MARITIME

PERFECt Ship - LNG fuel feasibility study -
- Piston Engine Room Free Efficient Container Ship -

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2016-05-31 and 2016-06-01

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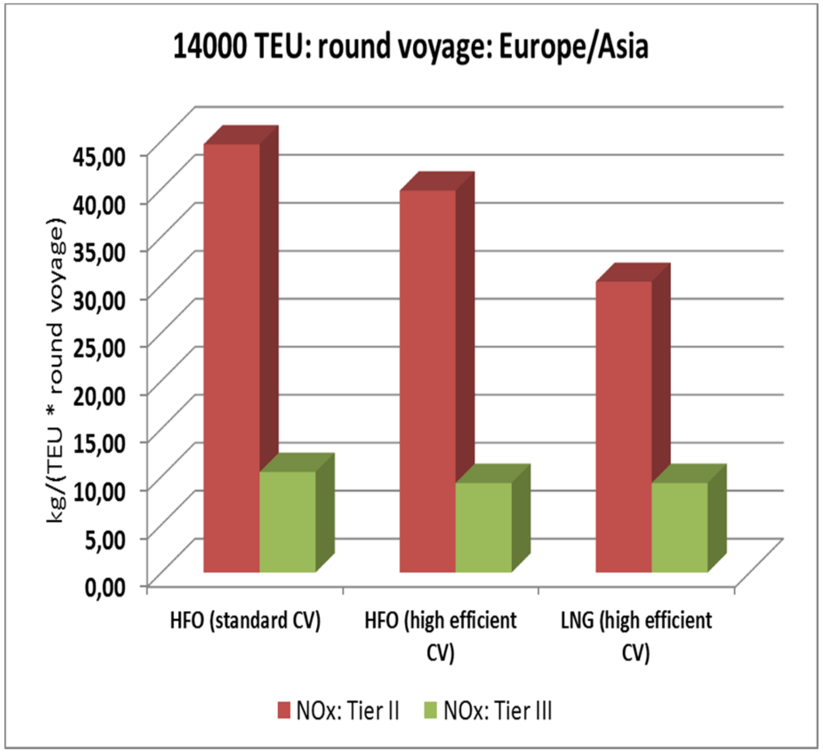
NOx Emission reductions by use of LNG (2-stroke diesel cycle)



emissions gewue April 2016.xlsx

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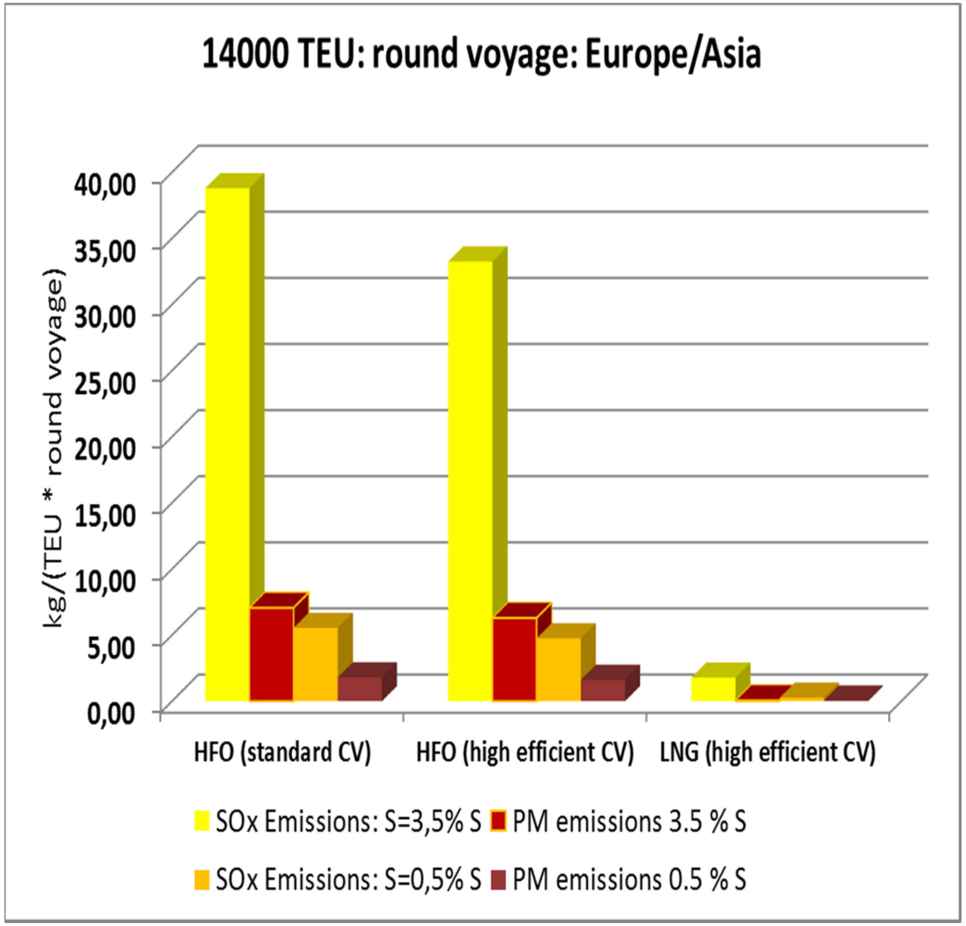
SOx emission reductions by use of LNG



