



Shoreside Electrification: Challenges & Solutions

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Contents

Range of ferry charging demands

Cape May – Lewes Ferry Case Study

Phase Infrastructure Improvements

Shoreside Battery Charge Cycles

Emission Reductions and Cost Savings

Conclusions

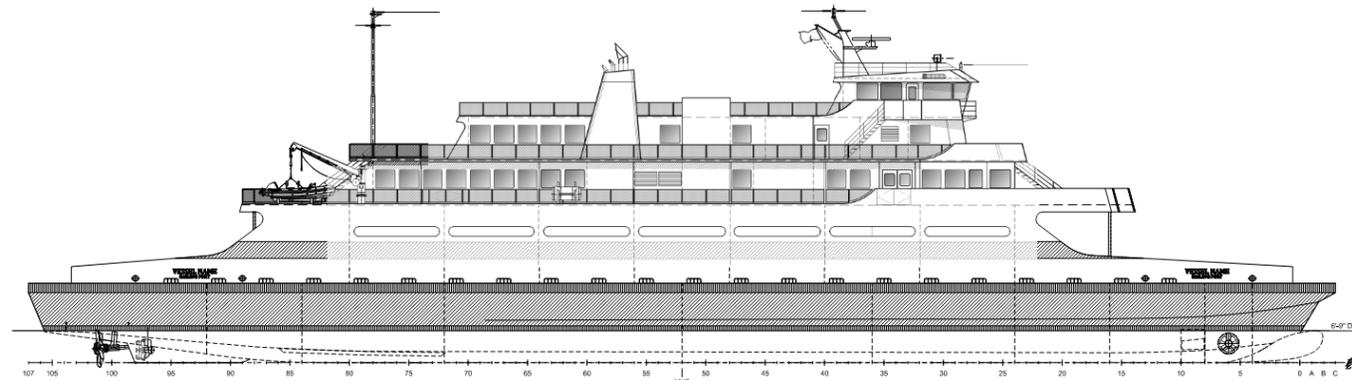
Range of Ferry Electrification Demands



Cape May – Lewes Ferry Case Study



Current Cape May – Lewes Ferry



Plug-In Hybrid Electric Ferry (Notional Design)

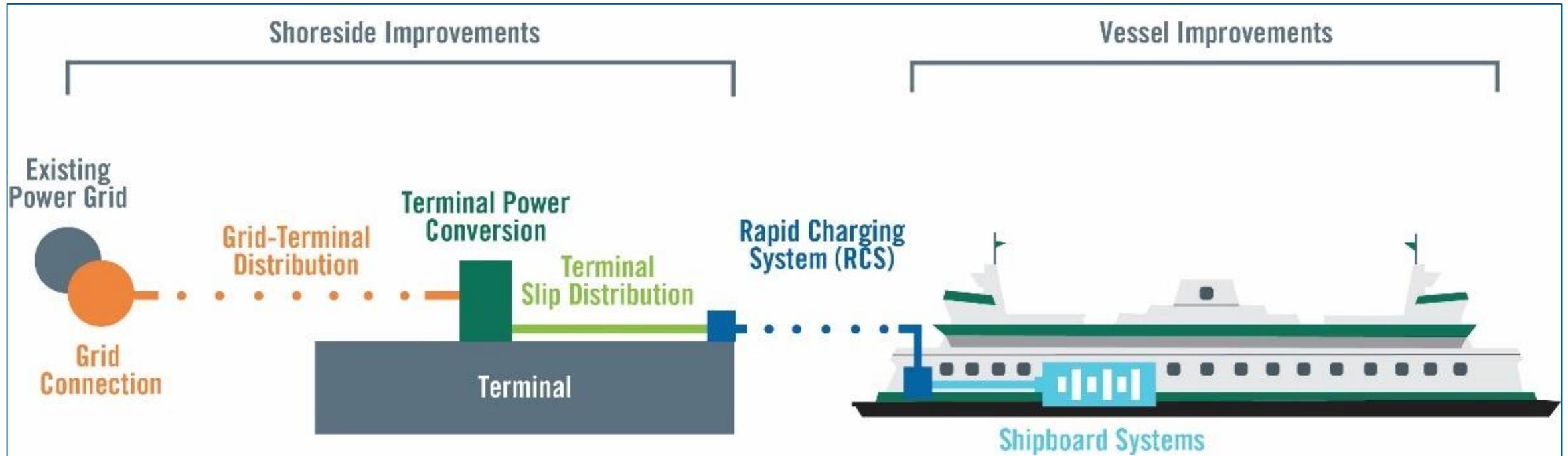
Overview & Background

Objective: Maximize greenhouse gas emissions using currently available power and allow for further reductions as more and greener power becomes available

