

WÄRTSILÄ HY

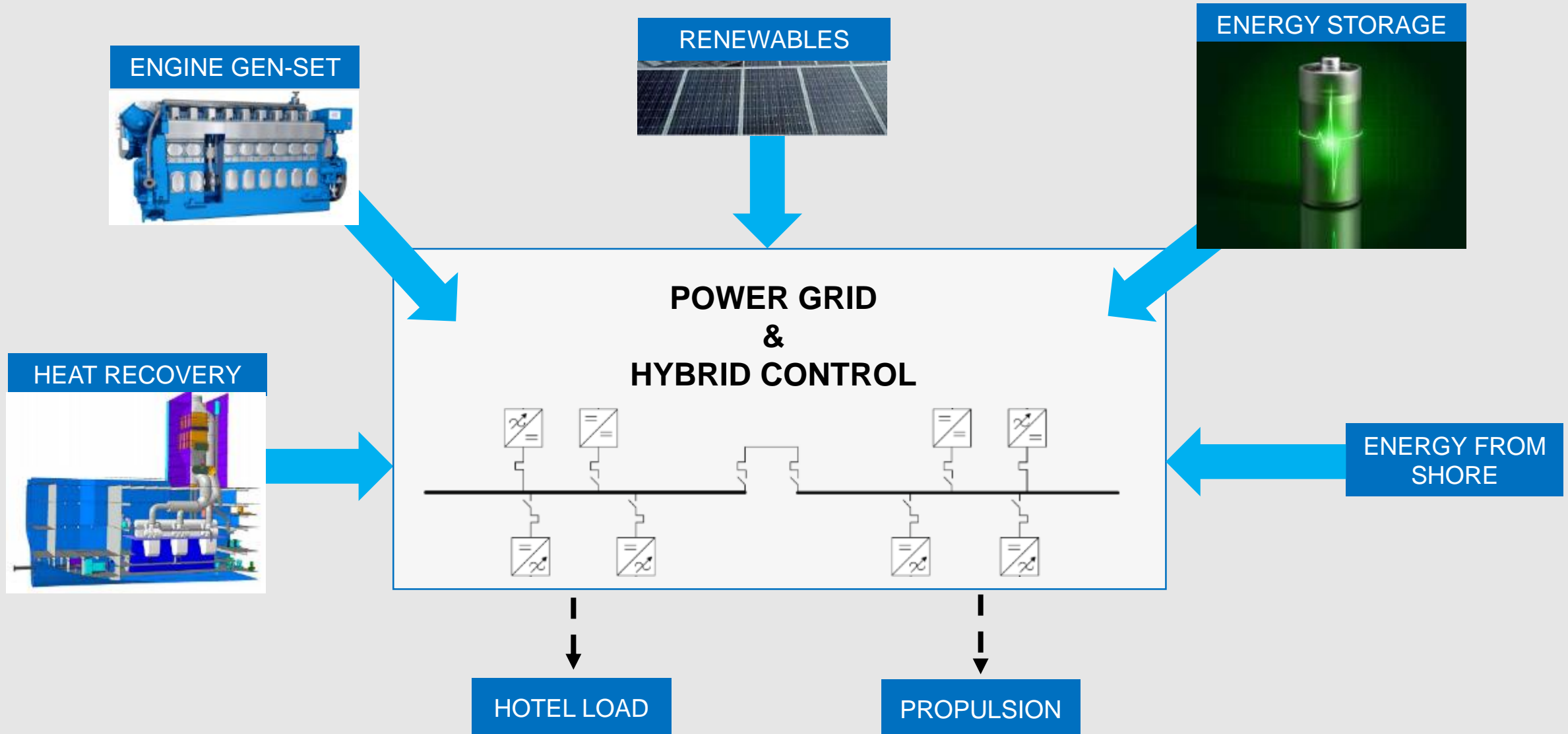
And electric propulsion

Raymond Tay
General Manager, Sales Project
Marine Power Solutions

November 2018



A flexible and efficient energy system with **energy storage**

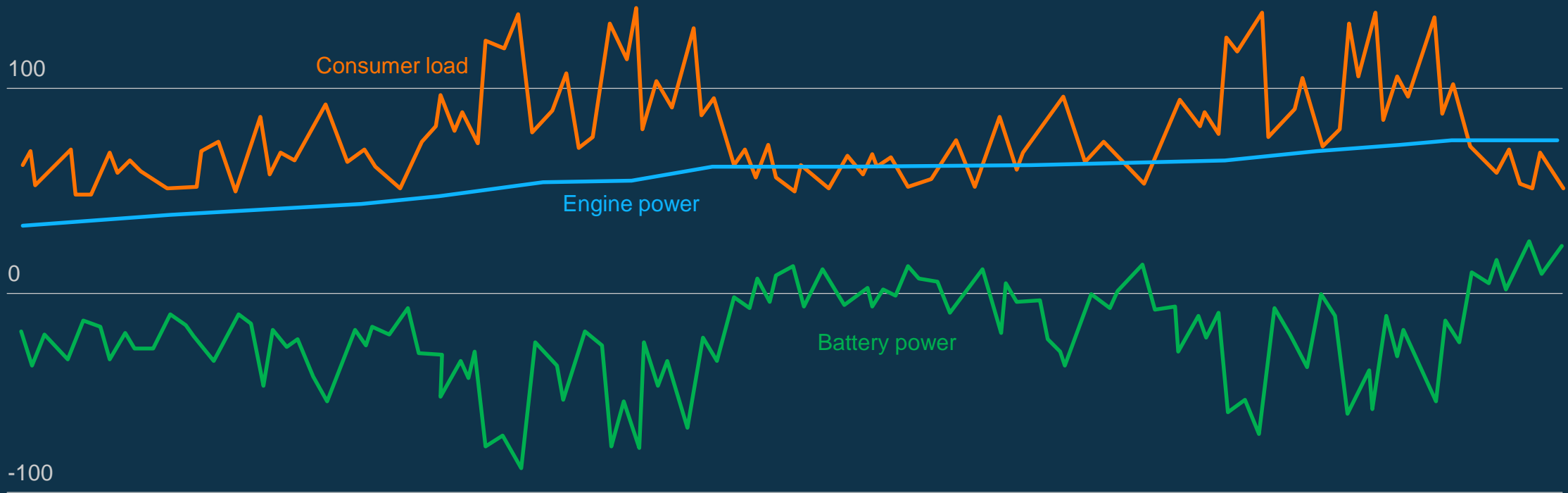


Why hybrid marine power?

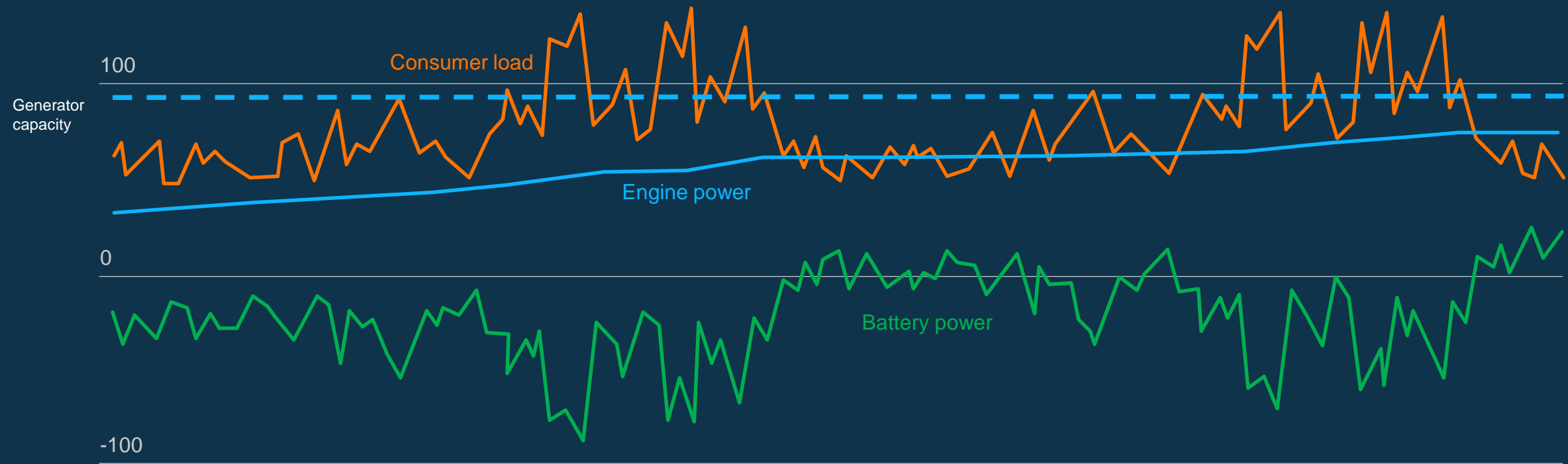




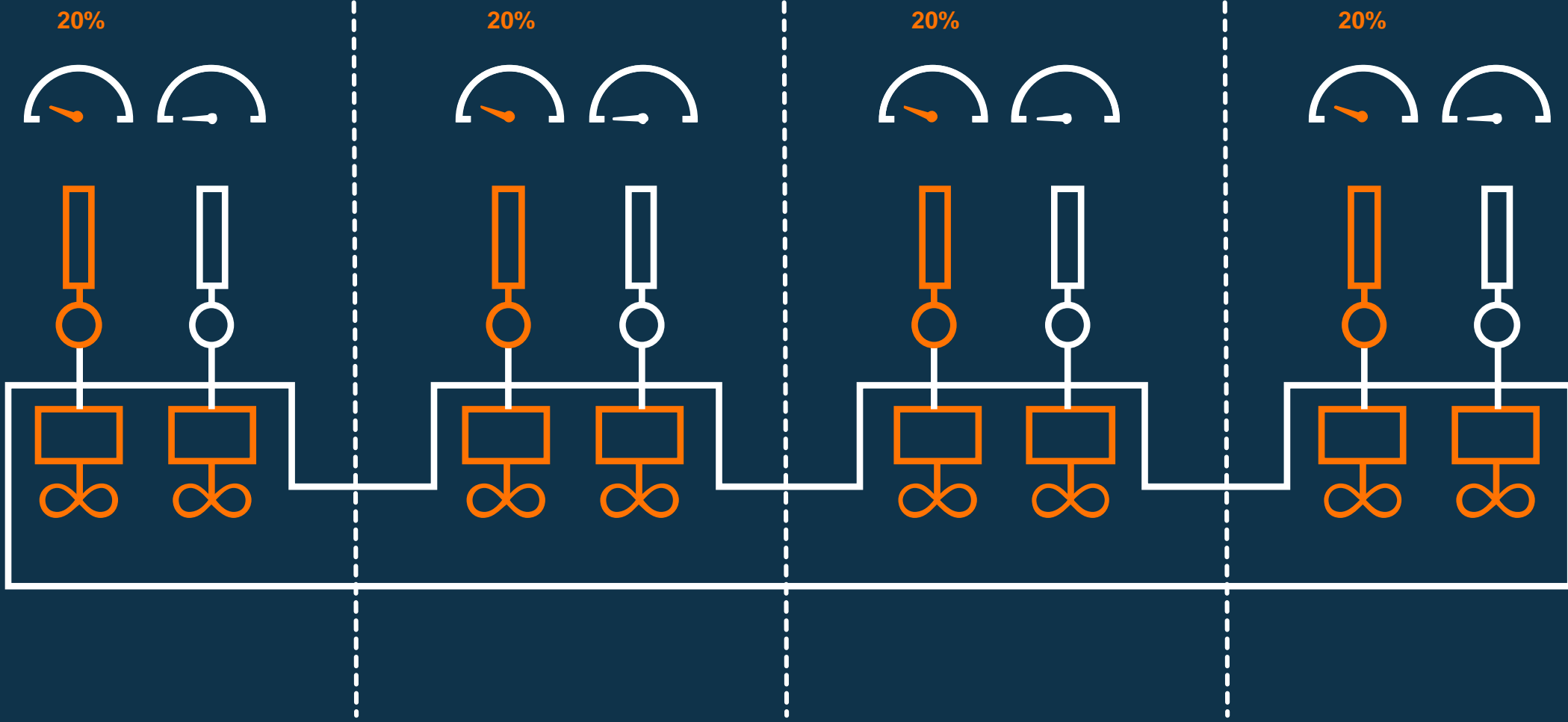
What can a hybrid system with batteries do ? **PEAKSHAVING**



