

DAMEN

THE FUTURE IS NOW

Electric propulsion for hybrid tugs

Manager Design Tugs: Erik van Schaik

Emission reduction

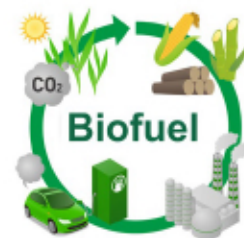
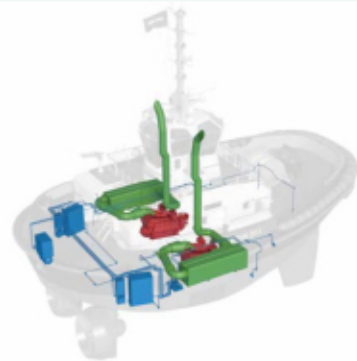
- Worldwide target Paris agreement
 - Keep the increase in global warming to 2°C above pre-industrial levels.
- European targets
 - 55% reduction in 2030 and zero CO2 in 2050.
- Many ports and big companies are setting zero emission targets for 2040 or 2050.



Image source: Bloguila.com

Available technology

	A	B	C
	Low emissions	CO ₂ reduction	Zero emission
Technology (short term < 4y)	Aftertreatment	<u>BioFuels</u>	E-propulsion
Technology (long term > 4y)	(Aftertreatment)	<u>eFuels</u>	H ₂ / Fuel Cell
Driver	IMO regulations (NO _x / <u>SO_x</u>) EU (NO _x / <u>SO_x</u> /PM)	Paris Agreement 2015 IMO EU	Paris Agreement 2015 IMO EU



Economic viability



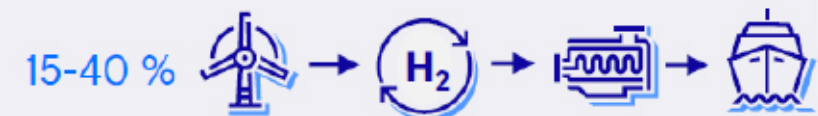
Efficiency 15-40 %



Efficiency ~80 %

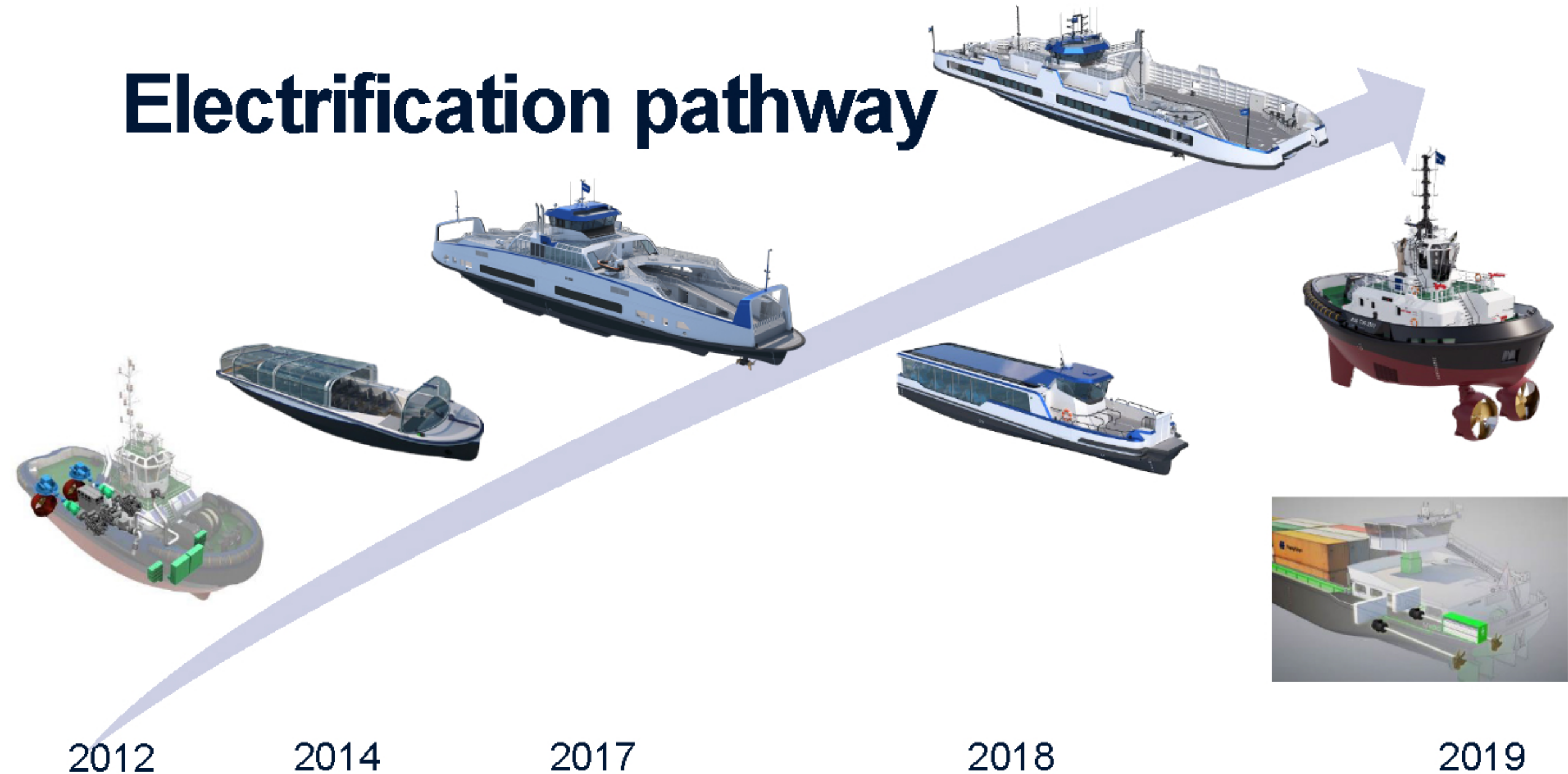
Electrification will increase driven by efficiency

