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Fuel cells in integrated power system of marine vessel

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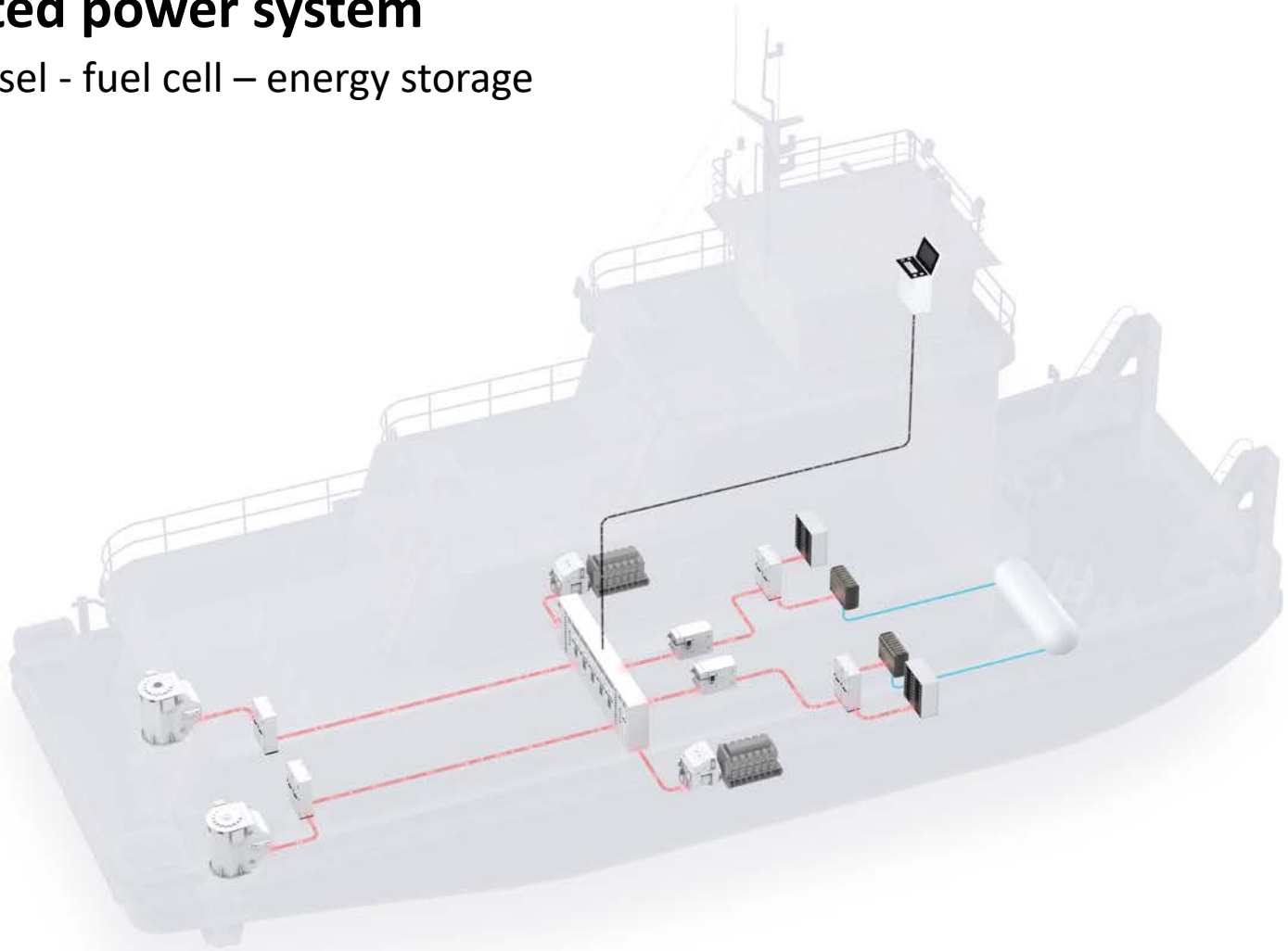
Integrated power system

