WÄRTSILÄ ELECTRICAL AND POWER SYSTEMS

SMART ELECTRICAL AND POWER SYSTEMS

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LEGISLATION

Cost of Compliance
CAPEX required for compliance (EEXI / EEDI)

Cost of Carbon
Carbon levy, carbon credits, carbon neutral & zero carbon fuels

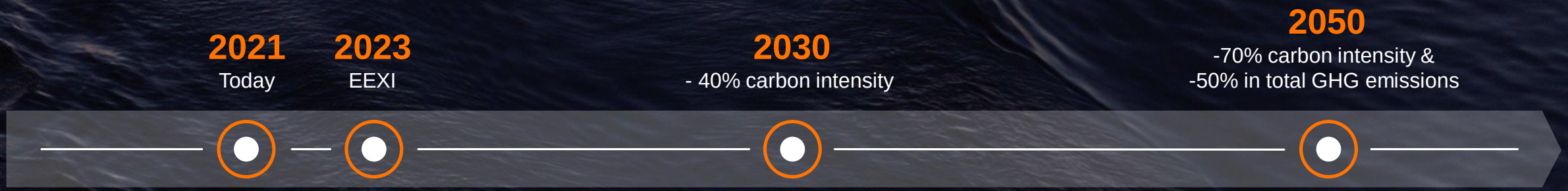
MARKET

Access to Capital
Poseidon Principles, ESG-linked loans (AER / EEOI)

Business Risk
Impact on day rates & time charters (CII)

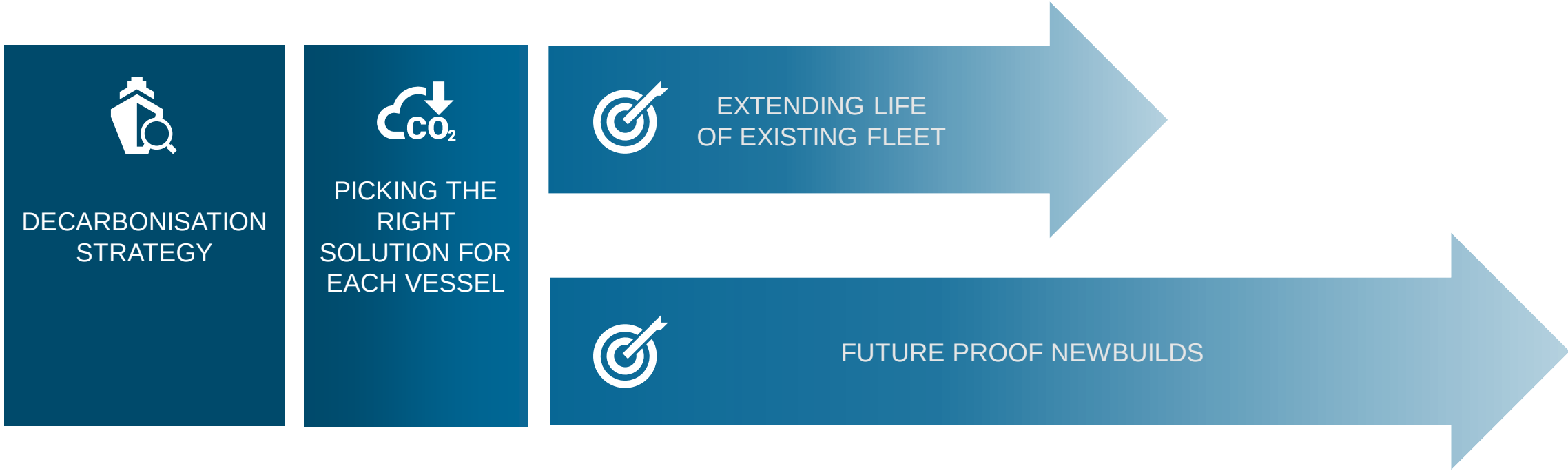
30,000 VESSELS WILL REQUIRE RECERTIFICATION*

