joules

Joint Operation for Ultra Low Emission Shipping

General Presentation

Maritime Abgasrunde

Hamburg, Decmber 10 th 2014

Content

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- Targets
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- Conclusions

This project receives funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 605190

Political goals

On the Maritime Agenda

- Reduction of greenhouse gases → **climate change**
- Reduction of harmful emissions → **acidification, eutrophication, human health and biodiversity**
- Reduction of energy consumption → **economy** of ship owners
- Saving of fossil energy resources through use of alternative sources of energy → **sustainability**

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FP 7 targets

Towards the Zero Emission Ship

- The "20-20-20" EU climate/energy targets for 2020:
  - **20**% reductions in GHG
  - **20**% energy consumption covered by renewable energy resources
  - **20**% improvement in energy efficiency
- Strengthening of European maritime industry
- Contribution to a single European transport area- towards a competitive and resource efficient transport system COM(2011) 144
  40% GHG reduction, if feasable 50%

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Joules- targets – Estimated CO_2 reductions

Application Areas	Application Cases	2025	2050
Ferry	Ro-Pax	20%	80%
	Urban Ferry	25%	70%
Passenger Ships	Ocean Cruiser	40%	70%
	River Cruiser	15%	80%
	Mega Yacht	15%	30%
Work Boats	Tug Boat	20%	40%
	Dredger	25%	40%
Offshore	OPV	20%	40%
	OSV	20%	40%
Cargo	Arctic Cargo	20%	40%
	Wind Assisted	35%	50%

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Decision support

“Design in seven days”

+

expert tools for thorough optimization of ship’s energy grids

Joules Energy Grid Simulation Methodology

Life Cycle Performance

BAL.LCPA

KPIs
- NPV
- GWP
- AP
- EP
- PM

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JOULES – Scope to address

- Reduction of use of energy and related CO2-emissions
- Simultaneous reduction of harmful emissions
  - SOx, NOx and PM 10
- Ship specific simulation issues
  - Operating profile
  - Propulsion and auxiliary systems
  - Economical impact
- Fostering life cycle thinking → sustainability
  - Fuels incl. emissions from "well to propeller"
  - Societal impact → external costs
  - Screening LCA in early design stage

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JOULES - Application Cases

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Joules - Technology Areas

Technology Areas

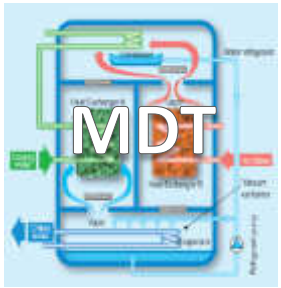
Renewables

WNL

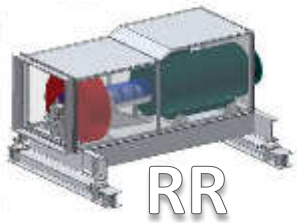
Primary converters

WFI

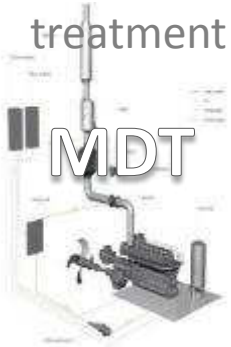
Secondary converters



Electric converters



After treatment

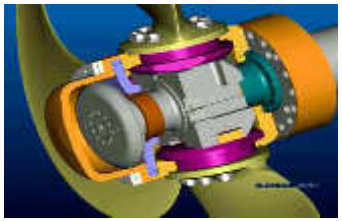


Consumption on board

MW

Consumption Propulsion

WNL



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38 JOULES Partners from 10 countries

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Summary and Conclusions

- **Optimisation of Energy Grid by simulation in focus**
- **Waste heat recovery, innovative primary and secondary energy converters, energy storage devices, abatment technologies as well as alternative fuels & wind power**
- **Concept from Cradle to Grave considered**
- **Challenging objectives**
- **Strong Consortium covering a huge range of products**
- **Knowledge available from shipyards, technology providers, engineering partners, ship owners as well as universities**
- **Expected result is a further step towards more sustainability in the maritime industry**

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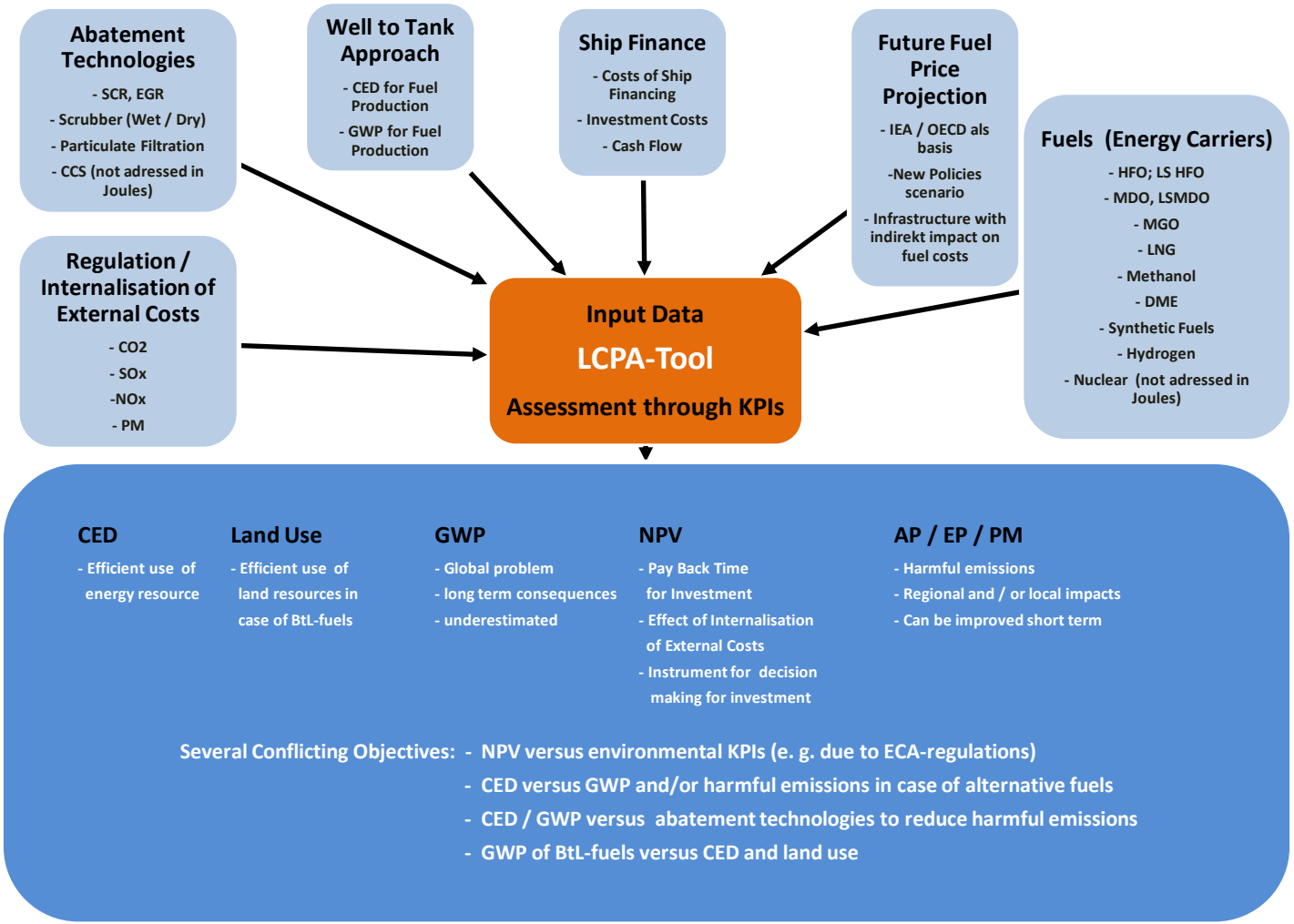
Complexity of LCP-Assessment