From generation to consumption

Integrated power system

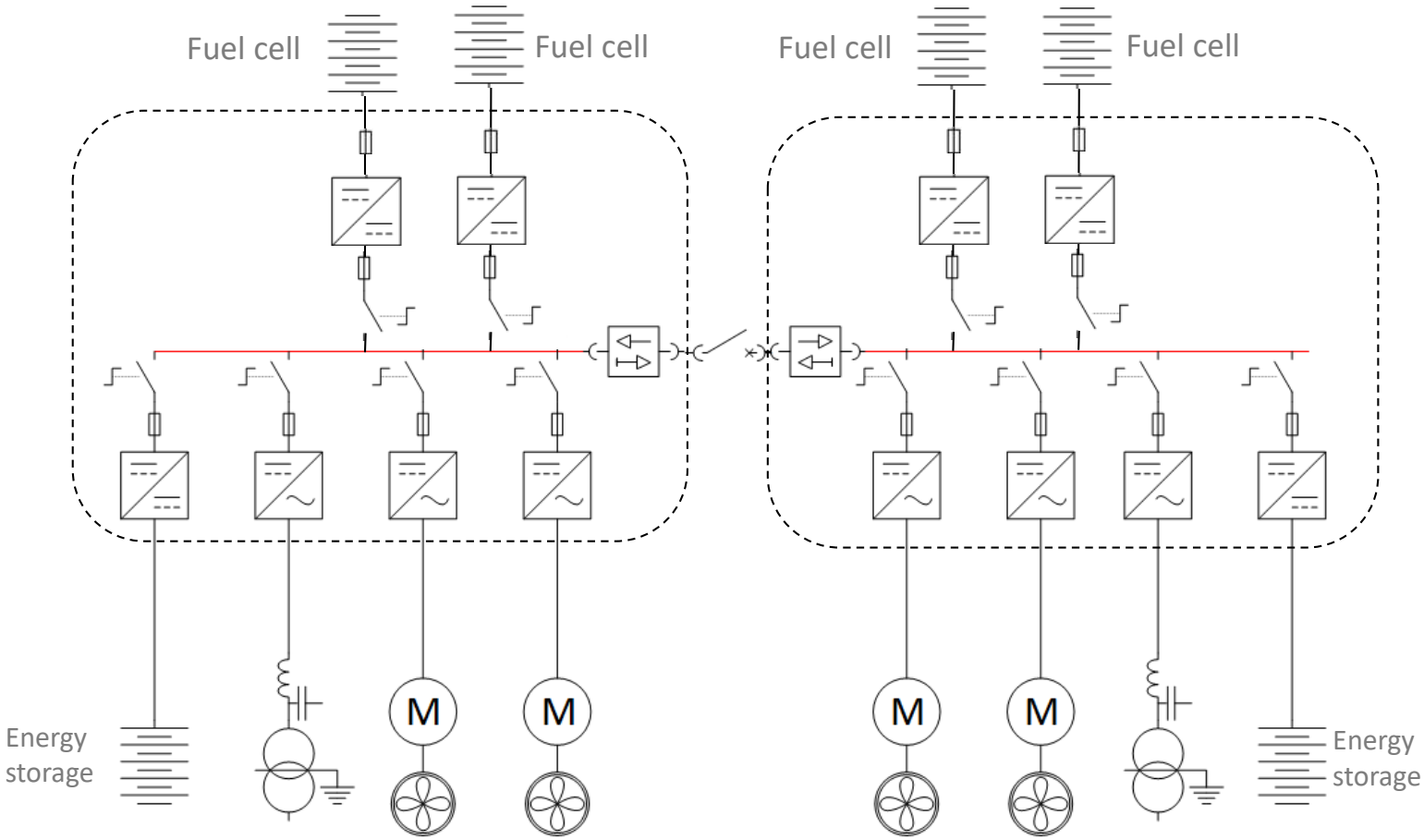
Hybrid diesel - fuel cell – energy storage



Integrated power system

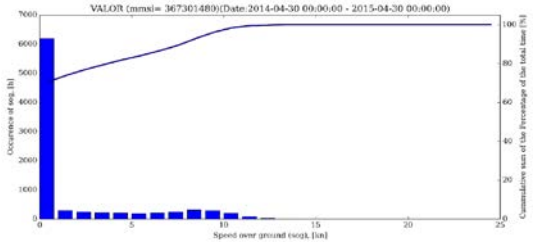
Fuel cell powered

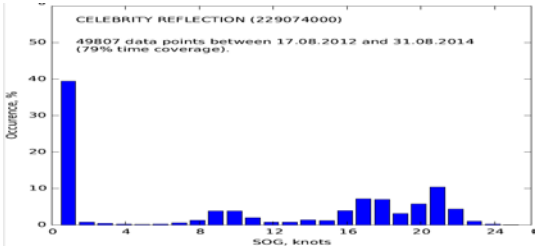
- Onboard DC Grid concept
- Hybrid fuel cell – energy storage system
- Zero-emission operation