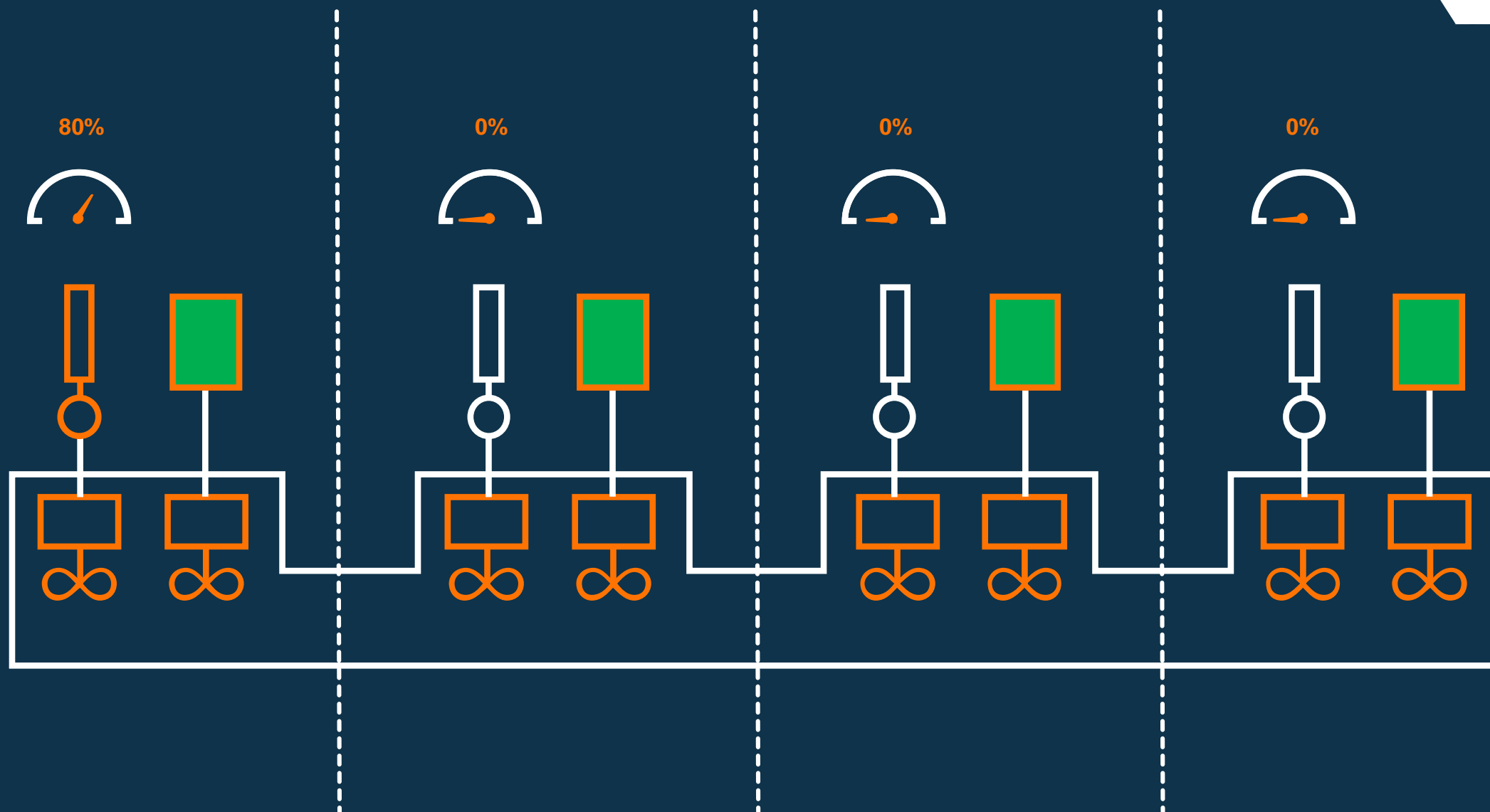
What can a hybrid system with batteries do ? **AVOID STARTING ANOTHER GENERATOR**



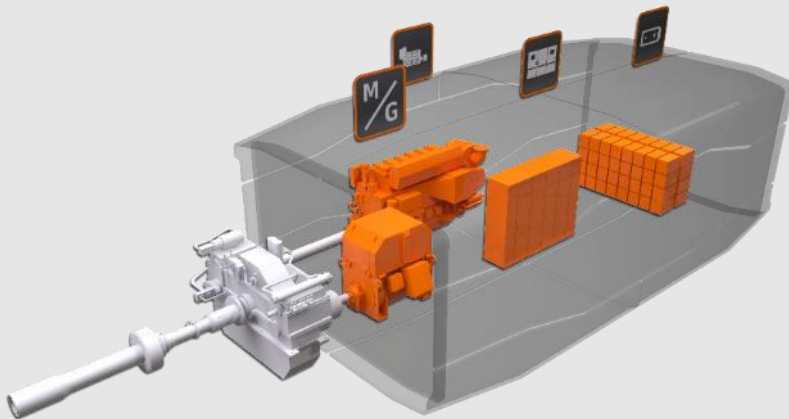
What can a hybrid system do ? **LOW LOAD TRADITIONAL**



What can a hybrid system do ? **LOW LOAD HYBRID**

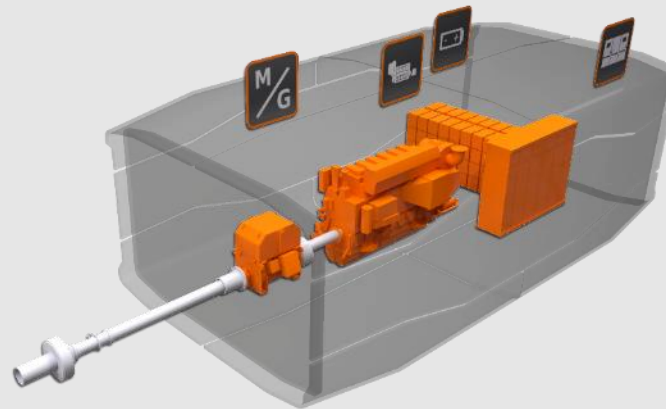


MECHANICAL-HYBRID PTO/PTI



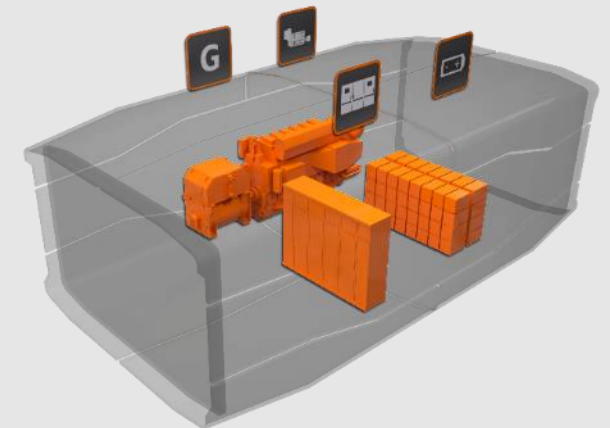
Main engine with clutch
PTO/PTI on the gearbox
Energy storage system
DC link and power drives
Energy Management System

MECHANICAL-HYBRID SHAFT M/G



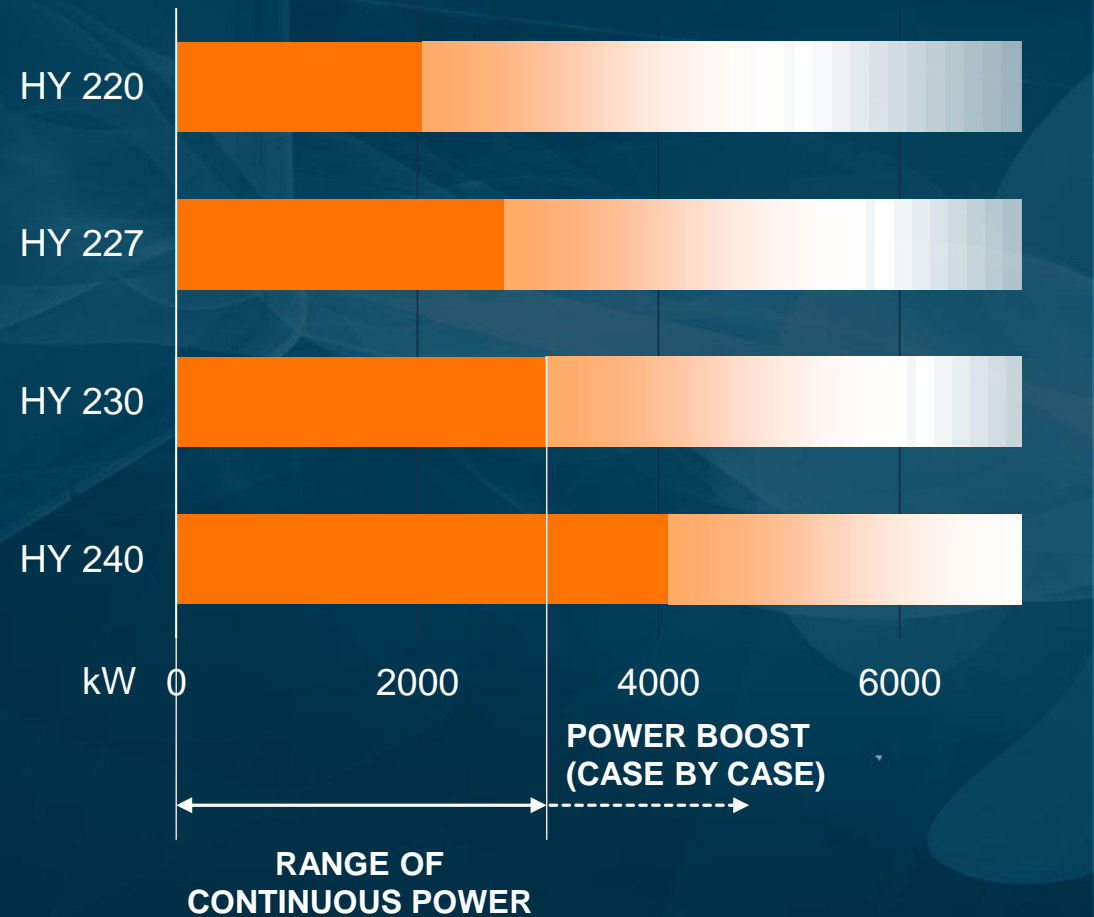
Main engine with clutch
In-line shaft generator/motor
Energy storage system
DC link and power drives
Energy Management System

ELECTRICAL-HYBRID



Generating set
Energy storage system
DC link and power drives
Energy Management System

WÄRTSILÄ HY 2



Wärtsilä HY is different from a hybrid system



Ad-hoc components design:

Internal components are pre-designed to work in the Wärtsilä HY environment, allowing best results and advanced features



Next-generation EMS:

The Energy Management System works as the brain, enabling advanced features (start&stop, cold start...) and controlling energy flows towards energy efficiency, performance, safety, emissions and smoke levels, lifetime



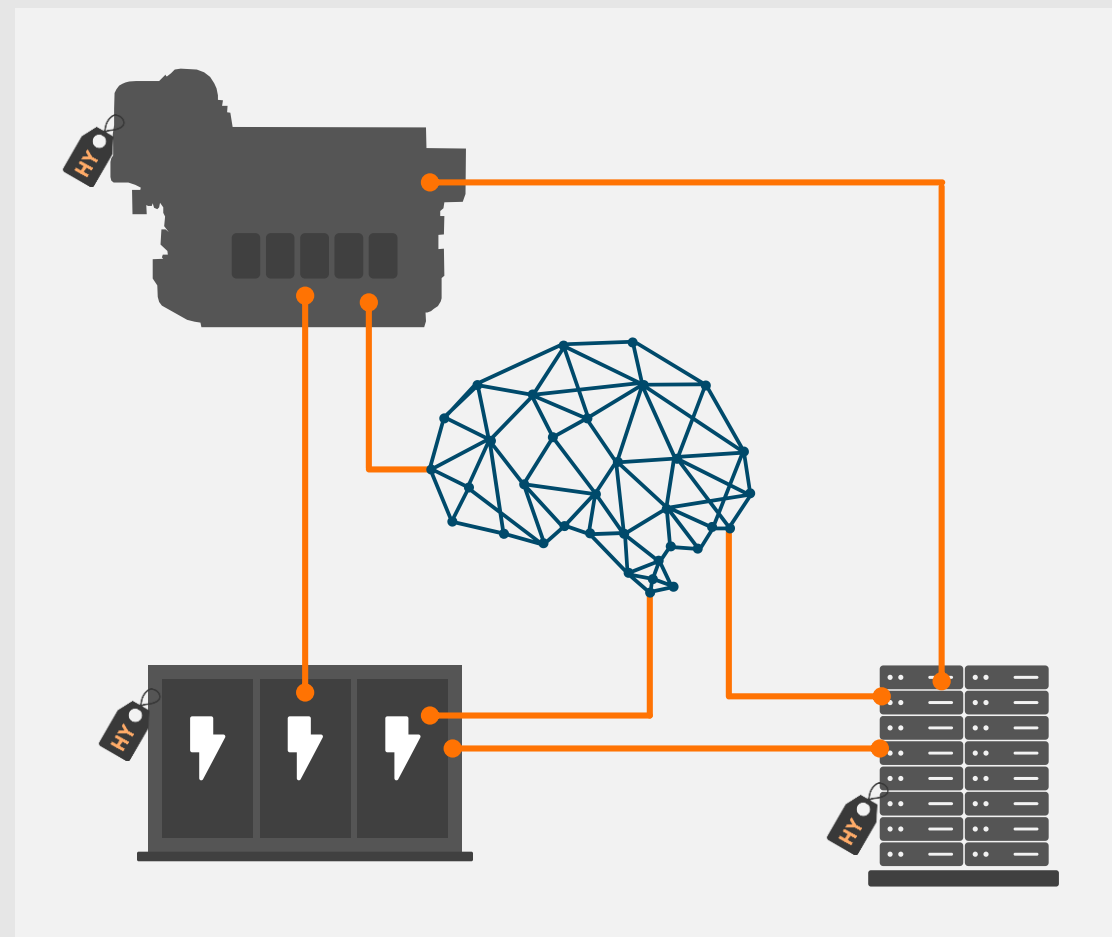
Customization:

Hardware and software are optimized for specific ship types and they can be customized for specific requirements



Tuning:

Wärtsilä HY can be tuned over time based on field data collection and to cope with evolving requirements and op. profiles





- Identification of ship type and mission
- Wärtsilä HY model selection and customization based on specific requirements
(optimal balance between stationary and transient parameters)
- First tuning after initial data collection
- Periodic monitoring and tuning during lifecycle





