Battery Sources and Power Converters Interface in Waterborne Transport Applications

Workshop “Hybrid Energy Storage Systems Oriented to Maritime Applications”

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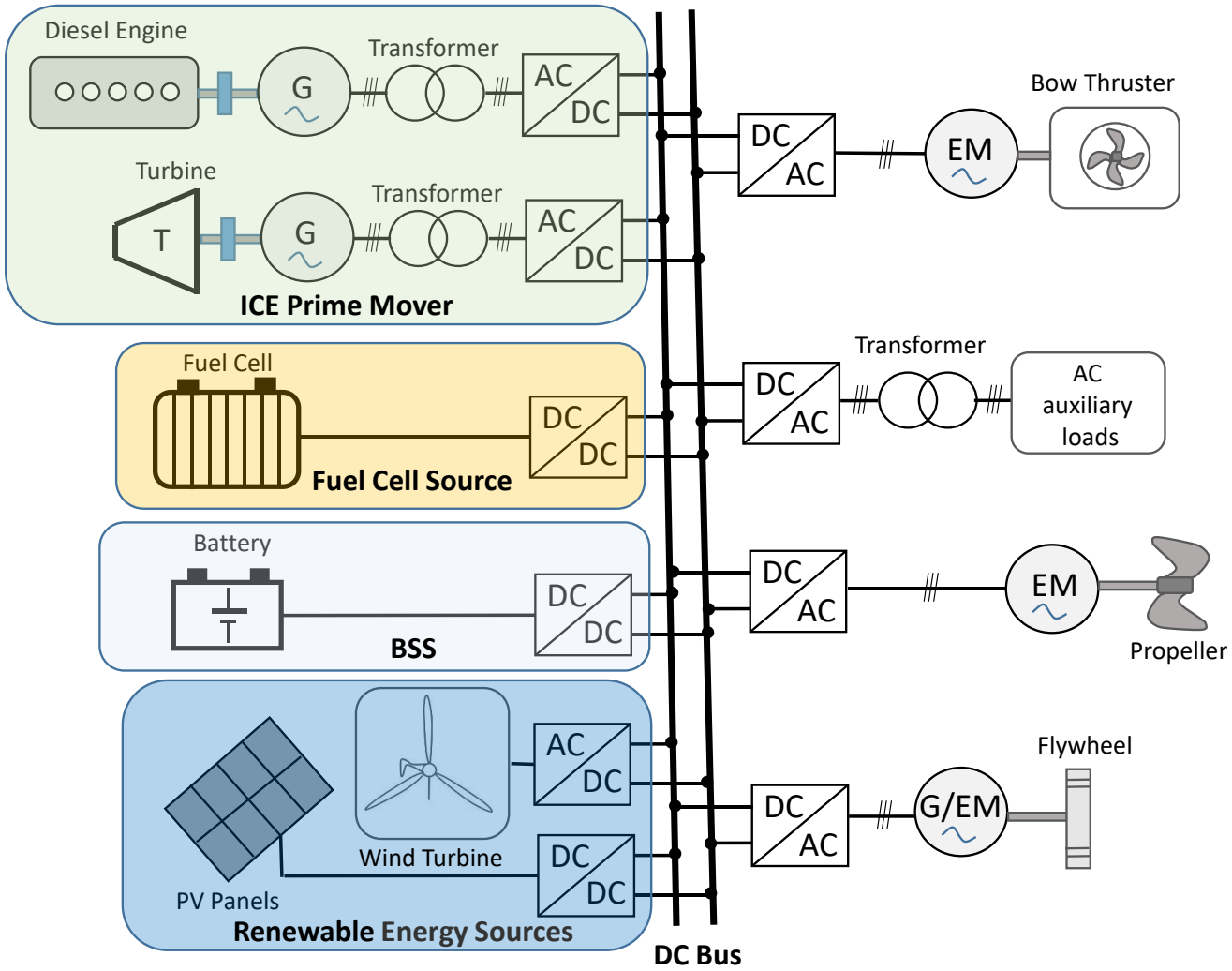
Background

