SATCHEL DOUGLAS, ABB

Electric Propulsion Integration Lessons Learned

SISDO 2024

Agenda

- Route Profiles
- Equipment Ratings
- Space Allocation
- Shore Charging Considerations

What are the major design risks in any ship design?

Design Risks

- Weight growth
- Lack of space
- Stability limits
- Speed/power

Route Profiles

Route Profiles

Traditional Diesel

- Design Speed
- Endurance/range

Hybrid - Electric

- Cycle Energy
- Trips/year
- Years of operation before battery replacement

Route Profiles

Traditional Diesel

- 13 kts
- 1500 nm range

Hybrid - Electric

- 2.8 nm crossing
- Charge on one end

250x increase in precision required in speed/power calculations

Route Profiles

- 2.8 nm crossing: 11 minutes @ 12 knots
- 3 minutes maneuvering, 16 minutes unloading/loading in berth
- 9 daily round trips

Route Profiles

Cycle Energy

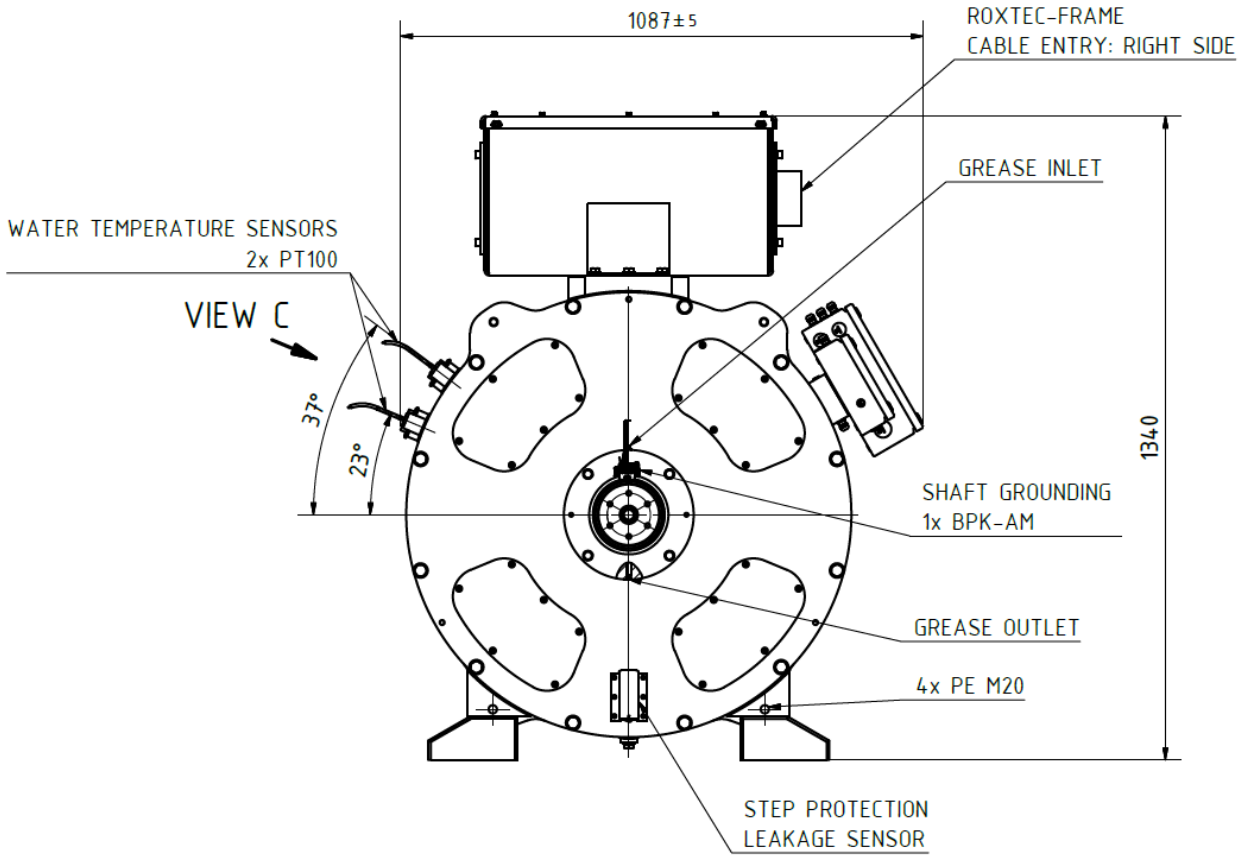
- Speed and power
- Current
- Weather
- Trip duration
- Loading conditions
- Hotel Loads