Environment

- Lower emission levels
- Green image
- Green mode enabled
- Even lower emission levels
- No visible smoke



Design

- Built-in redundancy
- Power boost available
- Less installed cylinders
- Better EEDI
- GA flexibility
- DP benefits
- Guaranteed performance
- Ship-type optimized
- Ship-mission optimized
- Integration by Wärtsilä
- All-in-one power module



Operations

- High op. flexibility
- Peak shaving
- Optimal engine loads
- Stable parameters
- Instant backup (safety)
- Instant load taking
- Less engines running hours
- Auto-optimization by EMS
- Cold starting
- Automatic start&stop



Operational costs

- Lower fuel consumption
- Lower maintenance costs
- Even lower operational costs



ENVIRONMENT

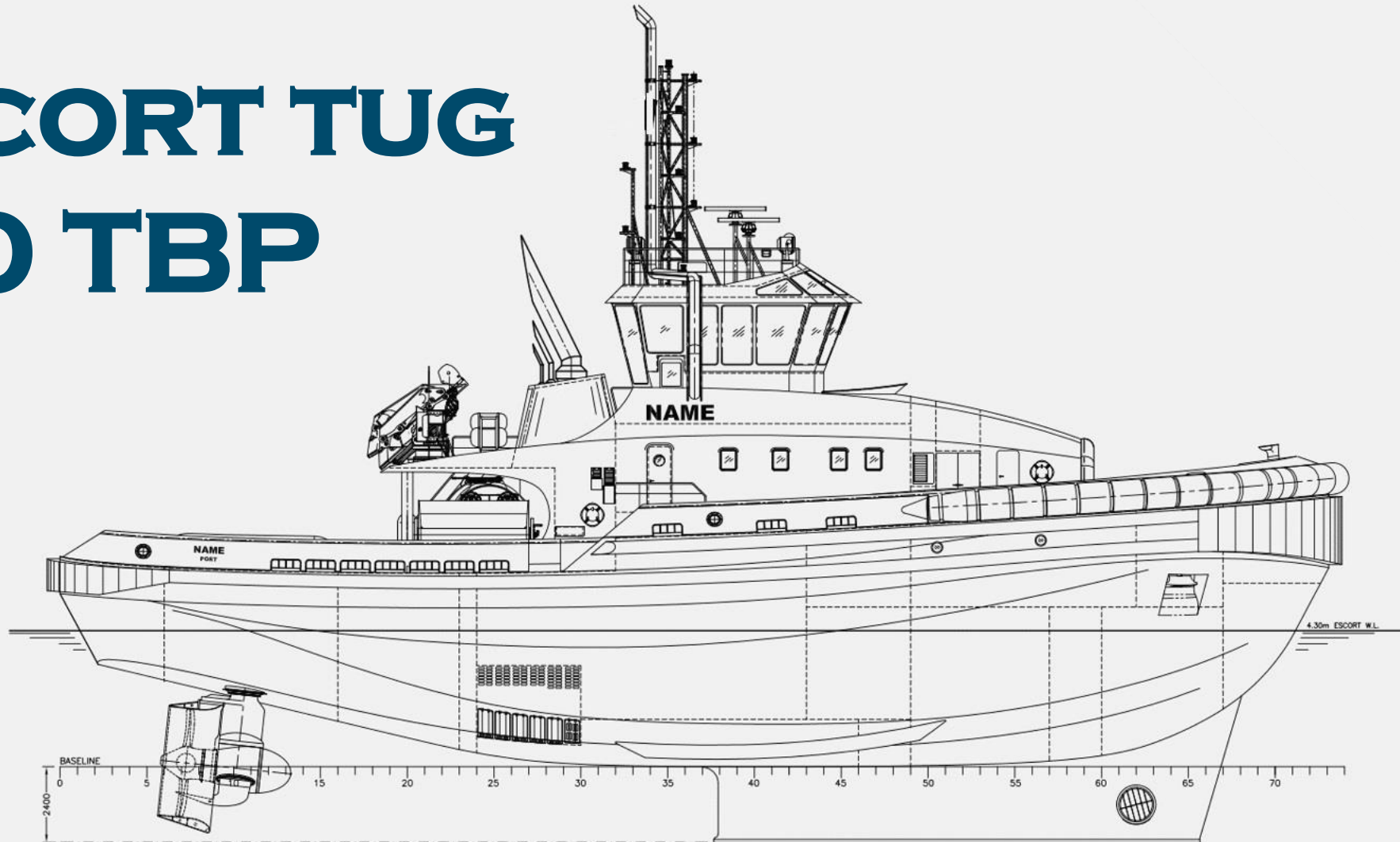
- High energy efficiency
- Low emission levels
- Best use of shore power
(when available)
- Green mode available in sensitive areas
- No visible smoke:
during all normal operations
during load ramps
during engines starting (Wärtsilä Patent Pending)



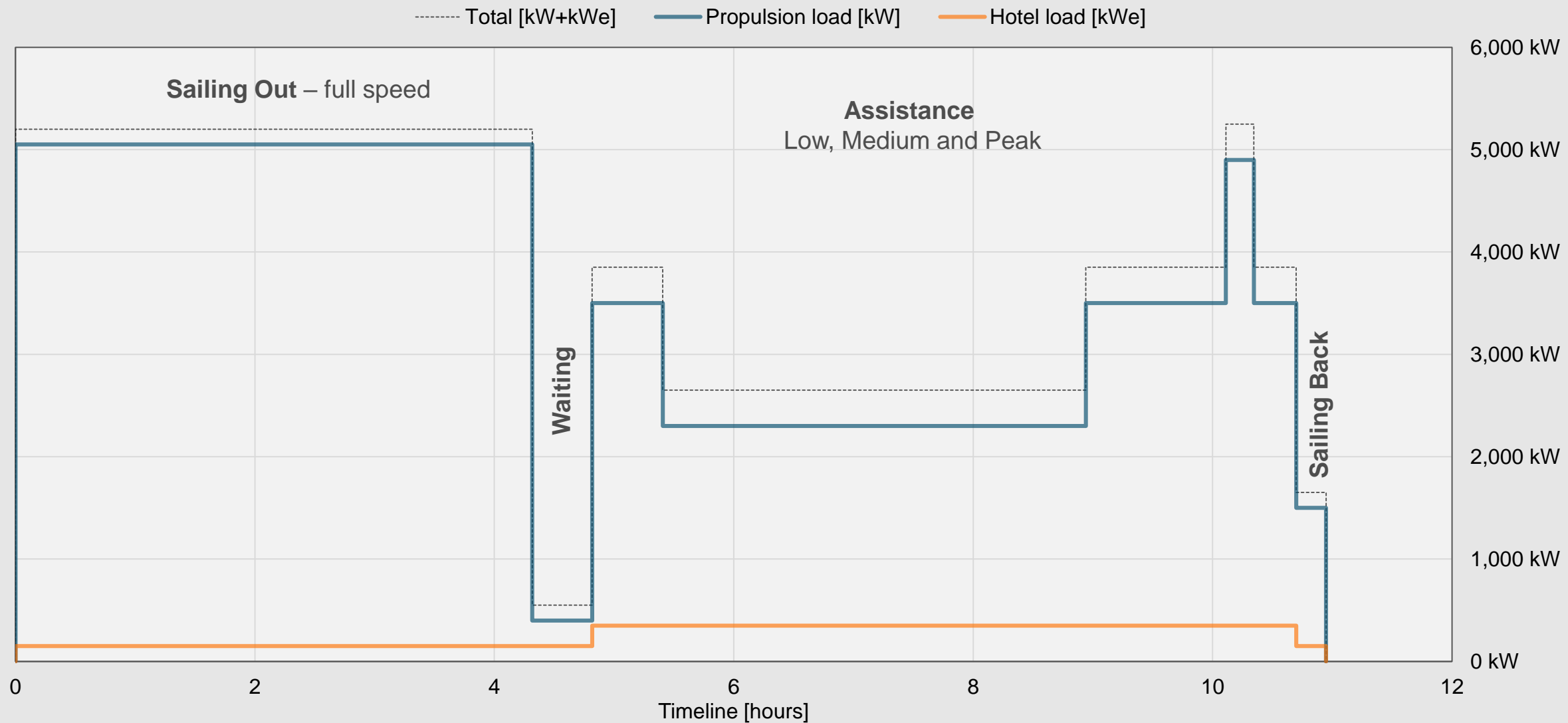
SAFETY

- Built-in redundancy
- Instant load taking and power boost
(manoeuvres, crash stop, harsh environment, towing, heavy duties...)
- Instant backup in case of engine failures
- Energy backup in case of blackout
propellers always turning
additional hotel services (with ref. to typical emergency standards)
energy for restarting engines