Electrification of the maritime propulsion

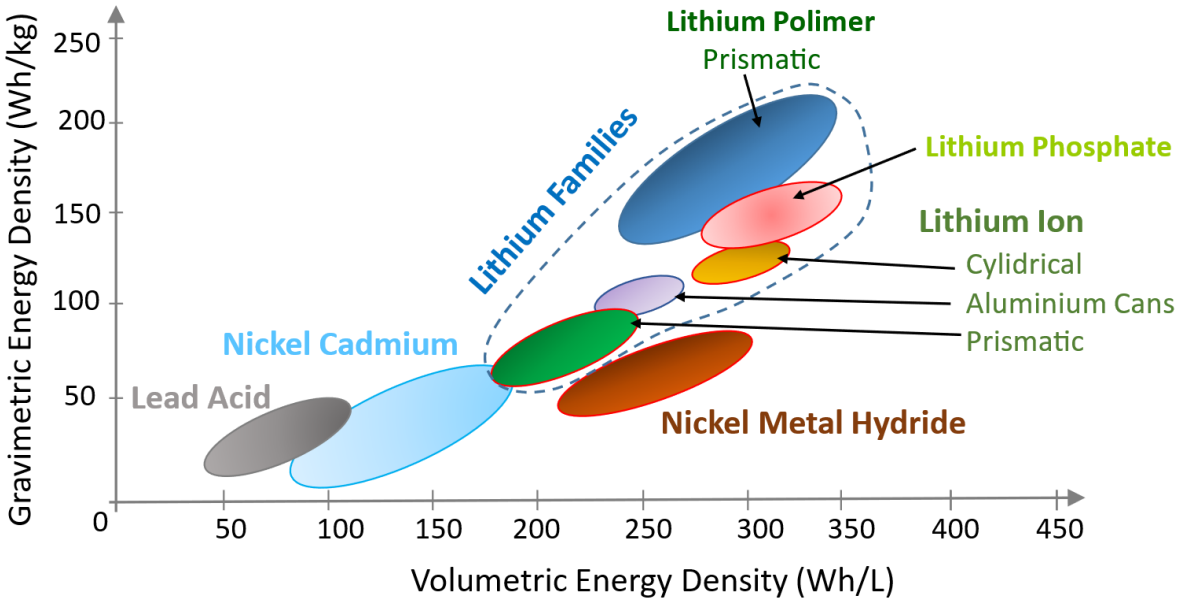
- Crucial role of storage systems
- What is the best arrangement for converter + battery system?
- Possibility of hybrid battery systems (high energy + high power)