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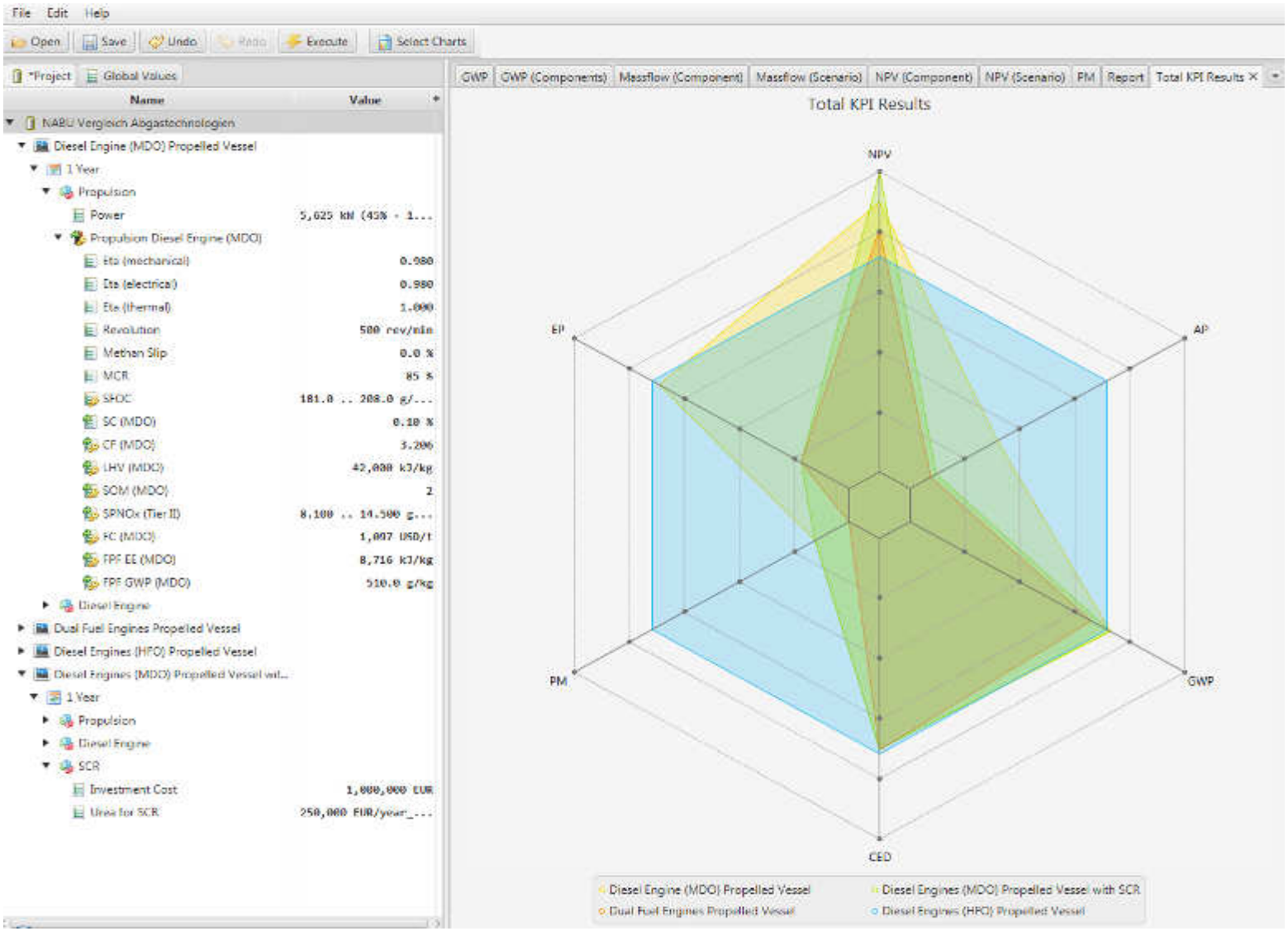

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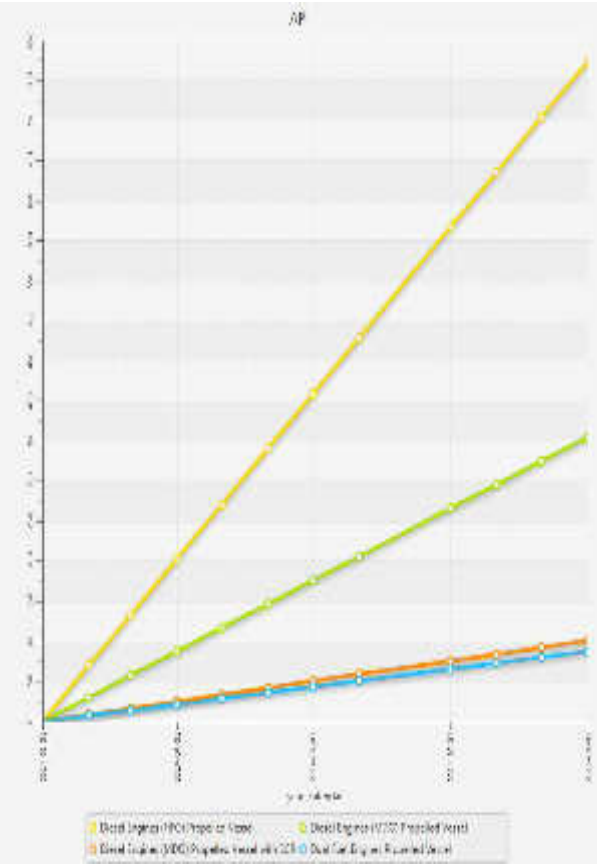