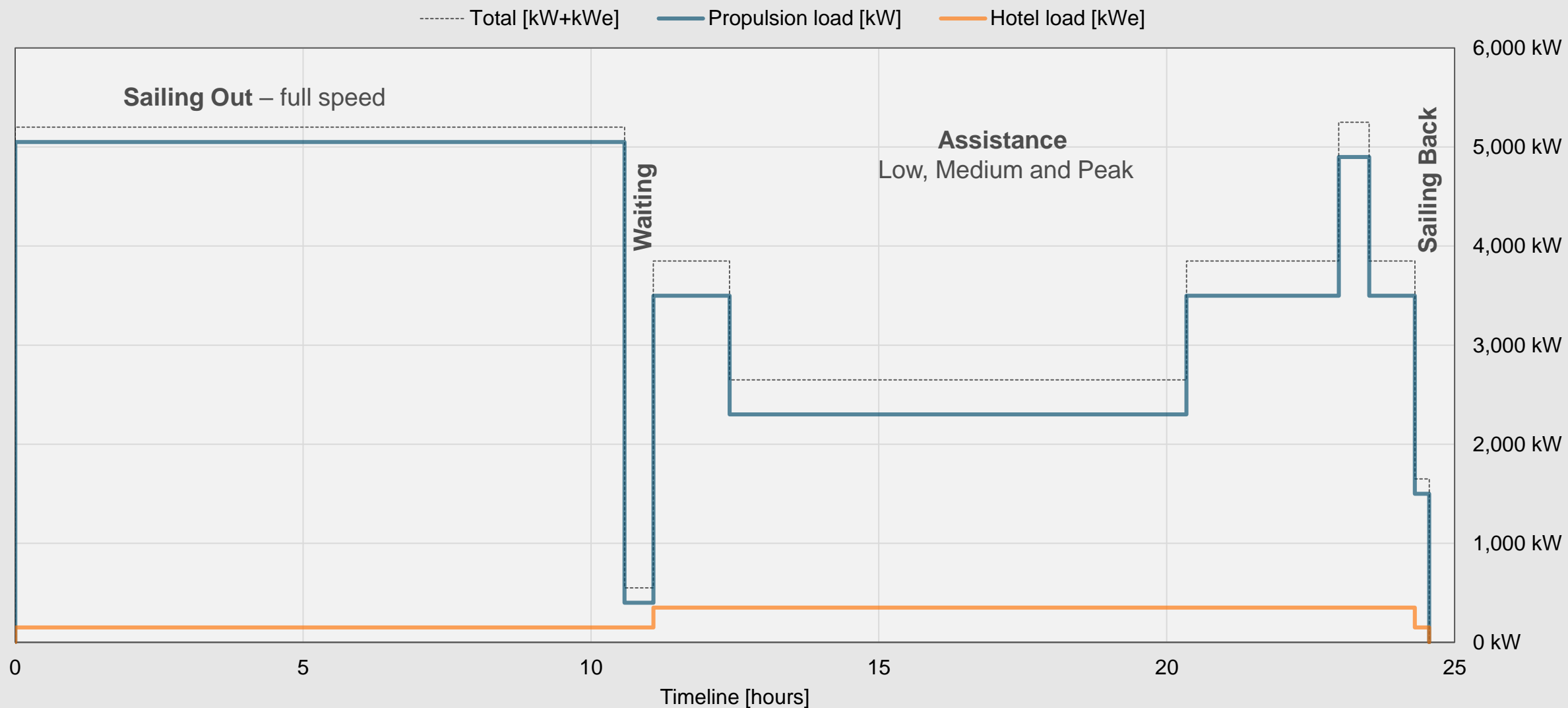
ESCORT TUG 100 TBP



Repeated **365 times a year**

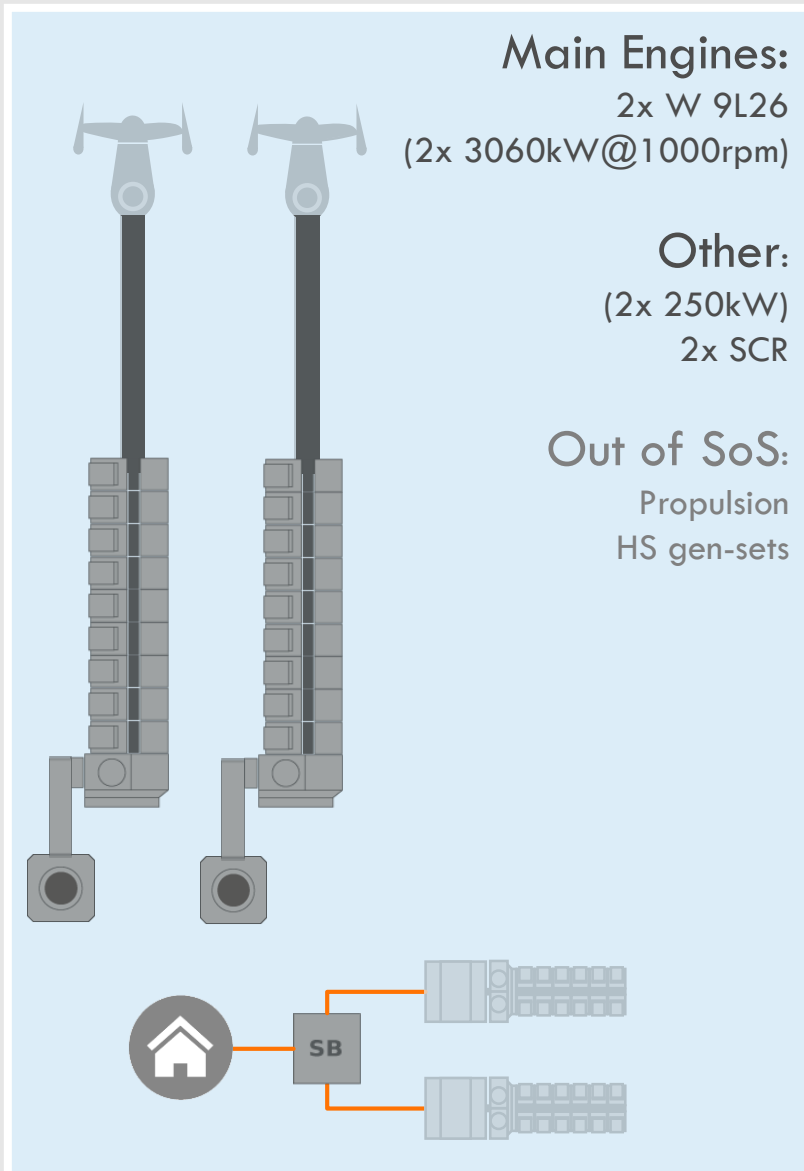


Repeated **350 times a year**

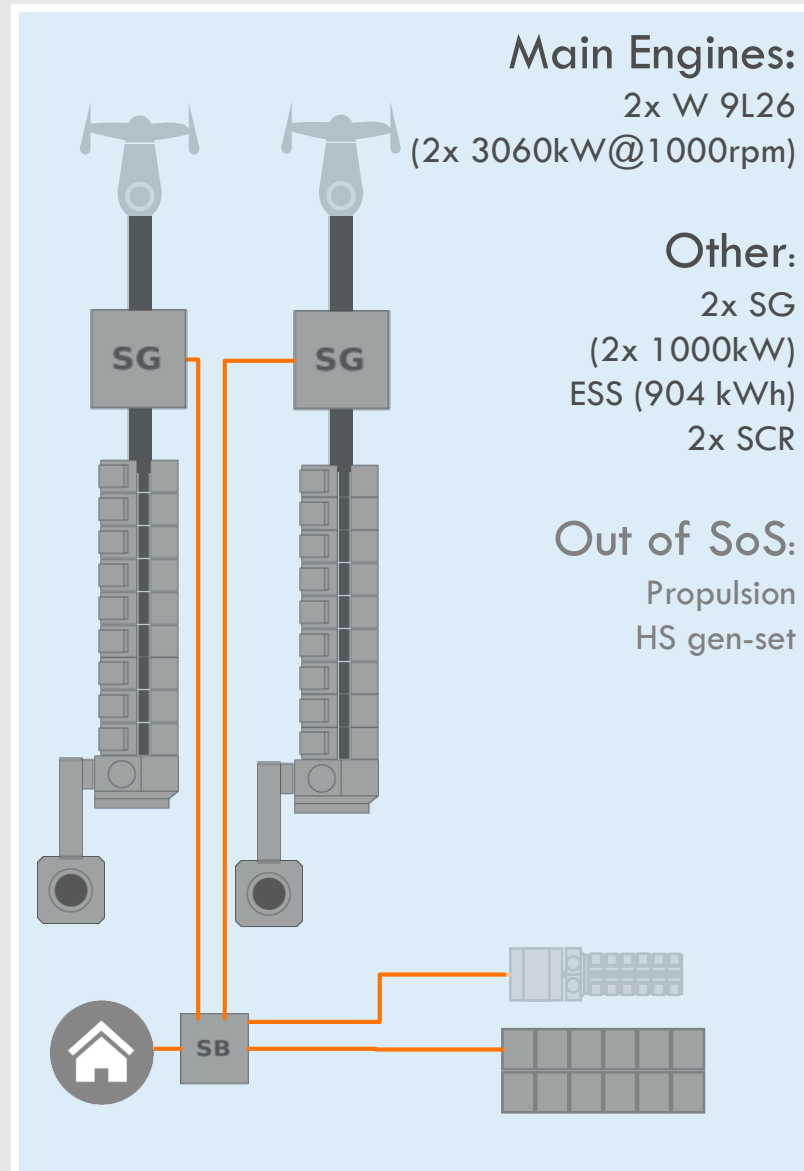


Alt 3

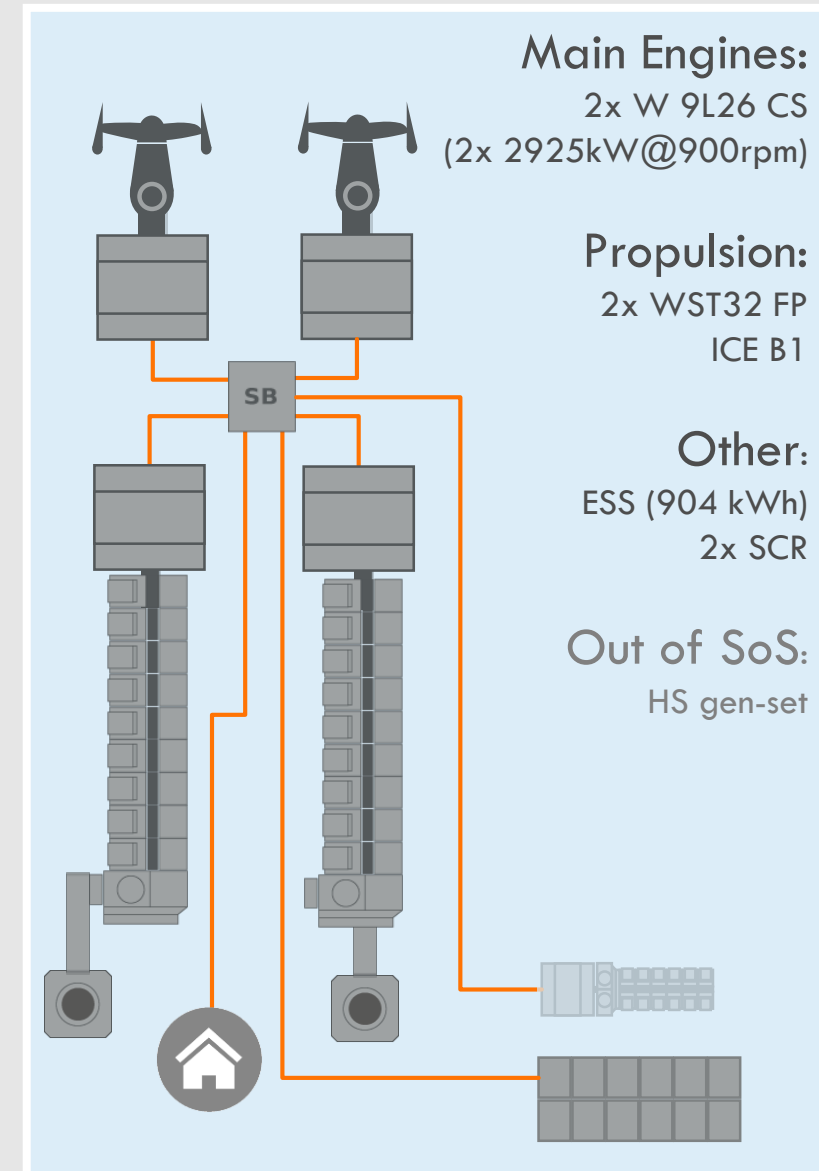
Alt 4

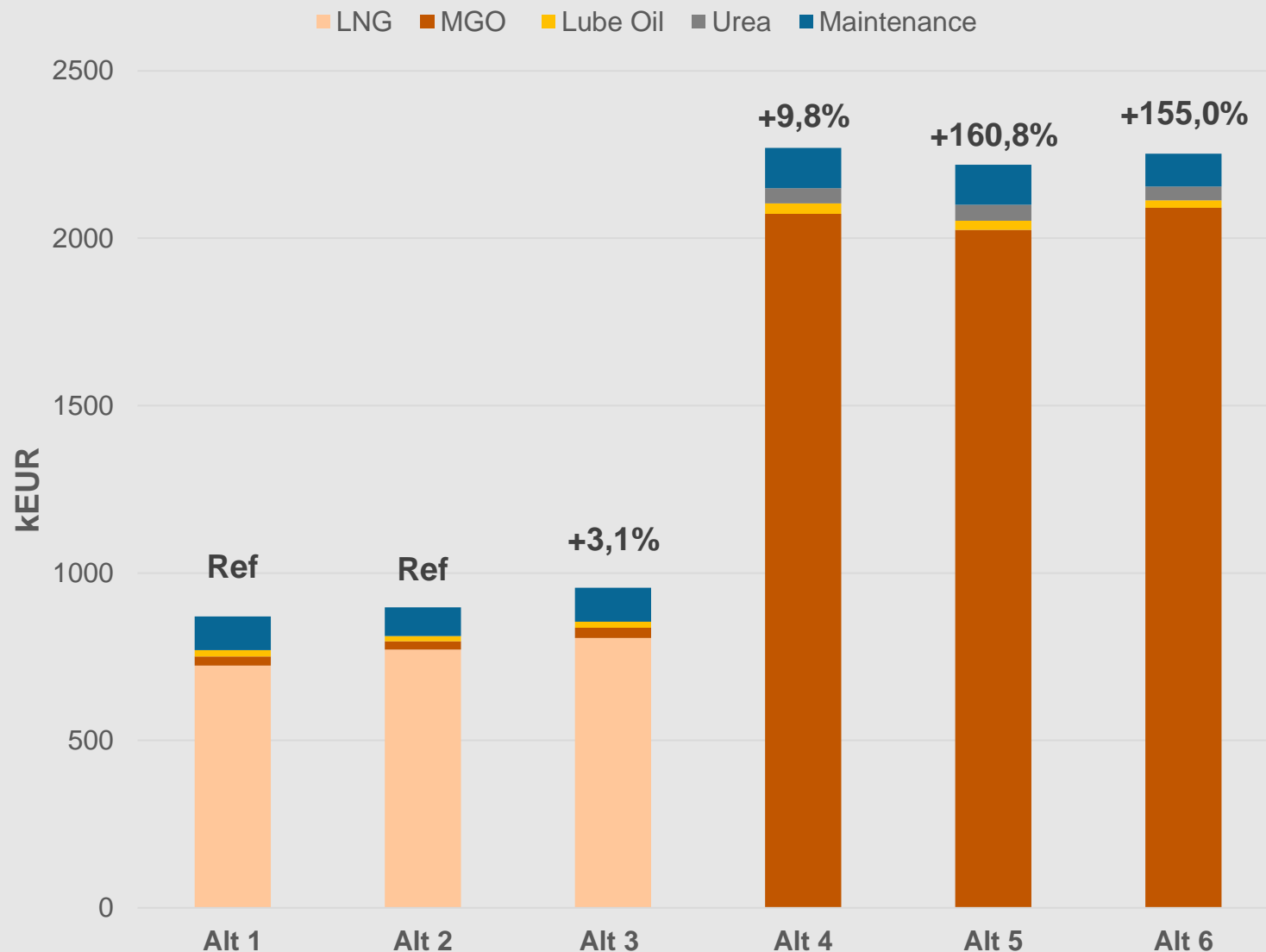


Alt 5



Alt 6





Alt 1 - DF DM Hybrid

Alt 2 - DF DE Hybrid

Alt 3 - DF DE

Alt 4 - MGO conventional

Alt 5 - MGO DM Hybrid

Alt 6 - MGO DE Hybrid

Bunker prices

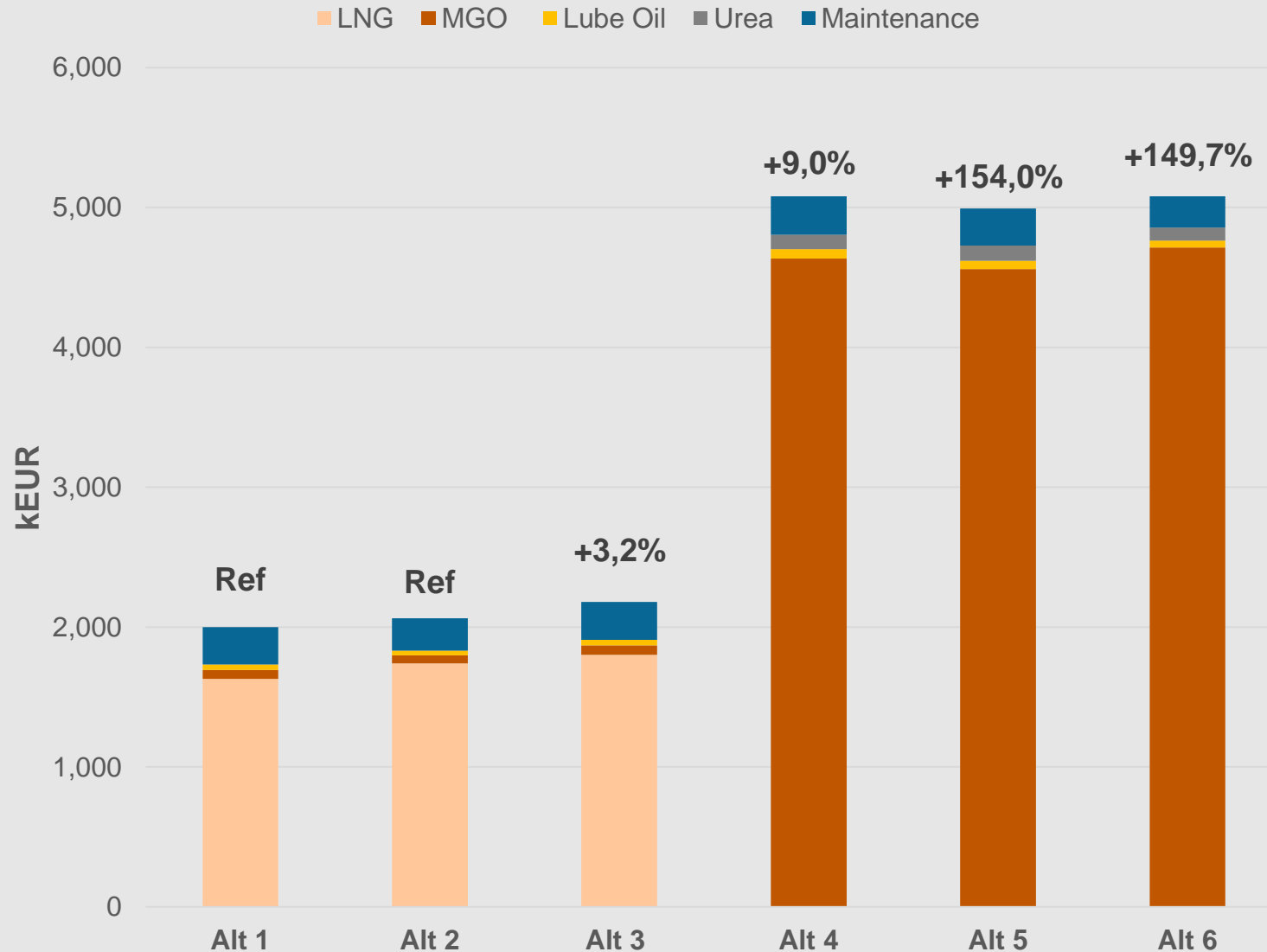
MGO: 660 EUR/ton

LNG: 300 EUR/ton

Lube Oil: 2300 EUR/ton

Urea: 250 EUR/ton

Maintenance include Spare parts and labor costs for Main Engines



Alt 1 - DF DM Hybrid

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Alt 4 - MGO conventional

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Alt 6 - MGO DE Hybrid

Bunker prices

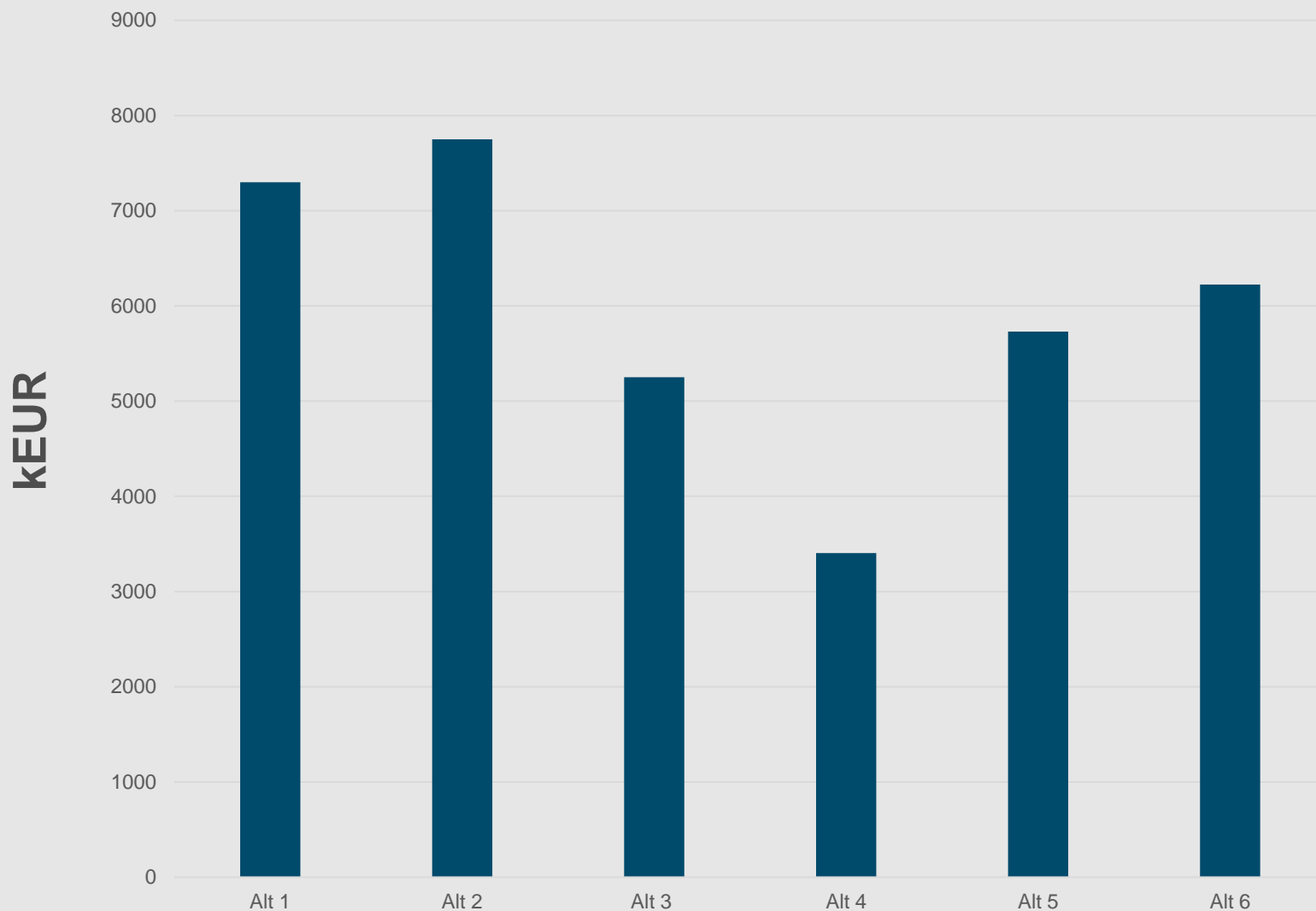
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Alt 1 - DF DM Hybrid