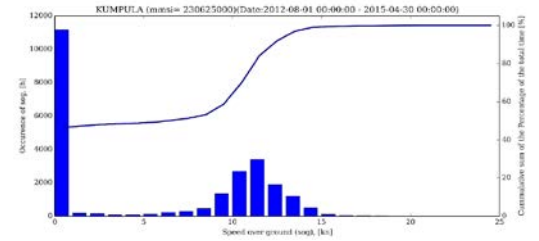


Dimensioning principles

Marine vessels are individuals



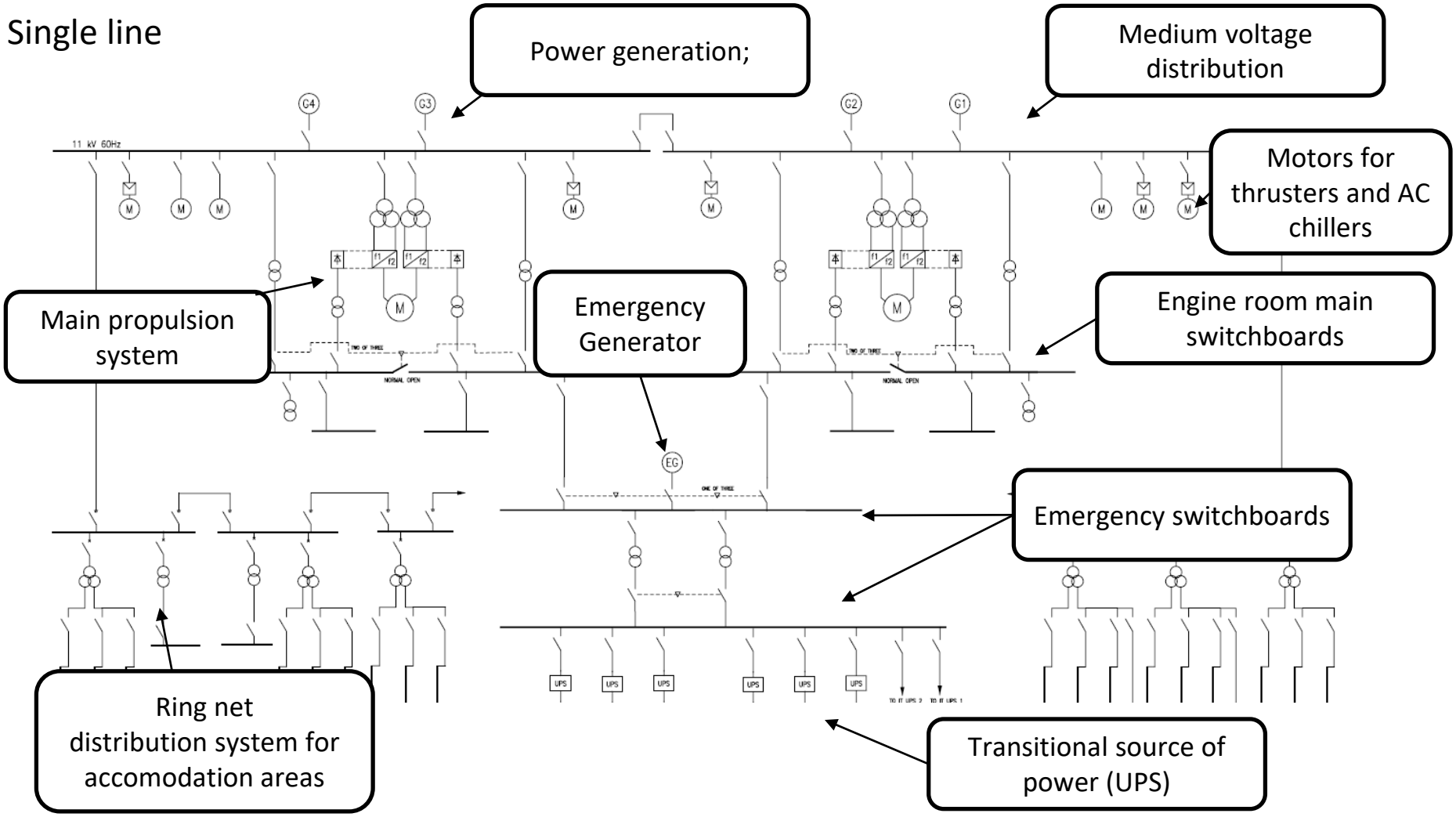




- Type and size of vessel
- Planned operation profile of vessel ->planned profile of power system
- Standards and legislations
  - Redundancy requirement
  - Normal operational and habitable condition
  - Emergency condition