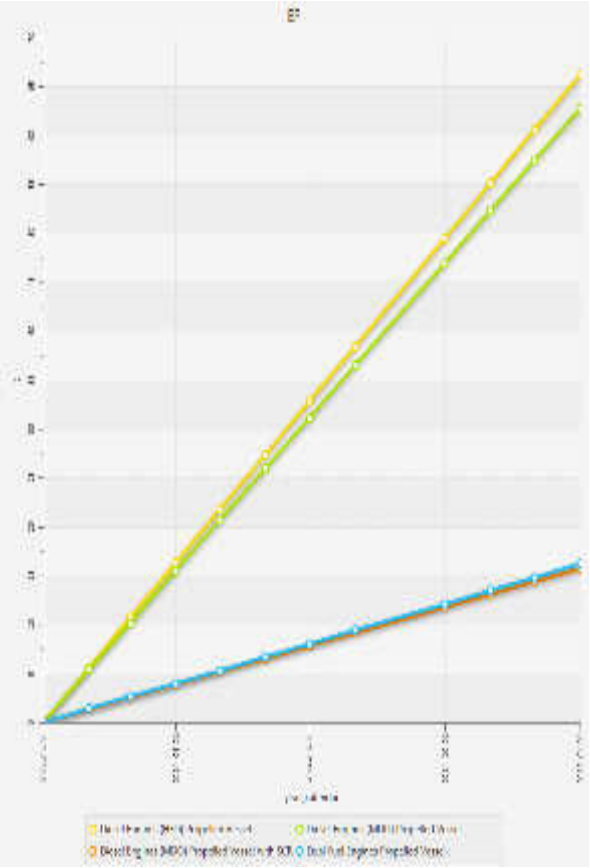

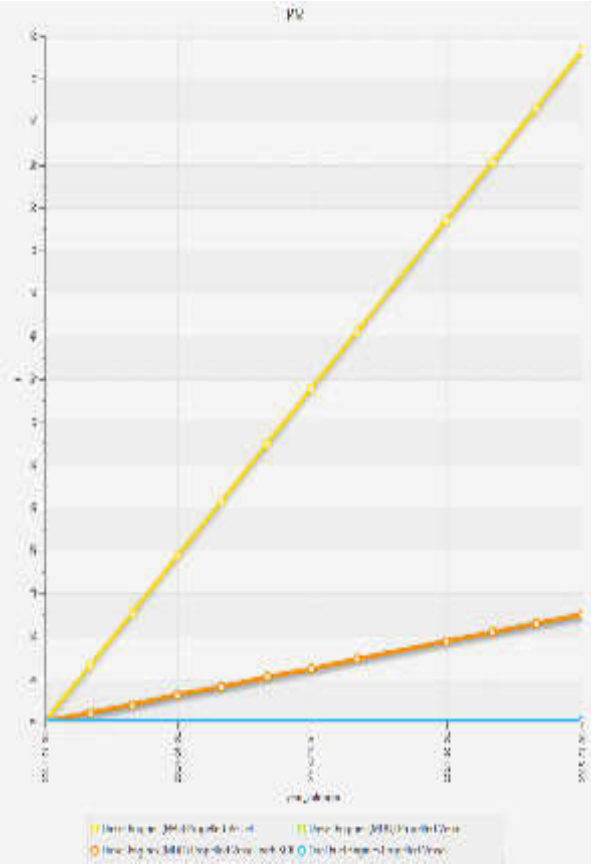

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Key Issues

- **Conflicting objectives are severely influencing the decision making process in ship design, no general solutions available**
- **“End of the pipe” technology for after treatment seems to be only interim solution (typically higher energy consumption and CO2-emissions, complex, monitoring in practice etc.)**
- **Clean fuels like LNG (in particular for shot sea shipping) are promising solution - energy consumption and CO2-emissions from “well to propeller” needs to be analysed**
- **Planning reliability of outmost importance for maritime industry**
- **Shipping is international business, avoid solo attempts for regulations from national or local authorities**

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Joint Operation for Ultra Low Emission Shipping

THANK YOU !

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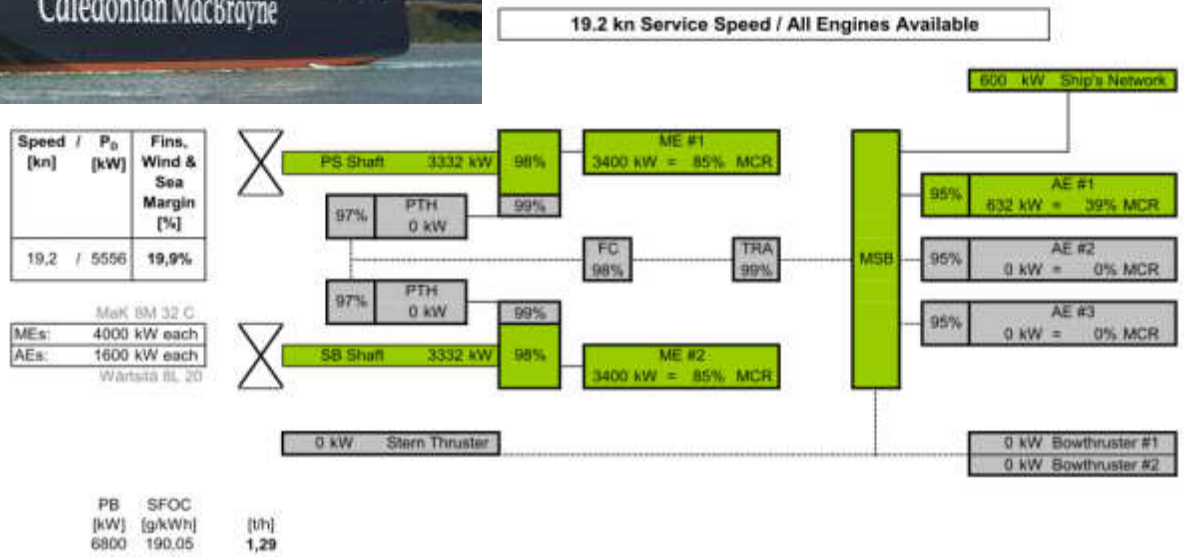
Case 1
Ro-Pax Ferry



Comparing measures $\frac{CO_2(t/yr)}{PAX(Nr)\cdot(Nm/yr)}$ $\frac{CO_2(t/yr)}{\text{Cargo}(t)\cdot(Nm/yr)}$