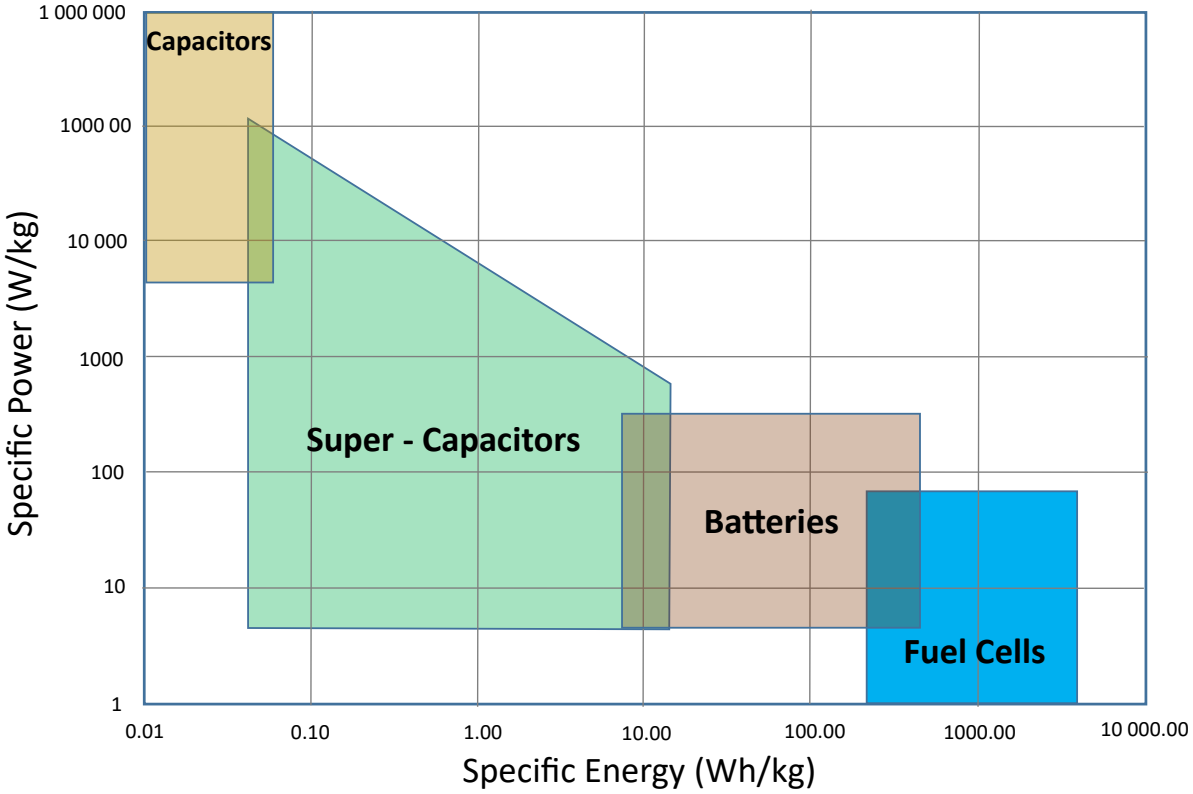


Storage Systems for Waterborne Transport

Various technologies are available

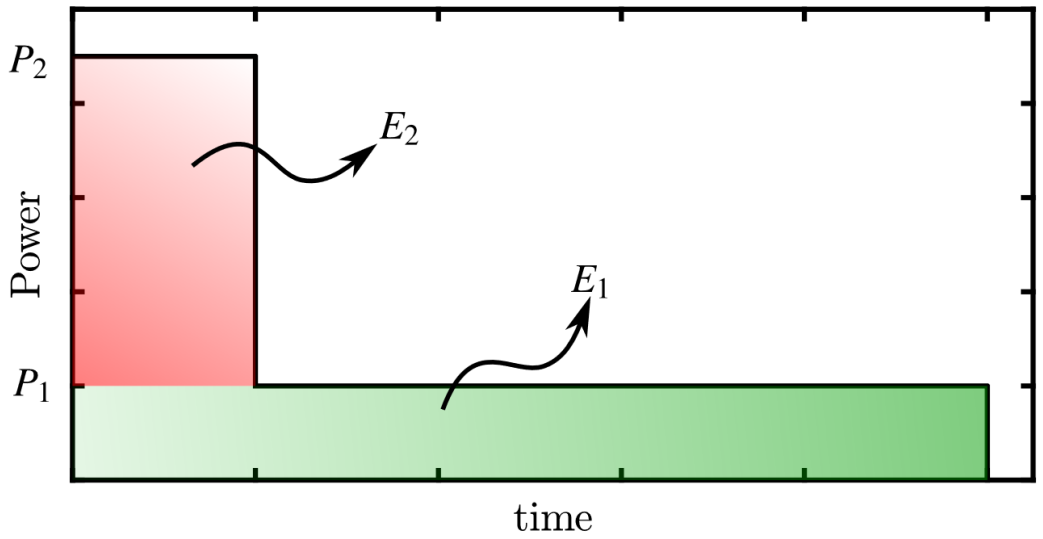
- High-power (e.g., SuperCaps)
- High-energy
  - ✓ Li-ion are preferred