Efficiency well-to-wheel



PtX requires 2-5x more renewable energy

Electrification pathway



RSD-E Tug 2513

- 2018: Feasibility study on Full Electric
- 2019: Concept design and launching customer
- 2020: Engineering ready
- 2021: Building ready
- 2022: Commissioning and delivery of first vessel



ELECTRIC SYSTEM

Design philosophy

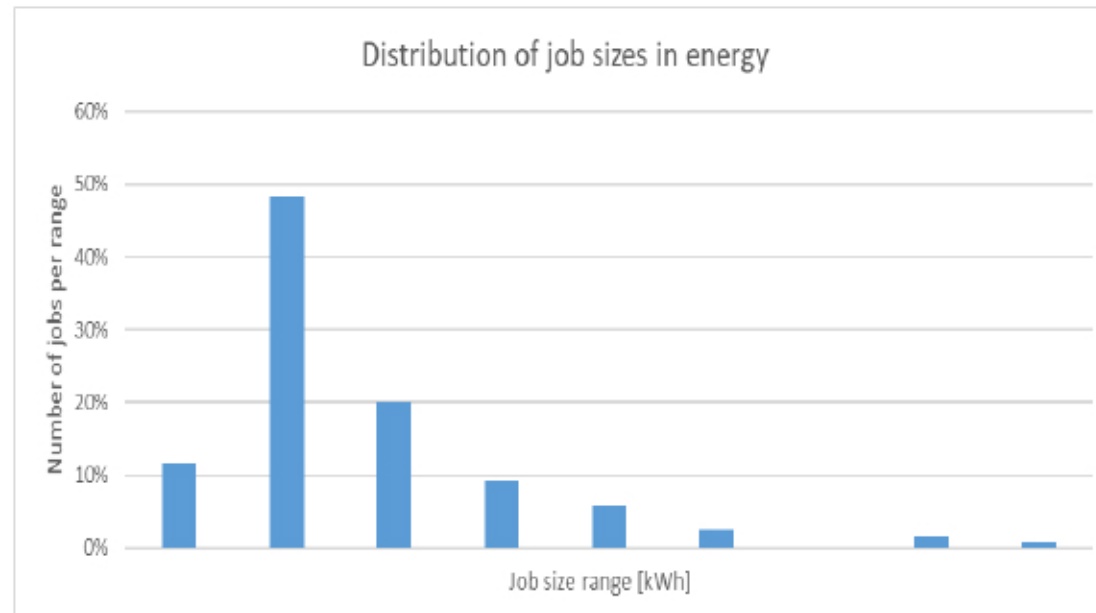
- Damen is system integrator
- Modular and scalable design
- World wide use possible
- Design for the lowest TCO