13-Knot Transit Profile Summary			
Voyage Segment	Duration (Min)	Fwd Propulsion Power (bkW)	Aft Propulsion Power (bkW)
Disconnection (N/A)	0	0.0	0.0
Maneuvering (Departing)	0.6	165.1	385.1
Accelerating	1.1	220.1	935.3
Transit	11.0	260.2	1040.9
Decelerating	0.7	54.6	218.6
Approach / Coast	0.9	0.0	275.1
Maneuvering (Arriving)	0.7	110.0	220.1
Connecting - Loading/Unloading	0.7	55.0	220.1
Charging - Loading/Unloading	14.1	55.0	220.1
Disconnecting - Loading/Unloading	0.2	55.0	220.1
Maneuvering (Departing)	0.6	165.1	385.1
Accelerating	1.1	220.1	935.3
Transit	11.0	260.2	1040.9
Decelerating	0.7	54.6	218.6
Approach / Coast	0.9	0.0	275.1
Maneuvering (Arriving)	0.7	110.0	220.1
Loading/Unloading	15	55.0	220.1

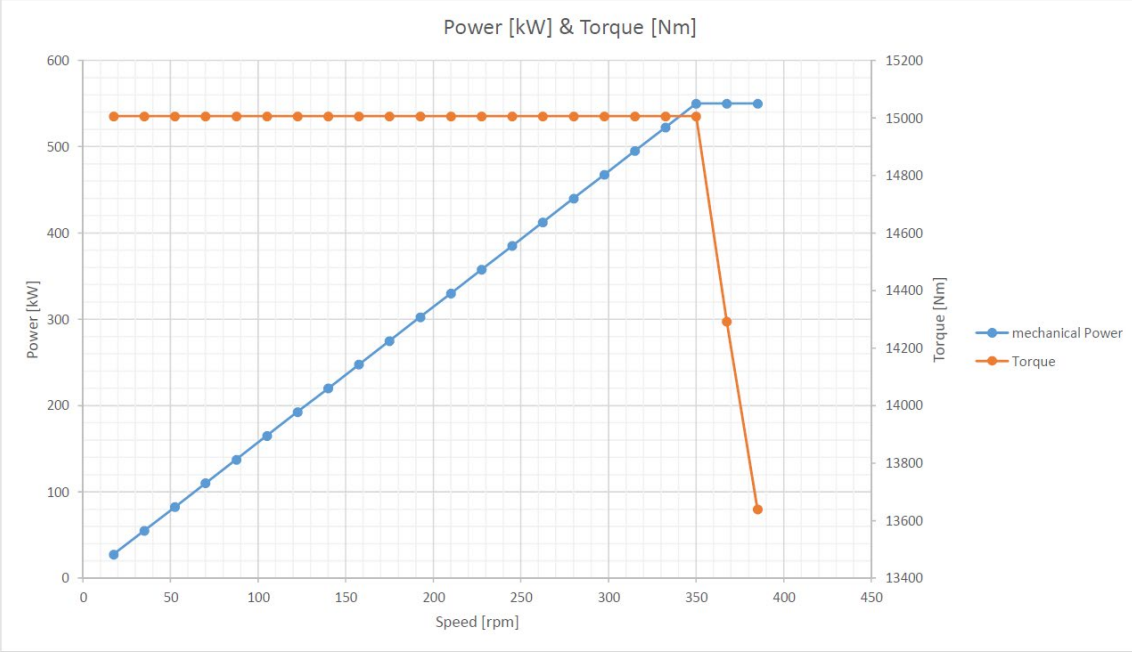
Equipment Ratings

Equipment Ratings and Margin

Electric Motors



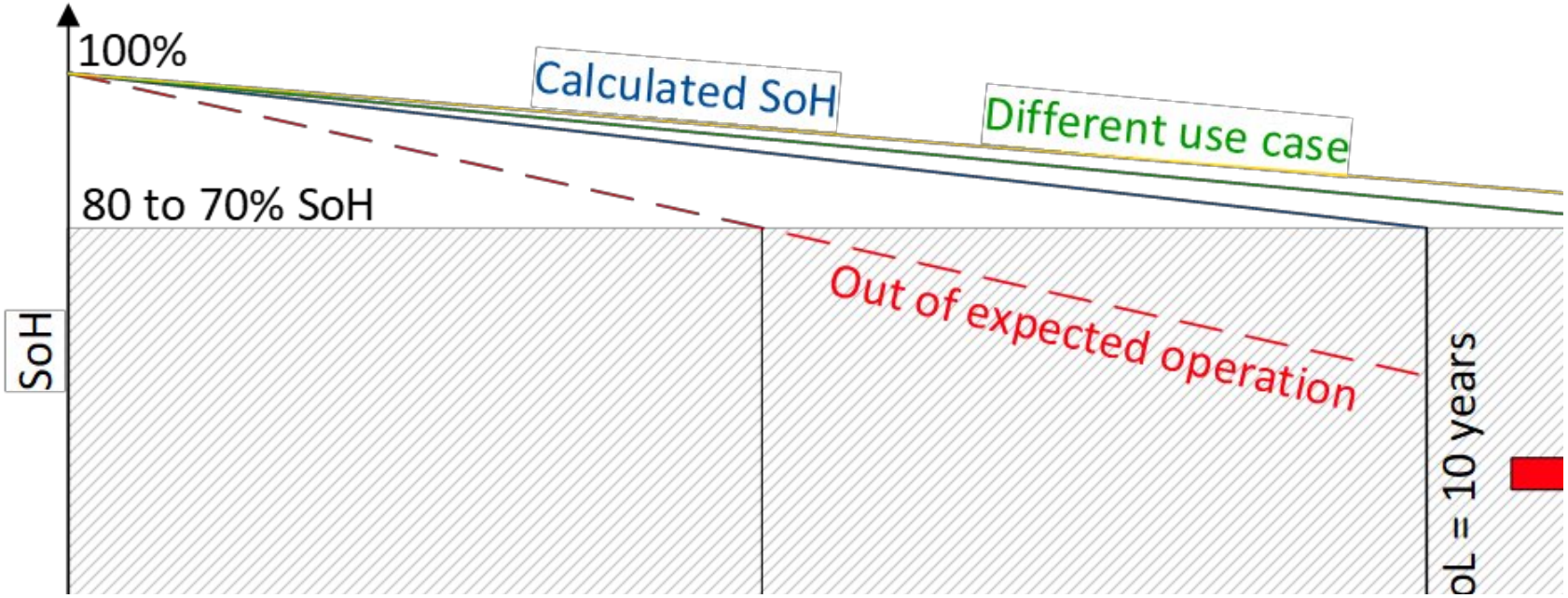
- Electric motors are torque limited by frame size
- Possible to increase RPM to increase power, without changing the frame



Equipment Ratings and Margin

Batteries

- Max C rate
- Need to calculate battery charge/discharge from route profile
- Share with battery vendors or ABB to select size