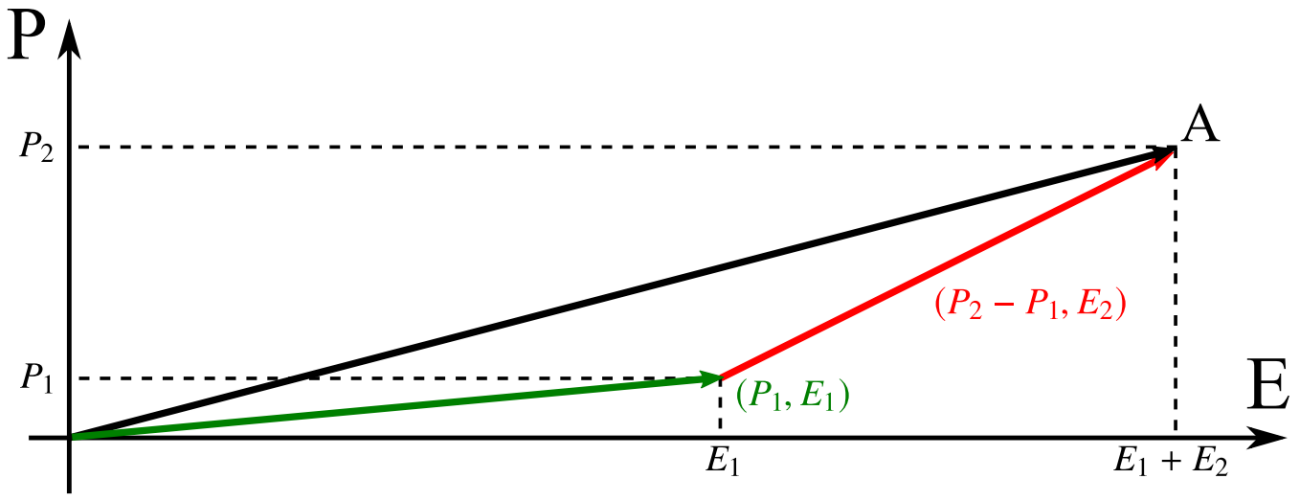




Storage Requirements and Management

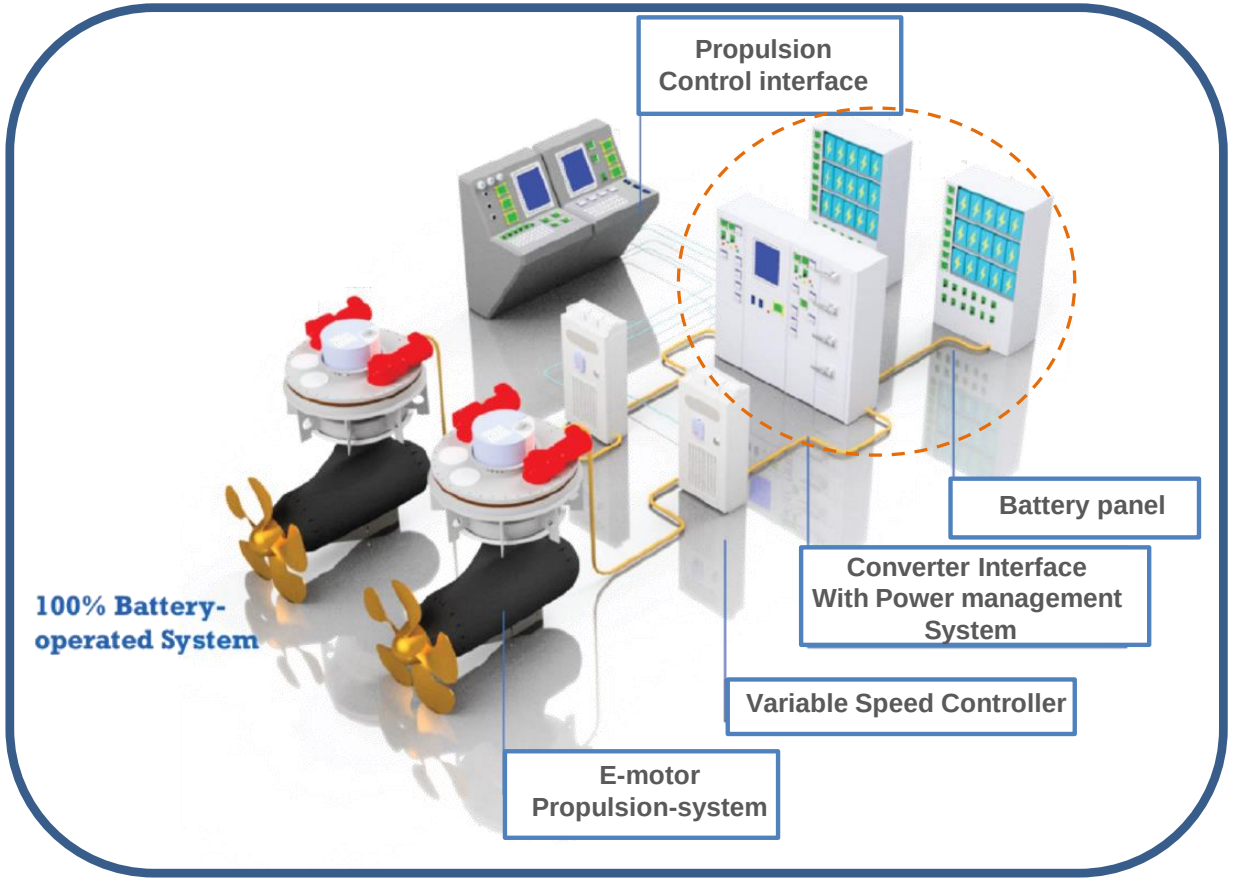
- Requirements:
  - Maximum power
  - Minimum energy
  - Number of cycles
- Operating cycle as input
- Goal minimize cost of battery pack
- Hybrid solution is an option!





