Washington State Ferries Electrification Program

Matt Von Ruden, Administrator, System Electrification Program

Northwest Energy Systems Symposium

April 7, 2022 – Virtual Event

Washington State Ferries

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WSF Overview

The largest ferry system in the U.S.

- 21 auto-passenger ferries
- 10 routes serving 20 terminals
- 23.9 million riders in 2019
- 10.5 million vehicles in 2019
- 450 sailings per day
- 1,800 employees

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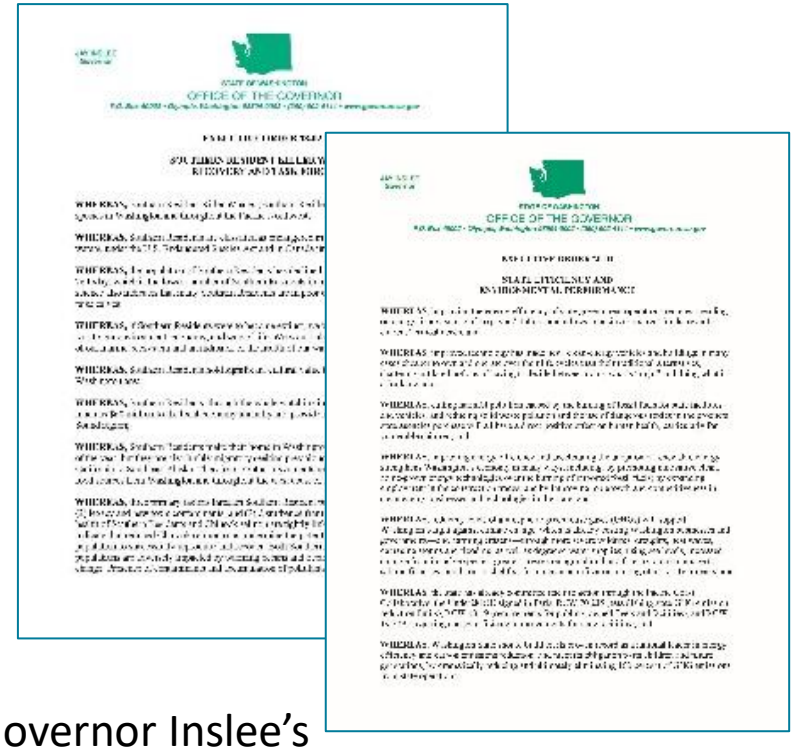
Electrification Program Launched

Legislative Mandate
RCW 70A.45.050 – Greenhouse gas emission limits for state agencies (2020)



Governor Inslee's Executive Orders 2018-01 and 2020-01

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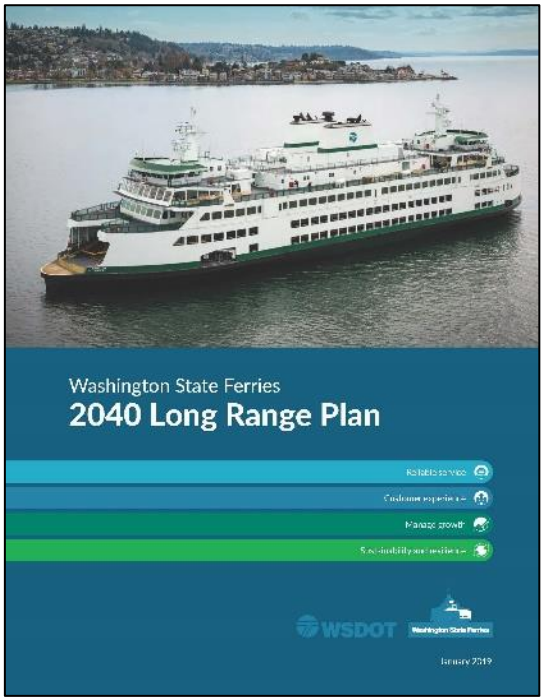
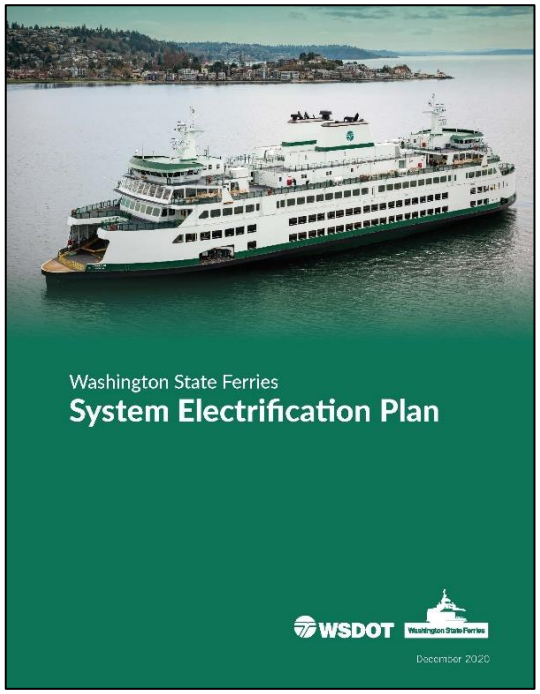
Plans for Action

Feb. 2018



Jan. 2019



Dec. 2020

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WSF System-Wide Electrification Plan

Addendum to 2040 Long Range Plan

Legislative Proviso
20-Year Planning Horizon
Final Report Delivery January 2021

- Technology Assessment
- Vessel Requirements & Feasibility Analysis
- Terminal Requirements & Feasibility Analysis
- Construction Project Schedule
- Workforce Assessment
- Financial Model
- Emissions Impact Estimate

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Examples of Hybrid-Electric Vessels


Texas DOT

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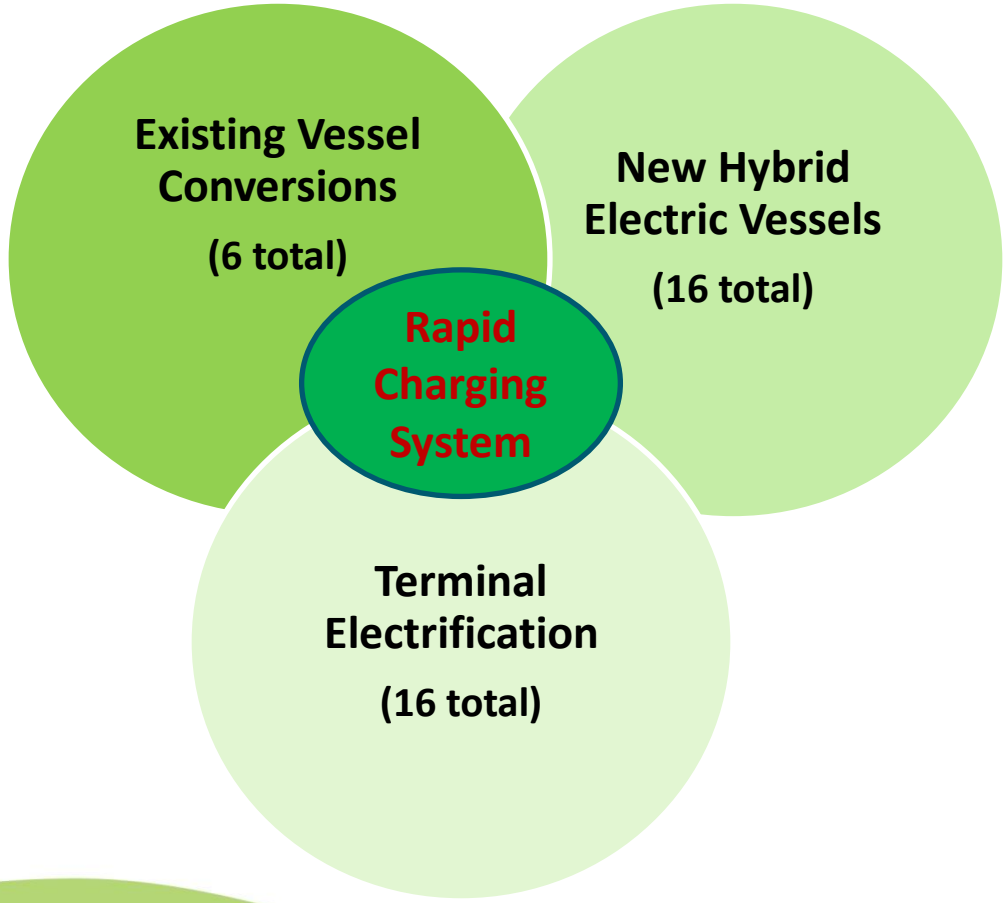
Electrification Program Elements