Eventually, as design progresses, fix the battery size

Equipment Ratings and Margin

Hotel Loads

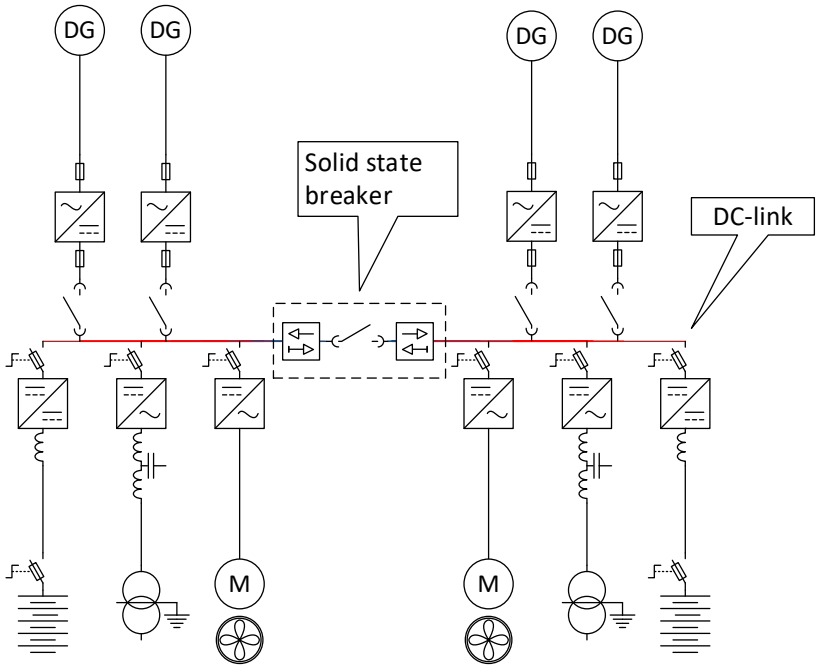
Electrical equipment runs on cooling

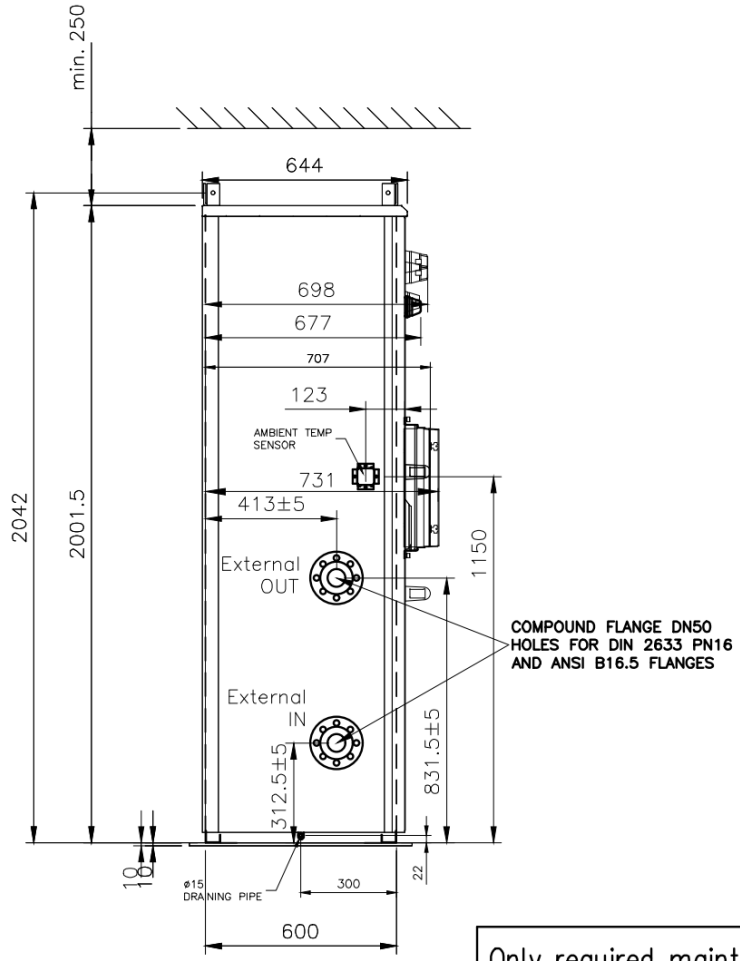
- Be careful with diesel parent vessel ELAs, similar size hybrid vessel will be higher
- Cooling pumps
- Cooling fans
- Anti condensation heaters
- UPSs
- HVAC for multi-drive and battery rooms
  - Avoiding condensation