ELECTRIC SYSTEM

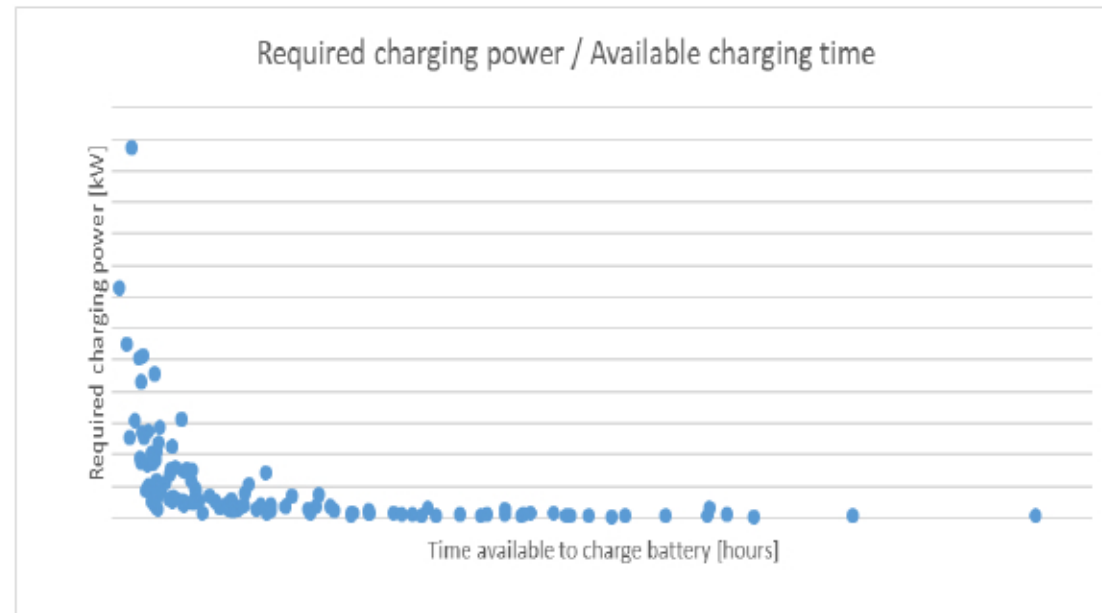
Energy storage capacity

- Analyze operational profile
- 2 or 3 (un)berthing jobs on shore power
- High autonomy operations on generator sets