OWNERS FACE A CRITICAL DECISION

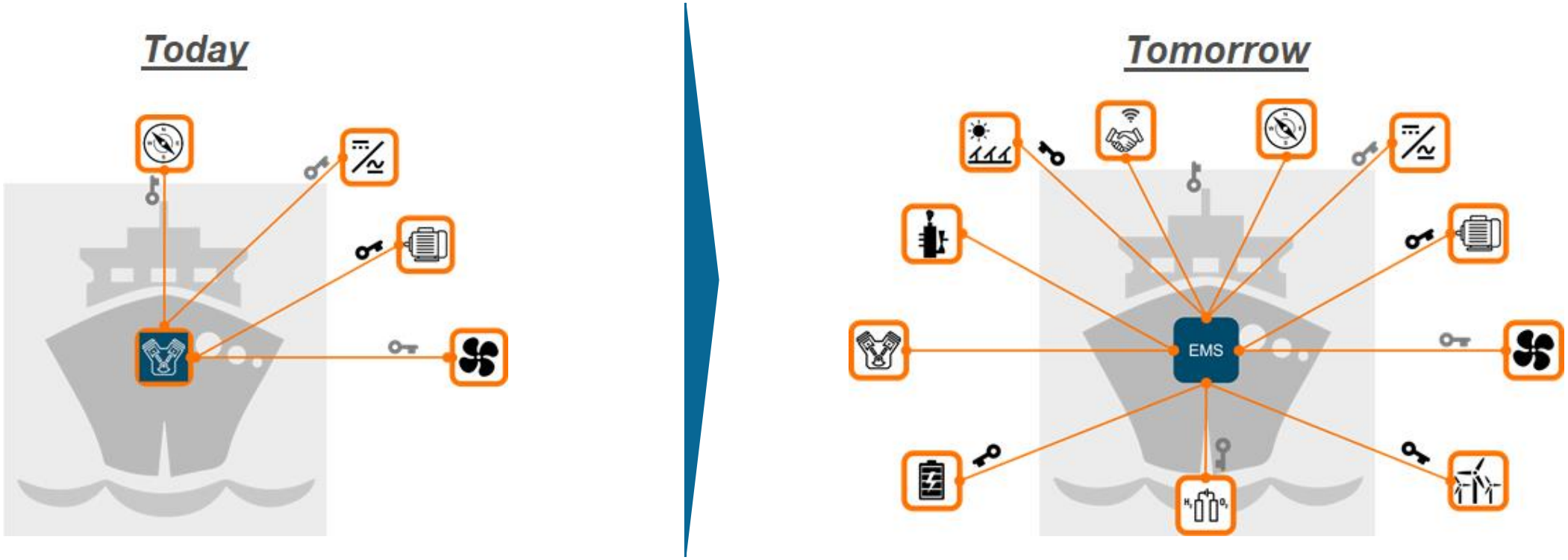


*Source: DNV

A TAILOR-MADE PATHWAY TO DECARBONISATION



TOMORROWS PROPULSION CONCEPTS
FROM ENGINE CENTRIC TO A SOFTWARE CENTRIC SET UP



The performance focussed energy management system (EMS) is a new software category on a vessel and sits on top of the safety focussed Power Mmgt. System (PMS)

VESSEL REFERENCES

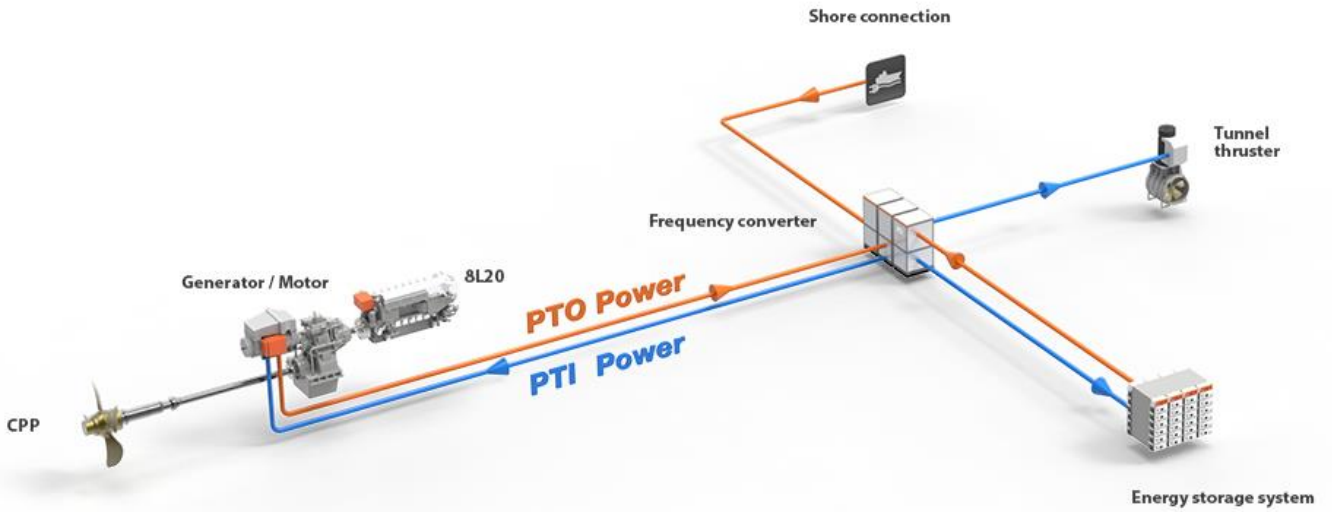
BULK CARRIER
DIESEL MECHANICAL CPP HYBRID

Base Case: 2S with FPP
Wartsila Solution: 4S with Hybrid PTO/PTI

Key Features & Benefits of Integrated Solution:

- Optimised for customer's operating modes
- Zero emission in and out of port & for cargo operations
- Possibility to connect other power sources in the future
- Propulsion Redundancy by utilisation of PTI
- Variable RPM on main engines & stable frequency via PTO
- Peak shaving for stable engine load

- Installed Power Reduced ~10%
- Running Hours Reduced ~12%
- Fuel consumption Reduced ~15%
- Total CO2 Reduction ~20%