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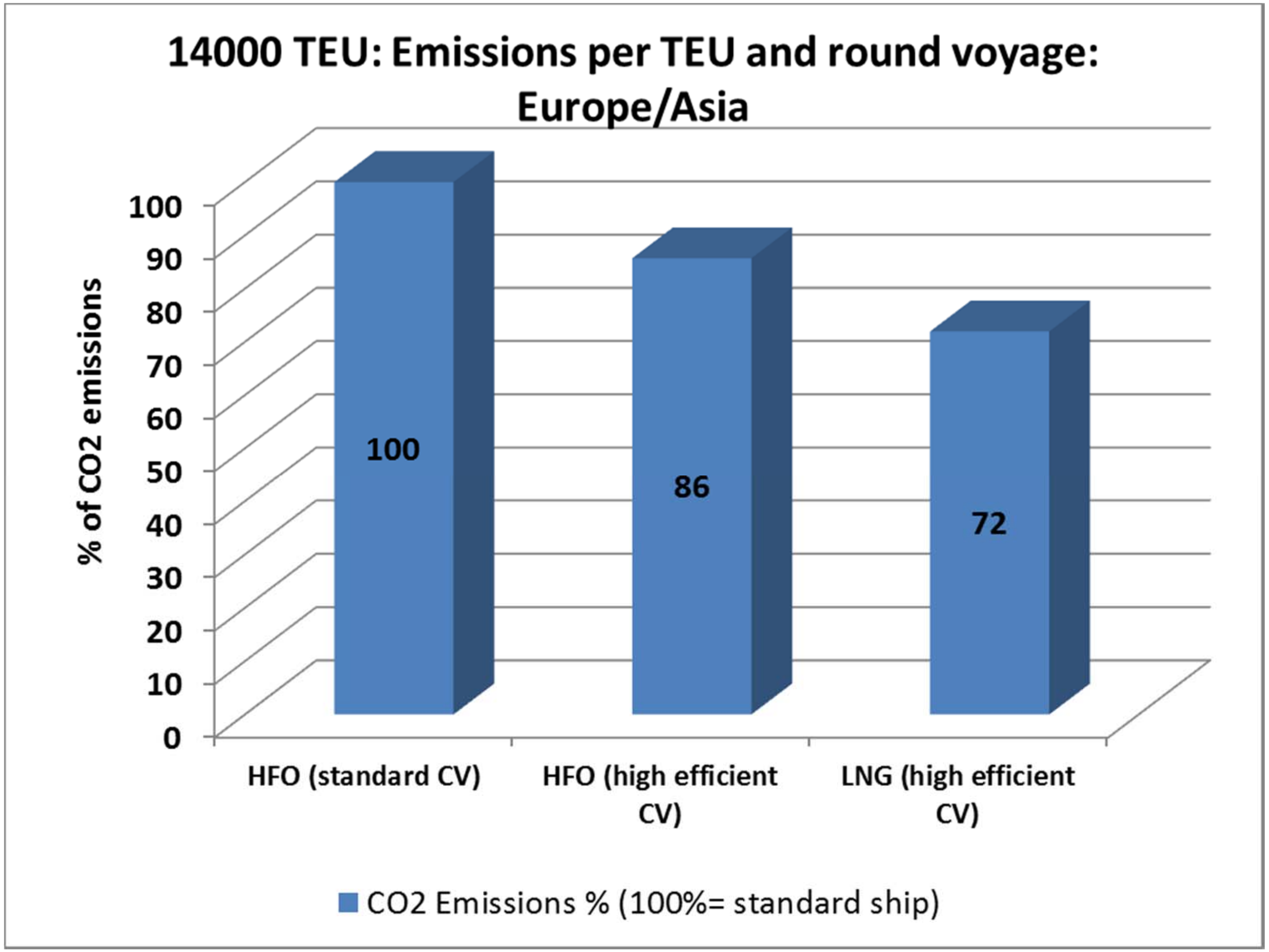
Relative CO2 Emissions



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PERFECT Project partners

- GTT, CMA Ships, DNV GL -

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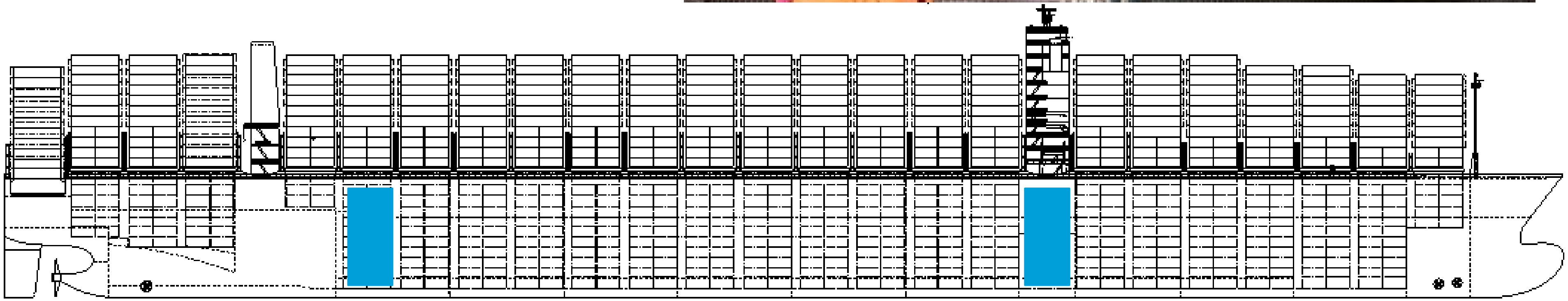
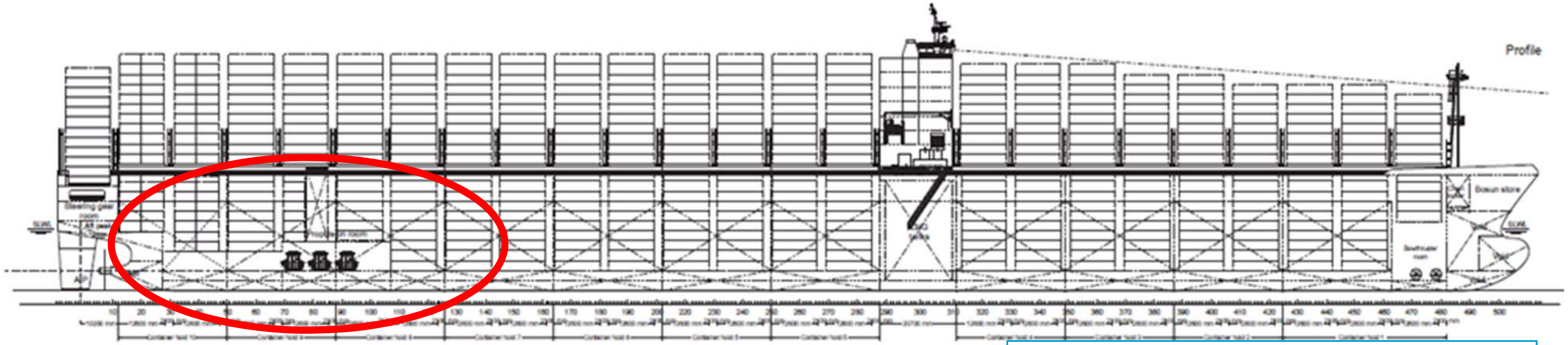
ULCS LNG tank arrangement options