Space Allocation

Space Allocation

Multi Drive Lineups (Onboard DC Grid™)





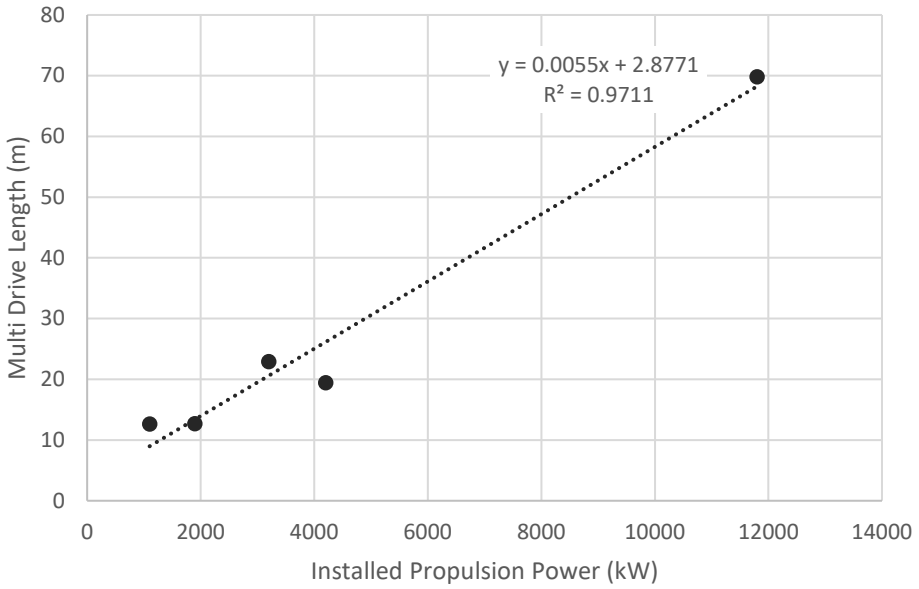
Multi drive (ODCG) Section View

Only required maintenance envelopes are on the front, based on door swing dimensions 800mm