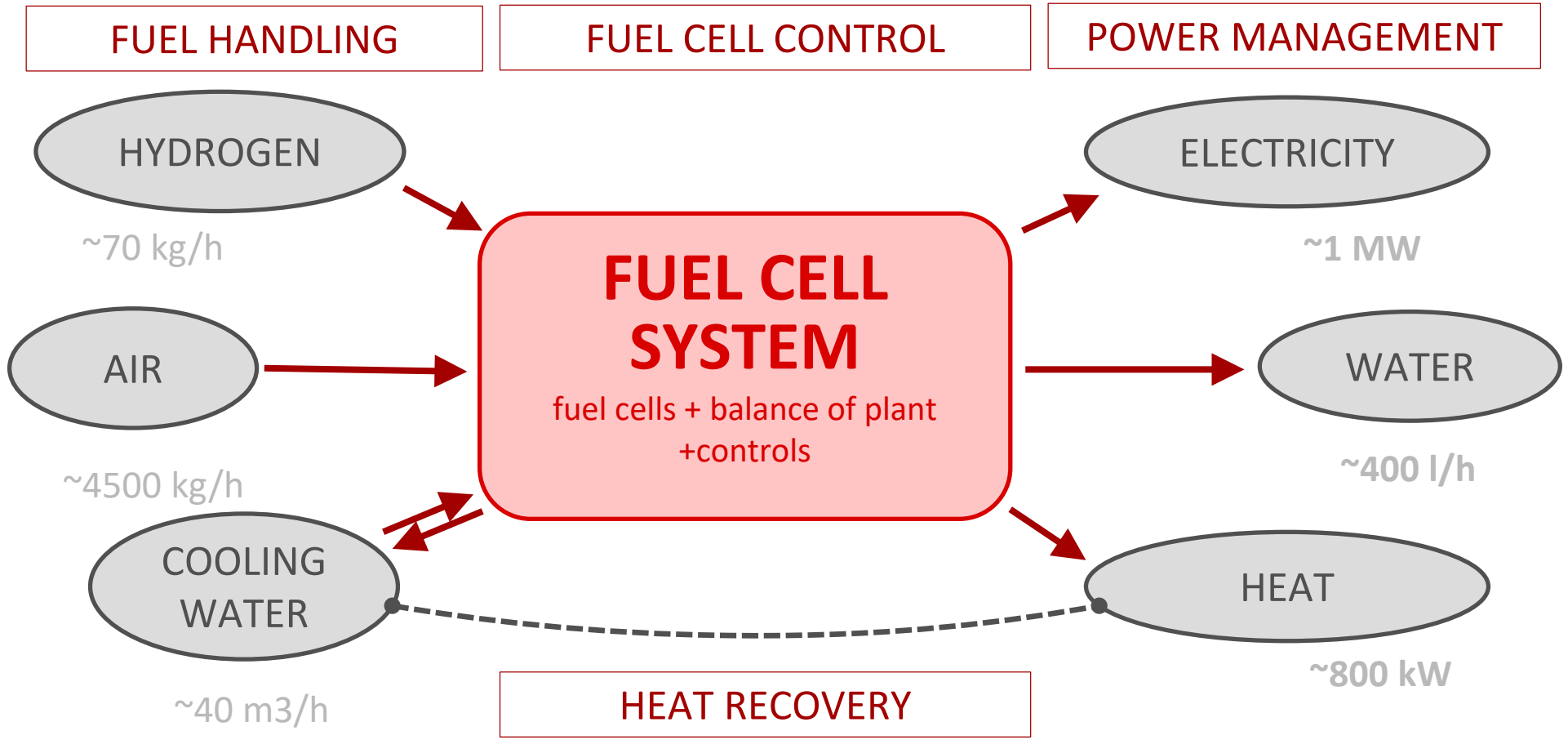
Electric infrastructure

Single line



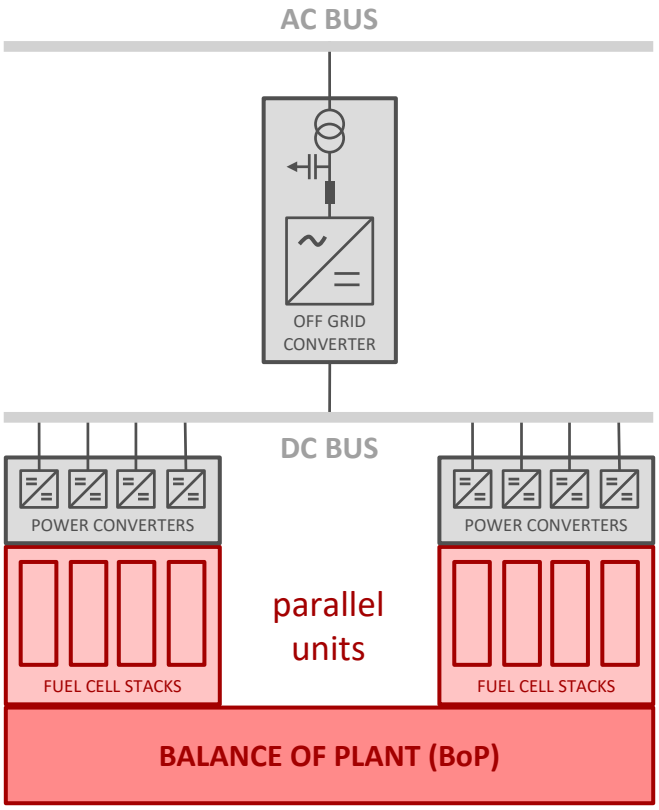