- To be considered
  - Tank capacity
    - Energy density
    - Target endurance
    - Bunkering infrastructure
  - Retrofit OR newbuilding
  - Tank type



General arrangement of the PERFECT ship



Credit: GTT / Marine Assistance

- 90 MW total installed power
- Single screw layout
- 65 MW (shaft) at 22 knots at scantling draft
- Length overall: 400 m
- Beam: 59 m
- Scantling: 16 m
- Container capacity: approx. 20,000

1. Compensation of the higher fuel volume
2. Giving additional cargo capacity
3. 4 to 5% less fuel consumption/(slot * a); comp to LNG 2 stroke

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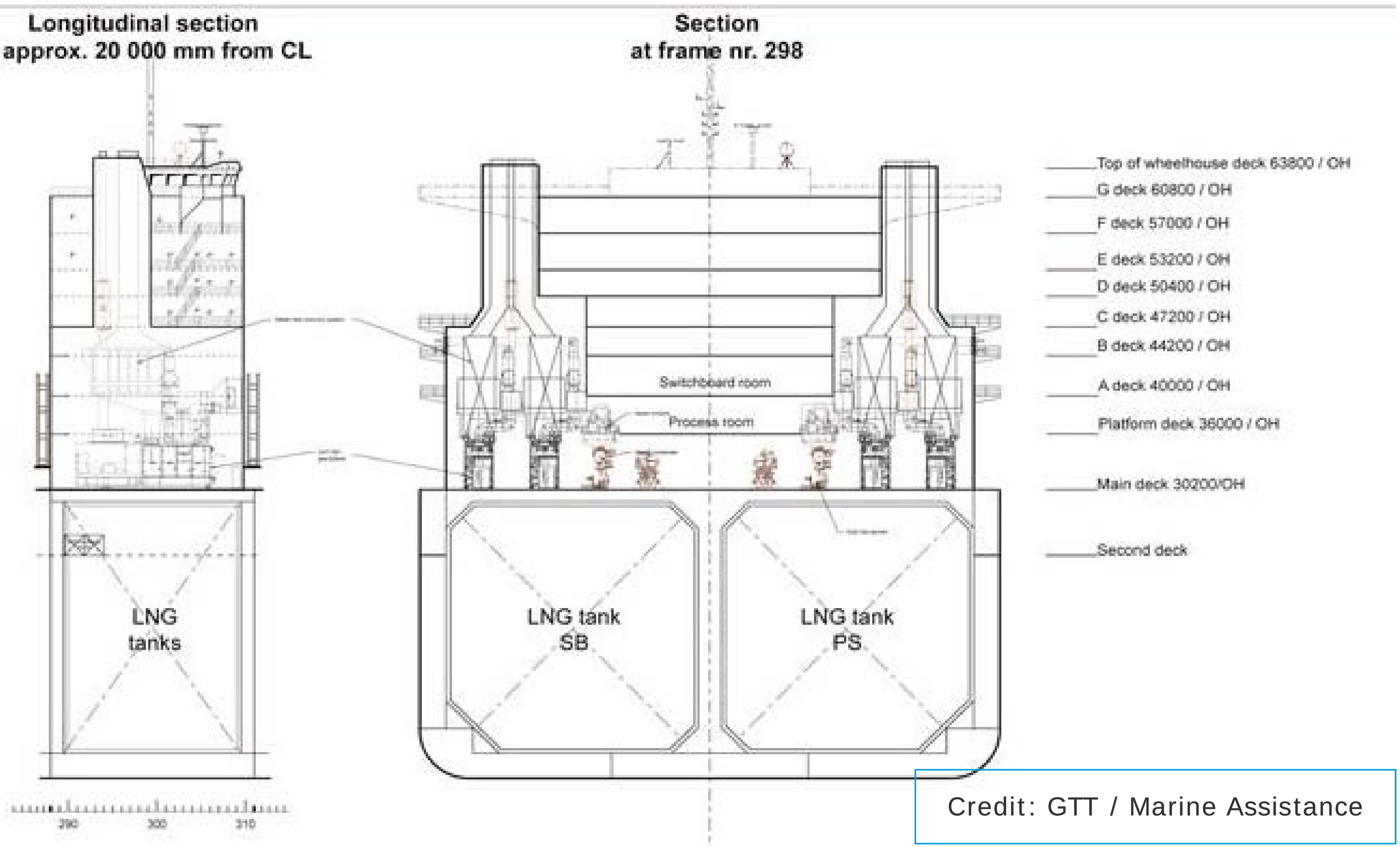
Arrangement of power generation plant