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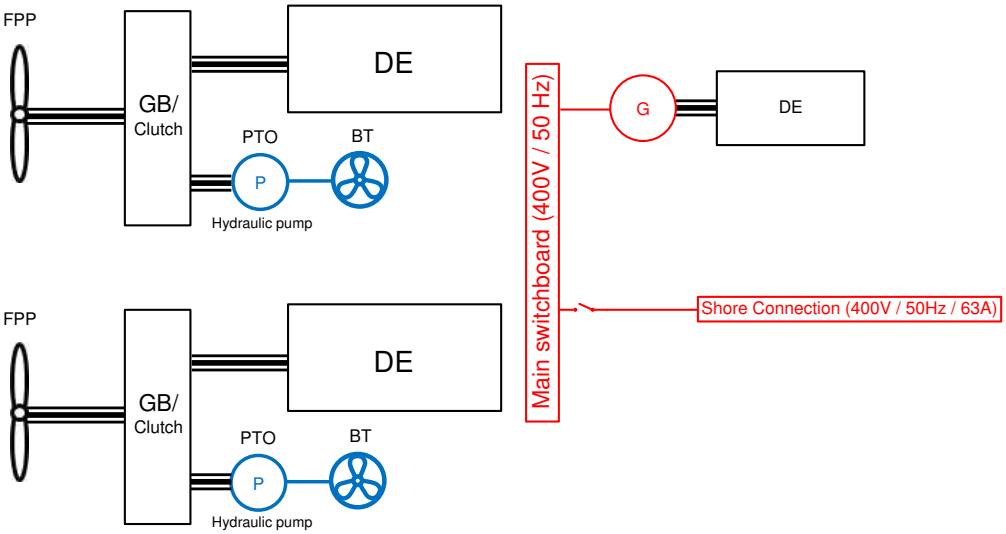
Case 2 Urban Ferry



Comparing measures	$\frac{CO_2(t/yr)}{trips(Nr/yr)}$	$\frac{Cost(fuel, \text{maintenacne}, etc)(€/yr)}{trips(nr/yr)}$	$\frac{NO_x(t/yr)}{trips(Nr/yr)}$

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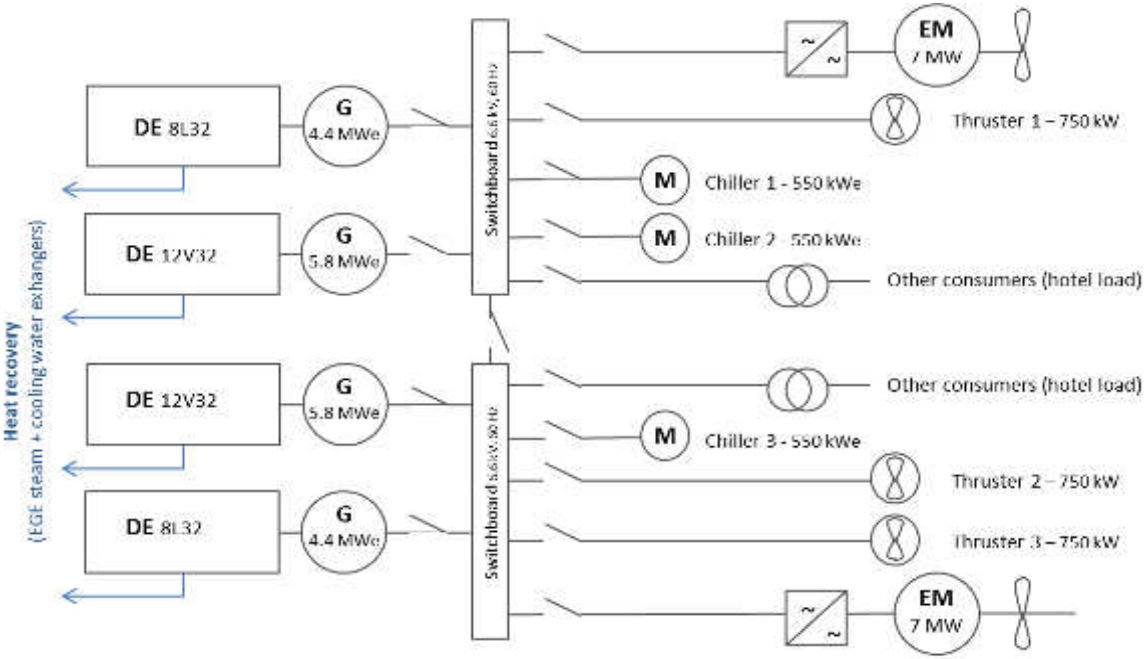
Case 3 Ocean Cruiser



Comparing measures	$\frac{Fuel(t/yr)}{APCD^*}$	$\frac{CO_2(t/yr)}{APCD}$	$\frac{SO_x(t/yr)}{APCD}$	$\frac{NO_x(t/yr)}{APCD}$	*Average Passenger Cruise Day

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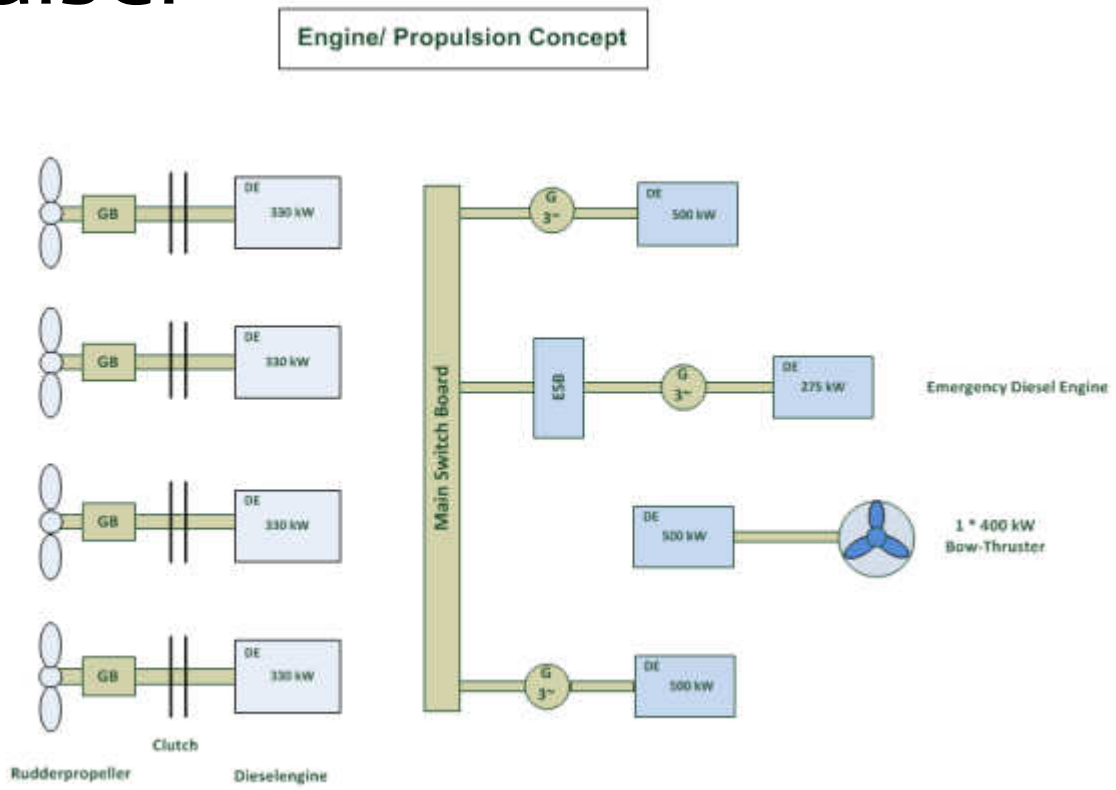
Case 4 River Cruiser