Fuel cell integration to vessel system

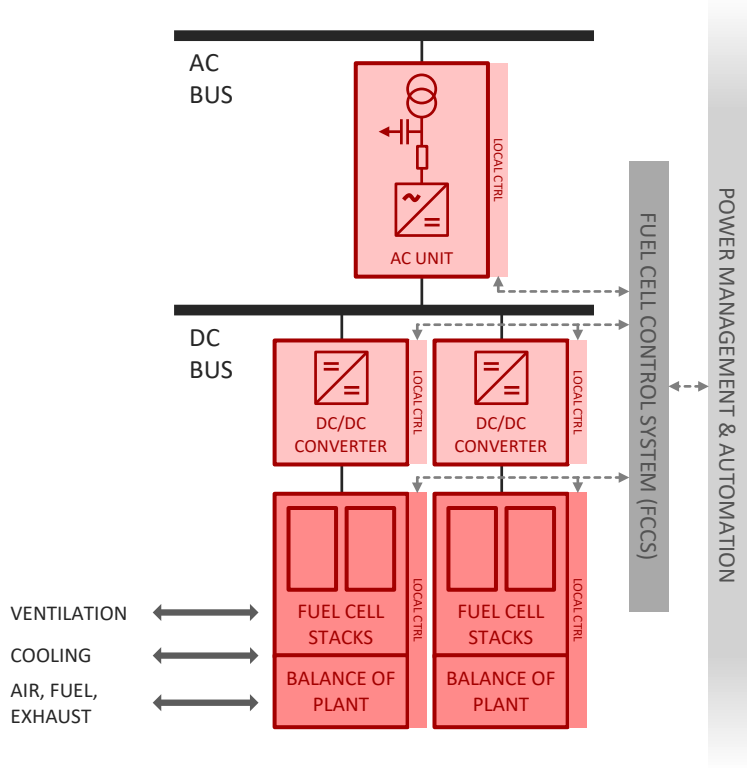
Integrated to almost every technical system