Credit: GTT / Marine Assistance

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Dynamic system simulation with COSSMOS

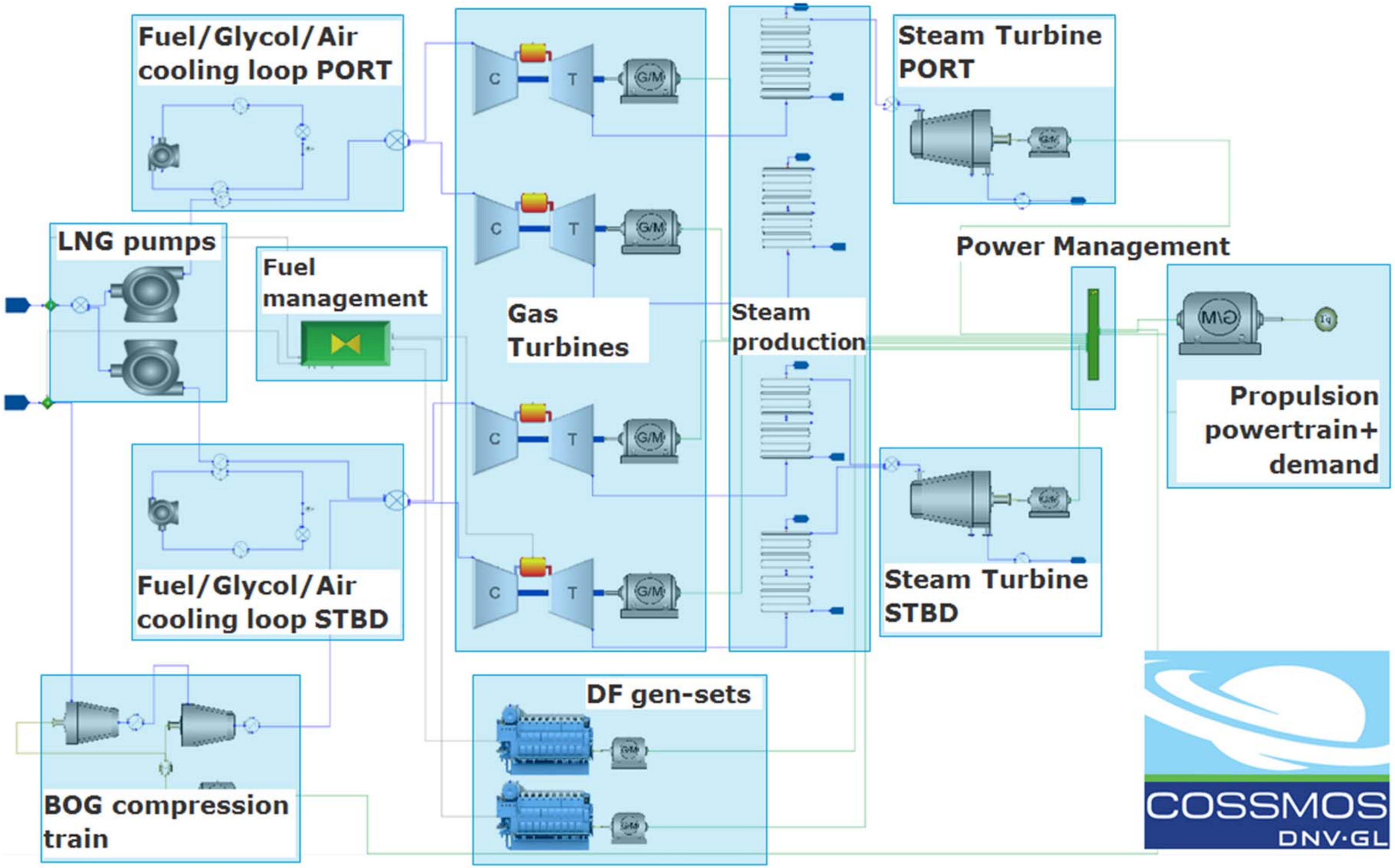

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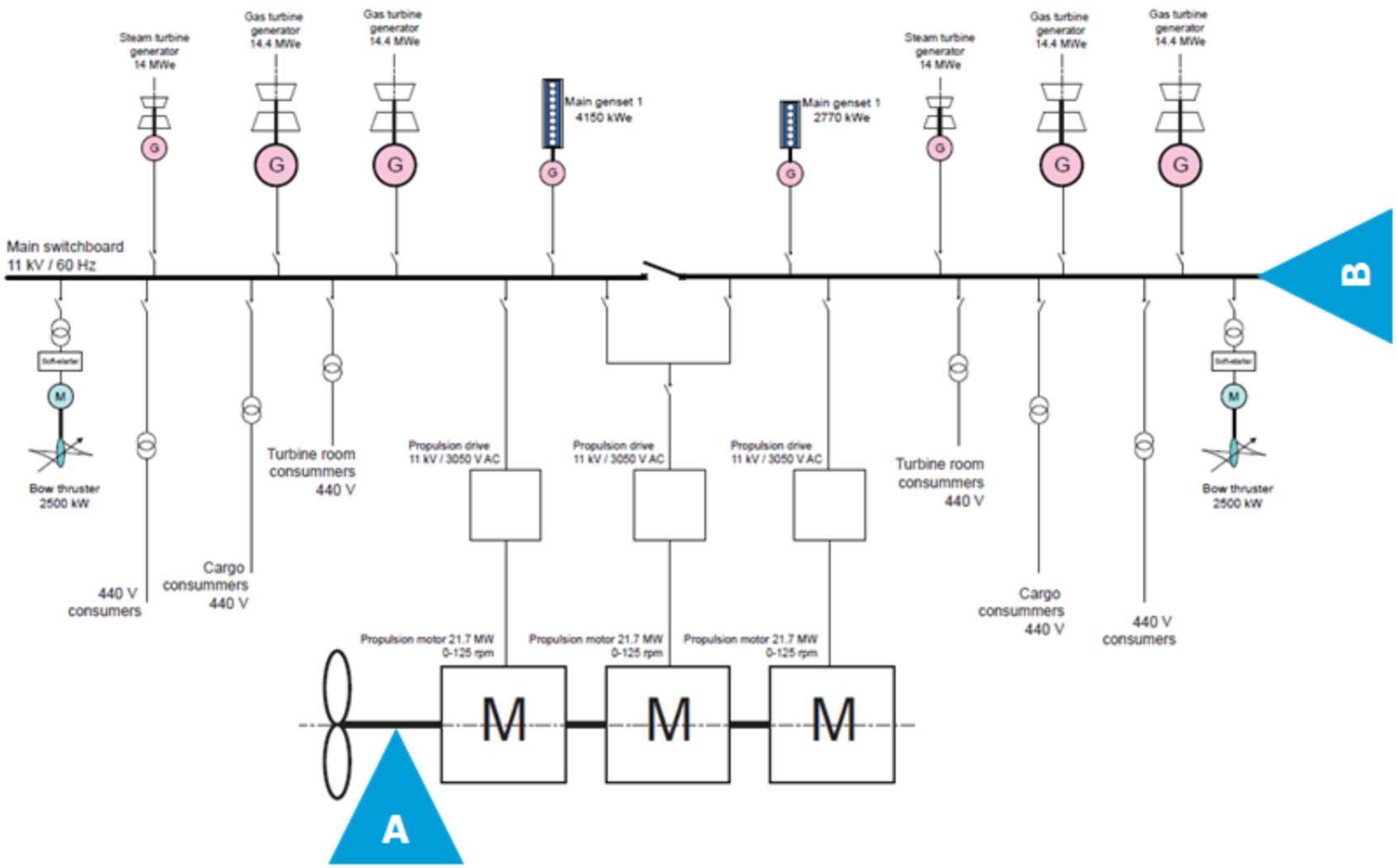
Figure 3-3: Definition of efficiency



Mechanical power demand point A (Fig. 3); Electrical power demand at point B (Main switch board).

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Power profile for 1 round voyage