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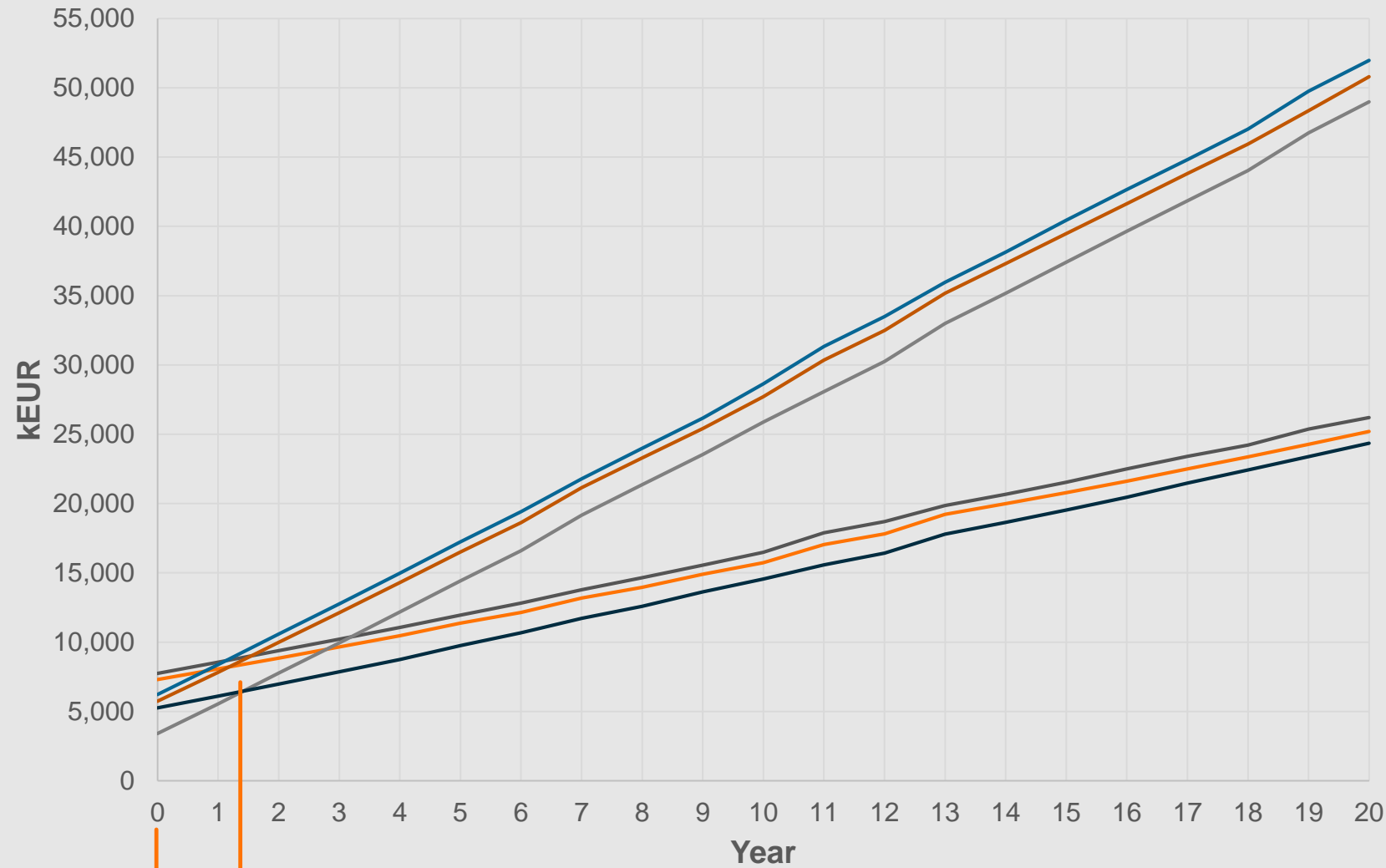
Alt 6 - MGO DE Hybrid

Scope of supply

- Engines & Gen-sets
- Electrical & Automation
- Propulsion
- ESS
- LNGPac
- SCR

HS gen-set out of scope

TCO BASED ON OPERATING PROFILE A



< 2y in order to recover DF investment

Alt 6 - MGO DE Hybrid

Alt 5 - MGO DM Hybrid

Alt 4 - MGO conventional

Alt 2 - DF DE Hybrid

Alt 1 - DF DM Hybrid

Alt 3 - **DF DE**

**ESS and catalyzer replace
included**

Bunker prices

MGO: 660 EUR/ton

LNG: 300 EUR/ton

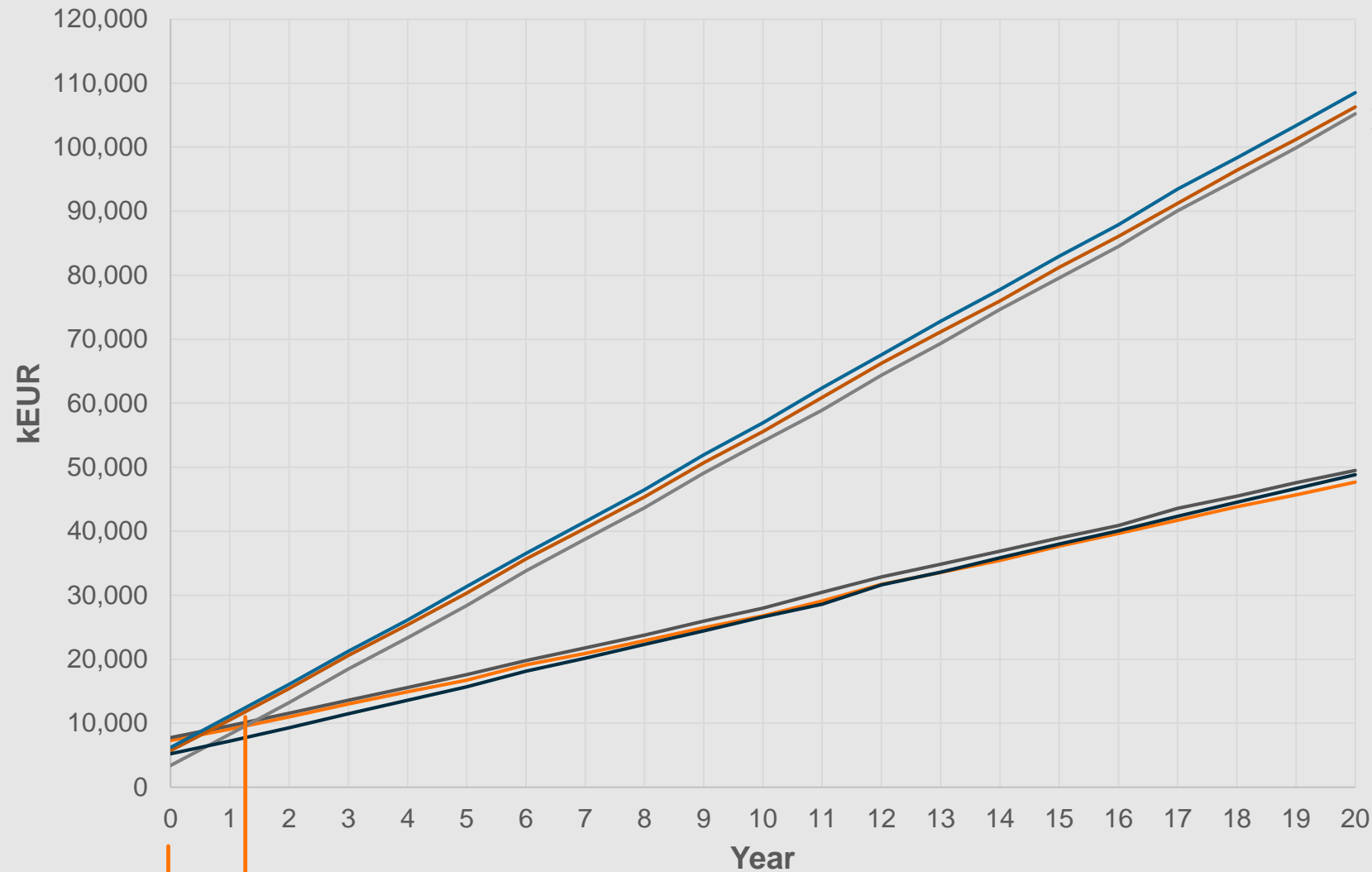
Lube Oil: 2300 EUR/ton

Urea: 250 EUR/ton

Maintenance **include** Spare parts and labor costs

Labor cost under 4000 hours is excluded

TCO BASED ON OPERATING PROFILE B



- Alt 6 - MGO DE Hybrid
- Alt 5 - MGO DM Hybrid
- Alt 4 - MGO conventional
- Alt 2 - DF DE Hybrid
- Alt 3 - DF DE
- Alt 1 - **DF DM Hybrid**