Interface Converter Topologies

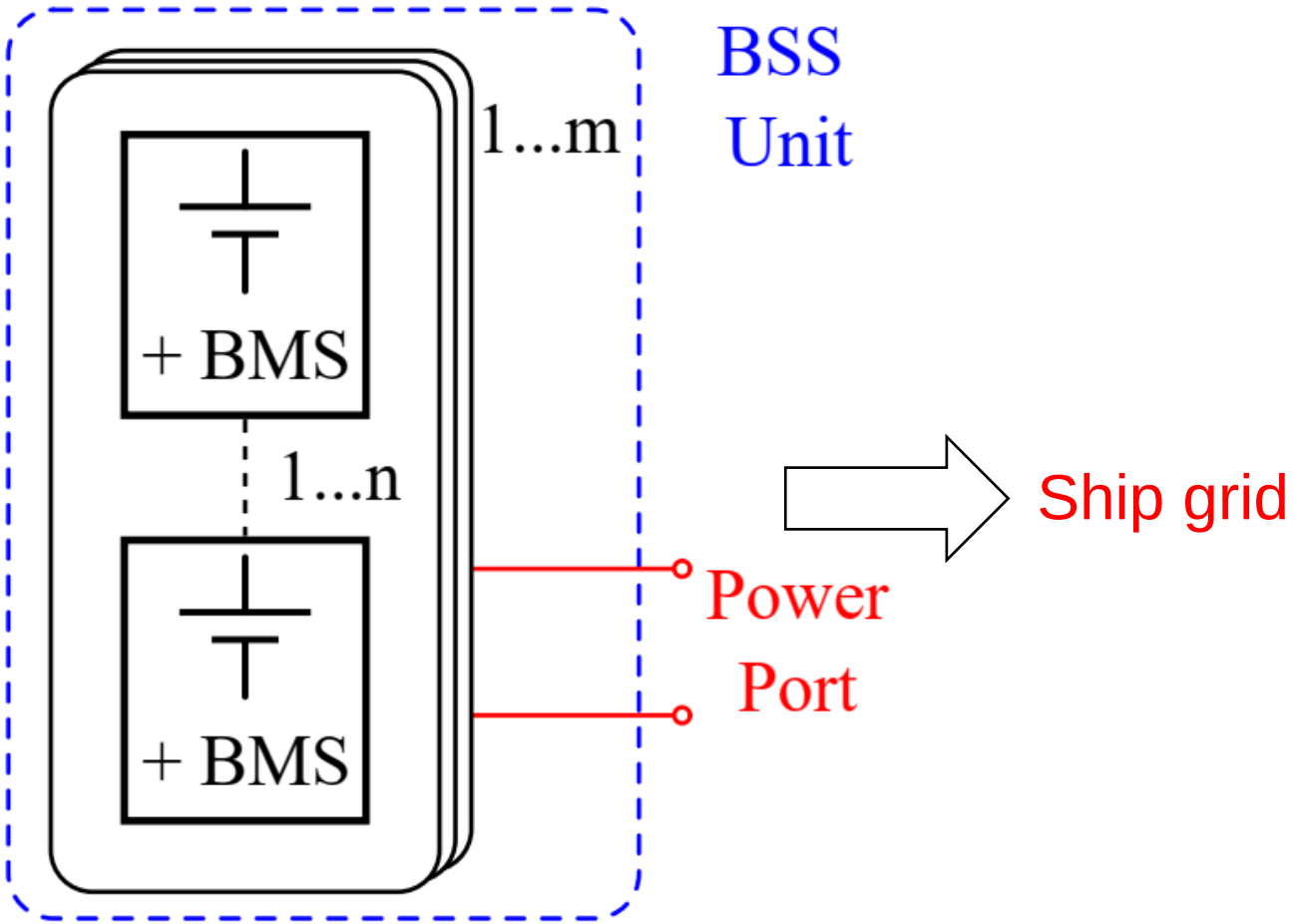
- Requirements:
  - Bidirectional (charging & discharging)
  - Isolated
  - High efficiency
  - Small and light
  - Optimal exploitation of battery (increased lifetime)



