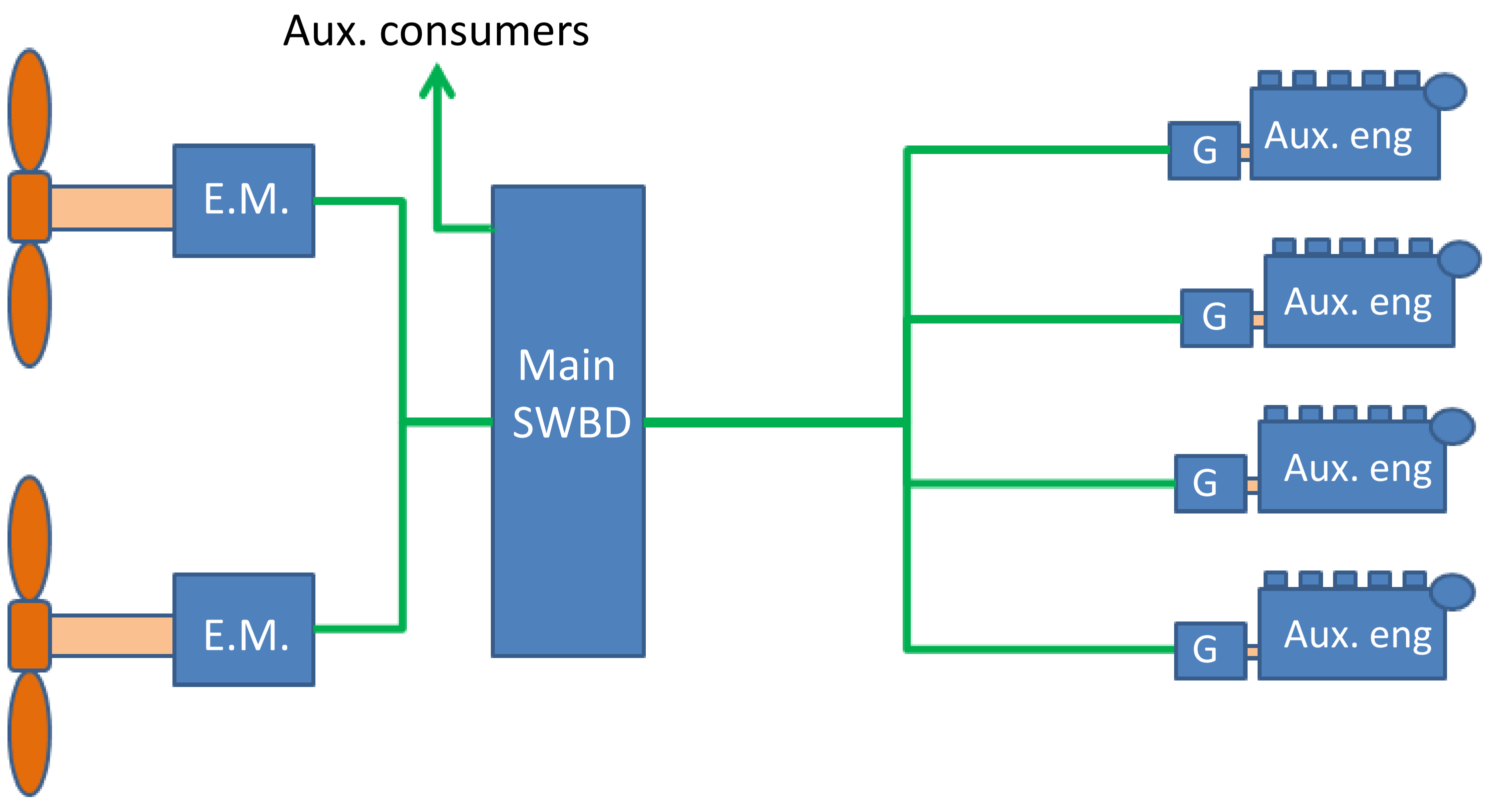
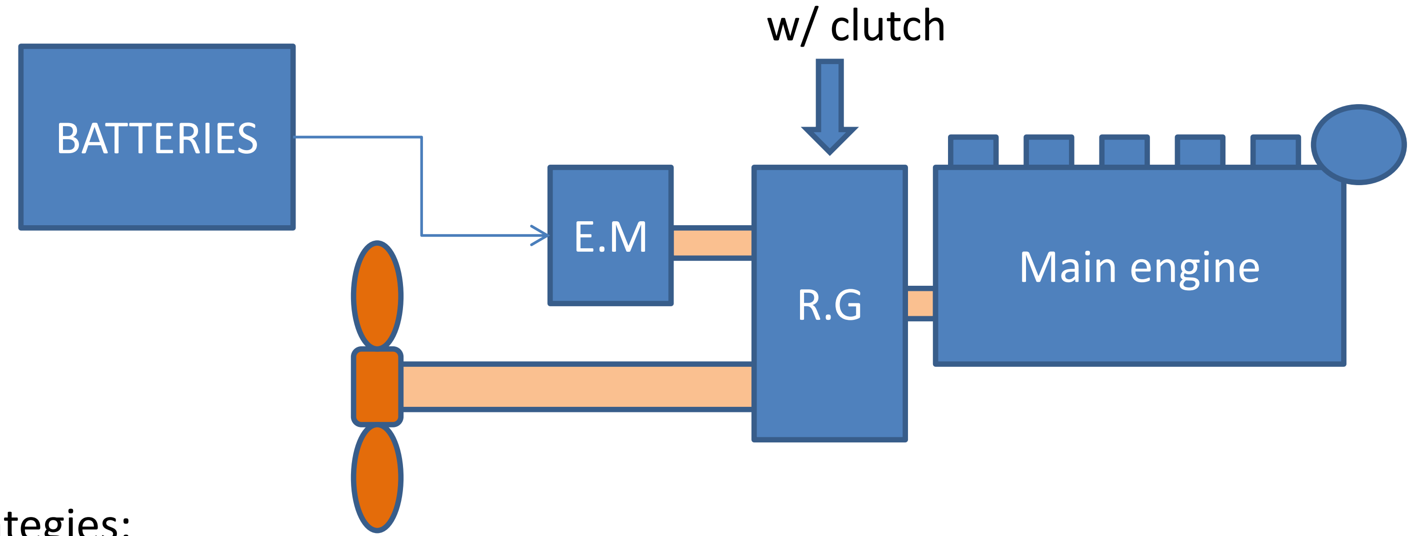
CONFIGURATIONS STUDIED