Comparing measures	$\frac{Fuel(t/yr)}{APCD^*}$	$\frac{CO_2(t/yr)}{APCD}$	$\frac{SO_x(t/yr)}{APCD}$	$\frac{NO_x(t/yr)}{APCD}$	*Average Passenger Cruise Day

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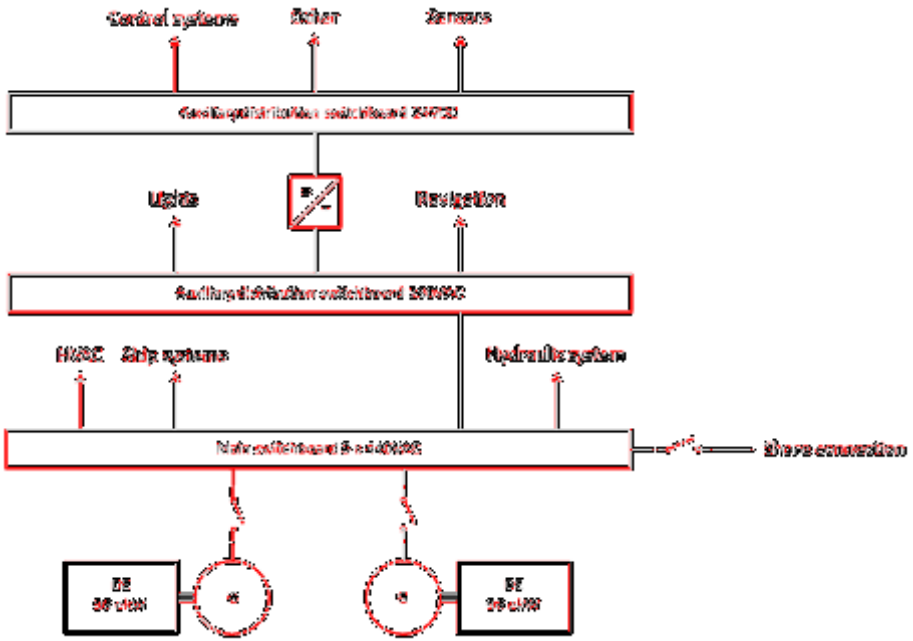
Case 6 Tug



Comparing measures $\frac{Fuel(t/yr)}{operations/yr}$ $\frac{CO_2(t/yr)}{operations/yr}$ $\frac{SO_x(t/yr)}{operations/yr}$ $\frac{NO_x(t/yr)}{operations/yr}$

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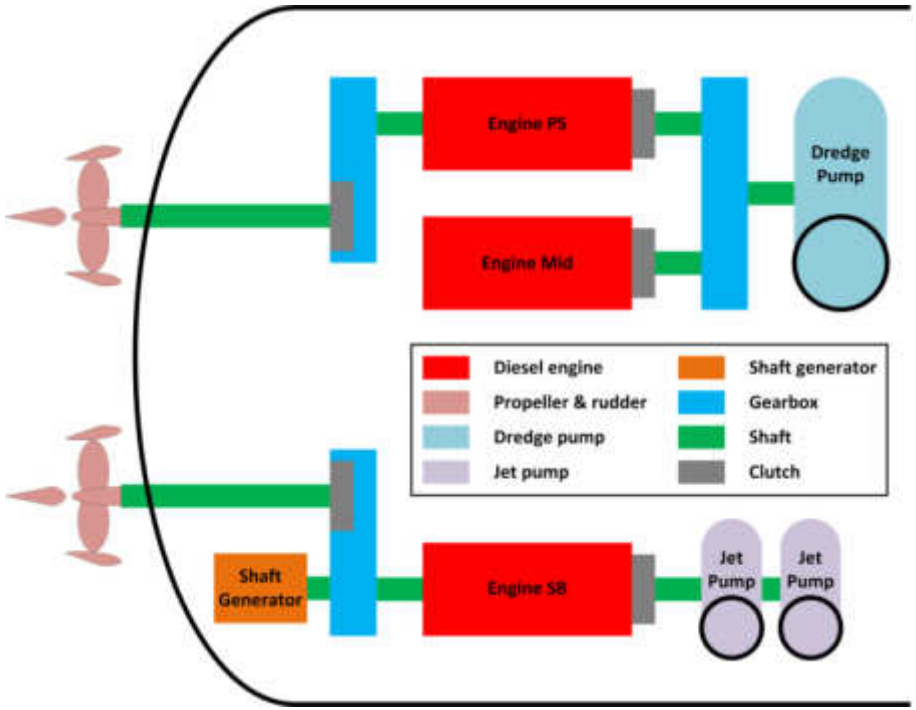
Case 7 Dredger



Comparing measures $\frac{CO_2(t/yr)}{m^3\,(dry)\,soil/rock}$ $\frac{NO_x(t/yr)}{m^3\,(dry)\,soil/rock}$

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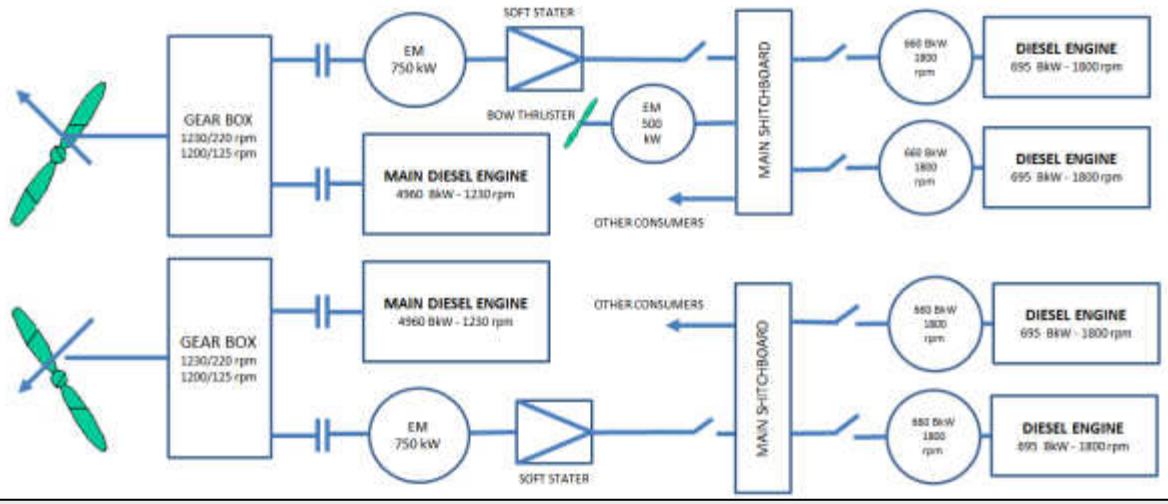
Case 8 OPV