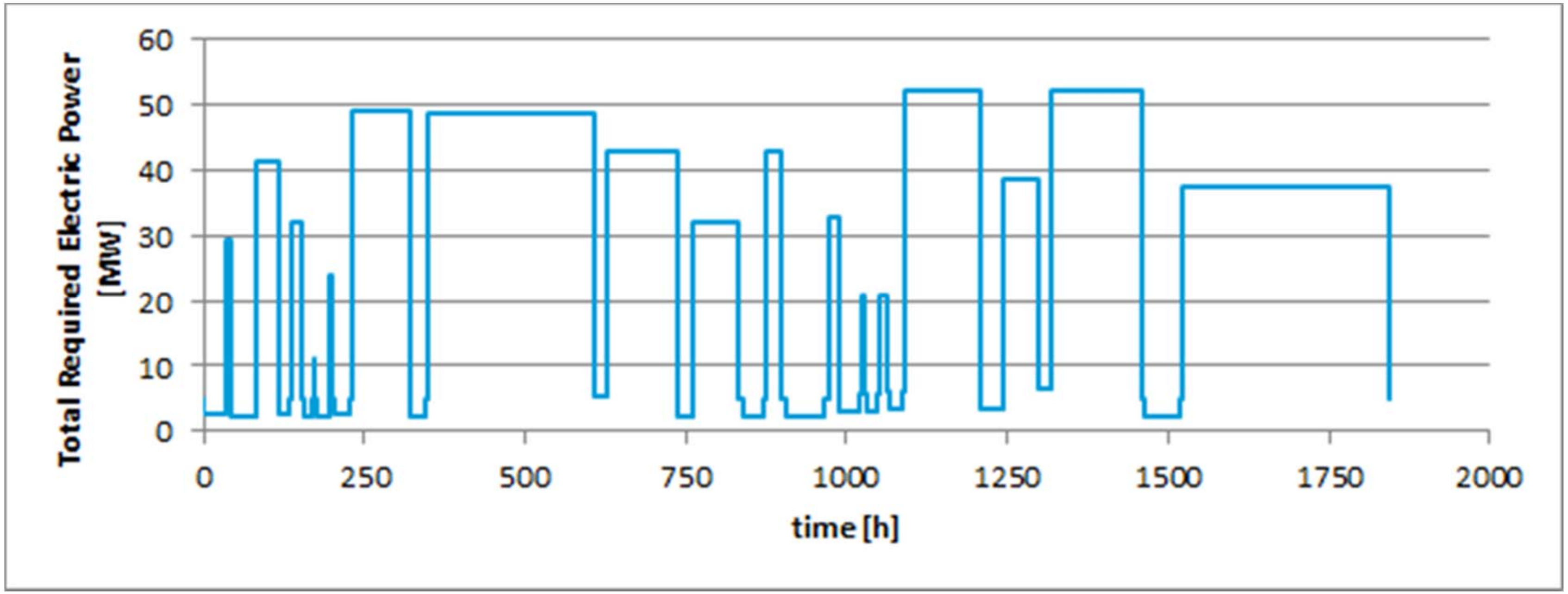

Figure 3 4: Overall electrical load profile (one round trip China/Europe/China; power at switchboard)

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Power requirements during 2 round voyages (winter and summer)

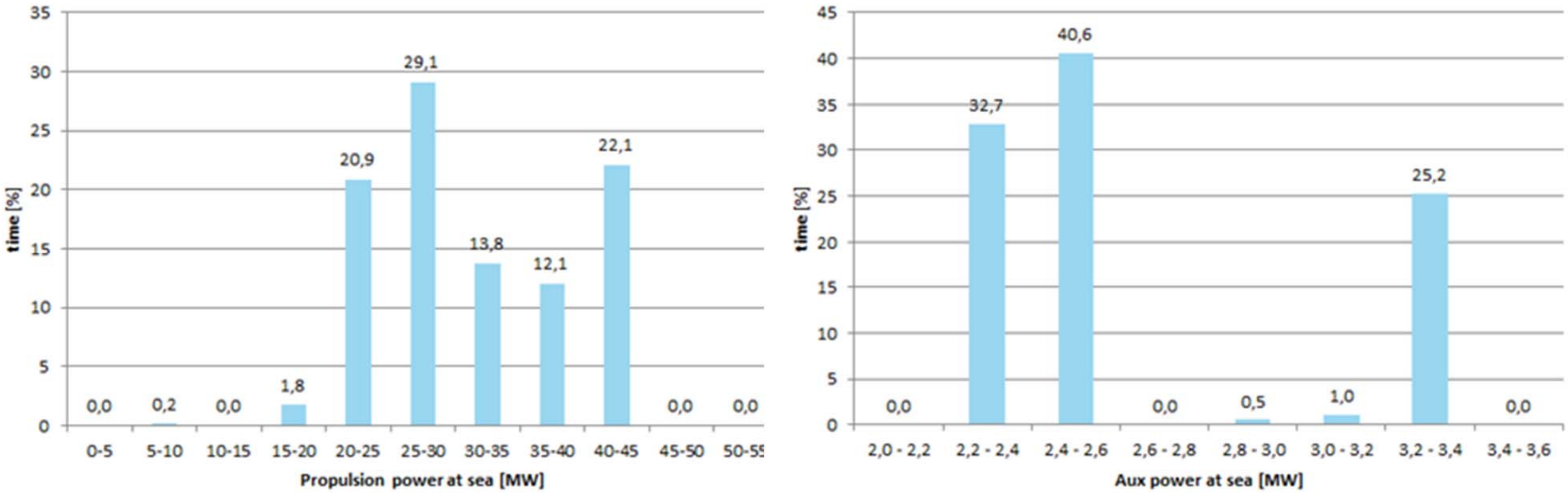

Figure 3 2: operational profile for the ship (taken from conventional propulsion arrangement; Propulsion Power= shaft power; Aux Power= E-Power at generator

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Ambient reference conditions