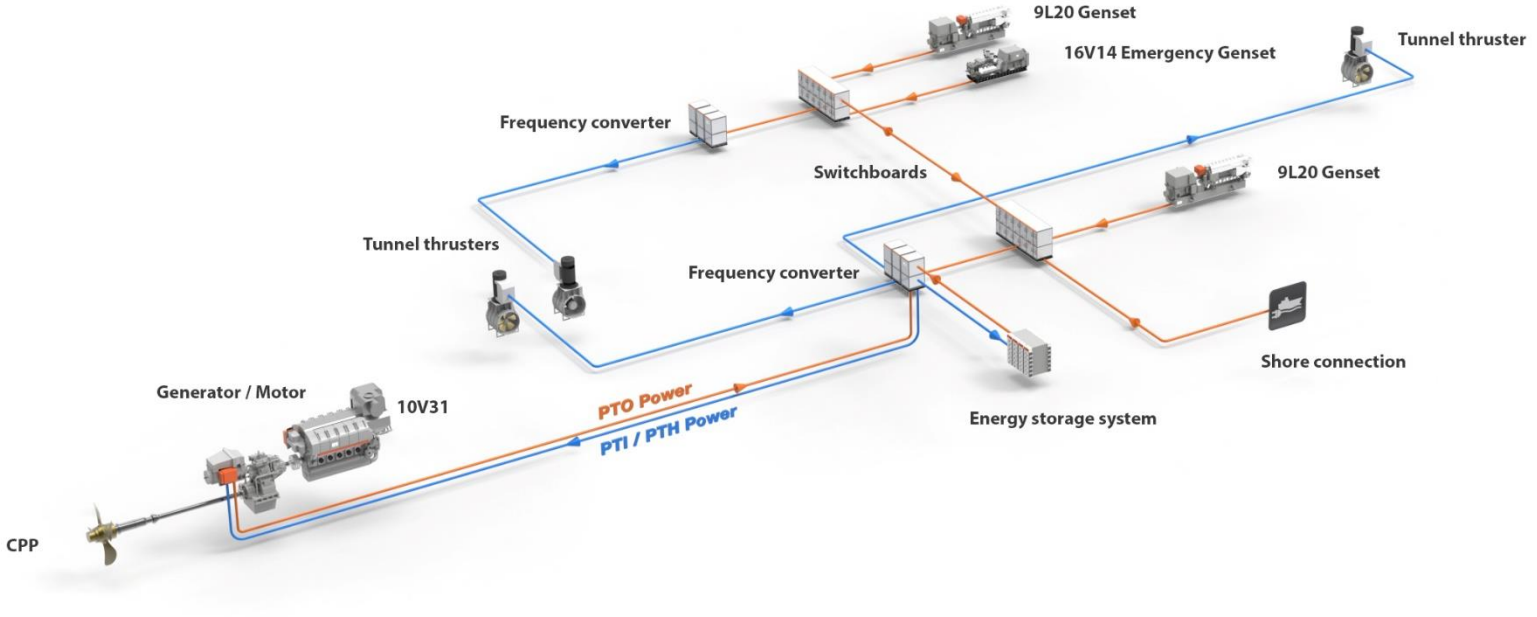


DP GENERAL CARGO VESSEL
DIESEL MECHANICAL CPP HYBRID

Base Case: 2S with FPP
Wartsila Solution: 4S with Hybrid PTO/PTI

Key Features & Benefits of Integrated Solution:

- Vessel Availability
- Operational risk reduction
- Fully integrated building process
- Increased Redundancy by utilization of PTI
- Variable RPM on main engines. Stable frequency and engine load due to PTO, active converter and battery
- Engine operation at optimal load and rpm
- Shore power utilisation.