Charging power

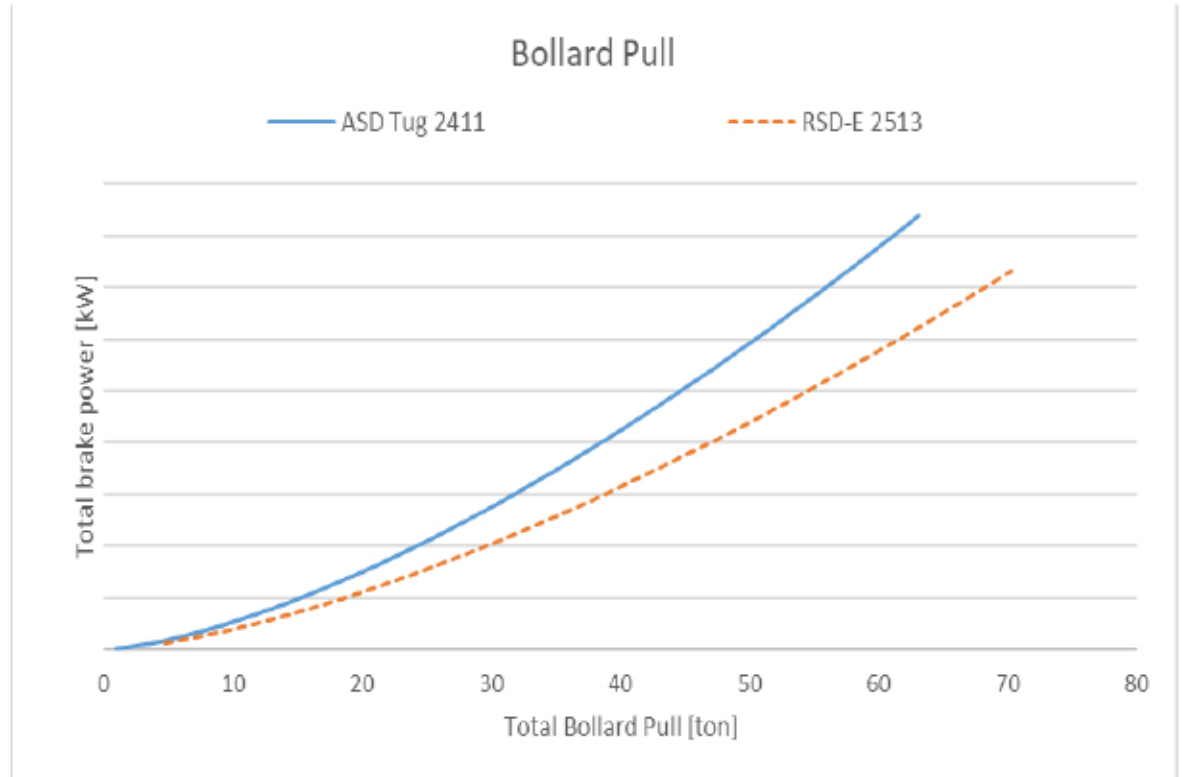
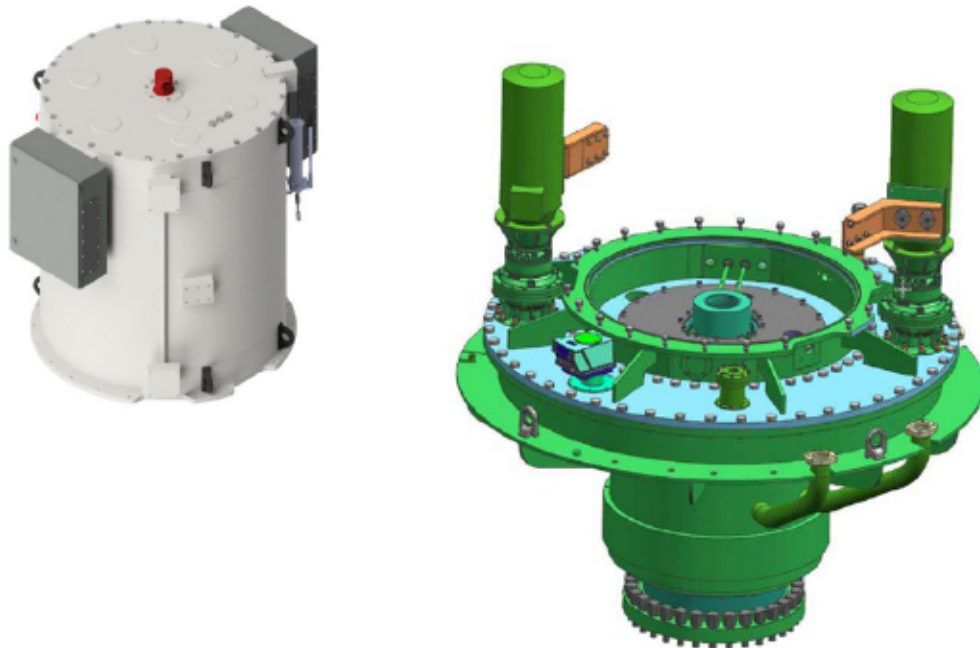
- Analyze operational profile
- Completely charge within two hours
- Back-up charging on generator sets