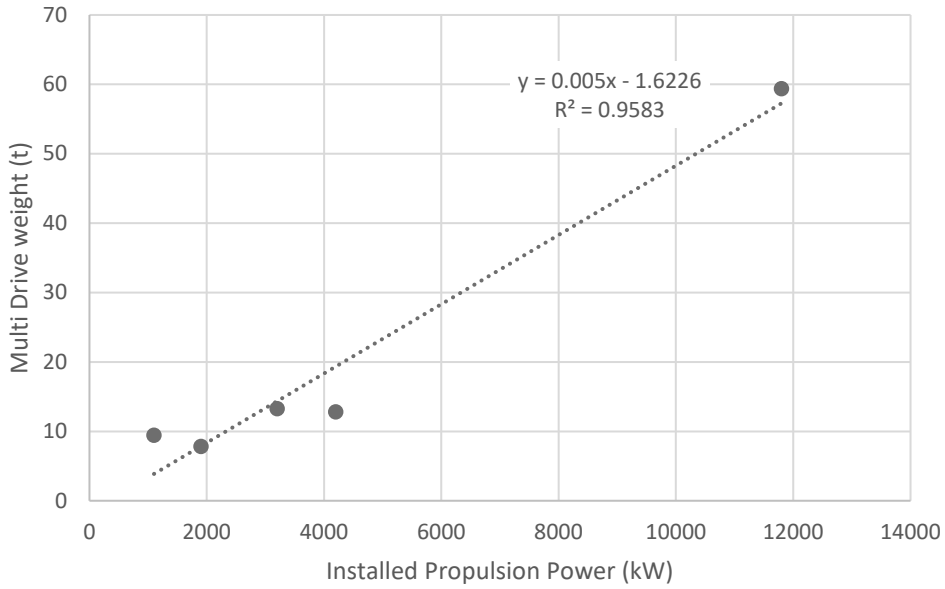
Space Allocation

Multi Drive Lineups

Lineup Length



Lineup Weight

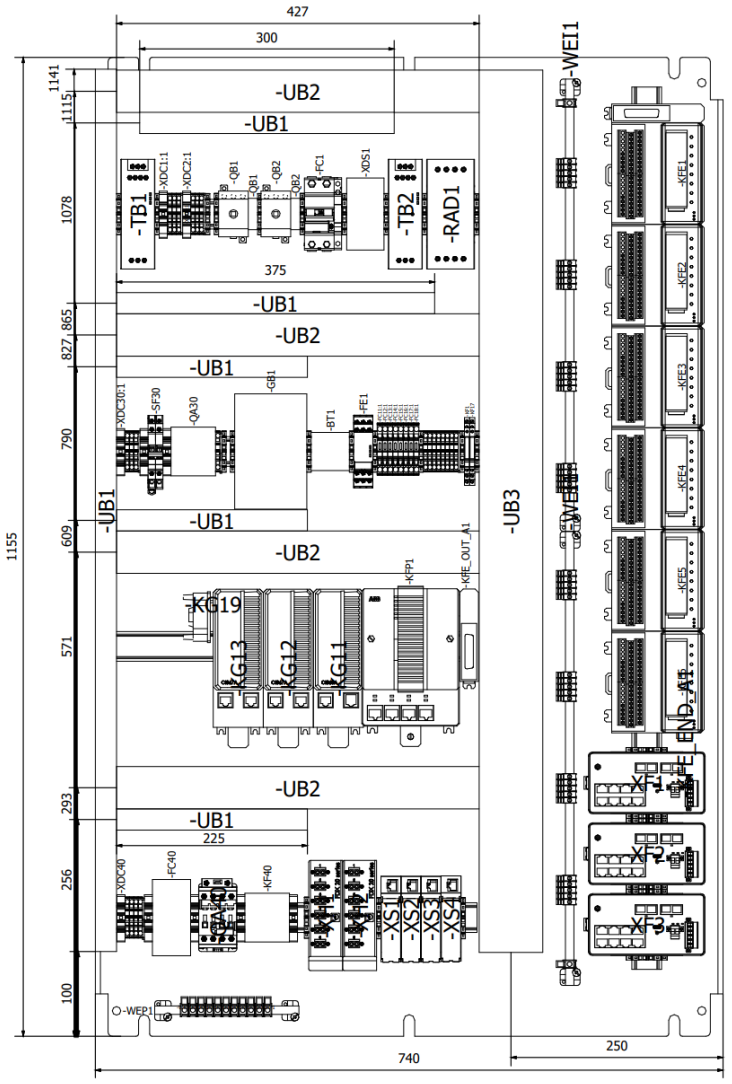


Space Allocation

Control Cabinets

- 1200 mm x 800 mm x 400 mm
- Wall mounted
- 100 kg

- 1x per motor
- 1x per engine
- 2x per Alarm and Monitoring (min)
- 2x control network
- 1x Remote Diagnostics/Data Logger System