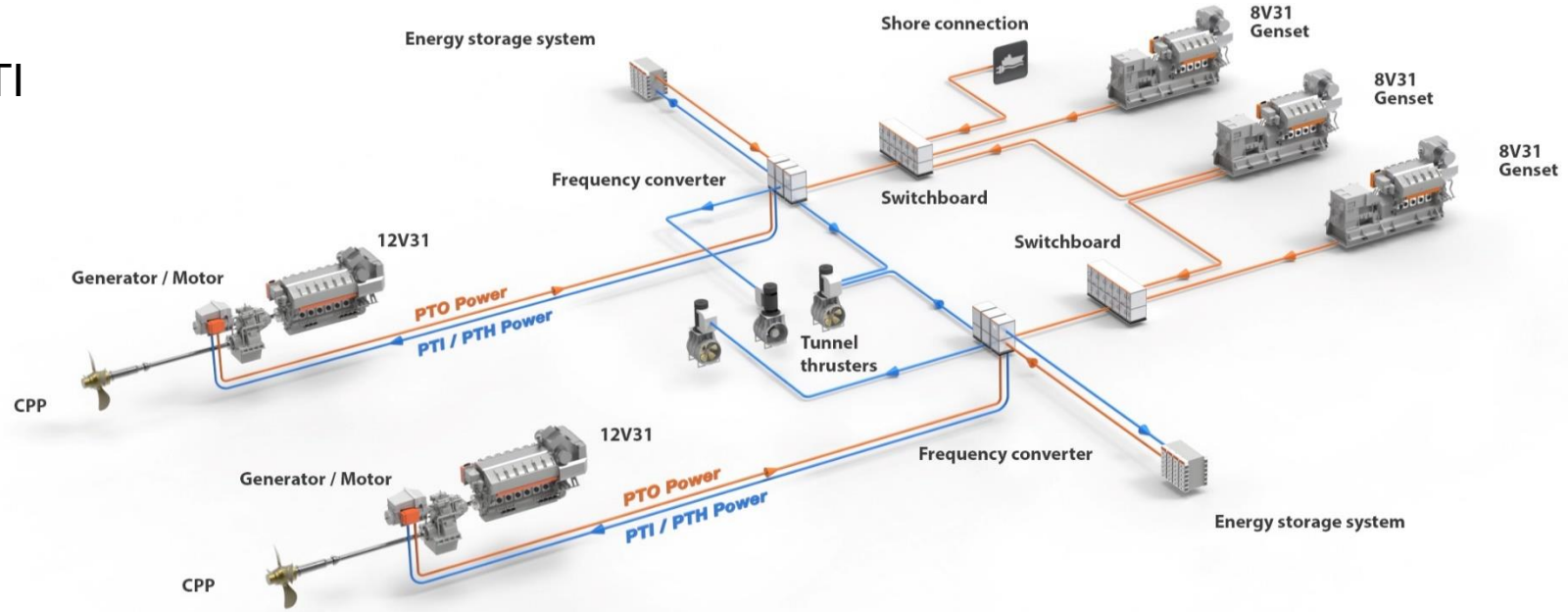
230M ROPAX
DIESEL MECHANICAL HYBRID

Base Case: 4 x 4S with CPP
Wartsila Solution: 4S with Hybrid PTO/PTI

Key Features & Benefits of Integrated Solution:

- Stable main engine load thanks to ESS peak shaving
- Reduced running hours on auxiliary engines with ESS+SG
- Future-ready for shore charging facility
- Reduced energy losses on TT wise thanks to VFD+FP setup

- Installed Power Reduced ~16%
- Running Hours Reduced ~20%
- Total CO2 Reduction ~7%
- Total NOx Reduction ~13%
- Total Opex savings ~8%

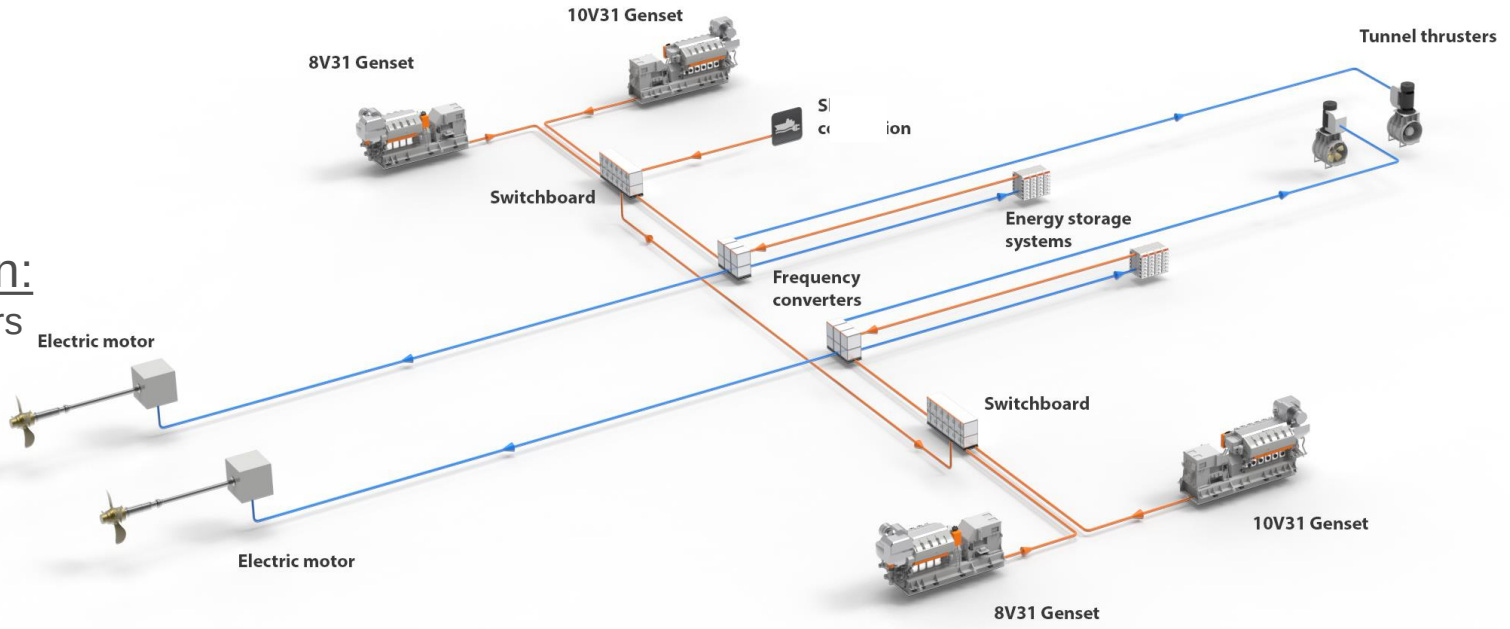


60 CAR PASSENGER FERRY DIESEL ELECTRIC HYBRID

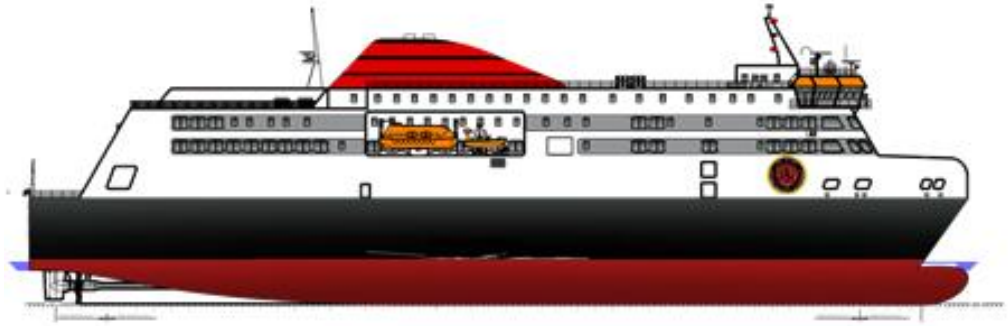
Base Case: 4S Diesel Electric
Wartsila Solution: 4S Diesel Electric Hybrid