https://epod.com.sg/e-pod-propulsion-system/

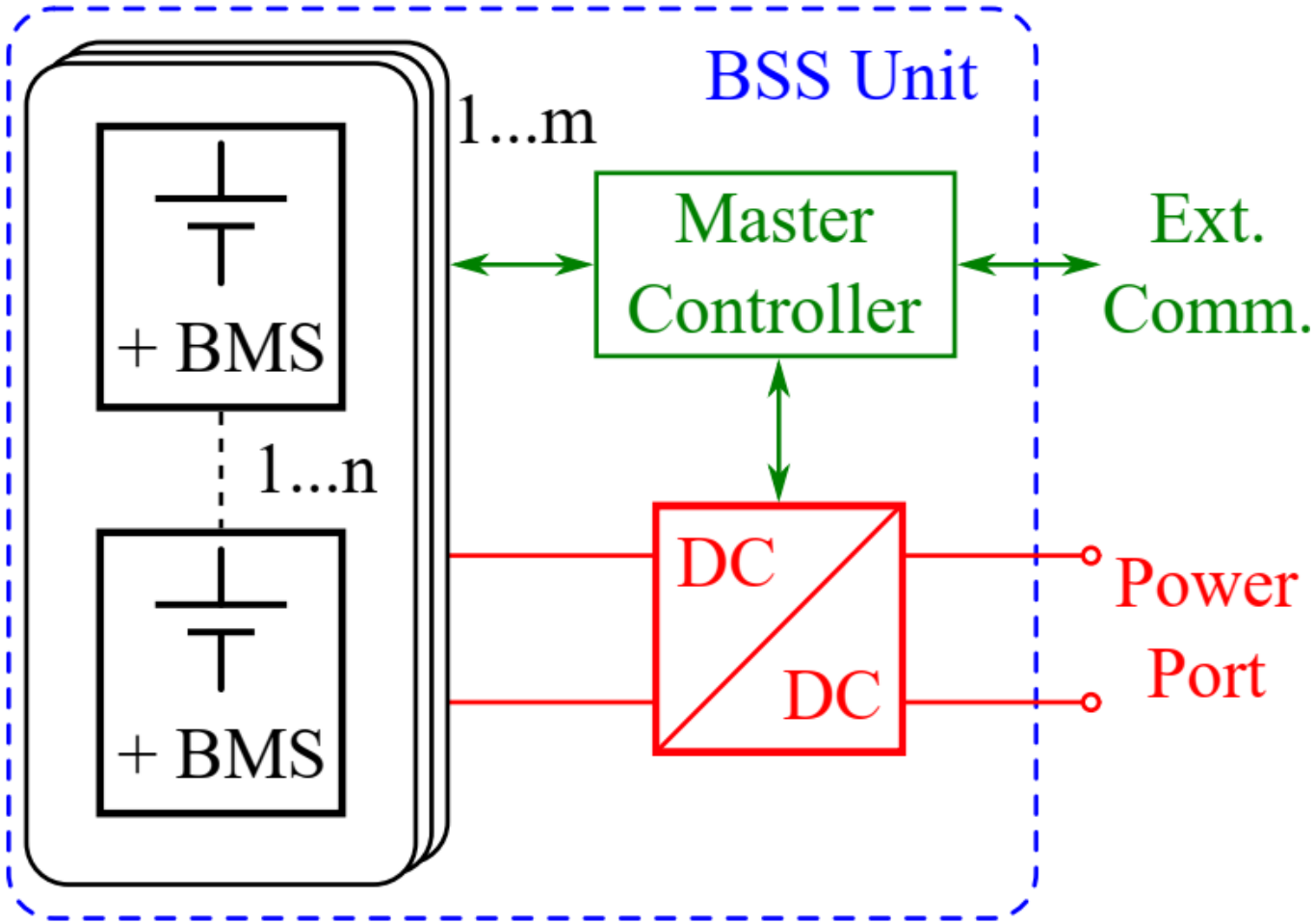
Interface Converter Topologies

- Basic Topology
  - Monotype battery only!
  - Variable DC voltage with SoC
  - Oversizing