**ESS and catalyzer replace
included**

Bunker prices

MGO: 660 EUR/ton

LNG: 300 EUR/ton

Lube Oil: 2300 EUR/ton

Urea: 250 EUR/ton

Maintenance **include** Spare parts and labor costs

Labor cost under 4000 hours is excluded

< 2y in order to recover DF investment

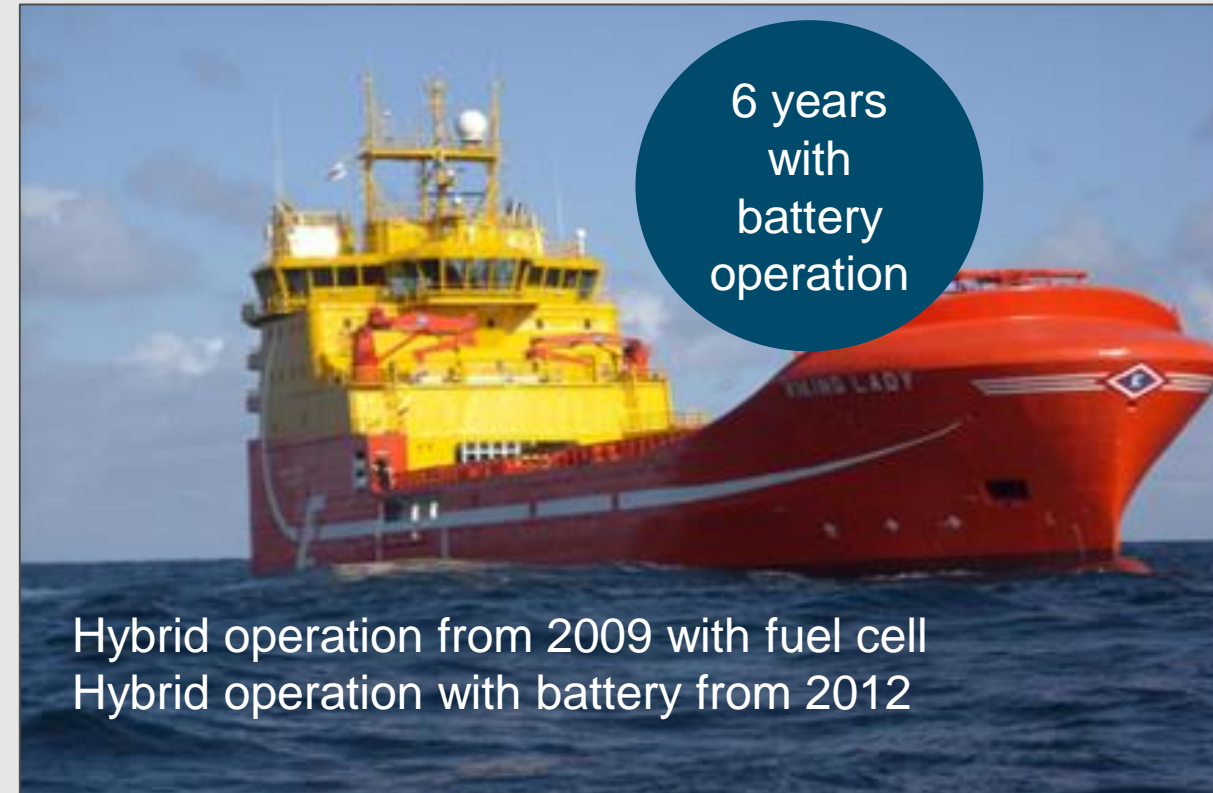


Hybrid plug-in operation since 2014

Viking Lady

PSV operation with DF engines

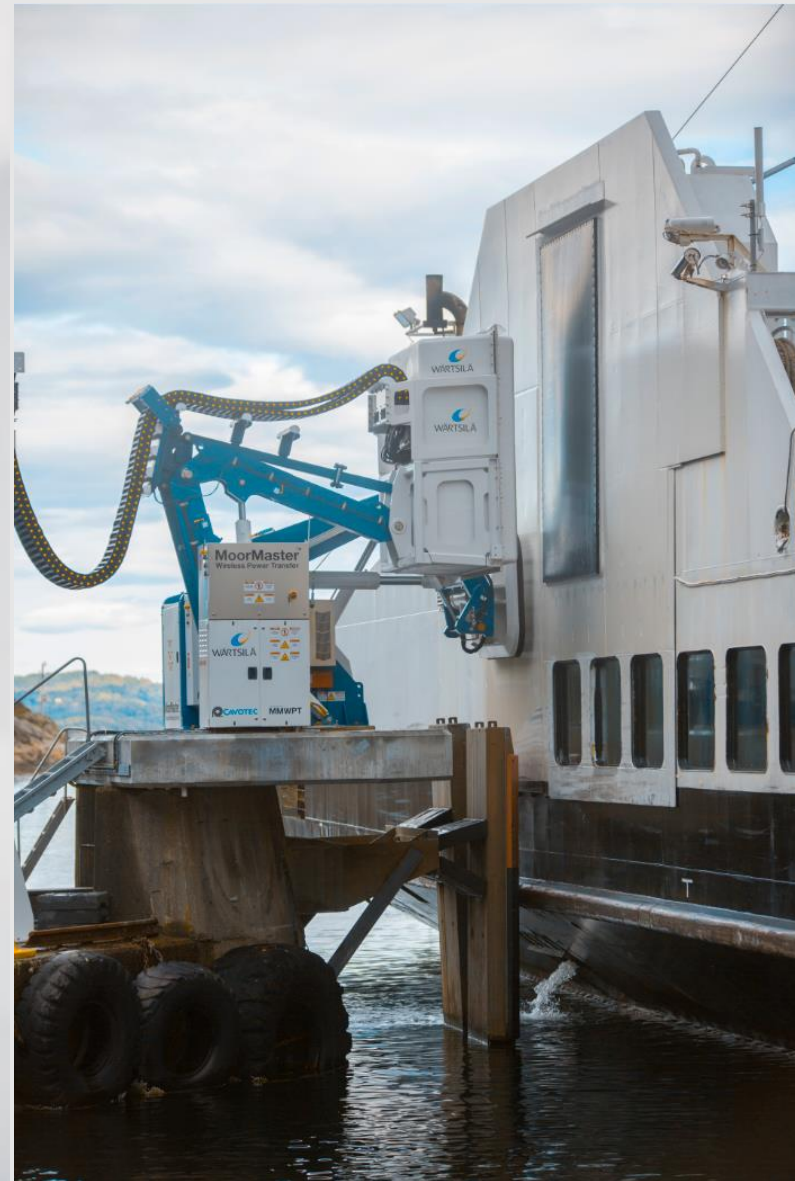
- 15% reduced fuel consumption
- 25% reduced NOx emission
- 30% reduced CH4 emission



Hybrid operation from 2009 with fuel cell
Hybrid operation with battery from 2012

MV Folgefonn double ended car ferry

- Hybrid operation without charging
- Plug-in Hybrid operation with charging from shore
- Plug-in Electrical operation with charging from shore



- Safe and reliant transfer of power from shore to ferry
- Transfer up to 2,4MW
- Distance from 0,15 to 0,5 m
- Physical size about 1 x 2 m
- Fully automated charging
- Automated moving in variations