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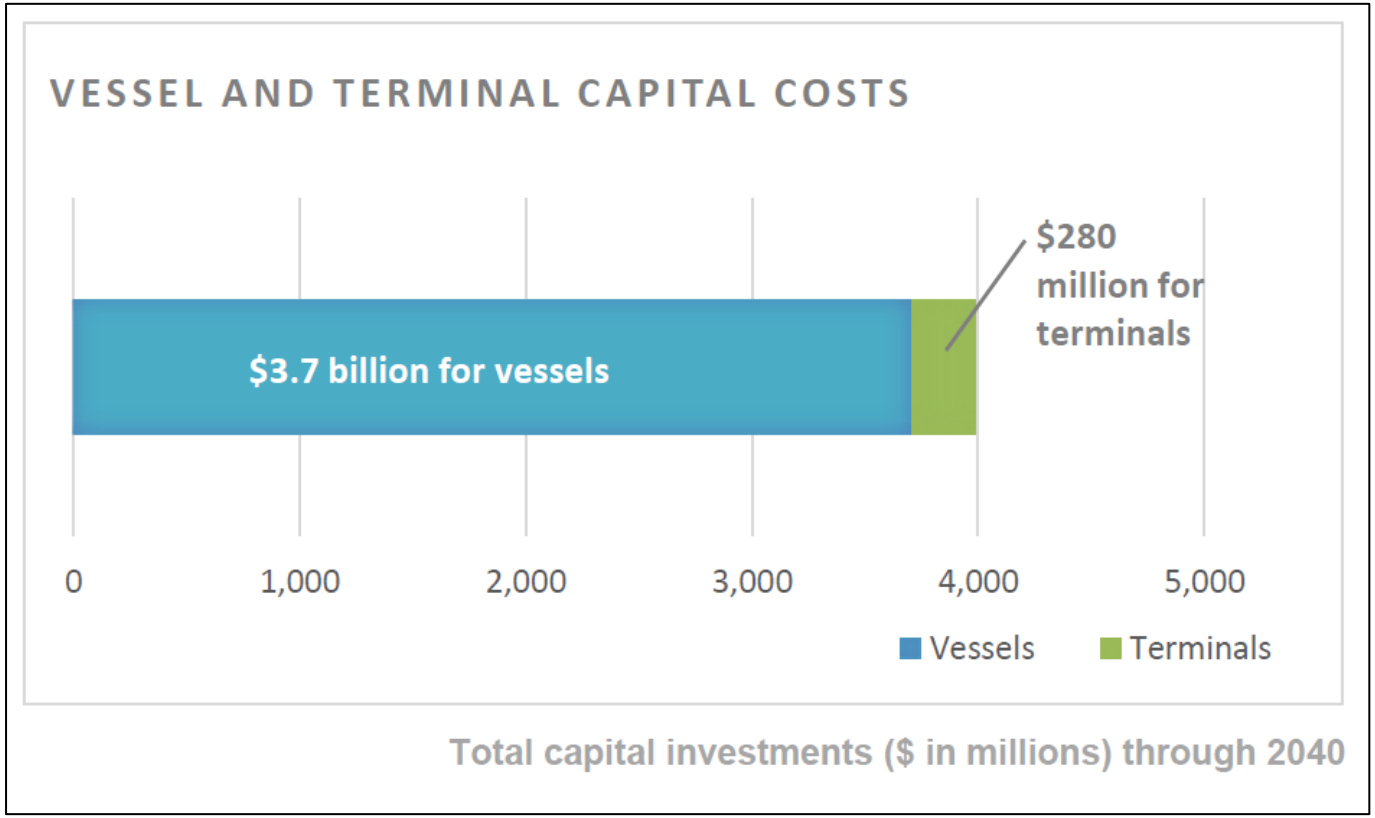
“Hybrid” Electric vs. Battery Only

- Provides system resiliency
  - Redundancy on vessel
  - Ability to move vessels between routes
  - Reduced utility rates
- Facilitates earlier transition
  - Start with vessels
  - Terminals take more time

Capital Investment



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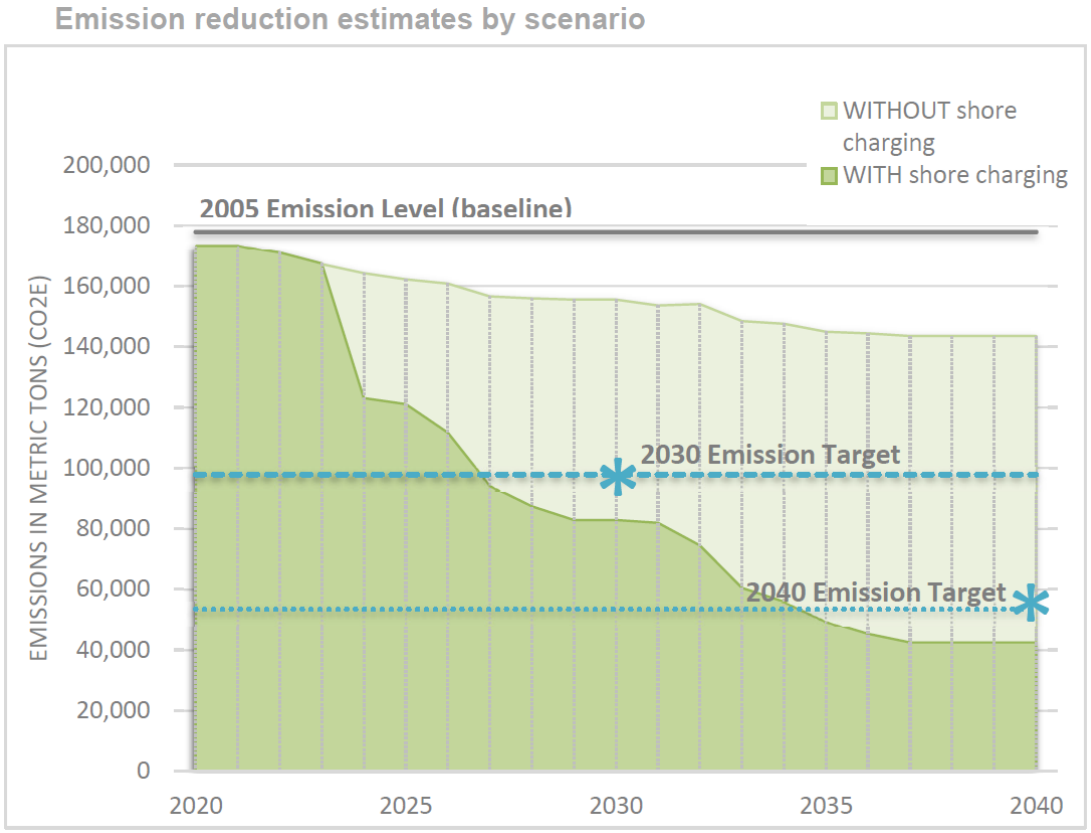
Meeting Emission Reduction Regulations

Two scenarios evaluated:

With Shore Charging
CO_2e reductions:
53% by 2030
76% by 2040
Meets requirements of RCW 70A.45.050.