Comparing measures	$\frac{CO_2(t/yr)}{\text{Patrolling Distance (nm/yr)}}$	$\frac{NO_x(t/yr)}{\text{Patrolling Distance (nm/yr)}}$	$\frac{SO_x(t/yr)}{\text{Patrolling Distance (nm/yr)}}$

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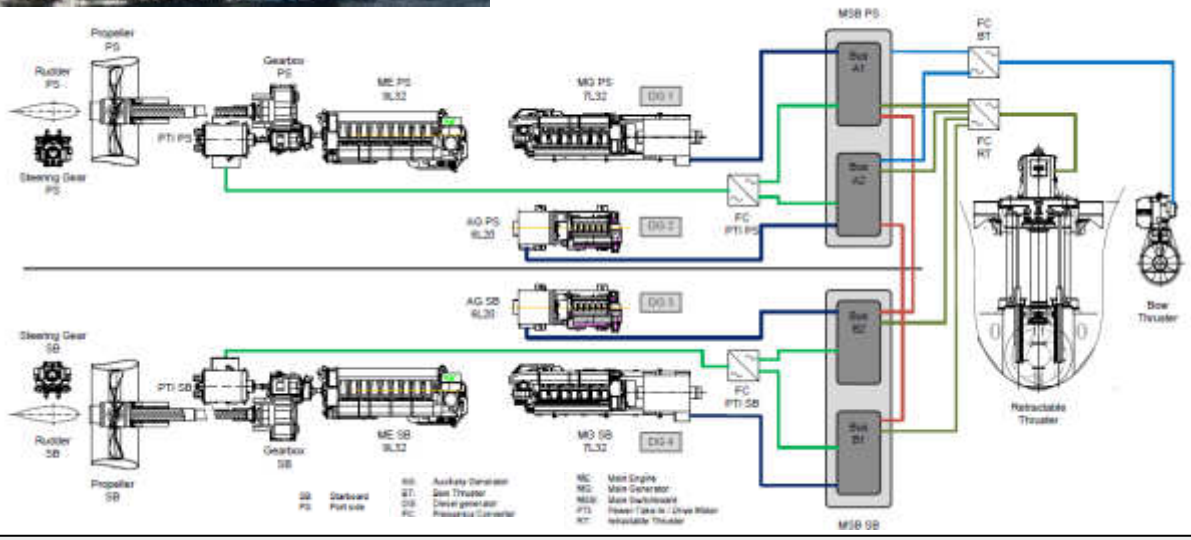
Case 9 OSV



Comparing measures	$\frac{\text{Area covered}}{\text{time of seismic operation}}$	$\frac{CO_2\,(t/yr)}{\text{area (m²/yr)}}$

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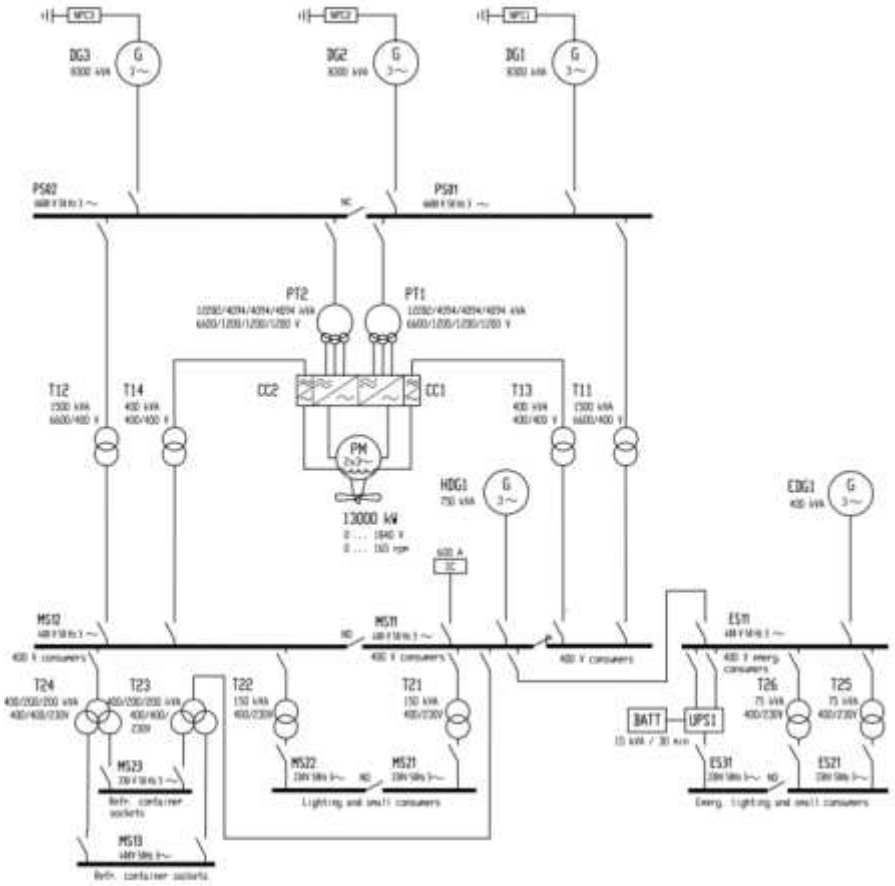
Case 10 Arctic Cargo



Comparing measures $\frac{annualCO_2, NO_x, SO_x(t)}{\text{distance}(Nm)}$ $\frac{annualCO_2, NO_x, SO_x(t)}{profit(€/yr)}$