ELECTRIC SYSTEM

Discharging power

- 70 ton BP and 12 knots on batteries
- 40 ton BP on generator sets
- Optimized propulsion efficiency



ELECTRIC SYSTEM

Battery system

- Toshiba LTO battery module
- Toshiba BMS up to string level (incl. protection)
- Echandia Marine system BMS and racking
- Expected lifetime 30.000 cycles (\pm 30 years)
- Classified by DNV-GL and BV

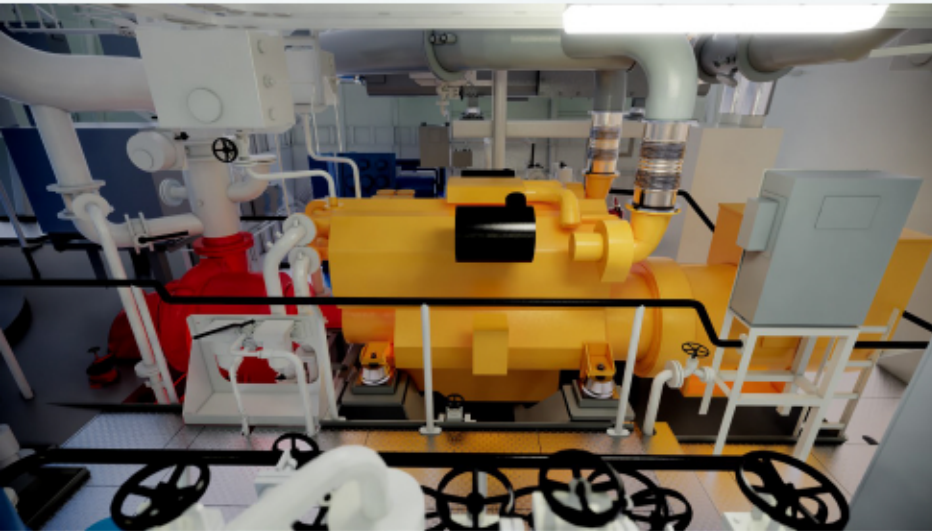


ECHANDIA

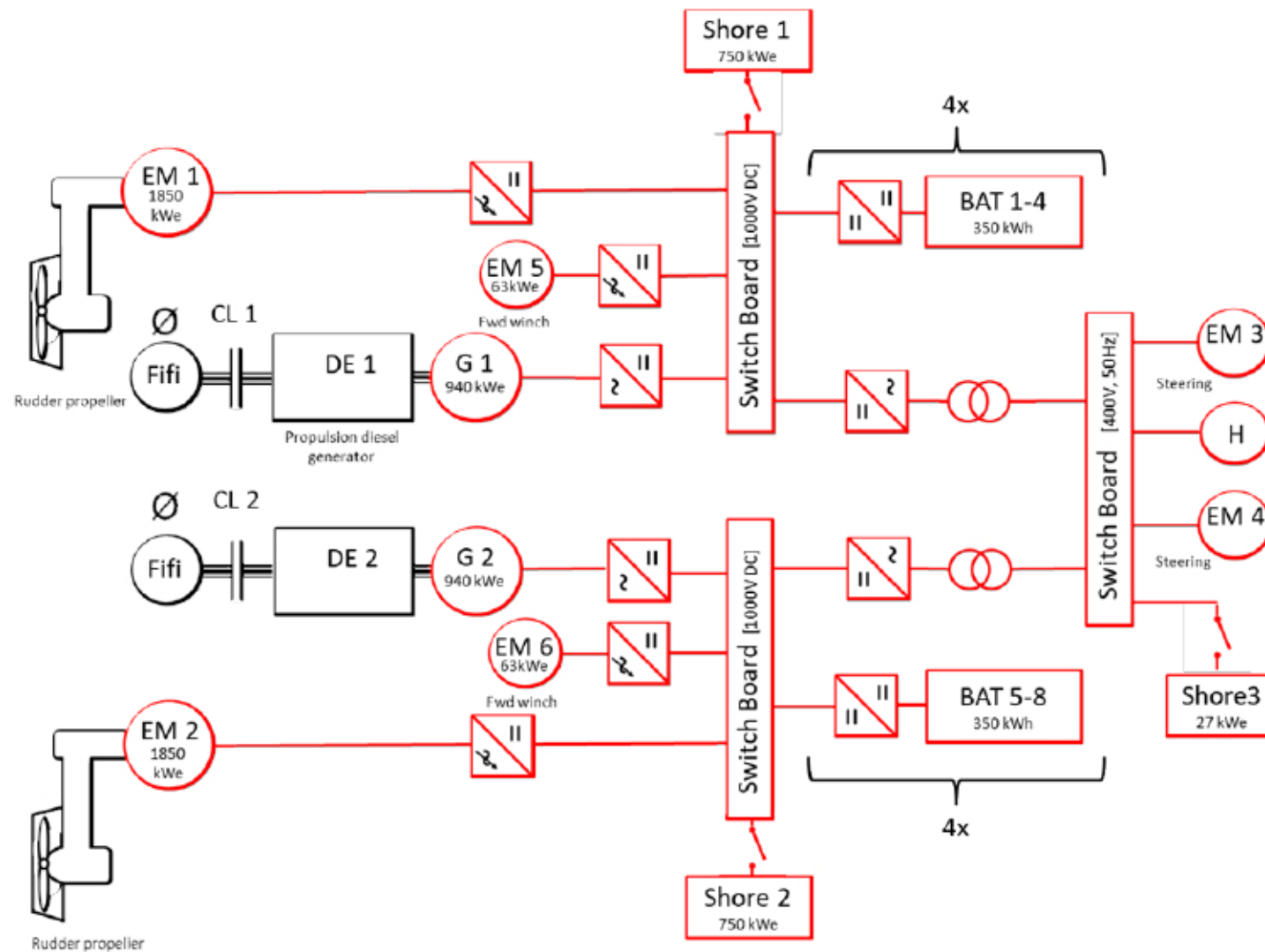
ELECTRIC SYSTEM

Generator sets

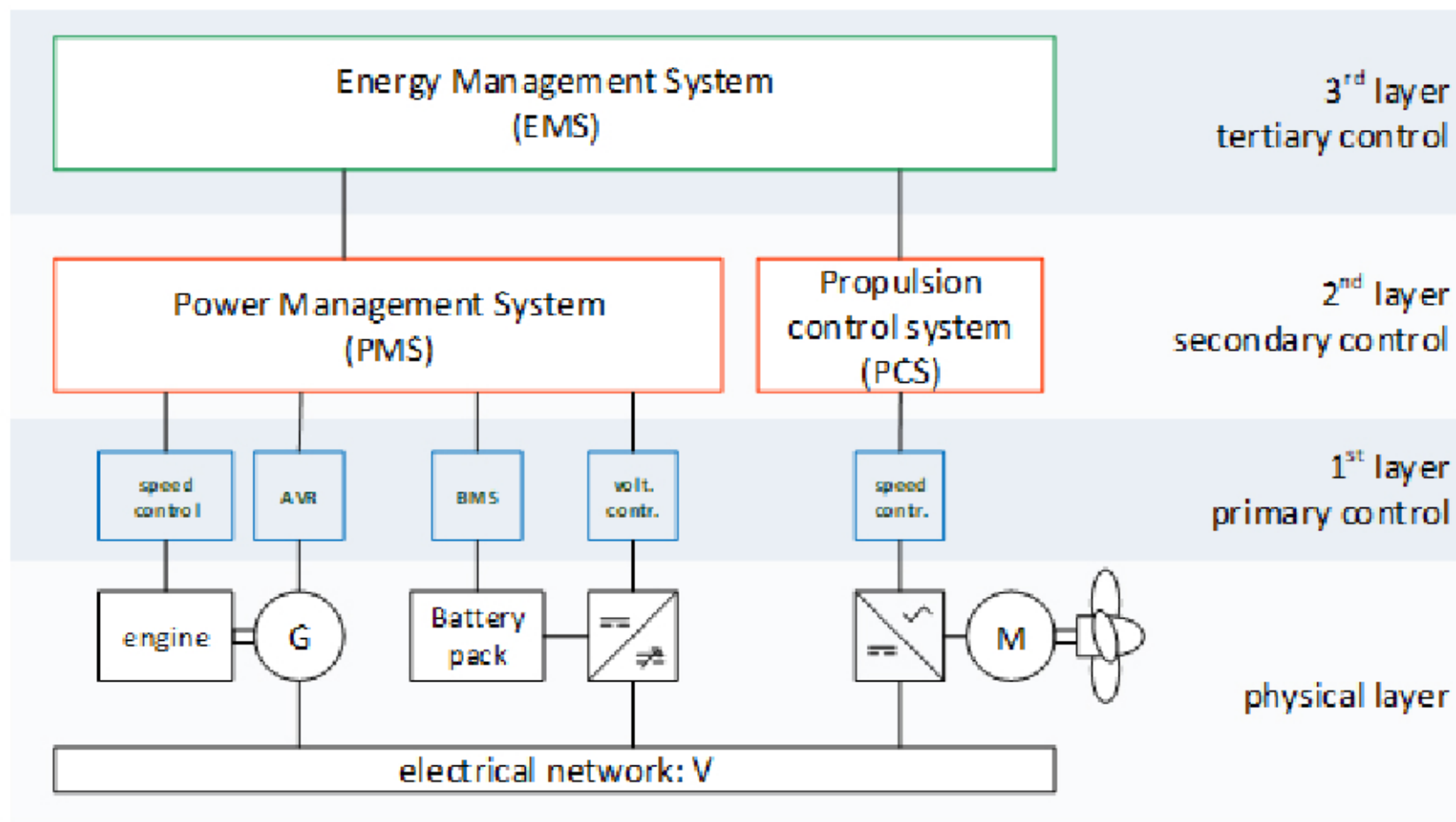
- Range extender / back-up / Fifi mode
- Caterpillar C32 diesel engine
- IMO Tier 3 certified with Damen SCR system
- Leroy Somer generator 940ekW@1800rpm
- Optional FFS fire fighting pump



Electric system



Control system



OPERATING PRINCIPLES

Battery modes

SAIL

Full battery mode with zero emission

MOORED

Vessel is at the quay side and being charged by the shore charging station





OPERATING PRINCIPLES

Genset modes

FIFI

Both C32 diesel engines are powering the fifi pump and the generator for propulsion without battery power simultaneously.

SAIL

Both C32 diesel engines are powering the generator for propulsion without battery power.

MOORED

Both C32 diesel engines are powering the generator for charging without shore power.