Without Shore Charging
CO_2e reductions:
20% by 2040
Not compliant with RCW 70A.45.050.



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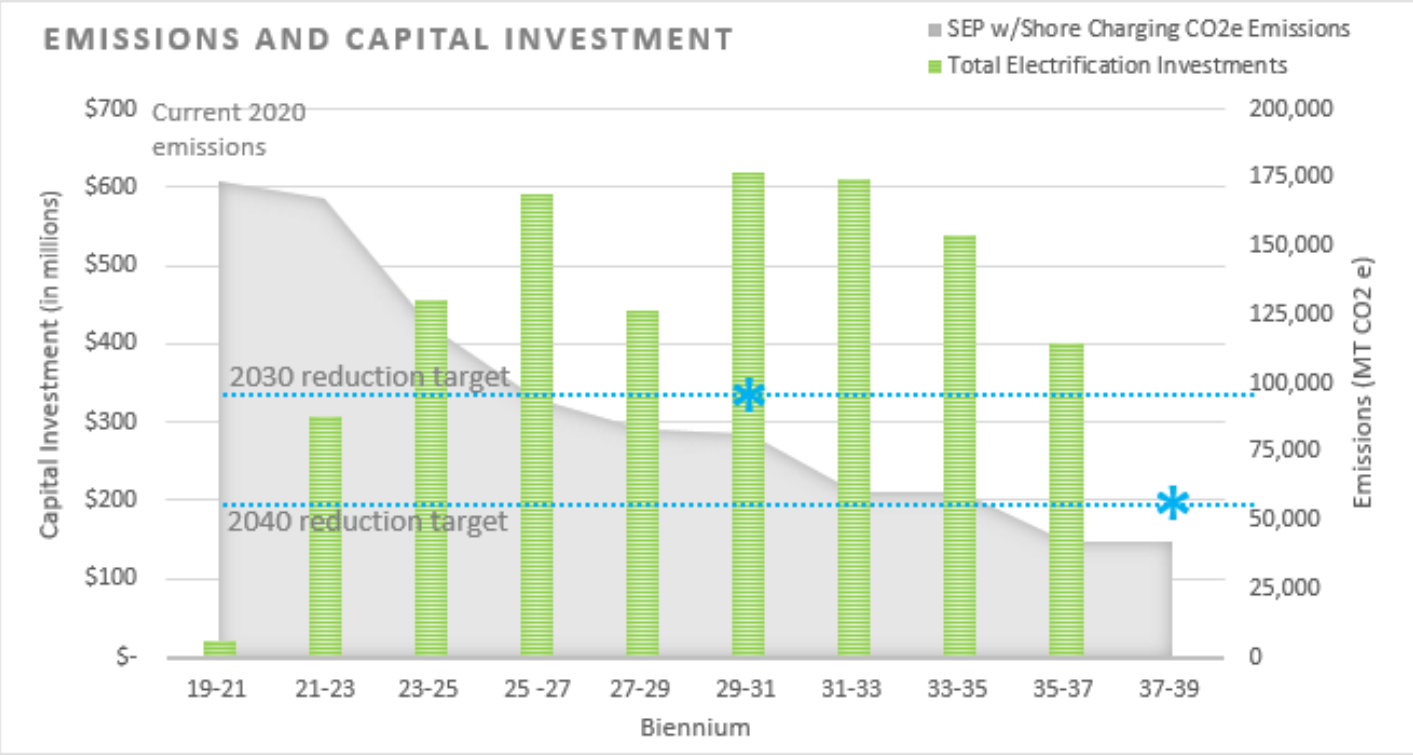
Return on Investment:
Greenhouse Gas Reductions



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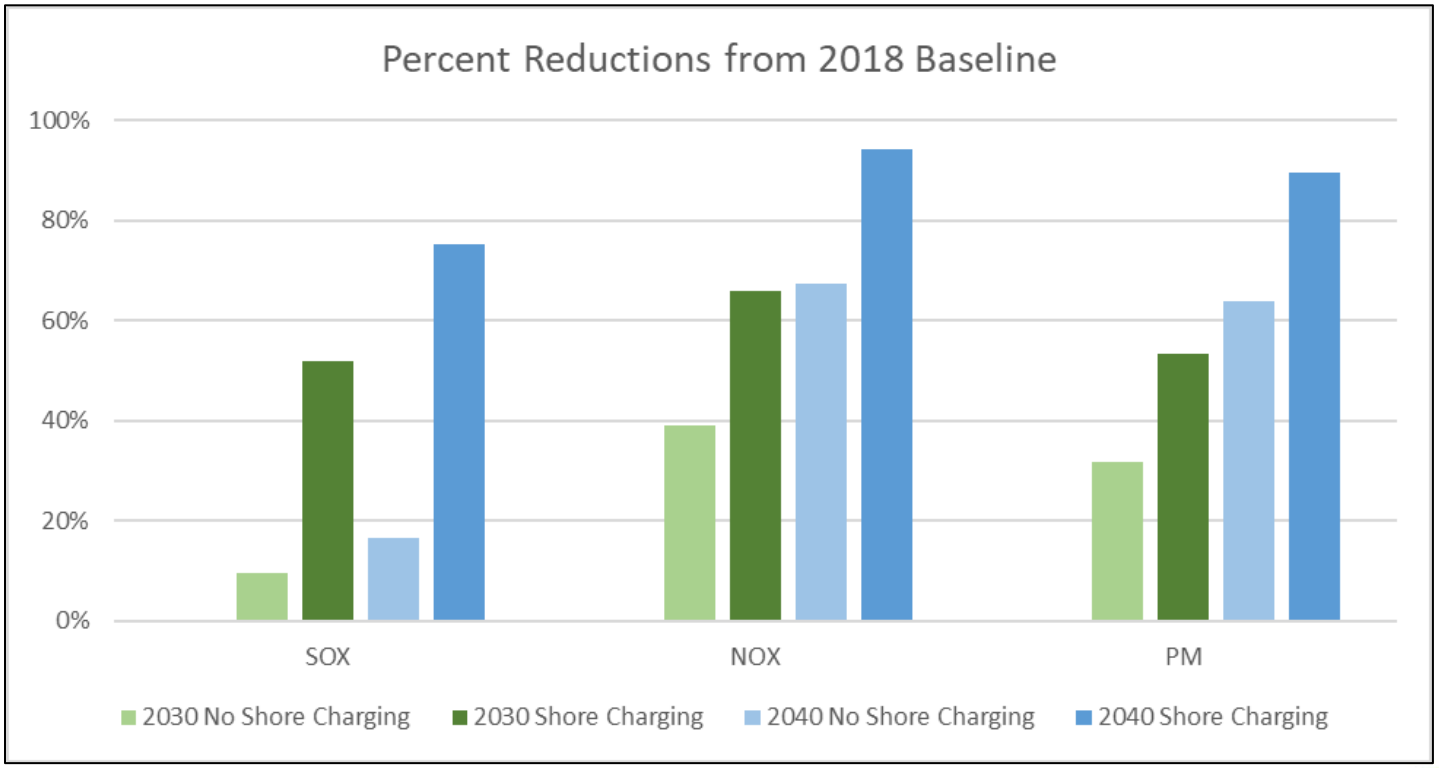
Return on Investment: Local Impacts

Improving Air Quality in Impacted Communities



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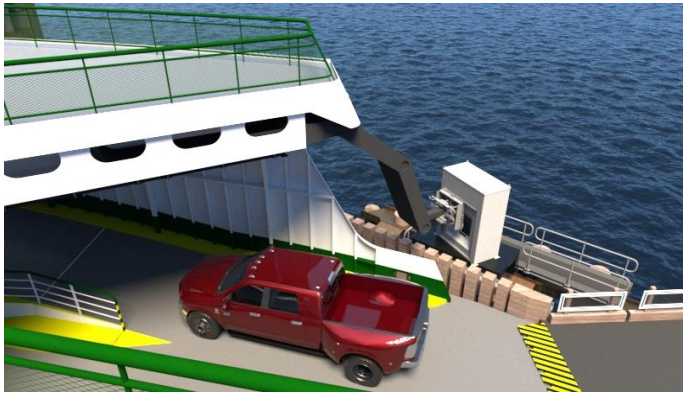
Vessel Designs in Progress