	Area	Air temp (°C)	Humidity (%RH)	Sea water temp (°C)
Summer	Atlantic ocean	20	60	17
	Mediterranean sea	25	60	21
	Red sea/ Gulf of Aden/ Persian Gulf	42	30	32
	Indian Ocean / Malakka Strait	32	95	32
	China sea, South	32	95	21
	China sea, East	25	60	17
Winter	Atlantic ocean	10	60	8
	Mediterranean sea	15	50	13
	Red sea/ Gulf of Aden/ Persian Gulf	30	40	32
	Indian Ocean / Malakka Strait	32	95	27
	China sea, South	25	60	21
	China sea, East	15	50	17

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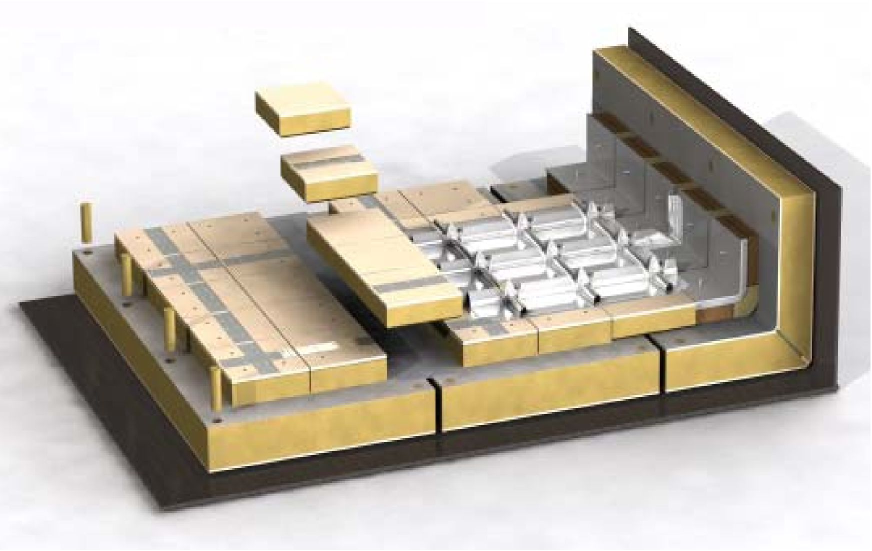
MARK III Flex Membrane Type LNG tanks