OPERATING PRINCIPLES

Hybrid modes

SAIL

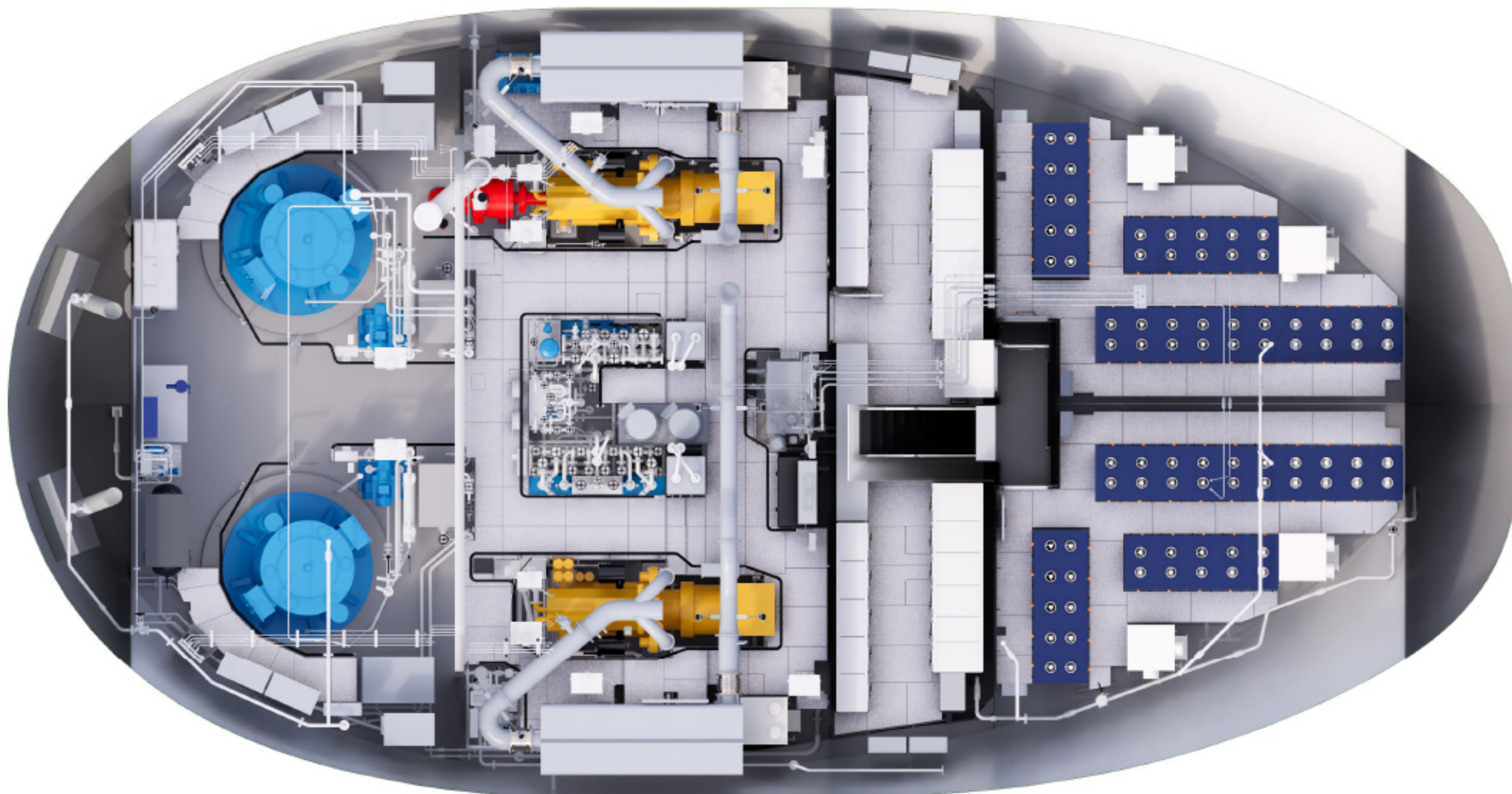
Both C32 diesel engines are powering the generator for propulsion and/or battery charging. When necessary, batteries are supplying boost power. Maximum performance and autonomy of the vessel are available in this mode.

MOORED (Hyper charging)

Vessel is at the quay side and both C32 diesel engines are powering the generator for fast charging the batteries together with the shore charging station. Completely charging of the batteries within 1 hour is possible in this mode.