Jumbo Mark II Conversion

- 460 ft long, 202 vehicle capacity
- 3 vessels, 2 routes
- 2 of 4 diesel engines removed
- 5.7 MW-Hr of energy storage
- 5 million gallons/yr fuel savings



Rapid Charging System

- 12.4 KV
- 15 MW maximum charging power
- 20 minutes available charging time
- 20 ft tidal range
- Minimal over-water construction

Hybrid Electric Olympic

- 5 vessels, 2 routes
- New propulsion design
- 9.9 MW-Hr of energy storage
- 5 million gallons/yr fuel savings

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Jumbo Mark II Conversion

3 Vessels and 4 Terminals

- Reduce fuel consumption by 5 million gallons/yr (26% of fleet total)
- Reduce CO_2 emissions by 48,565 MT/yr
- Reduce NO_X Emissions by 184.5 MT/yr
- Comparable reduction in particulates
- Reduced maintenance costs
- Lifecycle cost savings of $60 million

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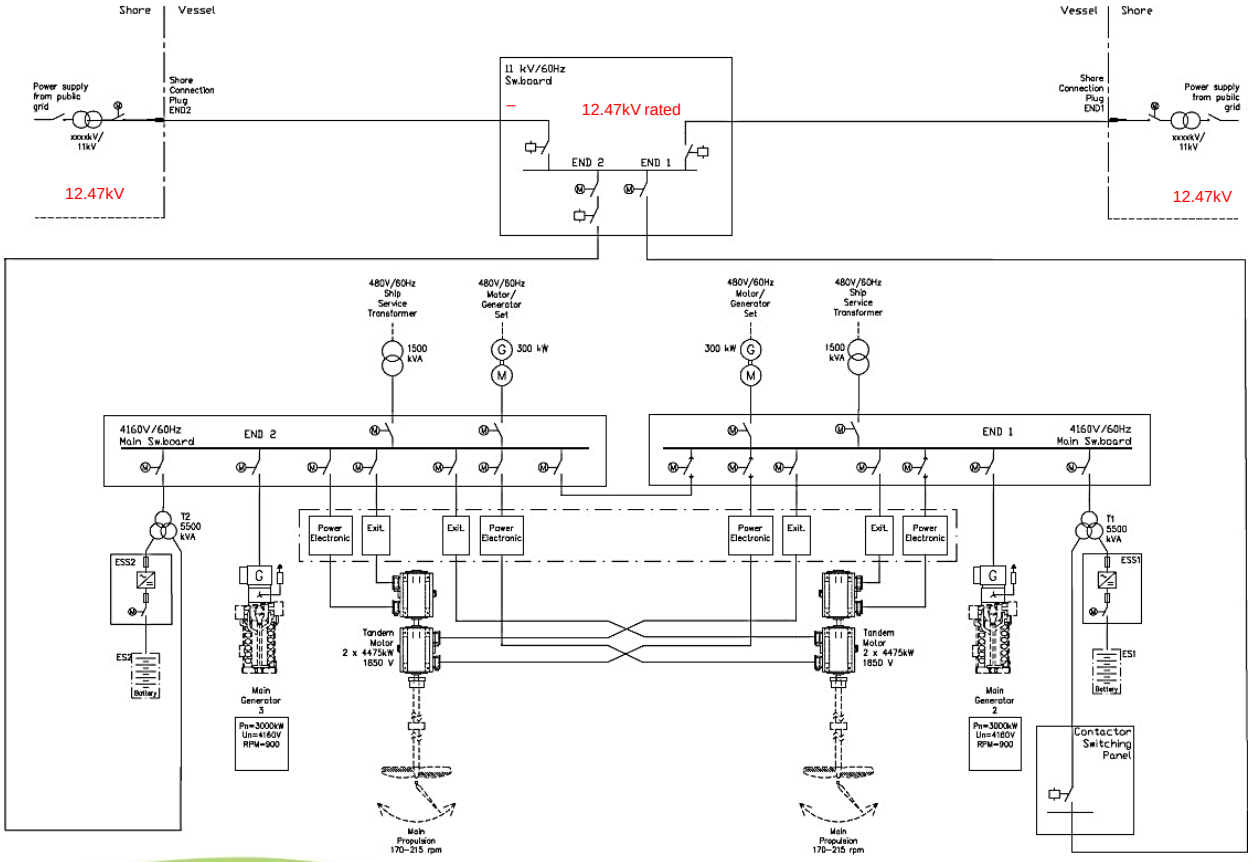
Jumbo Mark II Conversion

Design Basis: System Single Line



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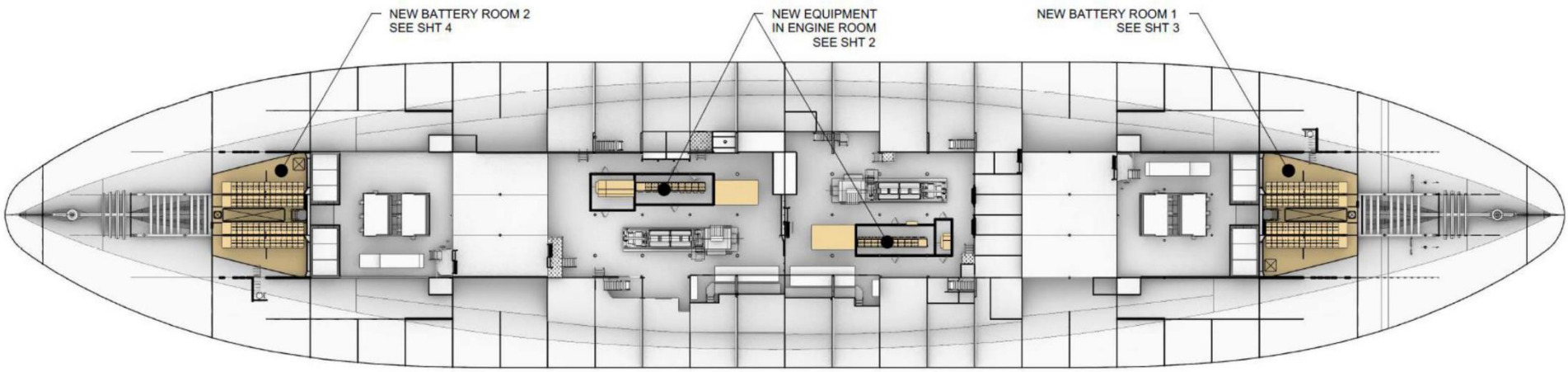
Jumbo Mark II Conversion



- Siemens design complete pending US Coast Guard approval
- Vessel #1 funded by VW Mitigation Fund, CMAQ, and MARAD (Wenatchee)
- Vessels #2-3 Funded by Move Ahead Washington
- Going to Ad in Dec. 2022; vessel deliveries:
  - Vessel #1 M/V Wenatchee September 2023
  - Vessel #2 M/V Tacoma May 2024
  - Vessel #3 M/V Puyallup October 2024

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Hybrid Electric Olympic Class (HEOC)

September 2019: Governor Inslee and Secretary Millar join event at Vigor to launch the Hybrid Electric Olympic Class program. Up to five vessels will be built.