Mark III principle of the insulation system

Mark III tank installed on an LNG carrier

Credit: GTT

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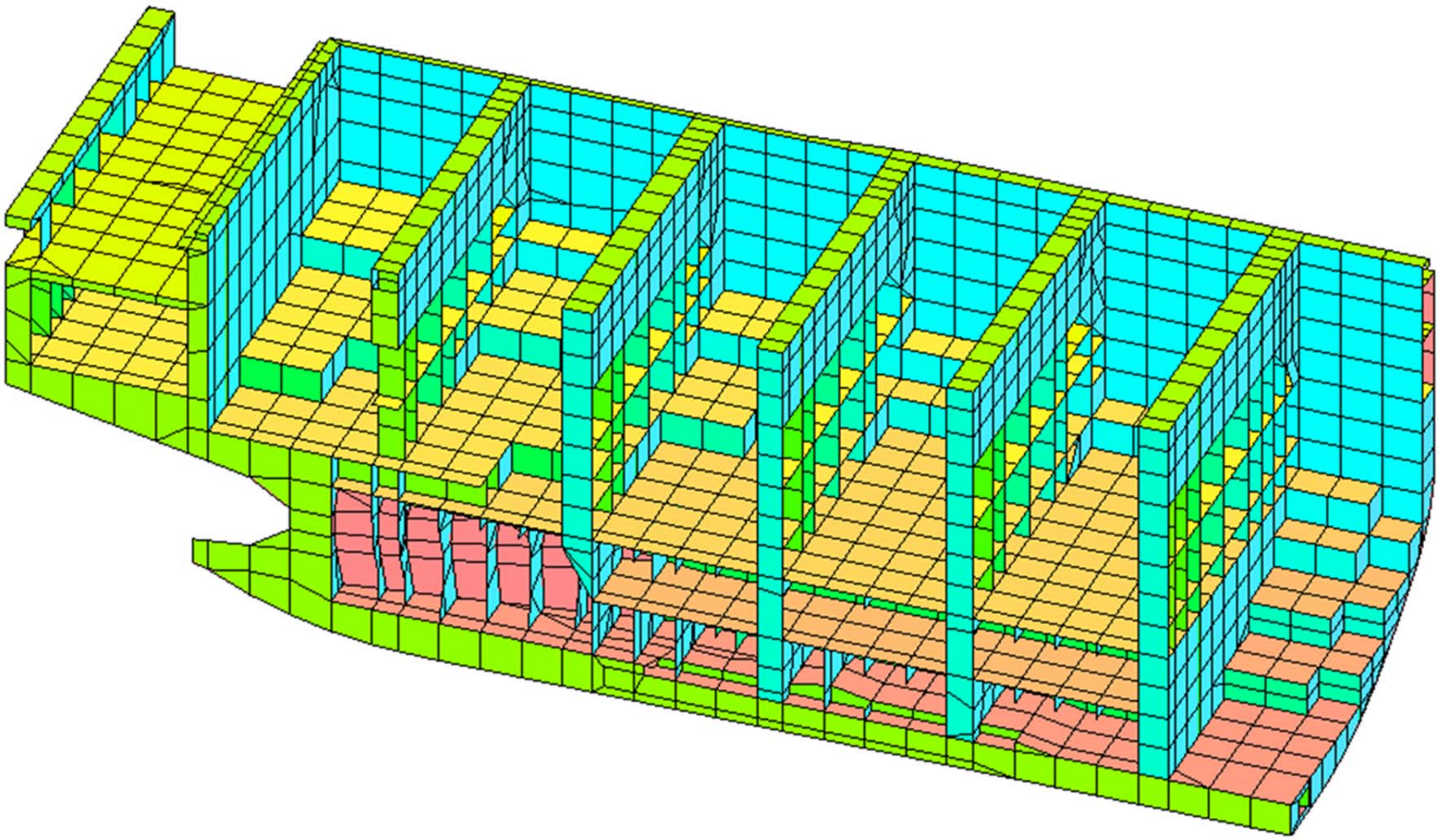
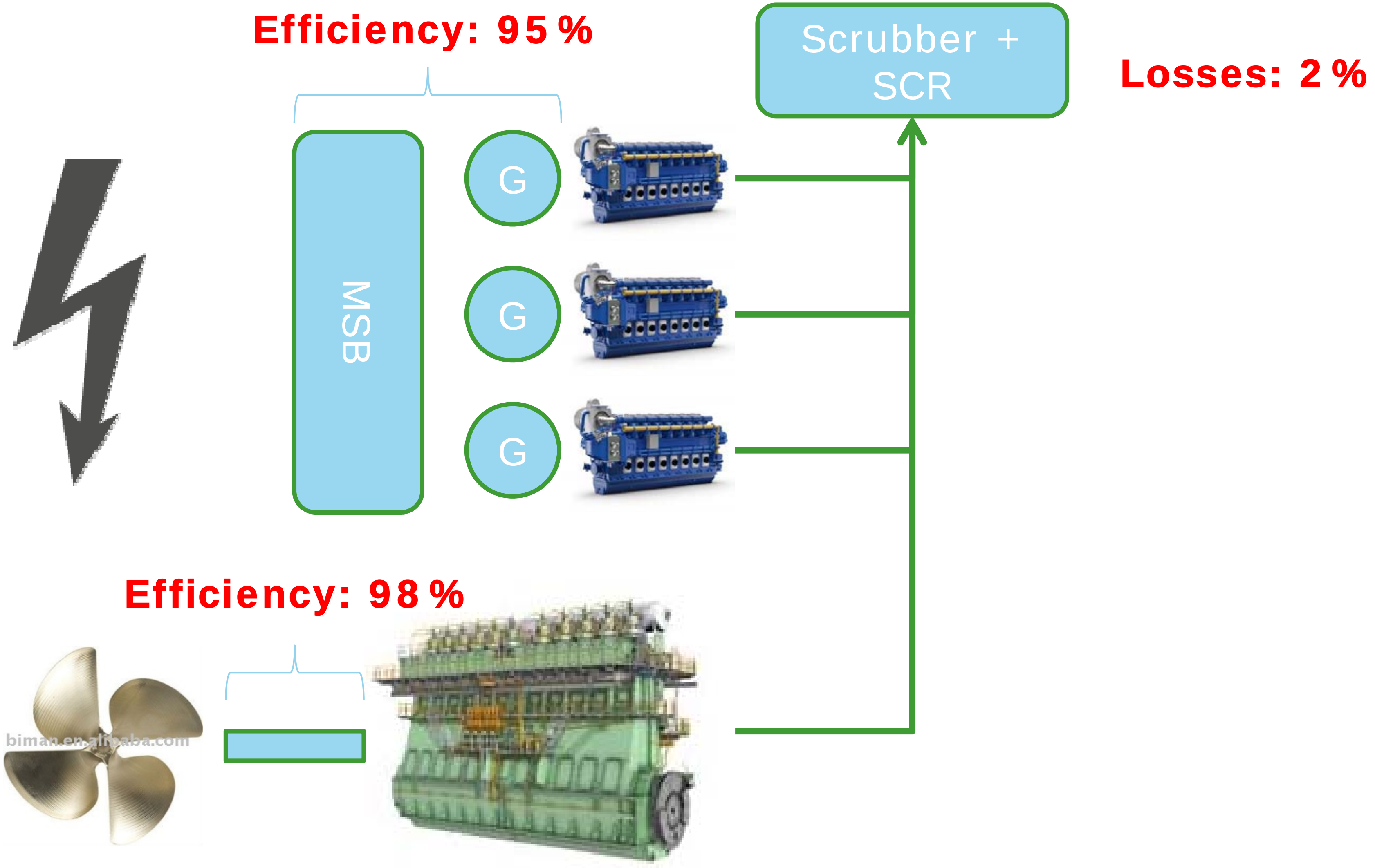
Considering the feasibility to built the ship
- Finite element model of the aft ship (PERFECT project)-