Fuel Cell electric integration

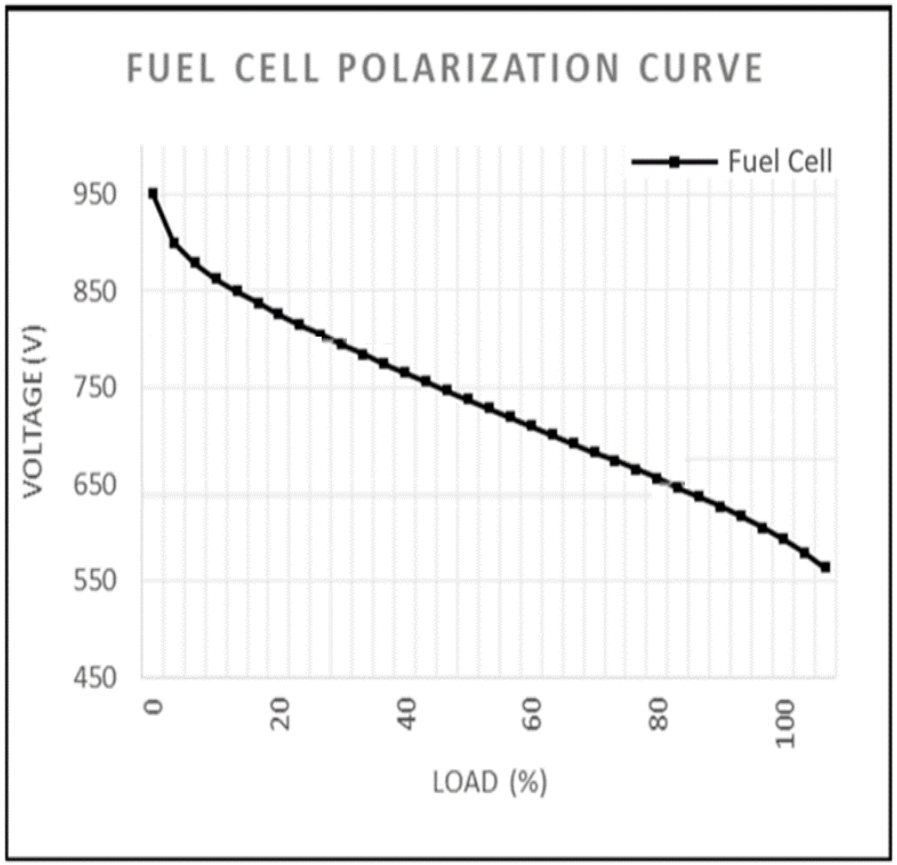
One solution will not fit for all purposes





Key factors for electric integration

- Fuel cell has a nonlinear voltage – current relationship and thus requires power conditioning
- Low voltage in high current leads overdimensioning as system to be dimensioned to withstand with no-load voltage
- Lack of ”inertia” need to be compensated by other means
- Requires tighter control integration than in traditional systems
- Control method (ripple) of power electronics may influence negatively to life time of the fuel cell



Valuable side streams

Waste heat and excess water

- 3046 passengers
- 1271 crew members
- ~650 000 liter water consumed daily
- ~100 000 kg fuel oil consumed daily
- Estimated cost of water production by RO ~ 2USD/m3

- 100 000 kg HFO means 460MWh produced electric energy + steam
- Fuel Cells would then produce 184 000 liter water/day -> 140kUSD/year
- 1/3 of water heated ~12,5MWh/day; possibility to utilize waste heat
- Laundry and dishwashing machines use steam
- Lot of other steam loads

Pathway for carbon free shipping

Laboratory, small scale, full scale

CARBON FREE SHIPPING ~ 2030

FLAGSHIP

HYDROGEN POWERED SHIPS

MARANDA

Zero emission in harbor

Small-scale fuel cell systems

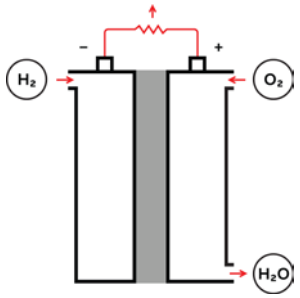
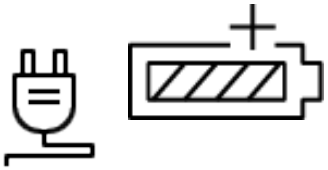


ABB & SINTEF Ocean hybrid laboratory

Energy storage & Shore charging



Let’s write the sustainable future. Together.