Olympic Class vessels carry 144 cars and 1,500 passengers

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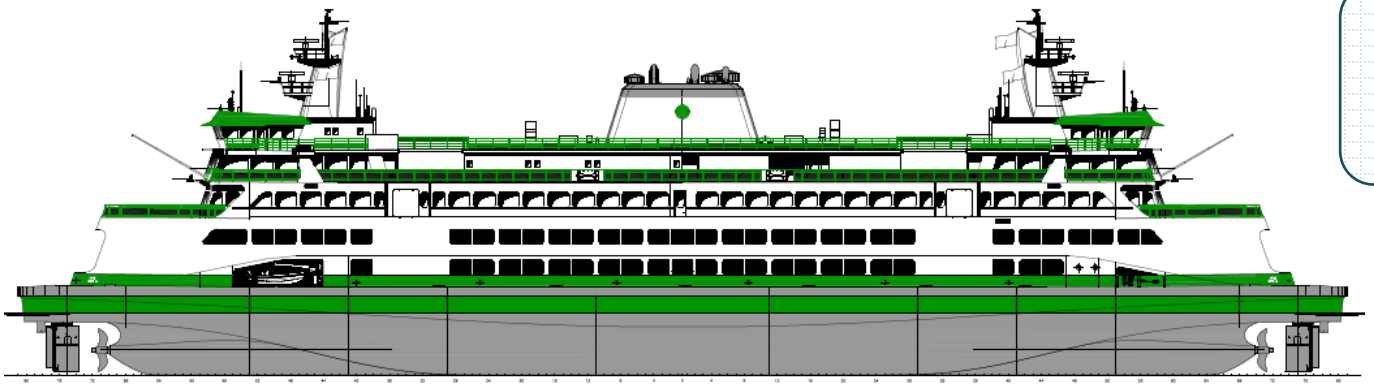
HEOC Design-Build

Update of an existing design



WSF OLYMPIC CLASS

LOA:	362’-3”
Beam:	83’-2”

- Starting with proven, USCG approved design
- Less engineering effort required for functional design
- Fleet and operational similarities
- Addition of batteries required weight reduction measures on vessel.
- Propulsion changed from Controllable Pitch Propeller to Fixed Pitch Propeller with tandem permanent magnet motors

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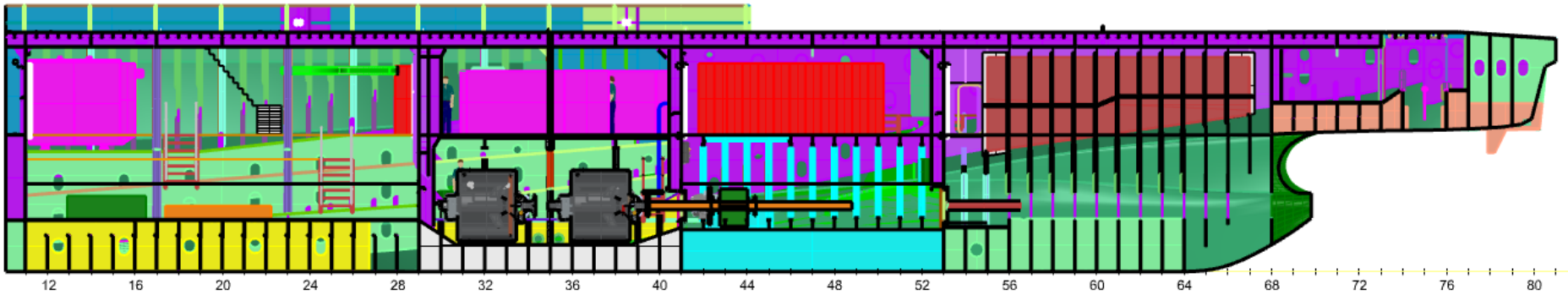
Hybrid Electric Olympic Class



Engine Room | Motor Room | Battery Room | Tank Room | Steering Gear Room

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Program Benefits

- Flexible vessel design that can operate on most system routes, with or without shore charging
- 300 million gallons of diesel fuel saved over 60 years
- $55 million lifecycle cost savings
- Passenger comfort (quieter operations in most vessel areas)

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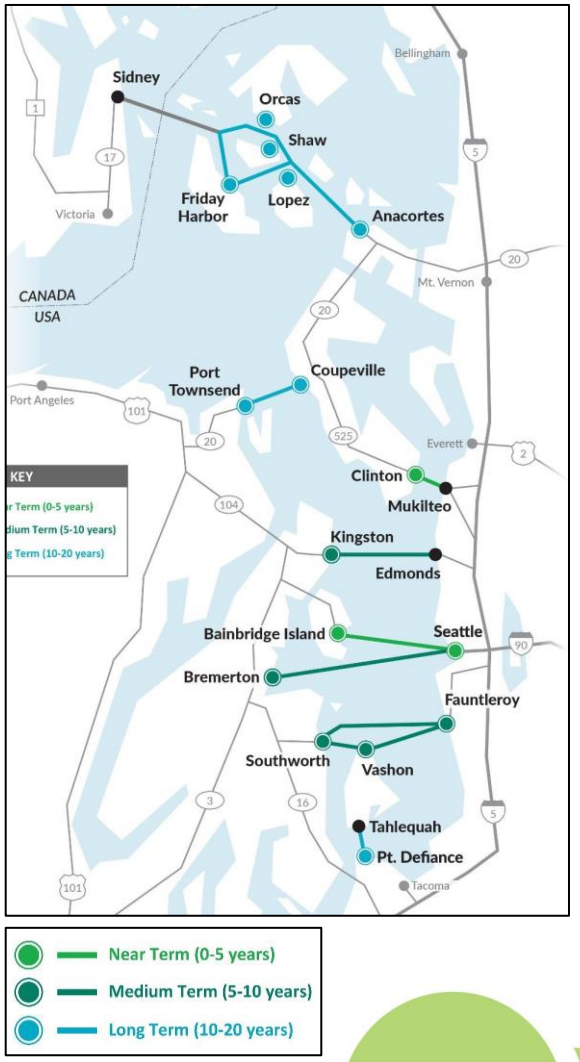
Terminal Electrification

- 16 terminals
- Power from 5 utilities
  - Seattle City Light
  - Puget Sound Energy
  - Tacoma Power
  - Jefferson PUD
  - OPALCO (Orcas Power & Light)



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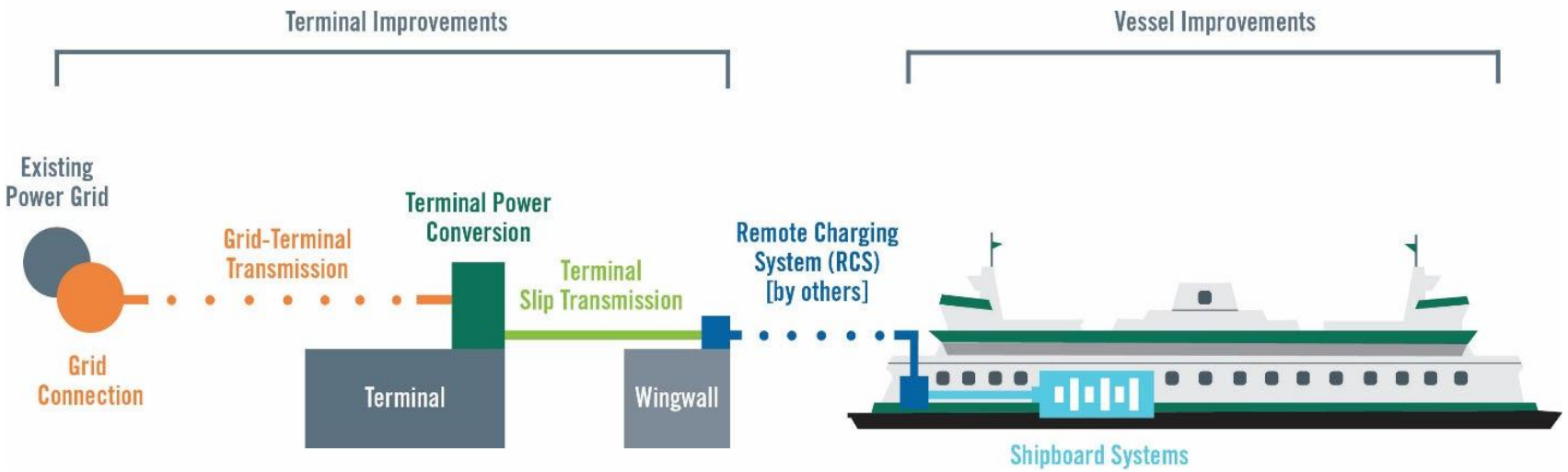
Electrification System Components