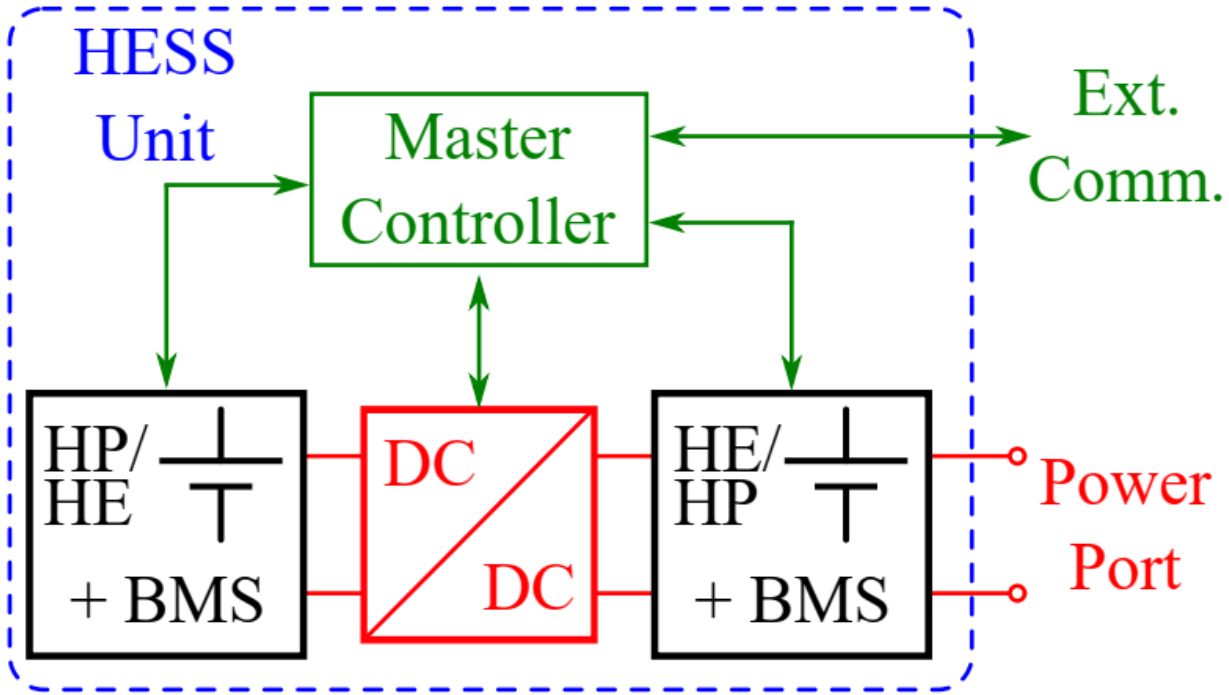
Interface Converter Topologies

- Interface DC/DC
  - Monotype battery
  - DC voltage adaptation: no oversizing
  - Is it possible to do better?



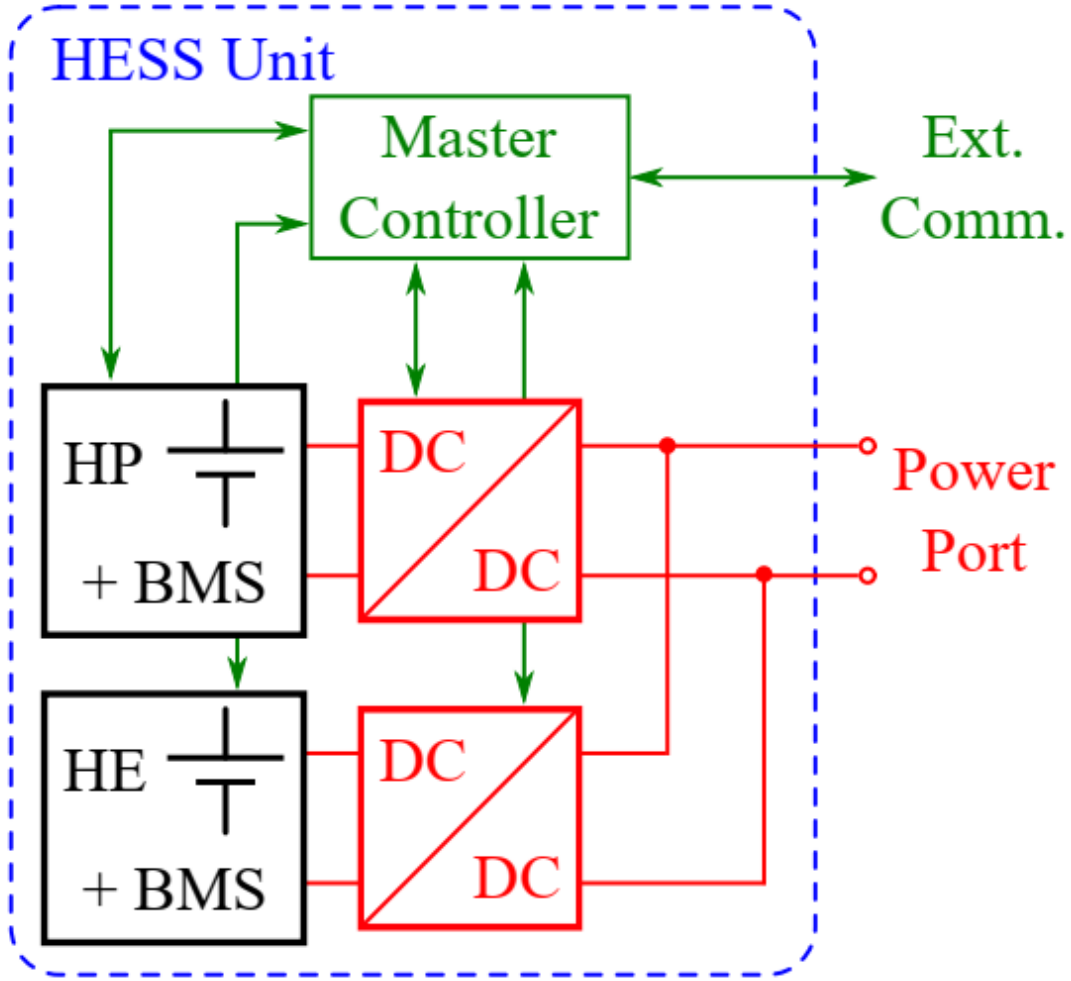
Interface Converter Topologies

- Semi Active Structure for Hybrid storage systems
  - Allows mix of battery technologies
  - One technology is directly connected to output
  - Second technology is converter interfaced
  - Variable DC output with SoC
  - Converter oversizing