Key Features & Benefits of Integrated Solution:

- Demonstrated fuel savings by medium speed generators and battery
- Green mode in port
- Energy calculations based on operation profile
- Single system responsibility



- Running Hours Reduced ~20%
- Total CO2 Reduction ~3%
- Consumption Savings ~3%
- Total Opex Savings ~5%

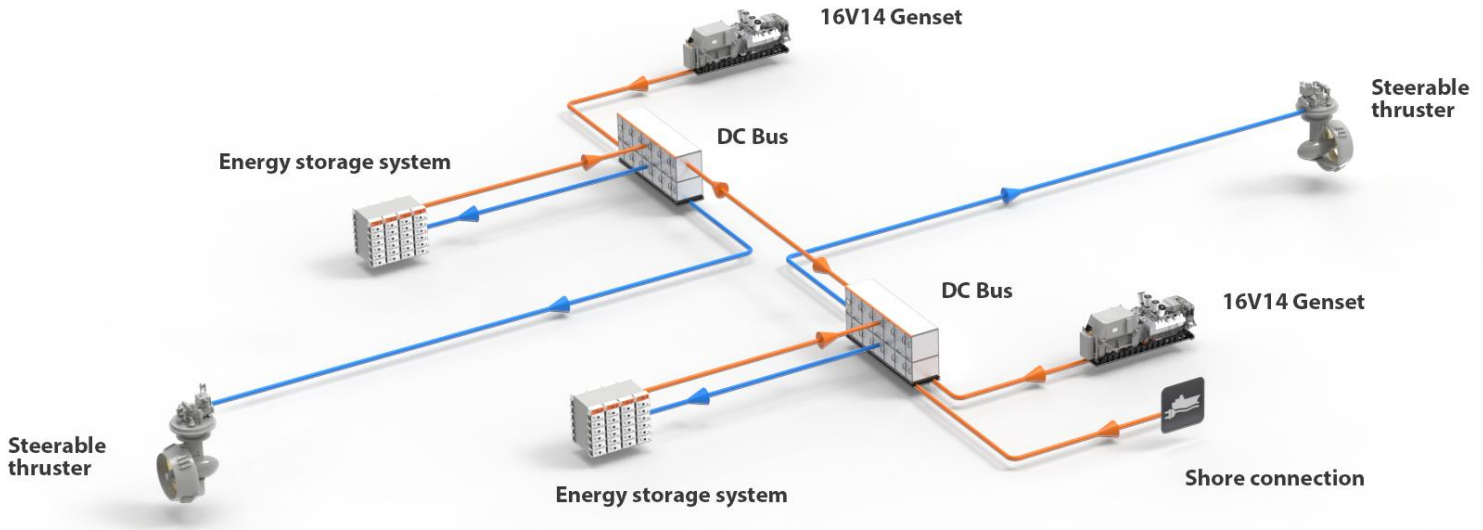


FULLY ELECTRIC FERRIES

Base Case: 4S DE or DM
Wartsila Solution: Full Electric

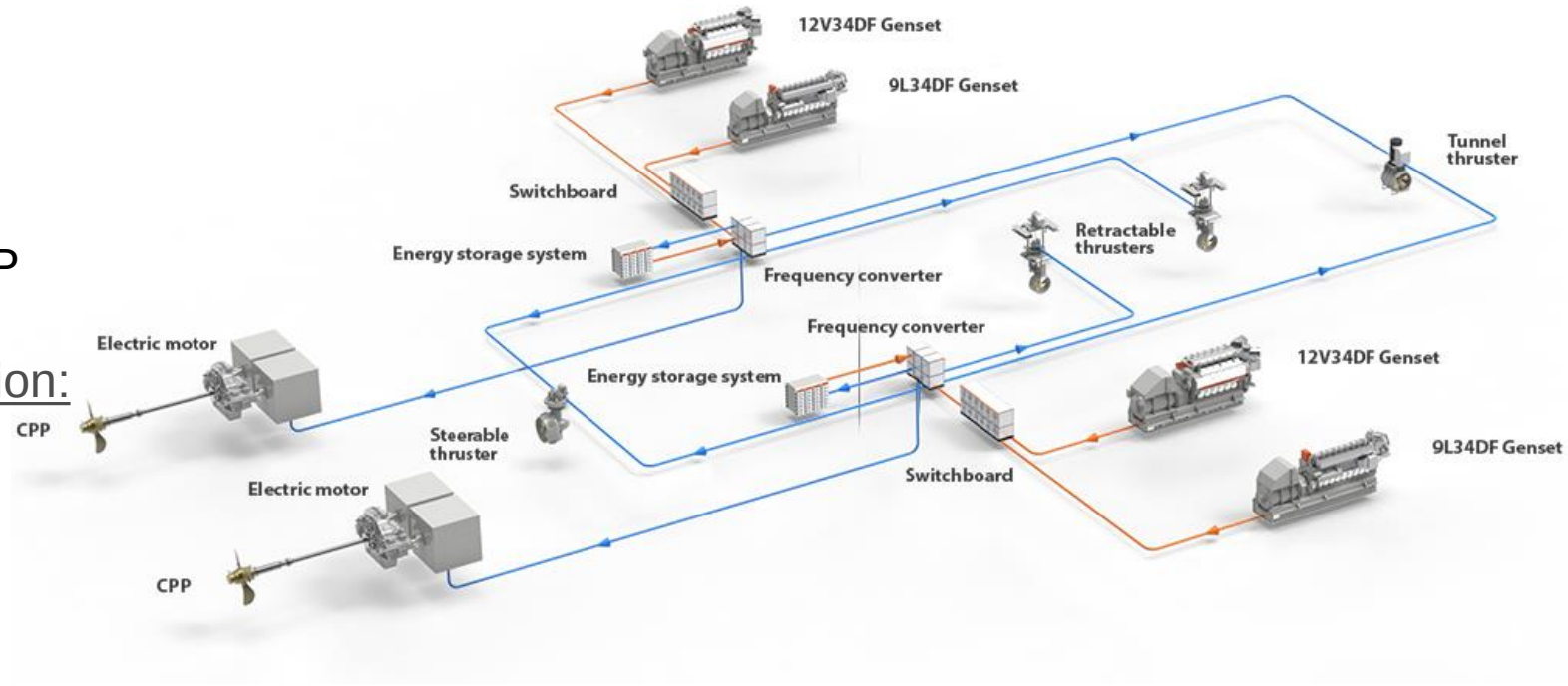
Key Features & Benefits of Integrated Solution:

- Full electric operation, zero emission
- Integration of vessel and shore system
- Optimization of energy consumption
- Service availability



SHUTTLE TANKER
DIESEL ELECTRIC HYBRID

Base Case: 2S with FPP
Wartsila Solution: 4S DFDE Hybrid with CPP



Key Features & Benefits of Integrated Solution:

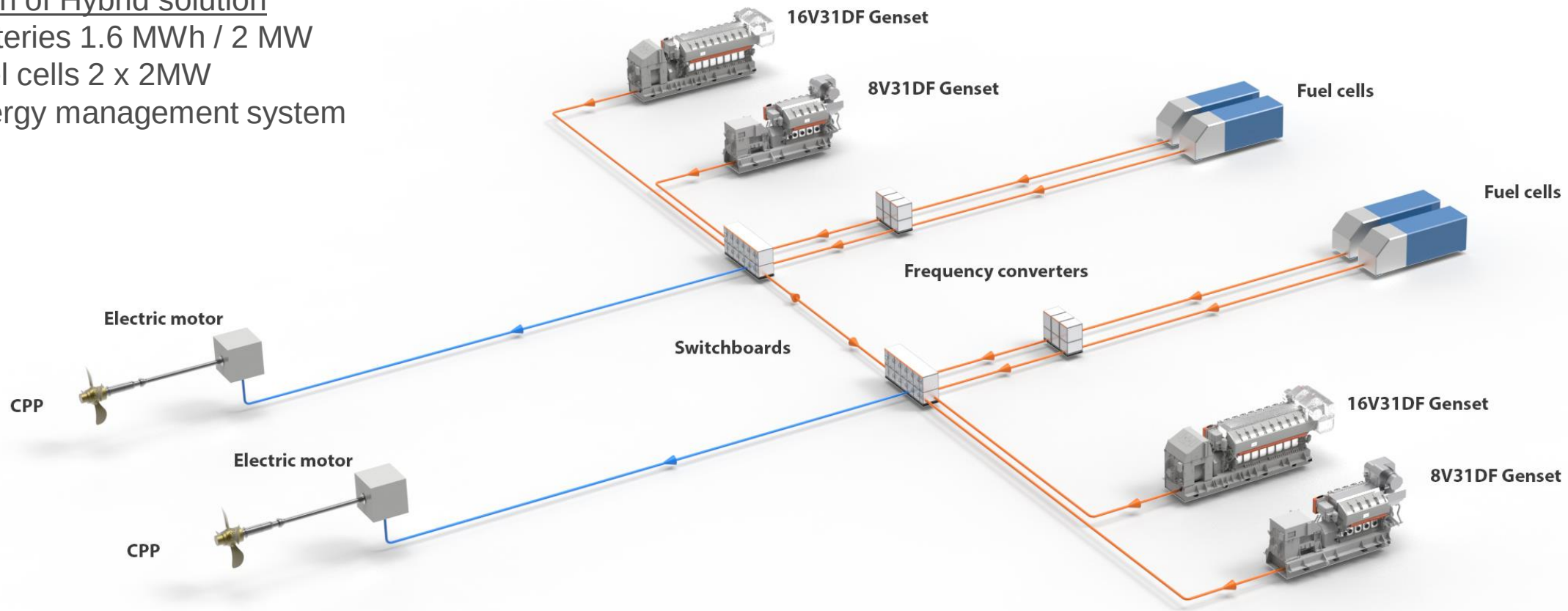
- CO2 reduced by more than 40%
- NOx reduction of 80%
- SOx and Particles almost entirely eliminated
- Use of VOC as fuel reduces bunkering by 46 %

- Reduced machinery power by 10%
- Reduced machinery running hours of 29%
- Reduced overall fuel consumption of 10%
- Peak shaving for stable engine load