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Route Power Requirements

Route	Vessel Class	Total Energy Charge Demand kWh	RCS Rate kW
Colman Dock (Bremerton)	HEO	4,550	15,200
Bremerton		4,550	15,200
Colman Dock (Bainbridge Island)	JM II	2,730	9,100
Bainbridge Island		2,730	9,100
Vashon	New	690	5,200
Southworth	124	980	8,400
Fauntleroy		980	8,400
Pt. Defiance (RT)	KDT	860	4,300
Tahlequah		(no charging)	
Kingston (RT)	New	3,280	11,000
Edmonds	144	(no charging)	
Clinton (RT)	HEO	2,080	10,400
Mukilteo		(no charging)	
Port Townsend	KDT	1,150	5,300
Coupeville		1,150	5,300

NOTE: Given the complexity of the service in the San Juan Islands, additional study is needed to determine the power demands for the Anacortes, Friday Harbor, Orcas, Shaw, and Lopez Island terminals.

The charge rate represents the rate at which energy needs to be transferred from shore to the ferry batteries within the design dwell time. The units are kWh per hour which has been simplified to kW to be consistent with standard industry practice.

Seattle Terminal Electrification

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Bainbridge Island Electrification

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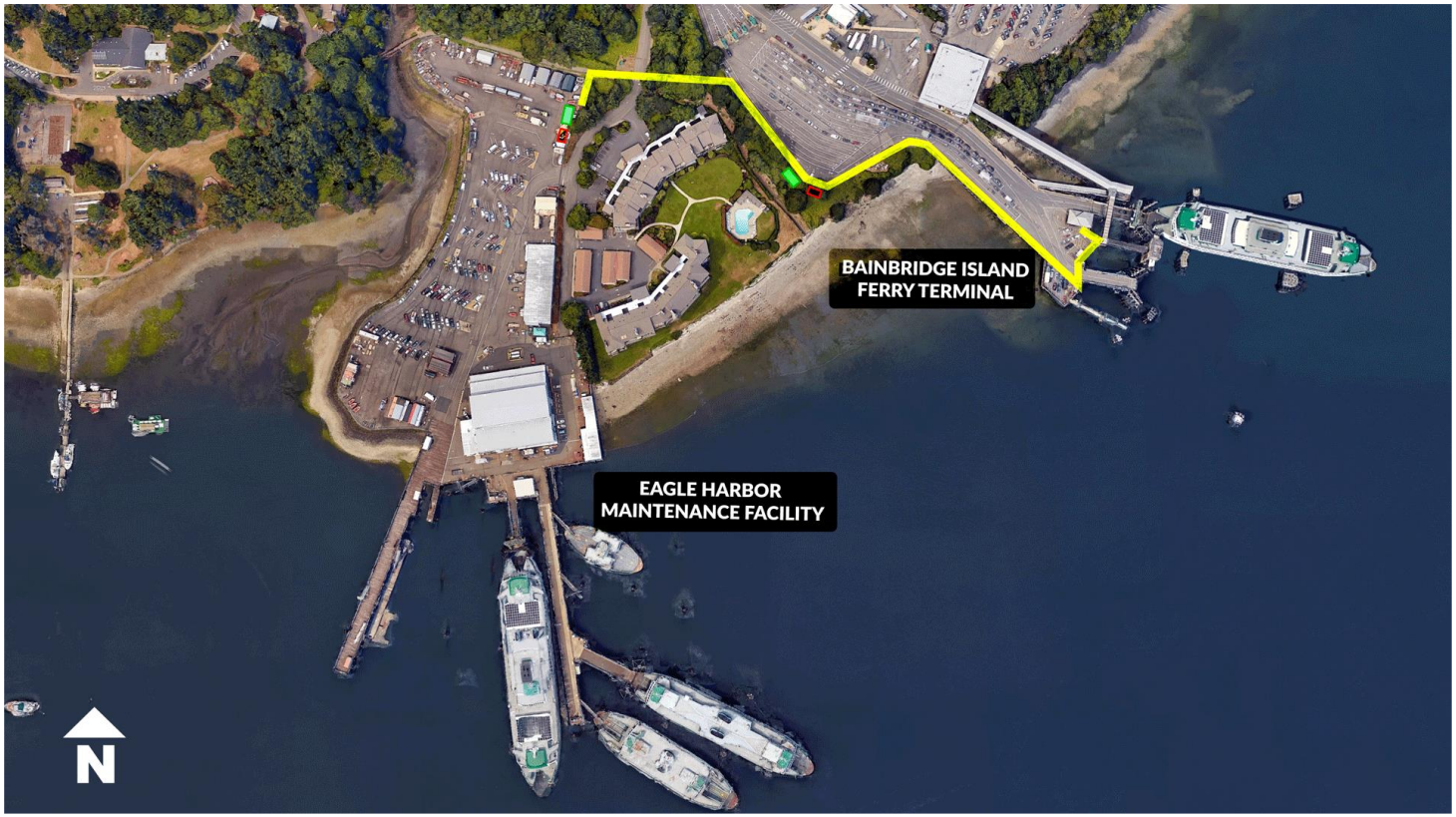
Bainbridge Island Power Route



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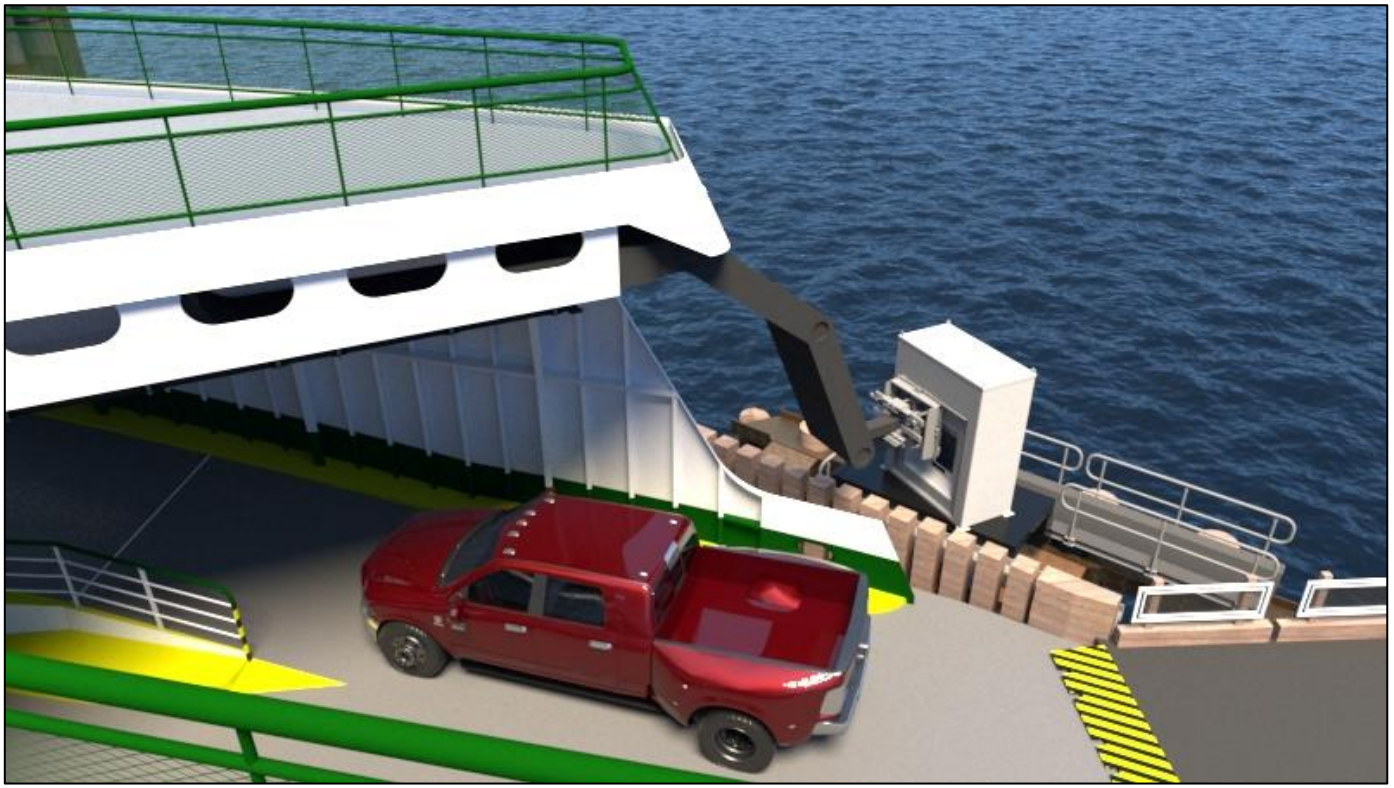
Rapid Charging System