Diesel-Electric FPP



CONFIGURATIONS STUDIED

Hybrid FPP



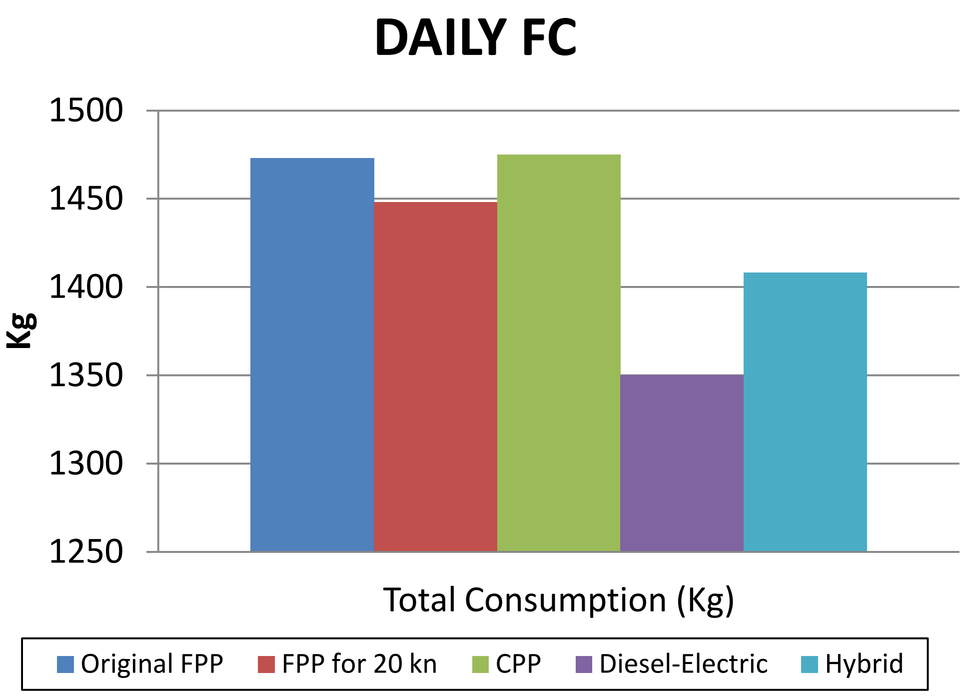
Hybrid Strategies:

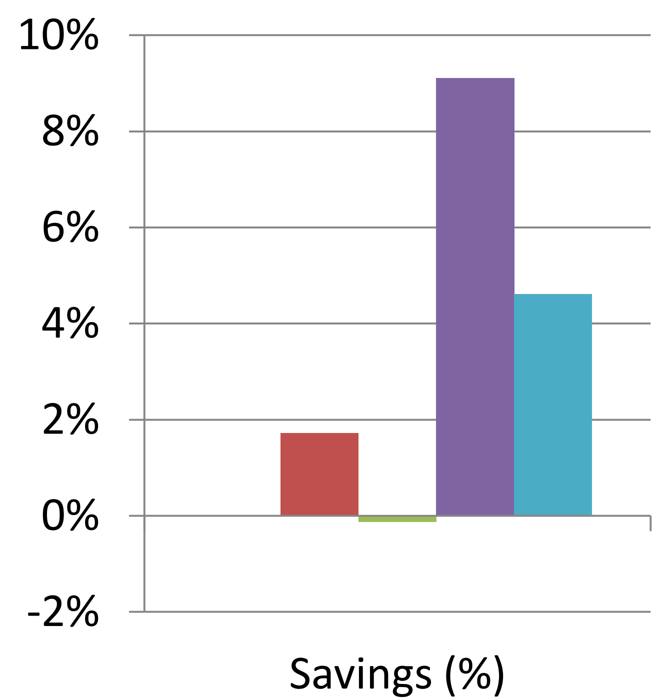
-Electric propulsion by means of Batteries when sailing inside the wind farm (800Ah batteries). Small amount of energy required

-Option: Electric propulsion with energy being supplied by aux. engines

RESULTS

Comparative Total Consumption:





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Annual savings above 25000 $ for this small ship

WHAT ELSE CAN BE DONE?

-Energy audit of existing vessels
-Increase the number of scenarios
-Increase the number of technologies
-Design for retrofitting
-Investigate more hull concepts
-Compare claimed savings from vendors with more realistic figures
-Apply weather statistics depending on the operational area
-Apply skipper practices and asses the impact

THANK YOU !

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