ADDING FUEL CELLS AND BATTERIES TO A CRUISE VESSEL

Addition of Hybrid solution

- Batteries 1.6 MWh / 2 MW
- Fuel cells 2 x 2MW
- Energy management system




STRATEGIC SOLUTIONS

CONSIDERATIONS OF A STRATEGIC APPROACH

DECARBONISATION STRATEGY

PICKING THE RIGHT SOLUTION FOR EACH VESSEL

EXTENDING LIFE OF EXISTING FLEET

FUTURE PROOF NEWBUILDS

2021 Today

2023 EEXI

2030 - 40% carbon intensity

2050 -70% CI & -50% in total GHG

Upgrade or newbuild

Evaluate the potential for NB or retro for existing fleet and company strategy

Electrical Enhancements

The easiest electrical enhancement of all newbuilds today is a PTO/PTI shaft generator system, which reduces EEDI and fuel consumption

Flexibility

A diesel-electrical propulsion system is the most flexible for future operational profiles and power sources

Hybrid

For many vessel types a hybrid propulsion system is already an econmically feasible option with a good ROI and emissions reductions

Future Design

All newbuilds should be ready for shore power, in the next decade it will become mandatory to use in many ports around the globe (today only LA)

Data and Insight

A central data collection unit is monitoring all vessel systems, allowing remote monitoring, remote support and performance analytics

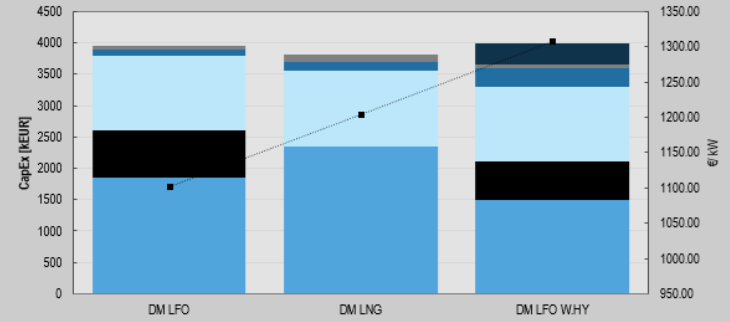
EXAMPLE CALCULATION

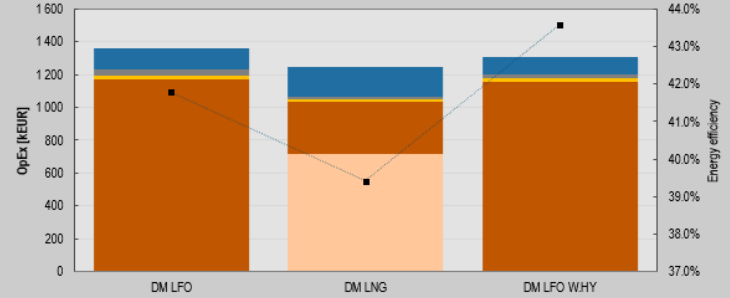
ESStimator

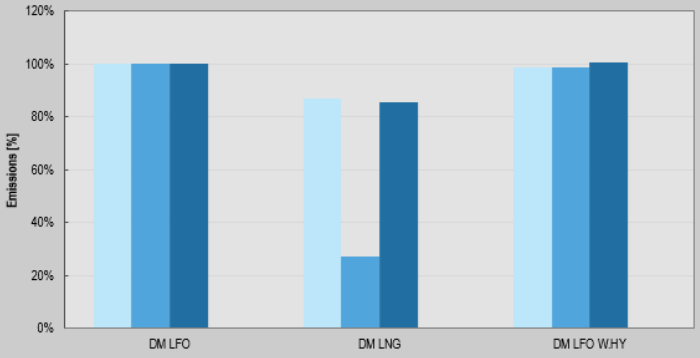
HOME
SHIP 1
SHIP 2
SHIP 3
SHIP 4
SHIP 5
SHIP 6
SHIP 7
SHIP 8
SHIP 9
SHIP 10
DATA
RESULTS

Results based on: Year REF ship: DM LFO

			DM LFO	DM LNG	DM LFO W.HY
CAPEX	Total	[kEUR]	3960	3820	3985
		[%]	REF	-3.5%	+0.6%
	Propulsion & shafting	[kEUR]	1200	1200	1200
	Engines & gensets	[kEUR]	1850	2350	1500
	Electrical & automation	[kEUR]	100	150	300
	Energy Storage System	[kEUR]	0	0	325
	Fuel system	[kEUR]	60	120	60
	After treatment	[kEUR]	750	0	600
	Other	[kEUR]			
OPEX	Total	[kEUR]	1360.13	1246.16	1310.40
		[%]	REF	-8.4%	-3.7%
	Gas fuel	[kEUR]	0.00	715.37	0.00
	Heavy fuel	[kEUR]	0.00	0.00	0.00
	Light fuel	[kEUR]	1175.12	318.57	1157.94
	Lube oil	[kEUR]	19.99	20.11	18.40
	Shore power	[kEUR]	0.00	0.00	0.00
	Urea	[kEUR]	35.43	8.61	22.75
	Caustic soda	[kEUR]	0.00	0.00	0.00
	Sludge disposal	[kEUR]	0.00	0.00	0.00
	Maintenance (year basis)	[kEUR]	130	184	111
	Other (year basis)	[kEUR]			
PBT	Pay-back time	[years]	NA	NA	0.5
EMISSIONS	Carbon dioxide	[mt]	8188.61	7135.06	8068.89
		[%]	100.0%	87.1%	98.5%
	Sulphur oxides	[mt]	10.38	2.81	10.23
		[%]	100.0%	27.1%	98.5%
	Nitrogen oxides	[kg]	31215.97	26737.35	31367.25
		[%]	100.0%	85.7%	100.5%
	Particulate matter	[kg]	NA	935.60	NA
		[%]	NA	NA	NA
CONSUMABLES	Gas fuel	[mt]	0.00	1788.42	0.00
	Heavy fuel	[mt]	0.00	0.00	0.00
	Light fuel	[mt]	2611.38	707.93	2573.20
	Lube oil	[mt]	8.69	8.74	8.00
	Shore power	[MWh]	0.00	0.00	0.00
	Urea	[mt]	141.72	34.44	91.01
	Caustic soda	[mt]	0.00	0.00	0.00
	Sludge	[mt]	0.00	0.00	0.00
	Total engines running hours	[hrs]	14196.09	16633.93	11669.54
	Approx. ESS cycles (80%DoD)	[cycles]	0.00	0.00	1611.09
EE	Average energy efficiency	[%]	41.8%	39.4%	43.6%
EEDI	Attained EEDI	[-]	4.12	2.46	2.93
	Required EEDI	[-]			9.79
CHECKS	SoC at start different from SoC at end		good	good	good
	Missing data on some components		good	good	good
	Other warnings / errors found		warning	good	warning