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Rapid Charging System Operational Requirements

- **Fully automated** connection requiring only a permissive control from the vessel to initiate Charging.
- **Remote operation** from each pilothouse including permissive control, monitoring and emergency release.
- **Charging on every trip** with a 90% successful connection rate.
- **Successfully transfer the required energy** within a 20-minute time window. Per the feasibility study (Reference 2), the following operations shall be accomplished within the 20-minute time window:

1.	Connection:	Mechanically *and* electrically connect vessel to shore power.
2.	Ramp up power:	Ramp up to full charging power over a defined time period to reduce the strain on the utility grid.
3.	Full Power:	Charge batteries at full charging power.
4.	Ramp down power:	Ramp down to zero charging power.
5.	Disconnect:	Mechanically *and* electrically disconnect vessel from shore power.

- **Safety disconnect** shall mechanically disconnect and open the shore breakers/contactors. This disconnection shall be possible without auxiliary power.

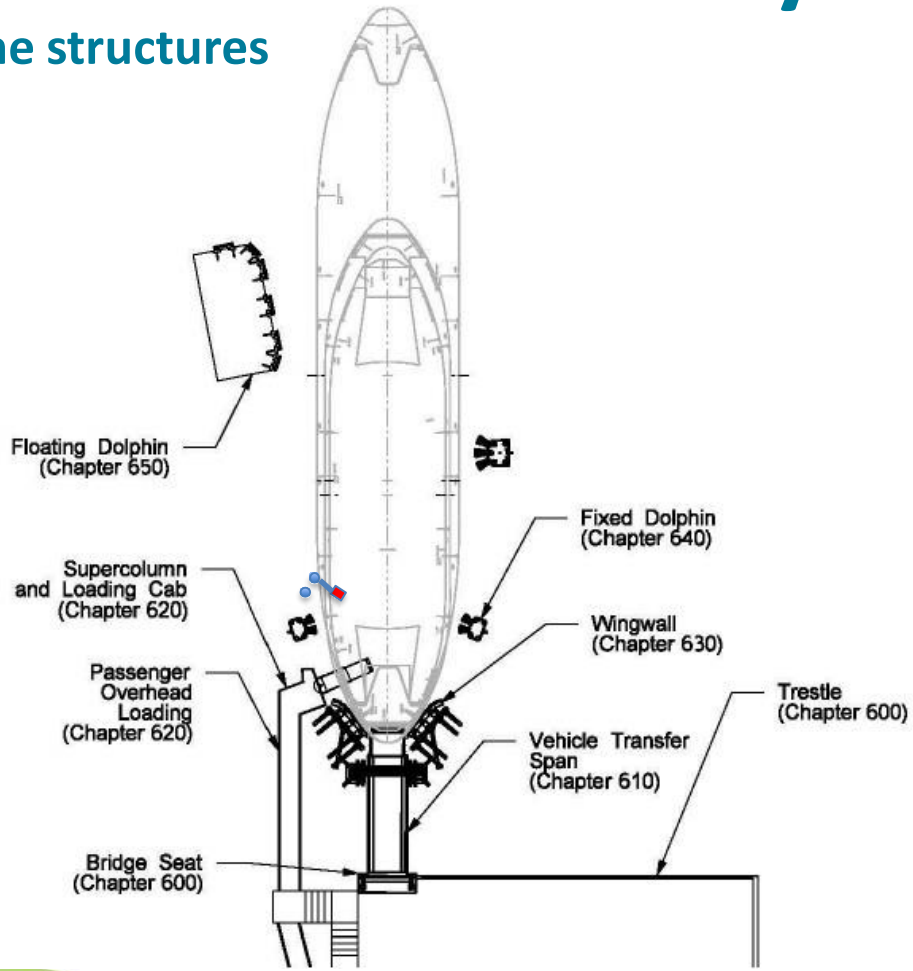
Design Basis: Electrical Requirements

Characteristic	Value	Comments
Charging Power	10 MW peak	This is a design value for the peak charging load.
Charging Voltage	12.47 kV	Deviates from contract requirement. See Section 2.2.
Frequency	60 Hz	
Auxiliary Voltage (pierside)	480VAC, 3P, 3W	
Auxiliary Voltage (ship)	480VAC, 3P, 3W	

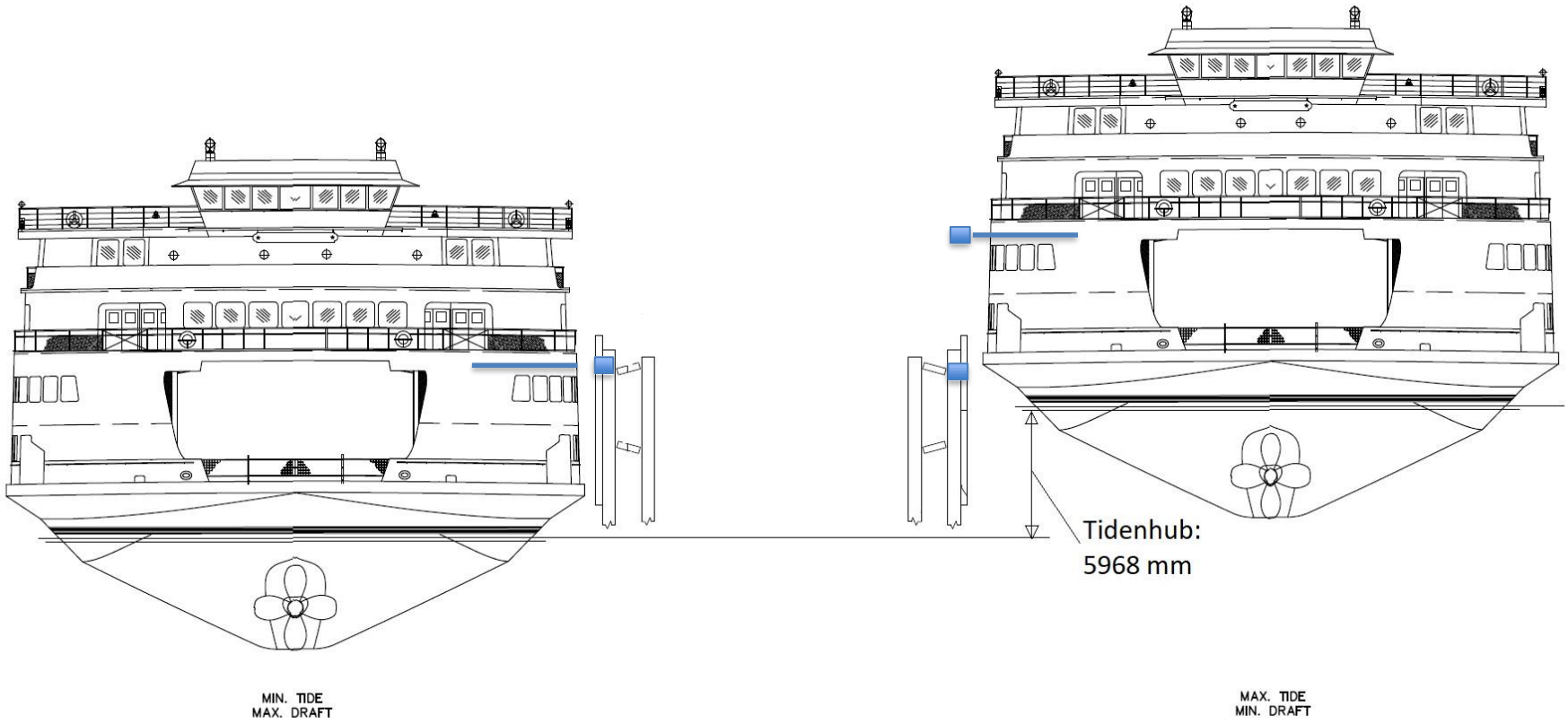
- 400kW ship service power while pushing dock
- 800kW propulsion power (average) while pushing dock
- 7200kW Battery Charging Required (8800kW available)
- Low power factor of while pushing the dock. Could be an impact on real component of power due to reactive power losses - Siemens study is underway
- 12.47 kV power to be provided to the charging apparatus by others