Below main deck



Battery rooms



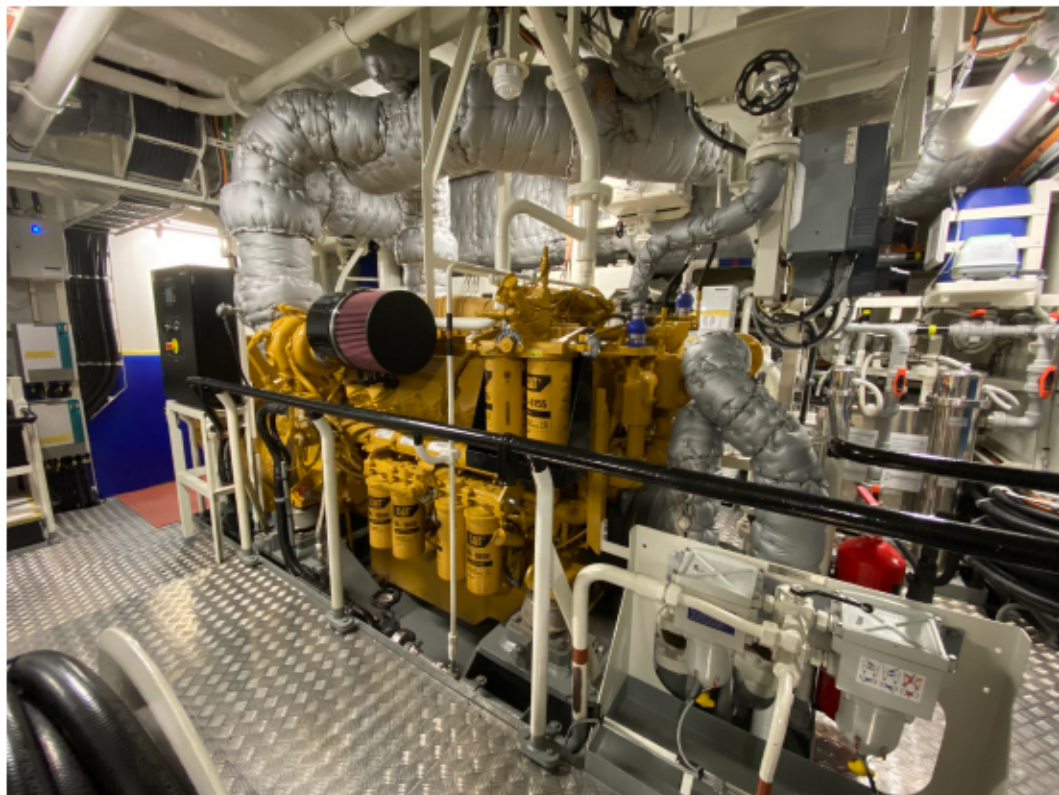
RSD-E TUG 2513

Switchboard room



RSD-E TUG 2513

Engine room



RSD-E TUG 2513

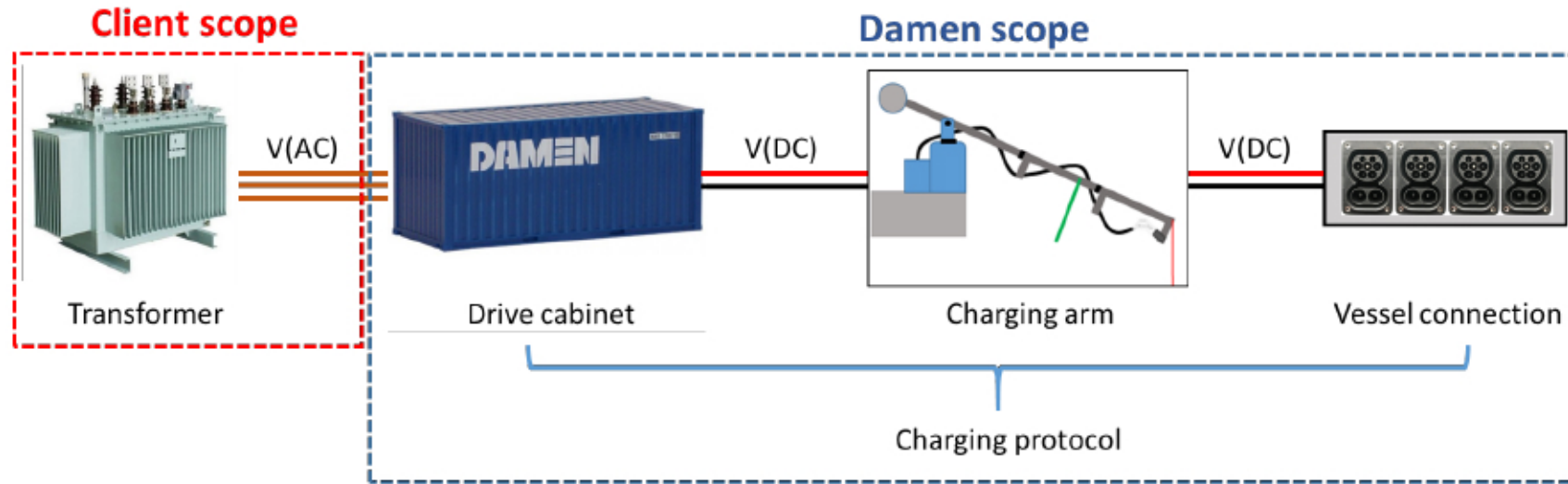
Rudder propeller room



SHORE CHARGING

Charging requirements

- Charge time 2 hours @ 1.5 MW
- Un-/deployment within 5 minutes





SHORE CHARGING

Charging arm

- Passive tidal difference compensation
- Robust and simple design
- 1 man operation (from jetty or vessel)



SHORE CHARGING

Charging cables

Usage of automotive High-Power Charging (HPC) cables

- Easy handling
- Compact and lightweight
- Off-the-shelf product

1500 kW charging power → 4 x 375 kW HPC cables

Connection terminal box on starboard vessel funnel





CONCLUSION

The future is Now

- Zero emissions (no future CO2 tax)
- No fuel consumption
- Low electricity consumption (high efficiency)
- Low maintenance
- Equal or lower TCO
- Technology available
- Infrastructure available





Questions?



DAMEN