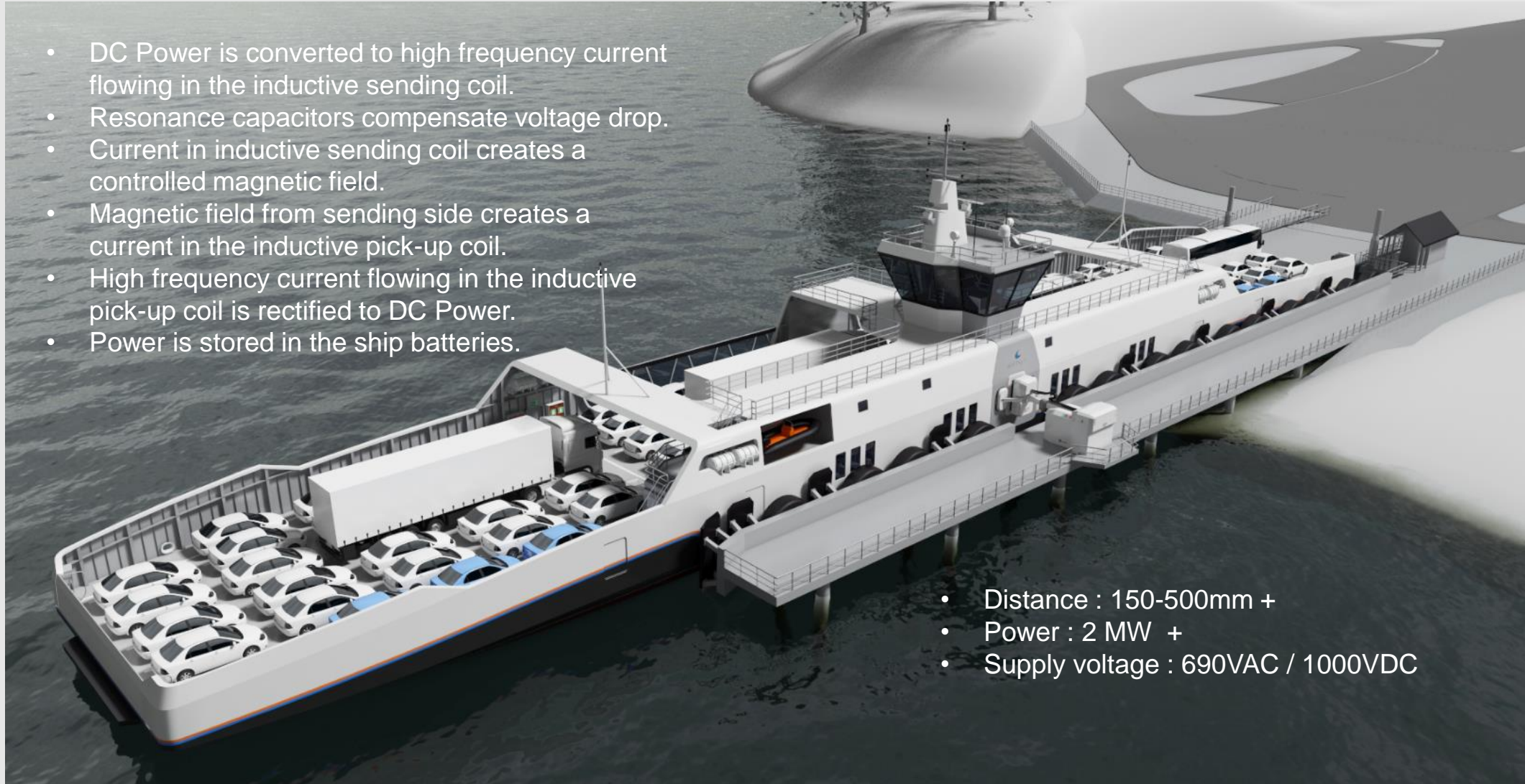


Seen from the ship

Operational principle

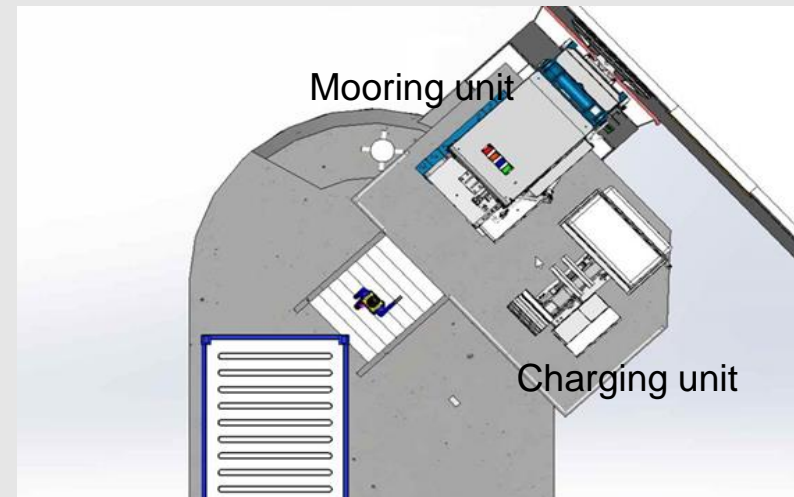
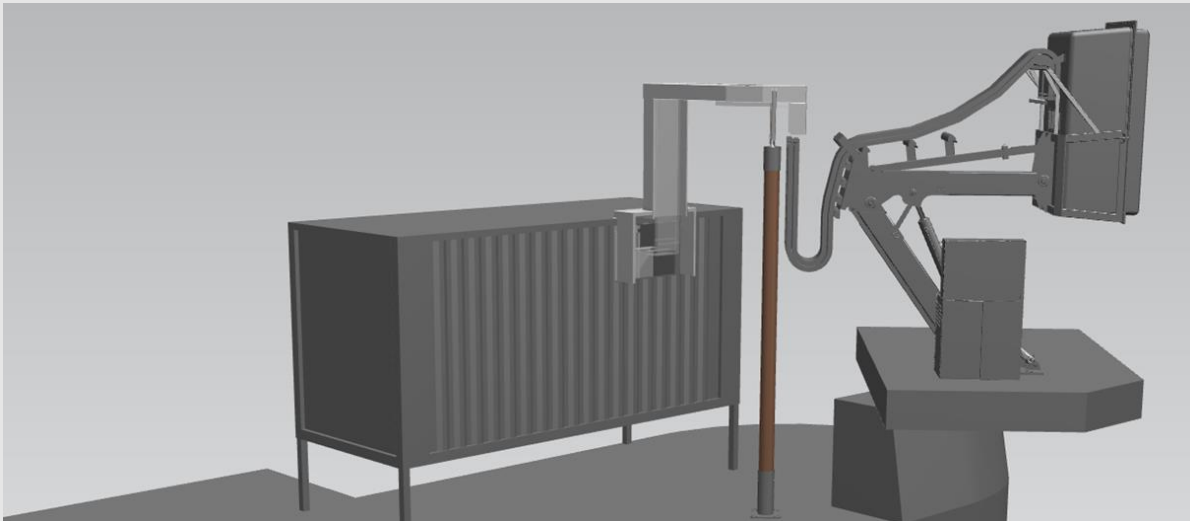
- DC Power is converted to high frequency current flowing in the inductive sending coil.
- Resonance capacitors compensate voltage drop.
- Current in inductive sending coil creates a controlled magnetic field.
- Magnetic field from sending side creates a current in the inductive pick-up coil.
- High frequency current flowing in the inductive pick-up coil is rectified to DC Power.
- Power is stored in the ship batteries.

- Distance : 150-500mm +
- Power : 2 MW +
- Supply voltage : 690VAC / 1000VDC





- Can be standardized for all ferries and port terminals
- Transfer of >2 MW power
- Increase time for energy transfer by fast connection and late disconnection
- Improved safety during operation as no mechanical connection is established
- Reduced maintenance cost
- Fully automated system
- Combined with auto mooring the propulsion can be shut down during docking
- Shore connection to AC or DC or both as standard
- Improve grid voltage quality

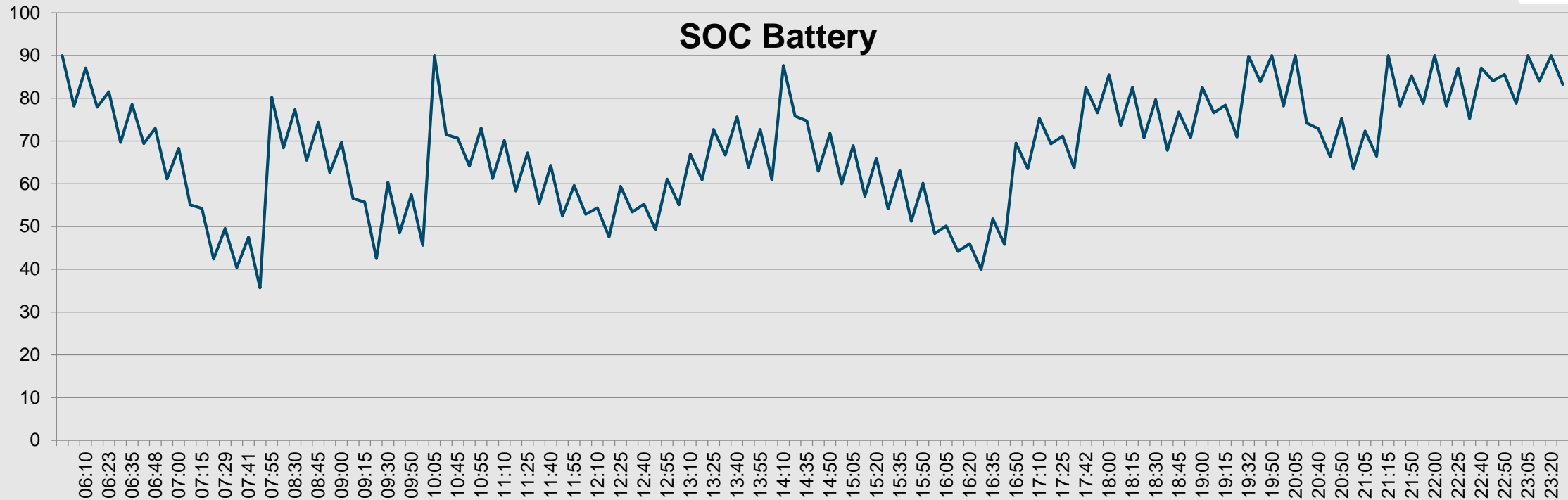


Inductive transfer

- No wear and tear –reduced maintenance cost
- High availability
- Safe solution without any connection between ship and shore
- Flexible positioning as the unit will work with asymmetrical alignment of induction plates
- Not sensitive for snow, ice and green sea
- Can easily be standardized for different ferry designs and different terminals
- Simple installation
- More losses than for a plug, but this will be compensated for with longer energy transfer and lower current and in total higher efficiency.
- Completed automated solution (no human intervention)
- More energy transfer during docking
- Defined galvanic isolation between shore and ship

Cable connection

- Higher maintenance cost due to number of connections(>10000 pr year)
- Lower availability may require back-up solutions
- Weather protection/cover needed on the vessel side
- Difficult to standardize due to the variety of plug/connection solutions
- Low losses
- Automated solutions have shown to be complicated to introduce due to environmental conditions and operational conditions
- Long connection and disconnection time reduces the time for energy transfer and has to be compensated with investment in the on-board batteries.
- Fault in physical disconnection may lead to severe damages
- Transformer for galvanic isolation needs to be installed



Typical route distances from 10 - 30 min

Short and variable docking time, <5 min in many routes, 10 min proposed for new routes

As many as 50-60 dockings each day

Harsh environment in many of the docking areas

- Light ship weight : 1165 tons
- Length over all : 82,7 m
- Length between perpendiculars (LBP/DWL) : 76,57 m
- Vertical centre of gravity : 4,49 m above baseline
- Longitude center of gravity : 36,52 m from 0
- Machinery systems :
 - Diesel electric 4 x500kW gen-set
 - Plug-in hybrid 1 x 500kW gen-set + 1000kWh batteries + 1500kW shore charging
 - Plug-in electric 1000kWh batteries + 1500kW shore charging
- Charging system :
 - plug connectcion to shore today max 1,5MW
 - replaced by Induction Charging + vacuum mooring in Q3/2017
- Propulsion system :
 - Aquamaster 1401 CRP 2 x 750kW

Jektavik

- Inductive charging
- auto mooring
- auto docking

Hodnanes alt 1

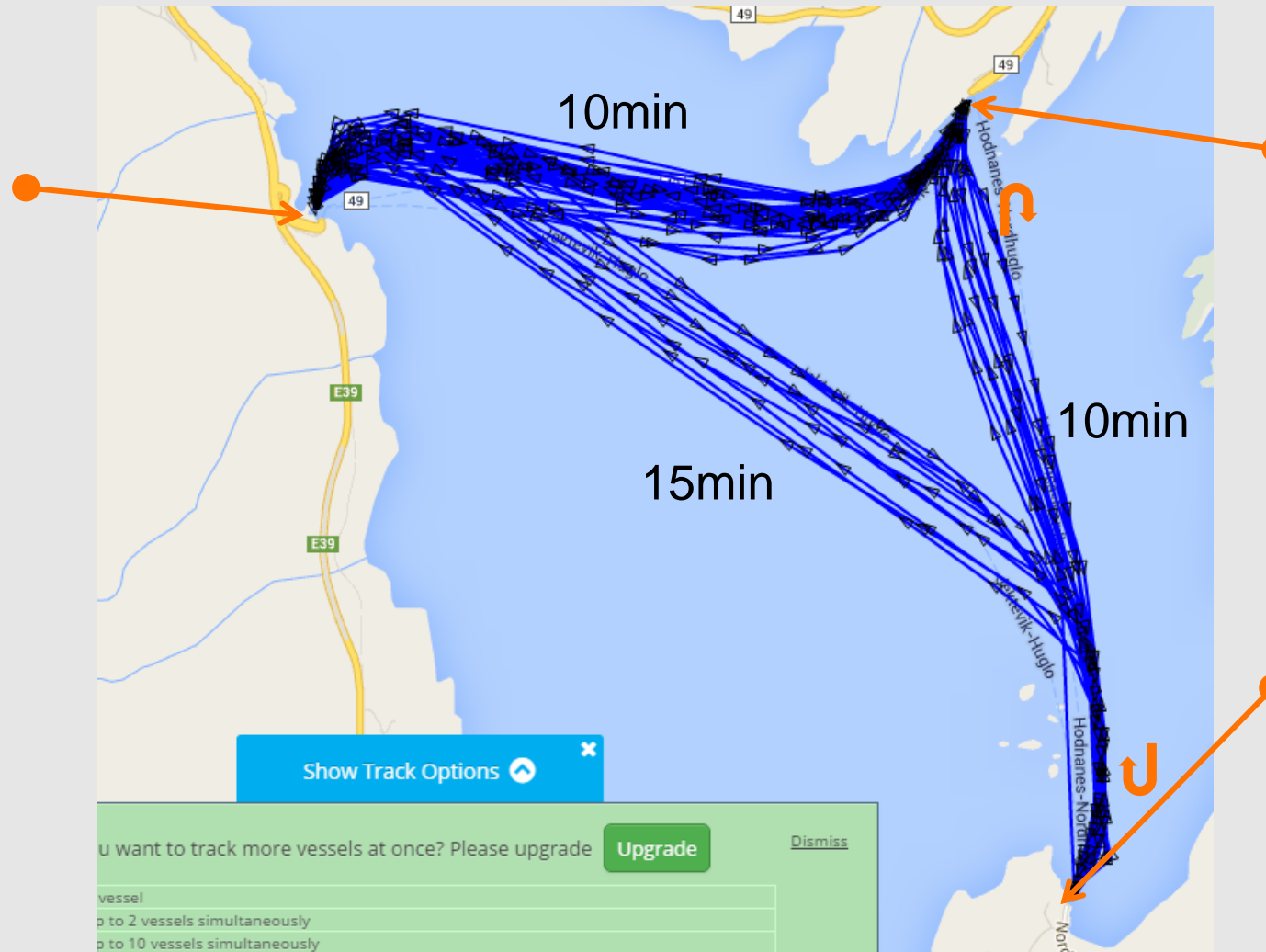
- No charging
- No auto mooring
- Auto docking

Hodnanes alt 2

- Inductive charging
- auto mooring
- auto docking

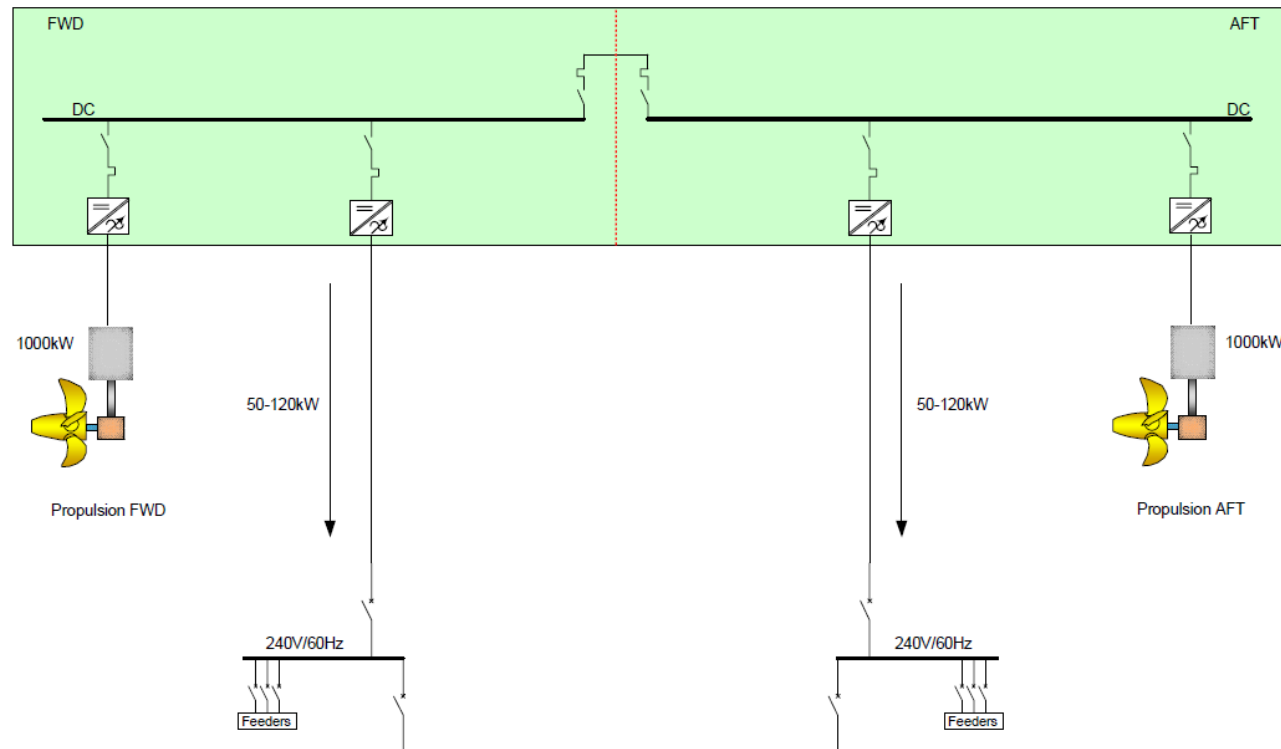
Nord-Huglo

- No charging
- No auto mooring
- Auto docking ?