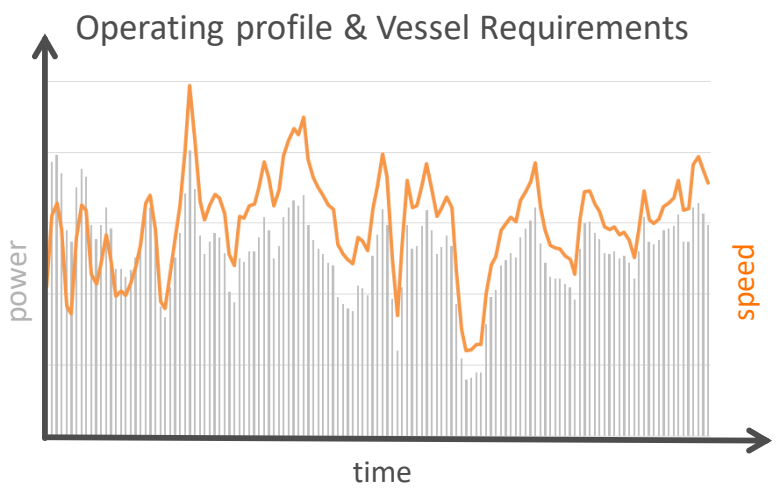


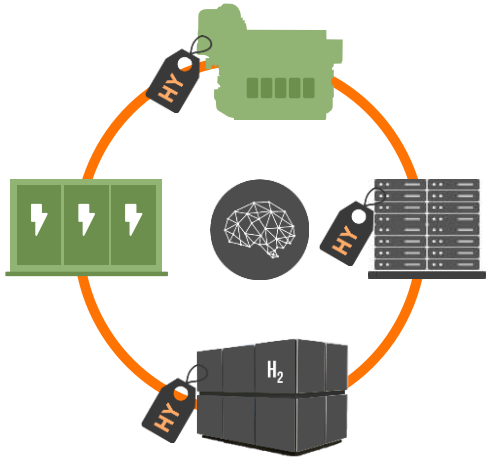




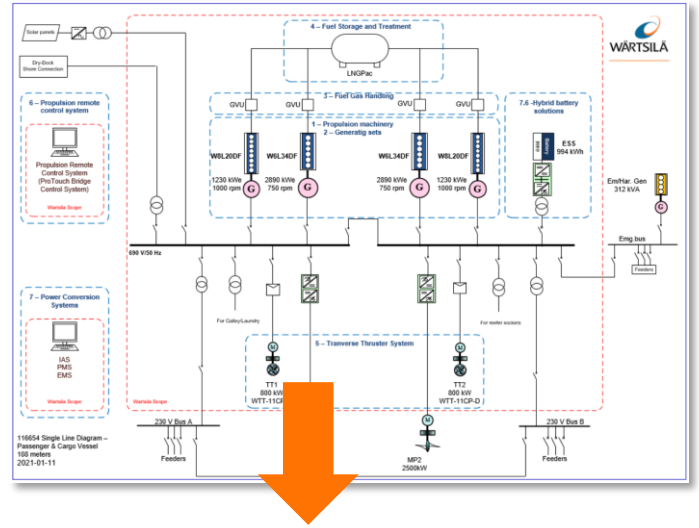
DESIGN OPTIMISATION PROCESS

DATA-DRIVEN DESIGN





OPTIMISED SYSTEM DEFINITION



SYSTEM FUNCTIONAL SPECIFICATION

Functional description
Date: 18.11.2020

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SUPERIOR PERFORMANCE & FLEXIBILITY THAT IS FUTURE-PROOF

CONCLUSION

- Electrification is one building block towards decarbonisation
- Legislation and local requirements will demand electrification of all vessels soon
- Electrically enhanced propulsion system reduce operating costs and GHG emissions
- Act now to identify, analyse and plan how your fleet can reduce their emission footprint
- To jump over the first milestone EEXI you want to be clear what options you have
- Integration is key to optimising the solution both for newbuild and retrofit
- For this the “Energy Management System” as new central software on the vessel is key


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