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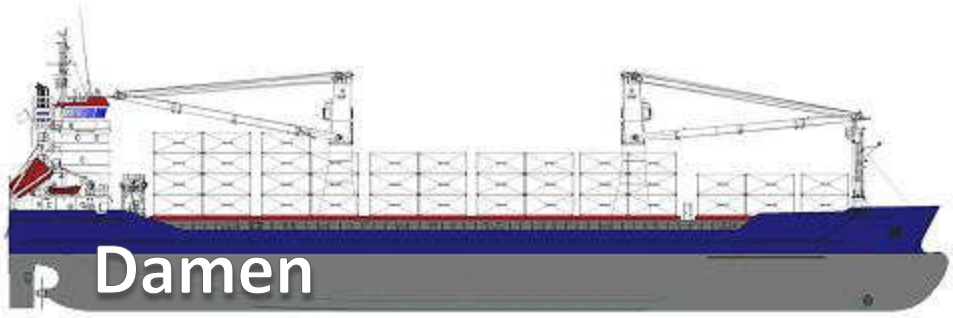
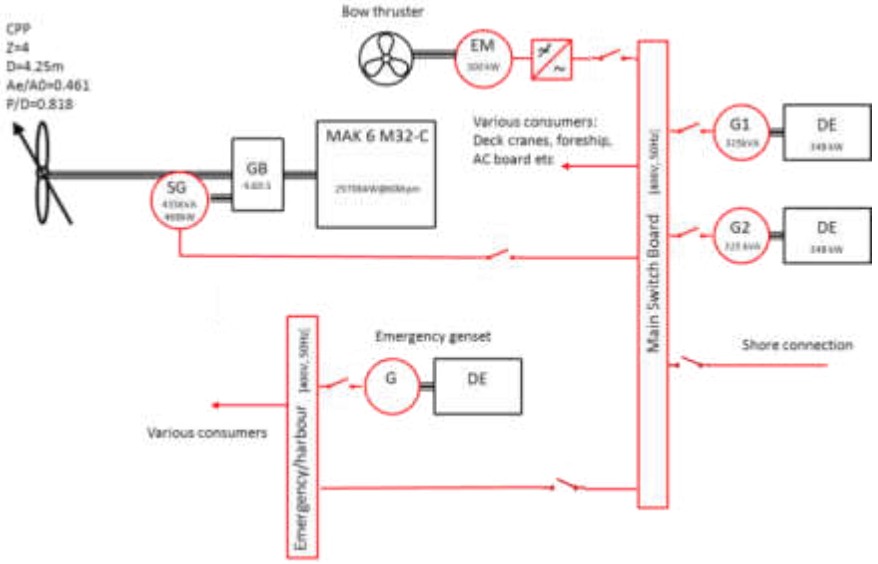
Case 11 wind assisted





Comparing measures $\frac{annualCO_2, NO_x, SO_x(t)}{\text{distance}(Nm)}$ $\frac{annualCO_2, NO_x, SO_x(t)}{profit(€/yr)}$

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Renewables

- Wind propulsion system such as
  - Kites,
  - Flettner rotors
  - Dynarigs or
  - Foldable wings
- Solar panels for reduction of energy consumption
- Use of wave energy

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Primary Converters

- Specific technology applied to the 2-Stroke engine
- Natural Gas as Fuel for 2-Stroke Engines
- General considerations for 4-Stroke Engines
- Natural Gas in 4-Stroke Engines
- Fuel Cell and reformers for maritime applications
- Gas Turbines
- Alternative Fuels

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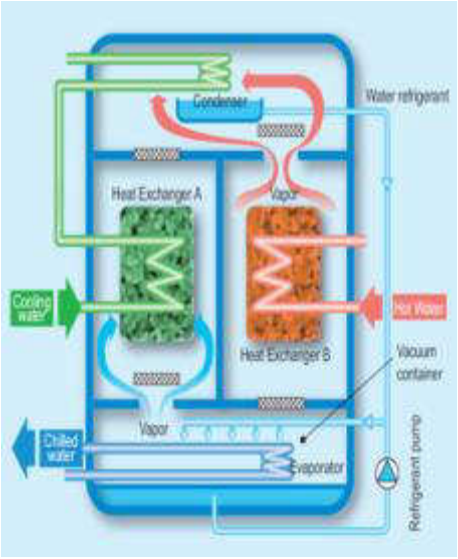
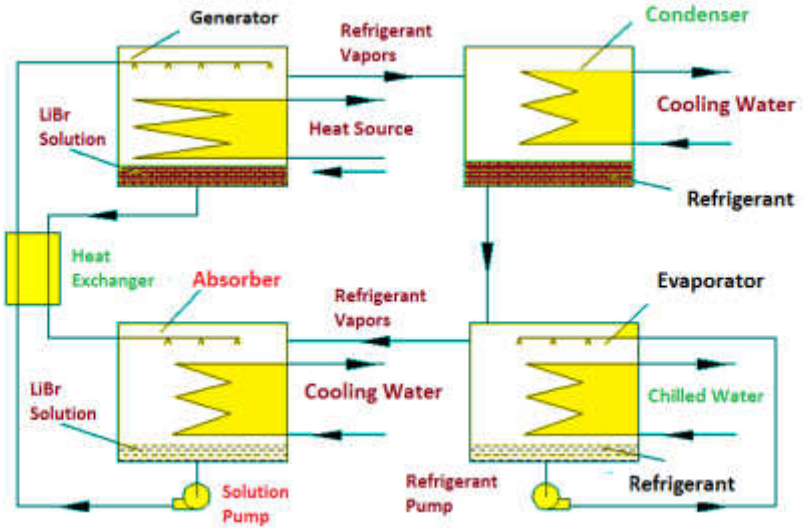
Secondary Converters

- Waste heat recovery systems





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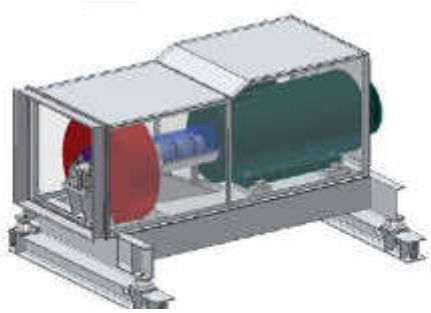
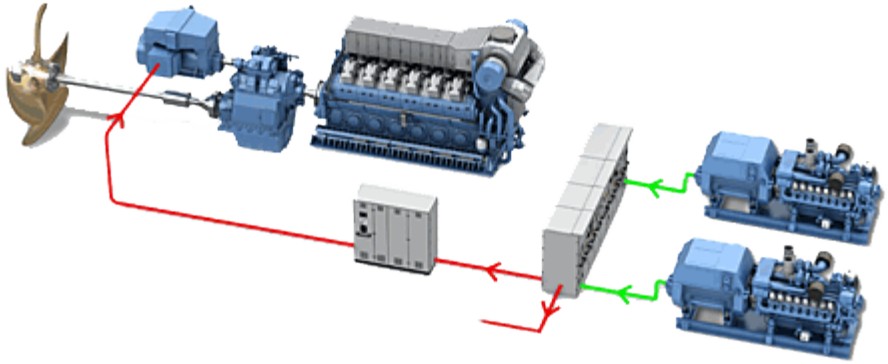
Electric Converters

- Power Conversion Applications
- Electrical Distribution
- Energy Storage
- Hybrid propulsion