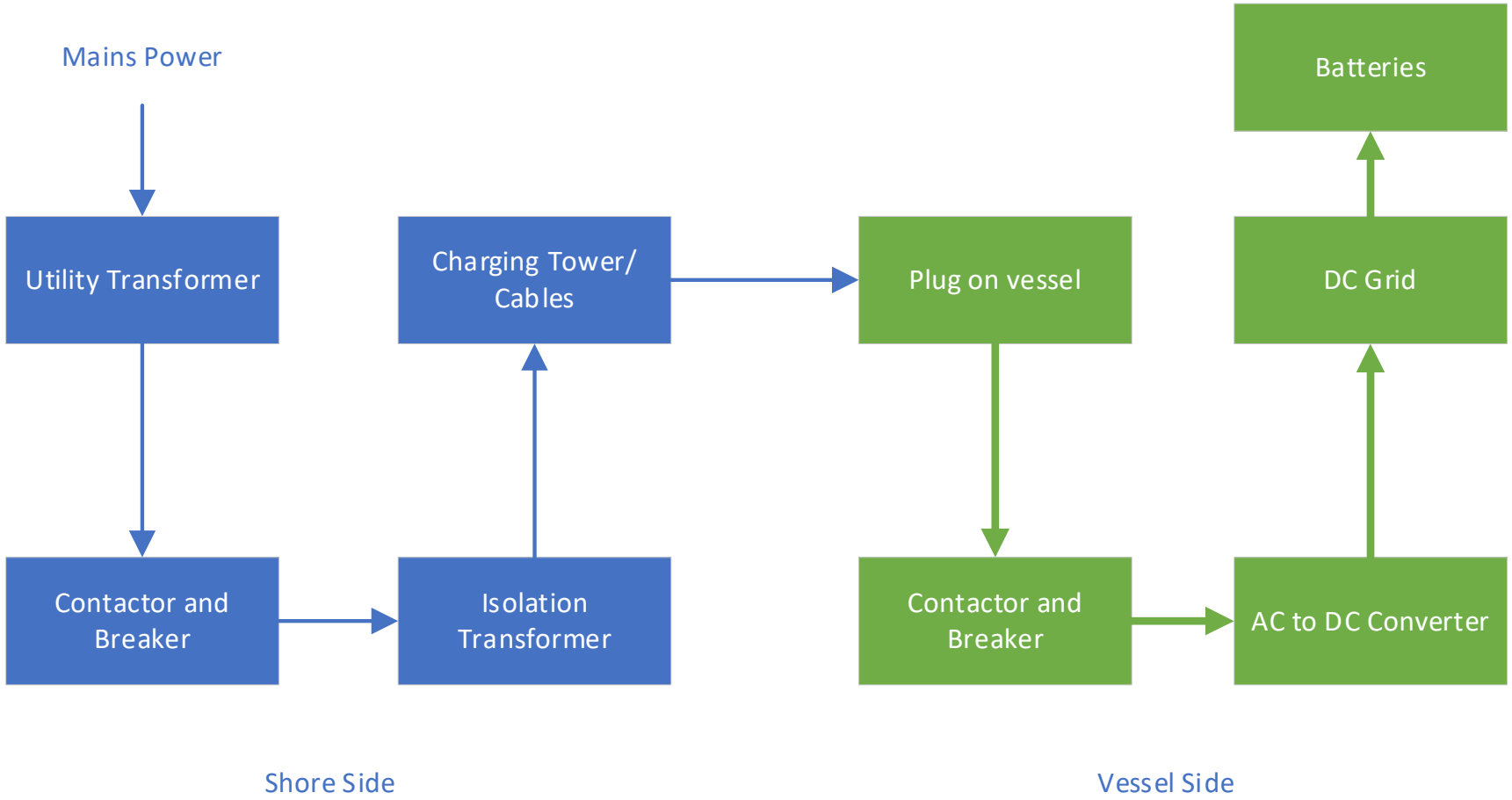


You can never have too many!