Benchmarking to HFO fuelled conventional system



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efficiency of the ship machinery system (2-stroke HFO)

- overall efficiency showed to be 47.6 % (operation in ECA compliance for full round trip)
- efficiency for operation outside ECA: 48.1 % (operating without TIER III compliance outside ECAS)

System	Summer (ECA) [%]	Winter (ECA) [%]	Average (ECA) [%]	Average (noECA) [%]
Turbine	45.5	45.1	45.3	45.3
Conventional	47.4	47.8	47.6	48.1

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Drivers for cost diffeences

Table Error! No text of specified style in document.**-1: Main drivers for costs differences of COGAS and conventional powering system**

COGAS system	Conventional system
Gas Turbines	Main Engines
Steam turbines	MDO Gensets
WHRS	Boiler
Gas Gensets	
Electric Drive M	
LNG Tank	
Fuel System	
Air cooling	Scrubber
Ships construction	DENOx
Crew Training	Sludge handling (from purifiers at pre-treatment and from scrubbers at post-treatment)

1. 34,5 MIO US$ additional CAPEX costs (to HFO)
2. approx. 20 Mio $US comparison to LNG 2-stroke

Comparing the costs for the PERFECt ship designs to the conventional fueled piston engine system gives approx. 34,5 MIO US$ additional CAPEX costs. It can be assumed that this figure will be approx. 20 Mio $US if the comparison is done between the PERFECt ship design and a 2 stroke engine system fueled with LNG.

Summary (1/2)

- LNG fuelled and **higher cargo capacity** than HFO fuelled 2-stroke at same efficiency level (already for the system used in the feasibility study).
  - **cargo capacity** is **increased by using LNG** and **not decreased** as it is the case for LNG-fuelled piston engine systems (cargo capacity is higher than the capacity of a conventional oil-fuelled ship of the same size)
- Efficiency potential for an **optimized LNG-fuelled COGAS system** goes **beyond** the **efficiency of the oil-fuelled engine systems** used today.
  - clean **LNG fuel** has **significant efficiency benefits** which cannot be achieved by a conventional-fuelled COGAS system.
- electric **power generation split from the propulsion motors**.
  - conventional **engine room is not needed** any more (COGAS system is placed at deck level within the area of the deck house and the LNG tanks)

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Summary (2/2)

- **increased redundancy and reliability**.
  - electric main motors run fully independently from each other,
- **Simplified system** with **environmental benefits**
  - COGAS system, utilizing a very clean fuel, electric propulsion.
  - No fuel treatment, tank heating, scrubber
- **new maintenance strategies** as found in the airline industry will lead to **additional cost savings**.
- **project partners** GTT, CMA Ships and DNV GL intend to **work on the optimization** of the power supply system and of the overall ship design.

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