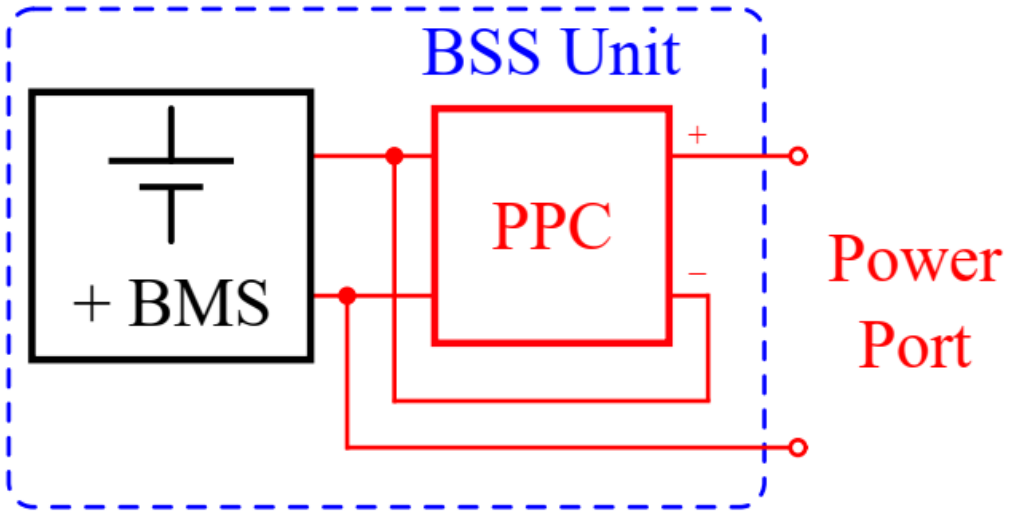
Interface Converter Topologies

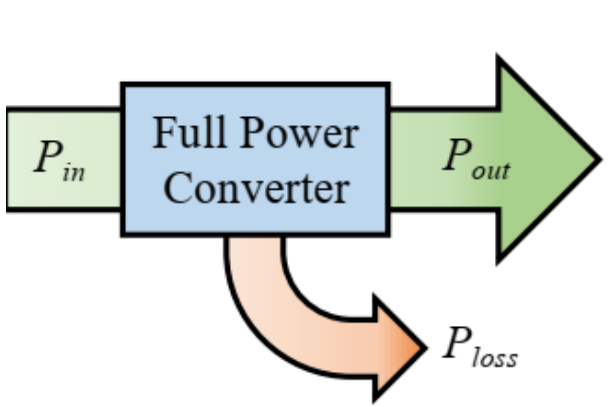
- Full Active Structure for Hybrid storage systems
  - Allows mix of battery technologies
  - Dedicated converter for each technology
  - Regulated DC output
  - Regulated sharing and stress on batteries
  - Higher complexity!

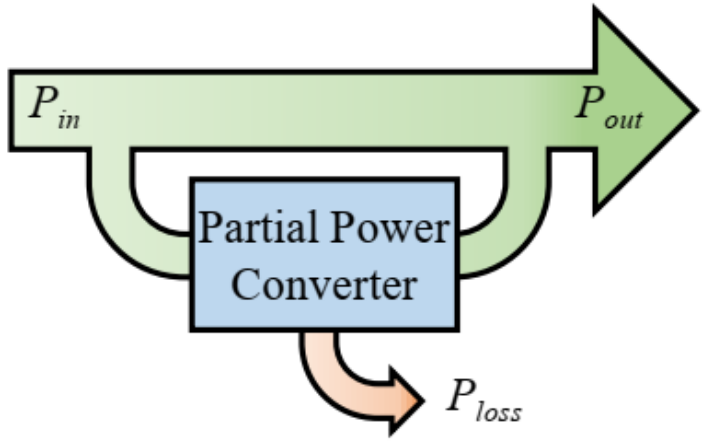


Interface Converter Topologies

- Partial power processing
  - Converter reduction
  - Conversion efficiency improvement
  - Less complexity, volume and weight compared to active structures
  - No galvanic isolation!







Conclusion

- Maritime electrification is growing
- Storage integration is open topic
- Hybrid storage systems with different technologies are appealing solution
- Optimization strategies for battery packs are required
- Converter topologies for storage interface are subject of optimization too