- * Take advantage of existing grid capacity and shoreside energy storage to get partial zero-emission operations
- * Design infrastructure to simplify long-term improvements

Round Trip Energy & Emissions		
Fuel Consumption (100% diesel)	278	gallons per R/T
Local CO2 Emissions (100% diesel)	6,244	pounds per R/T
Energy Required	4,372	kWh per R/T
Diesel Cost	\$973.00	per R/T
Electric Cost	\$524.64	per R/T
Energy Cost Savings	\$448.36	per R/T
Cost Assumptions		
Diesel Fuel (per gallon)	\$3.50	per gallon
Electric Cost (per kilowatt-hour)	\$0.12	per kWh

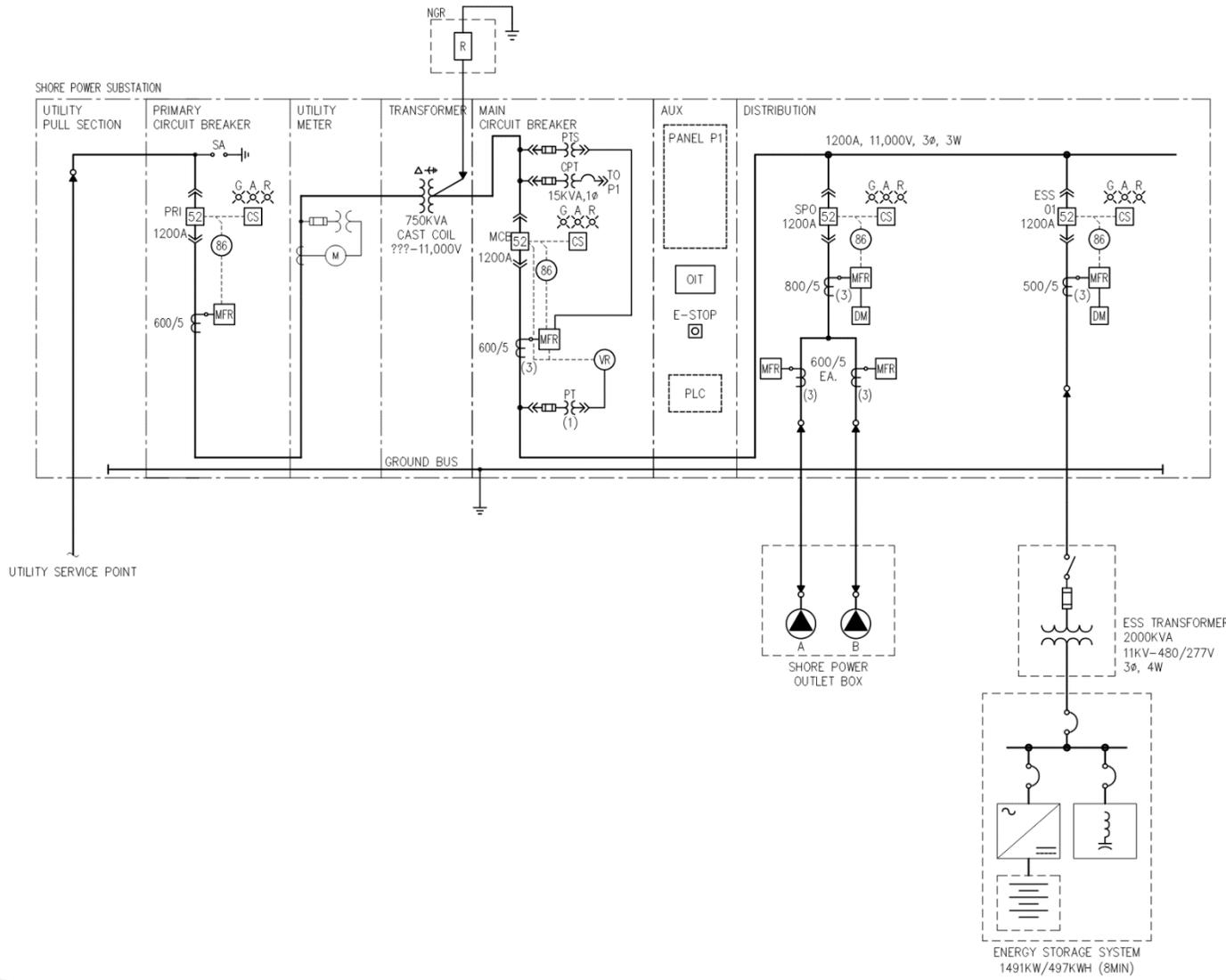
Shoreside Infrastructure



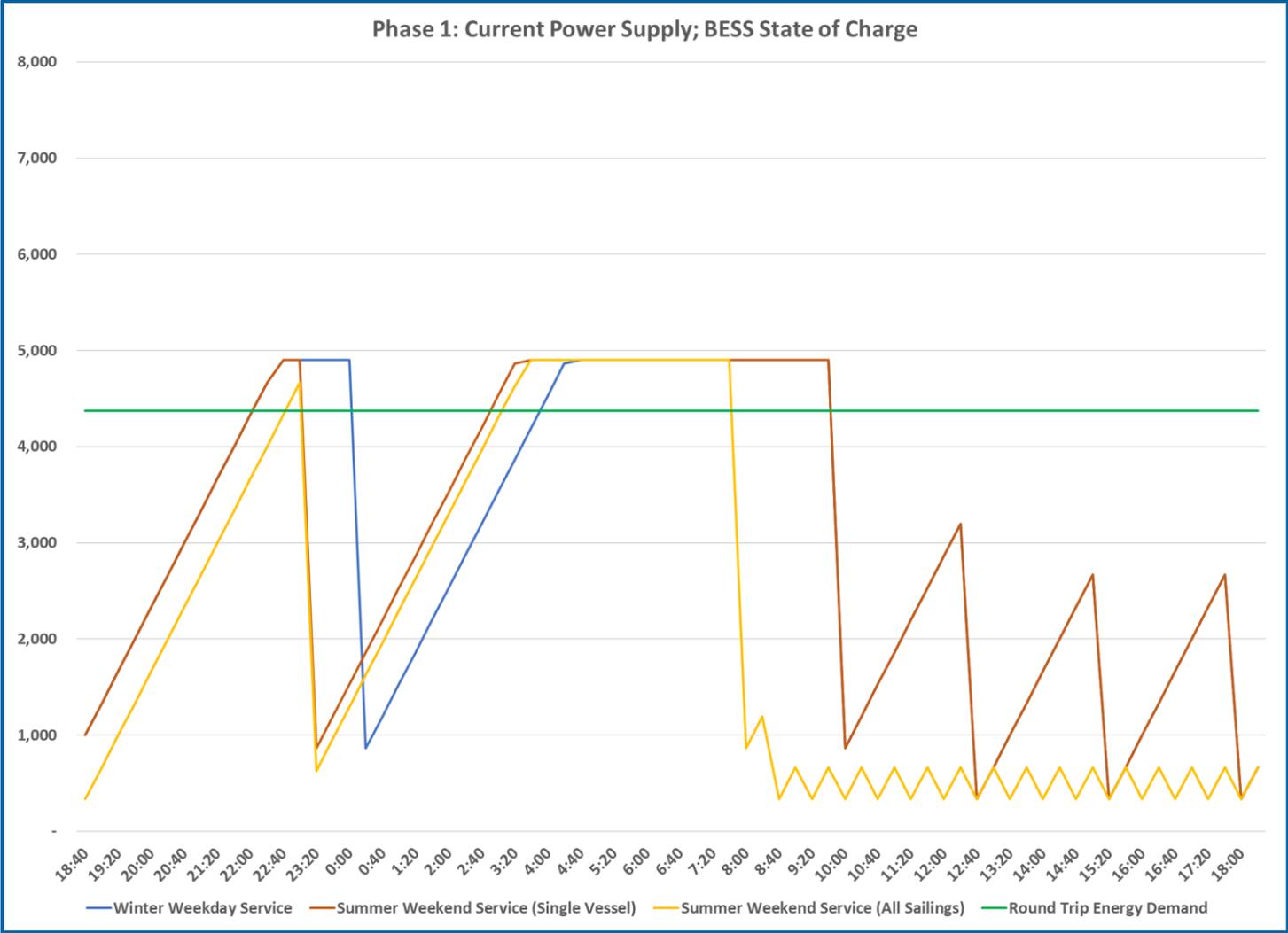
Phasing Assumptions

- **Phase 1: Currently Available Power**
 - Assume 1 MW available
- **Phase 2: Increase in available power without major grid improvements**
 - Assume 2 MW available
- **Phase 3: Grid improvements to allow 100% electric ferry operations**
 - Line voltage increase from 12.47 kV to 69 kV
 - New substation on-site