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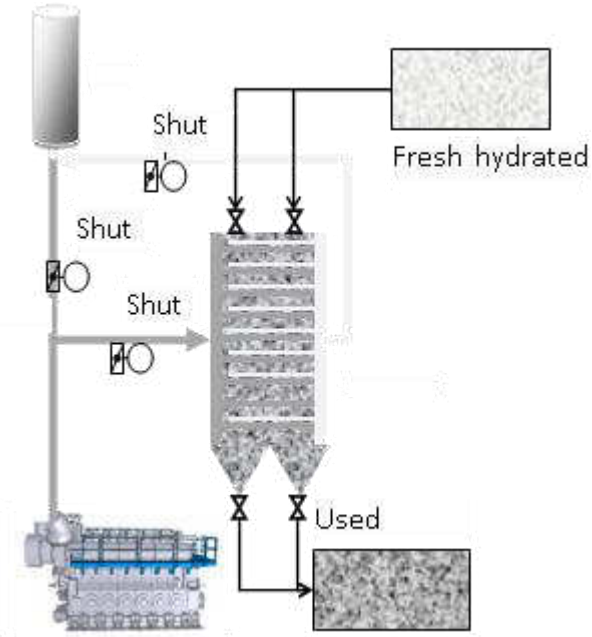
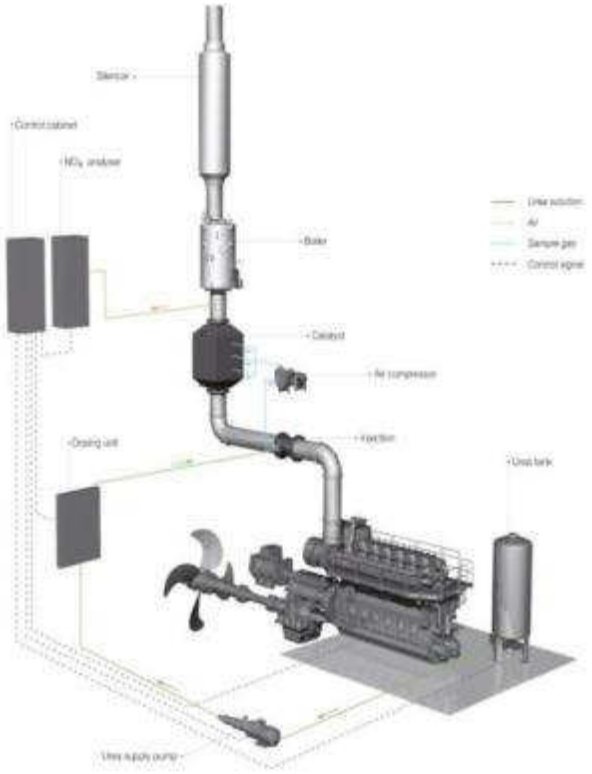
After Treatment

- Reduction on NOx
- Reduction of SOx
- Particulate filtration





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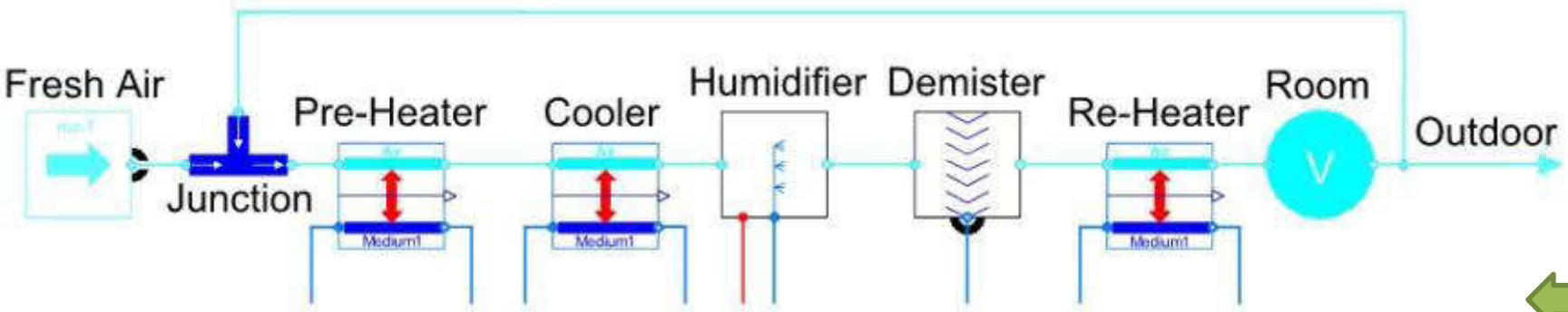
Consumption on board

- The number of cabins and heat and radiation losses.
- Energy consumption for electrical and water usage
- Heat load for air conditioning.
- Control parameter: required temperature



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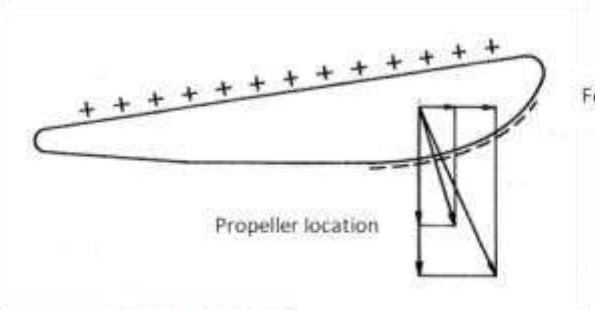
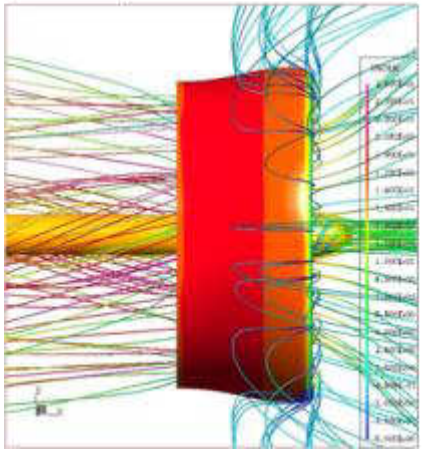
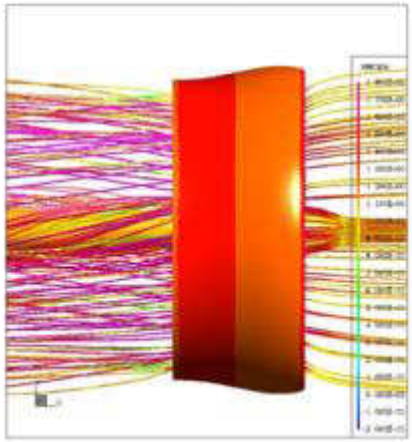
Consumption Propulsion

- Propeller in nozzle
- Steerable thrusters
- Electrical pods
- Cycloidal propulsors
- Counter rotating propellers
- LAP Large area propellers







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