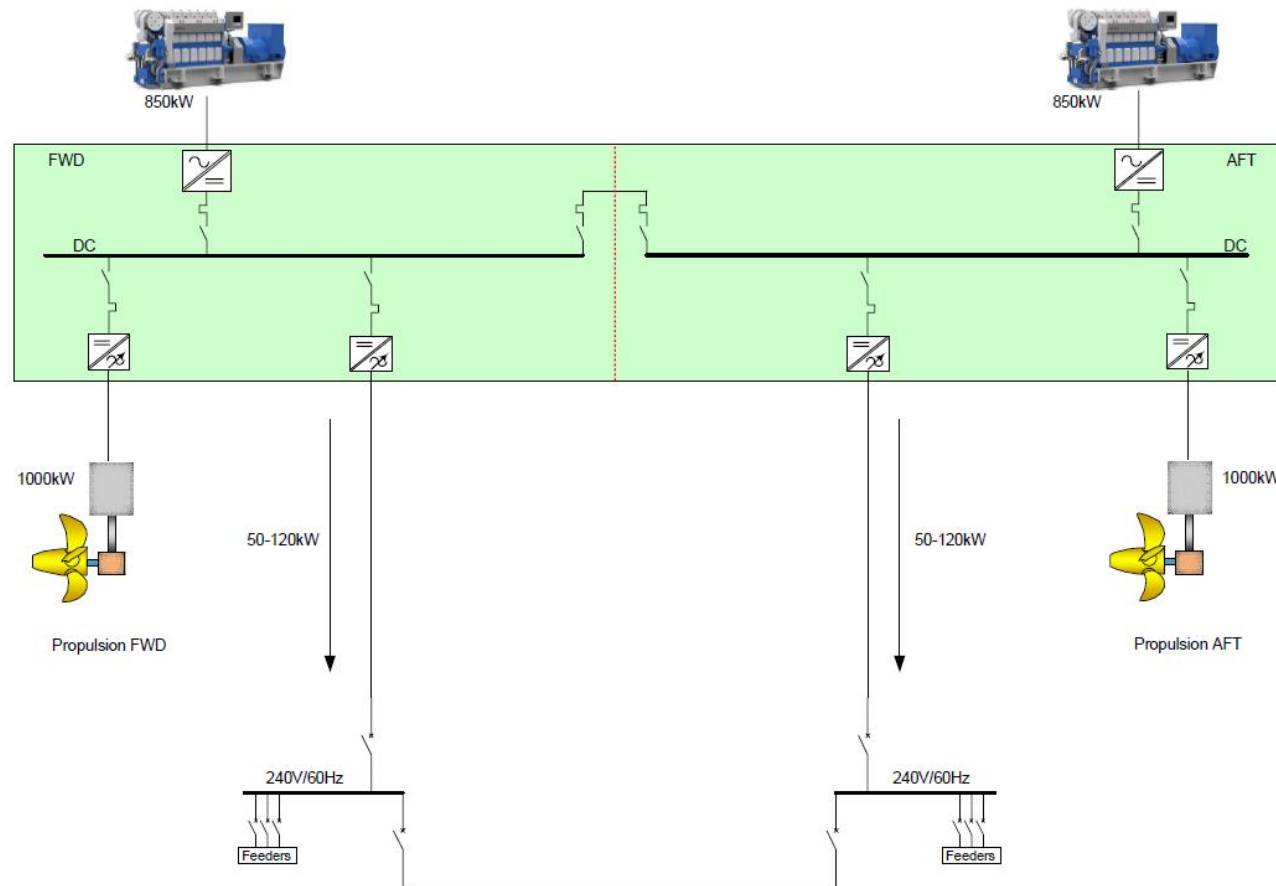
Basic configuration

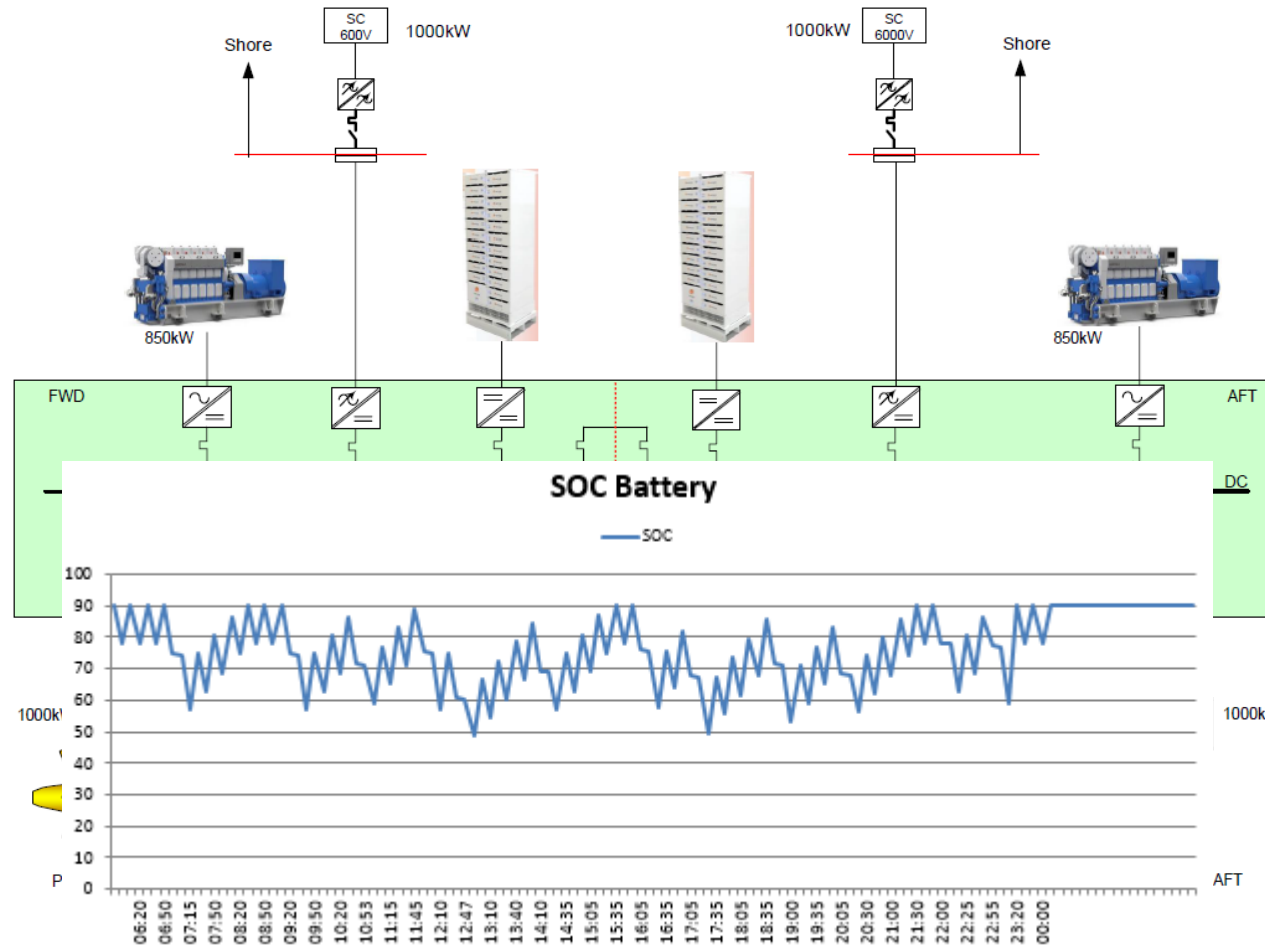
- 120 PCU
- 2 x thrusters, 1000kW
- Hotel load



Diesel electric

- 120 PCU
- 2 x thrusters, 1000kW
- 2 x generators, 850kW





Electric

- 120 PCU
- 2 x thrusters, 1000kW
- 2 x generators, 850kW
- 2 x batteries, 1020kWh
- Charging from shore



INCREASED REDUNDANCY



BACK-UP POWER



ENERGY FLEXIBILITY



LOW ENERGY COST



RENEWABLE ENERGY

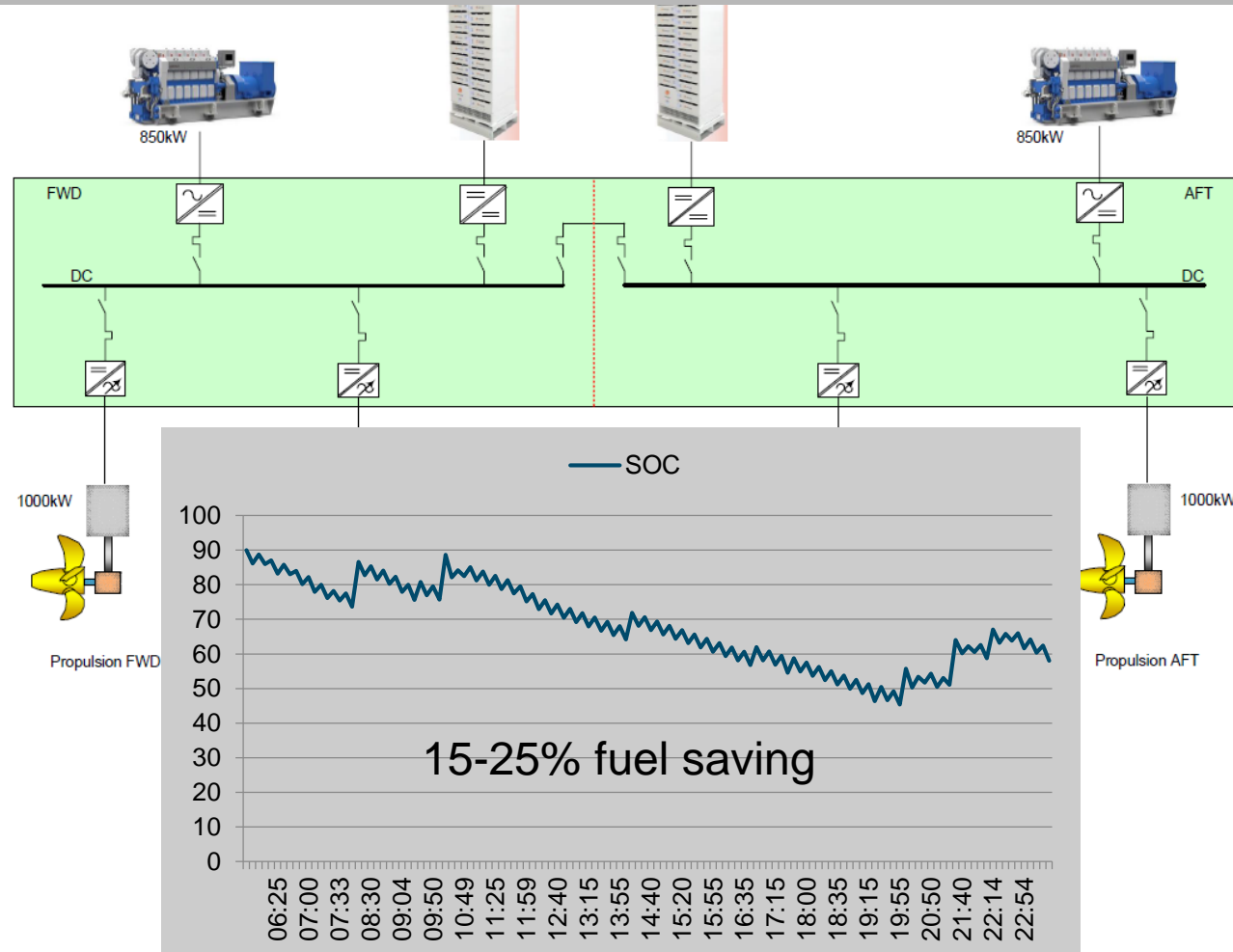


REDUCED EMISSIONS



LOW NOISE / VIBRATION

- Reduced engine operating time = reduced maintenance and increased service intervals
- Optimal load during running = lower fuel consumption



Hybrid

- 120 PCU
- 2 x thrusters, 1000kW
- 2 x generators, 850kW
- 2 x batteries, 1020kWh