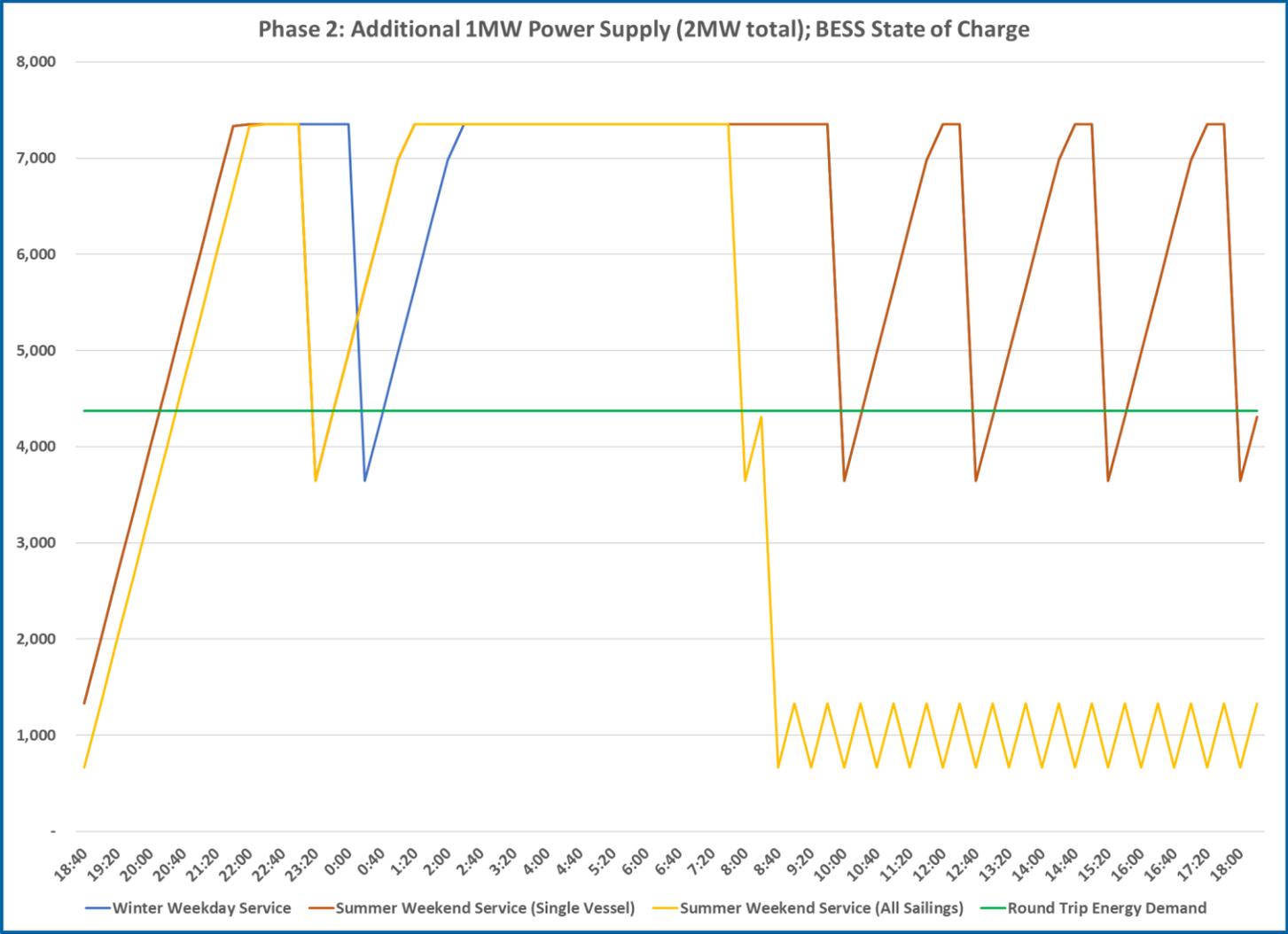
Local Switchgear



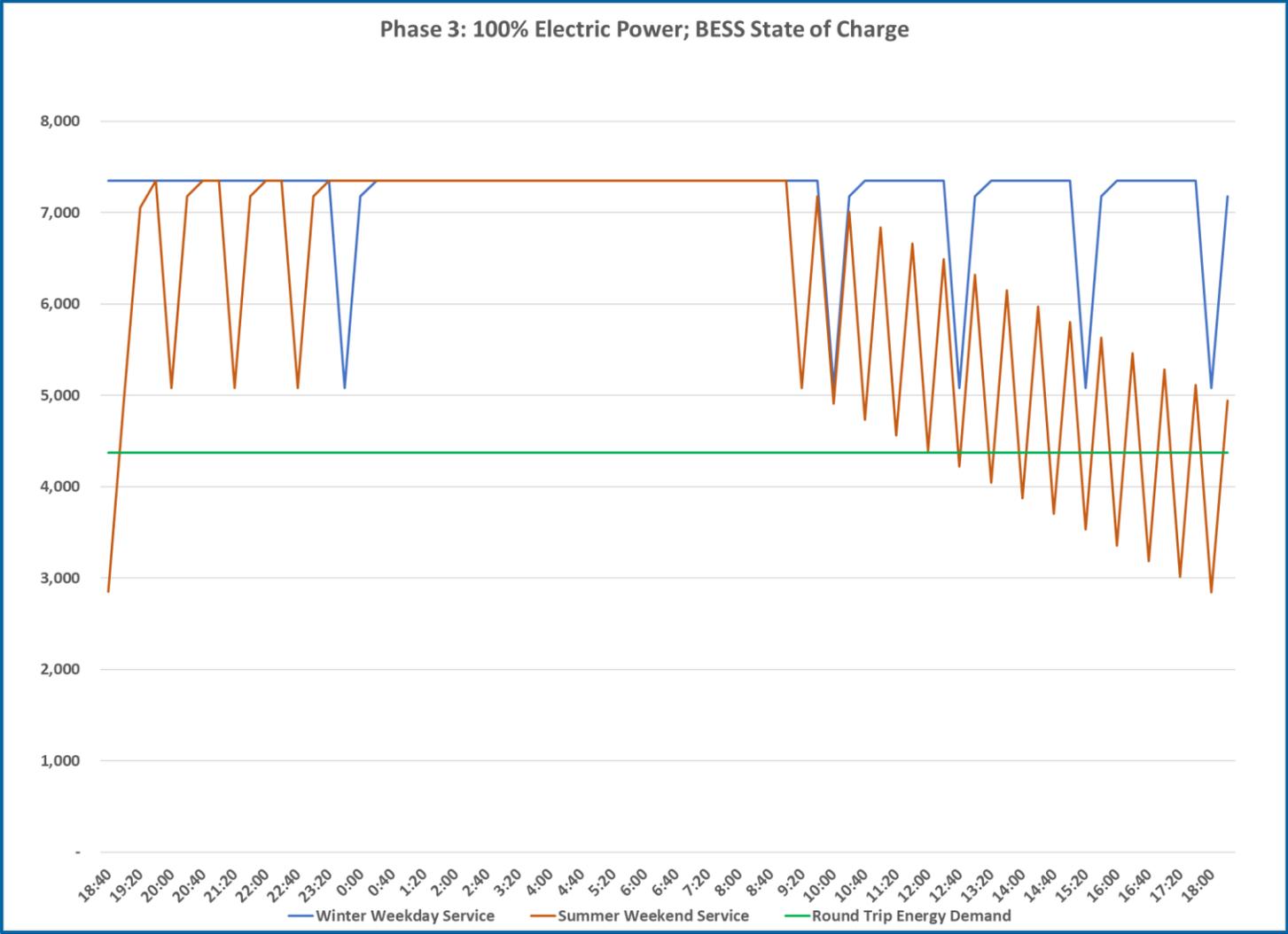
Phase 1 Charging Cycle



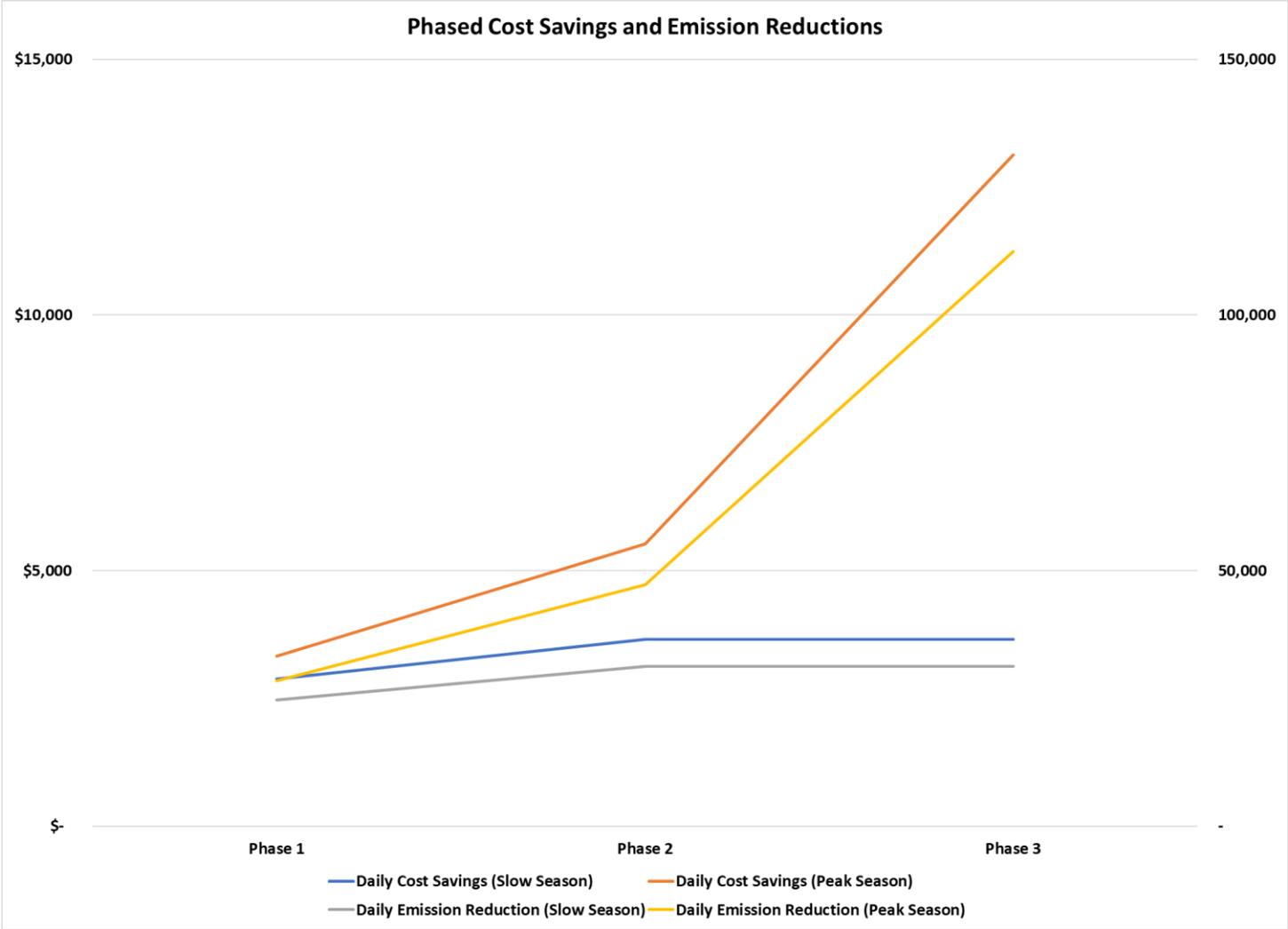
Phase 2 Charging Cycle



Phase 3 Charging Cycle



Improvements by Phase



Conclusion

- Shoreside energy storage necessary to obtain significant benefits today
- Design to take advantage of local grid improvements to further reduce emissions
- Major grid improvements required to eliminate need for shoreside charging of large, vehicle-passenger ferries