Shore Charging

Shore Charging

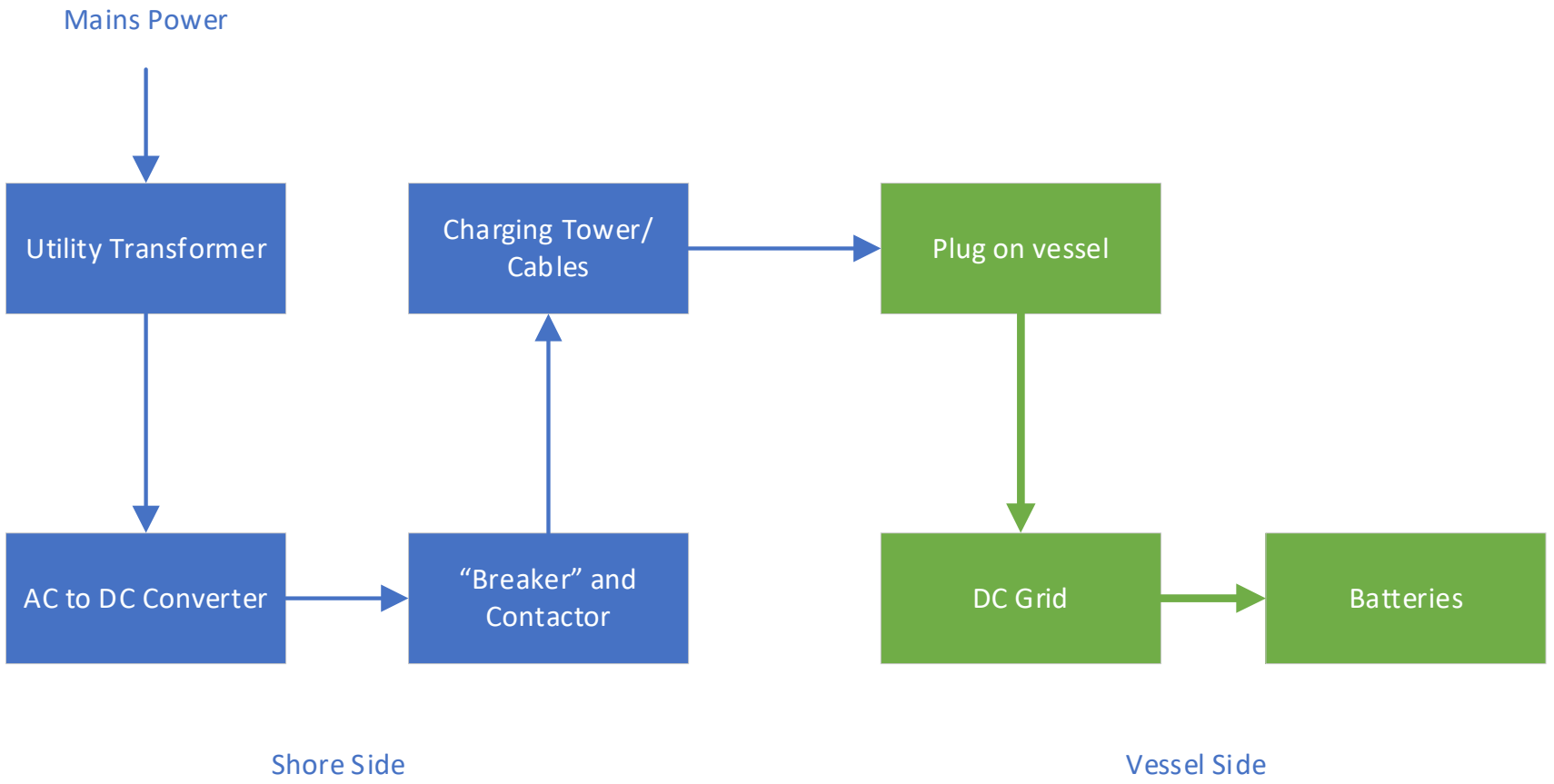
AC



AC Shore Connection

Shore Charging

DC



DC Shore Connection

Shore Charging

AC

- Less land side equipment
- Medium Voltage can provide higher (>15MW) power

DC

- Less equipment on the vessel
- Less long lead time transformers
- Feasible up to ~6MW charging power
- Supports land side batteries

Shore Charging
Who is responsible?

- AC – Transformer Secondary grounding
  - REALLY need high resistance grounding

YOU are responsible for the interface!

Shore Charging
Who is responsible?

- AC – Make line dead prior to connection/disconnection
  - Shore electrical engineers unclear not used to PLC control/remote switching

YOU are responsible for the interface!

Shore Charging

Who is responsible?

- DC – Short Circuit contribution from the shore to the vessel
  - Need an IGBT based static switch and control system on shore to protect cables and bus bar

YOU are responsible for the interface!

PS.

Just use metric…

Satchel.douglas@us.abb.com