Basic Requirements for the Ferry Charger

Typical set up of marine structures



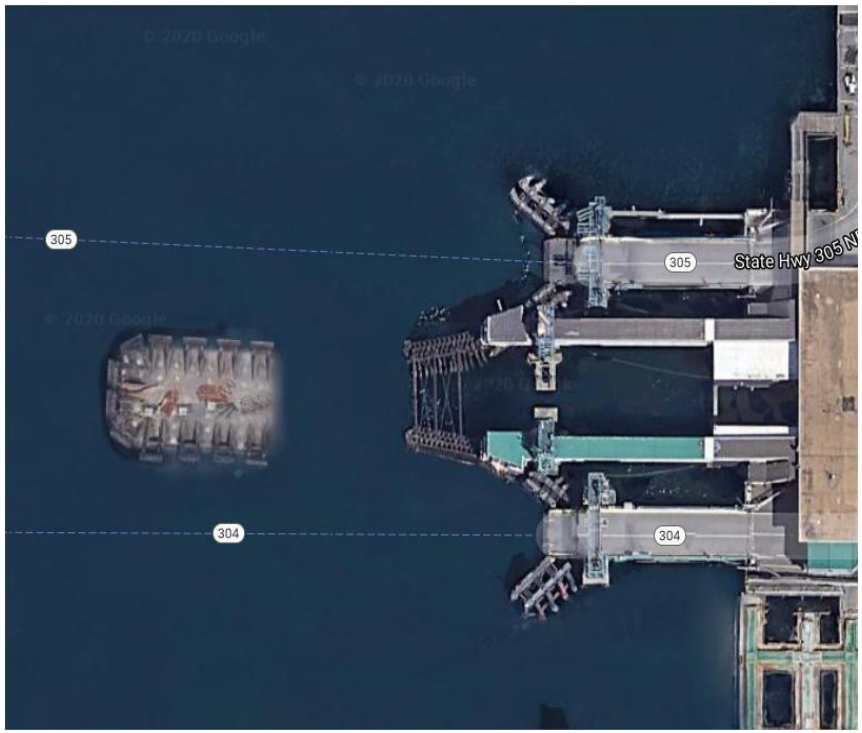
Basic Requirements for the Ferry Charger



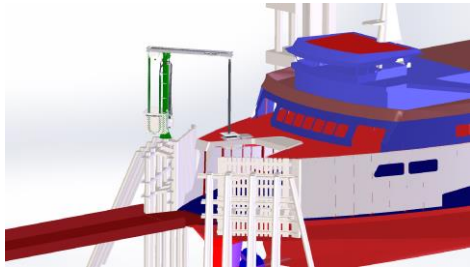
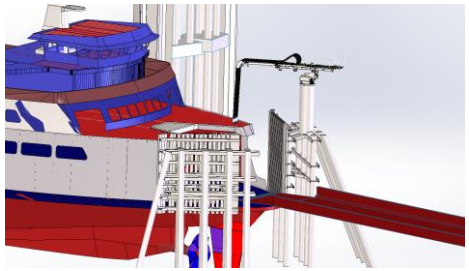
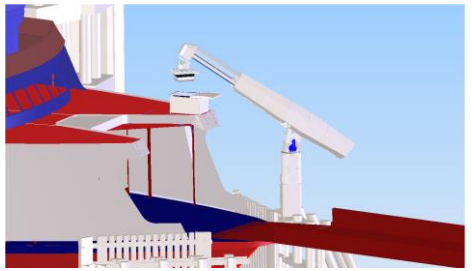
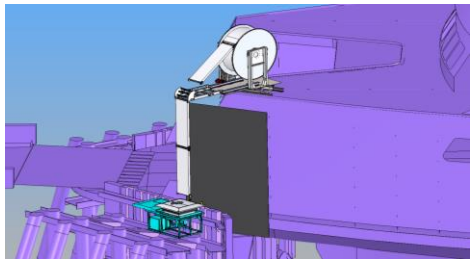
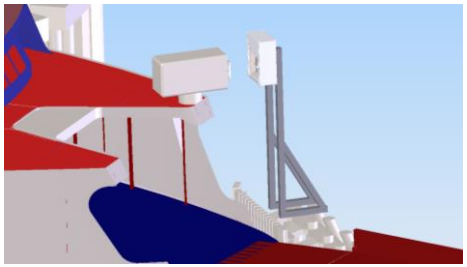
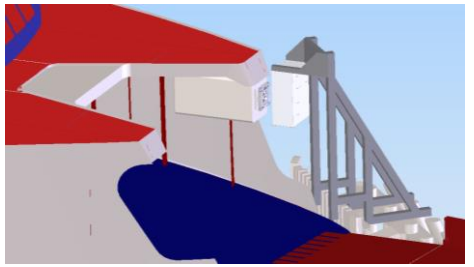
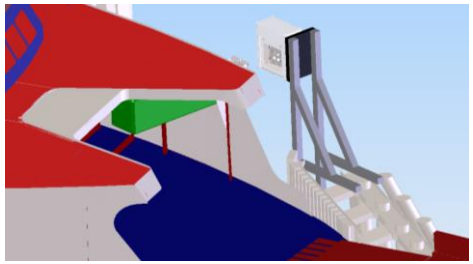
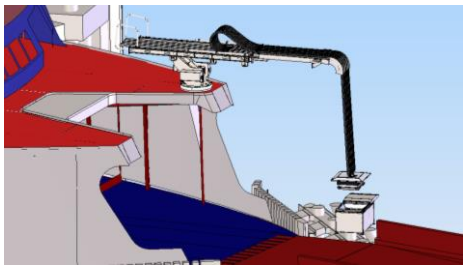
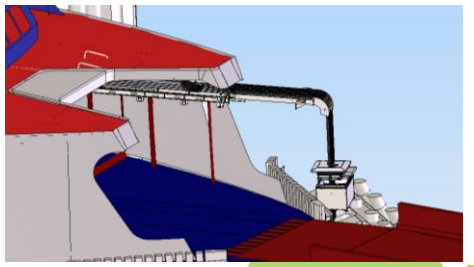
Basic Requirements for the Ferry Charger

Bainbridge

Seattle



Brainstorming potential concepts

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A Wabtec Company

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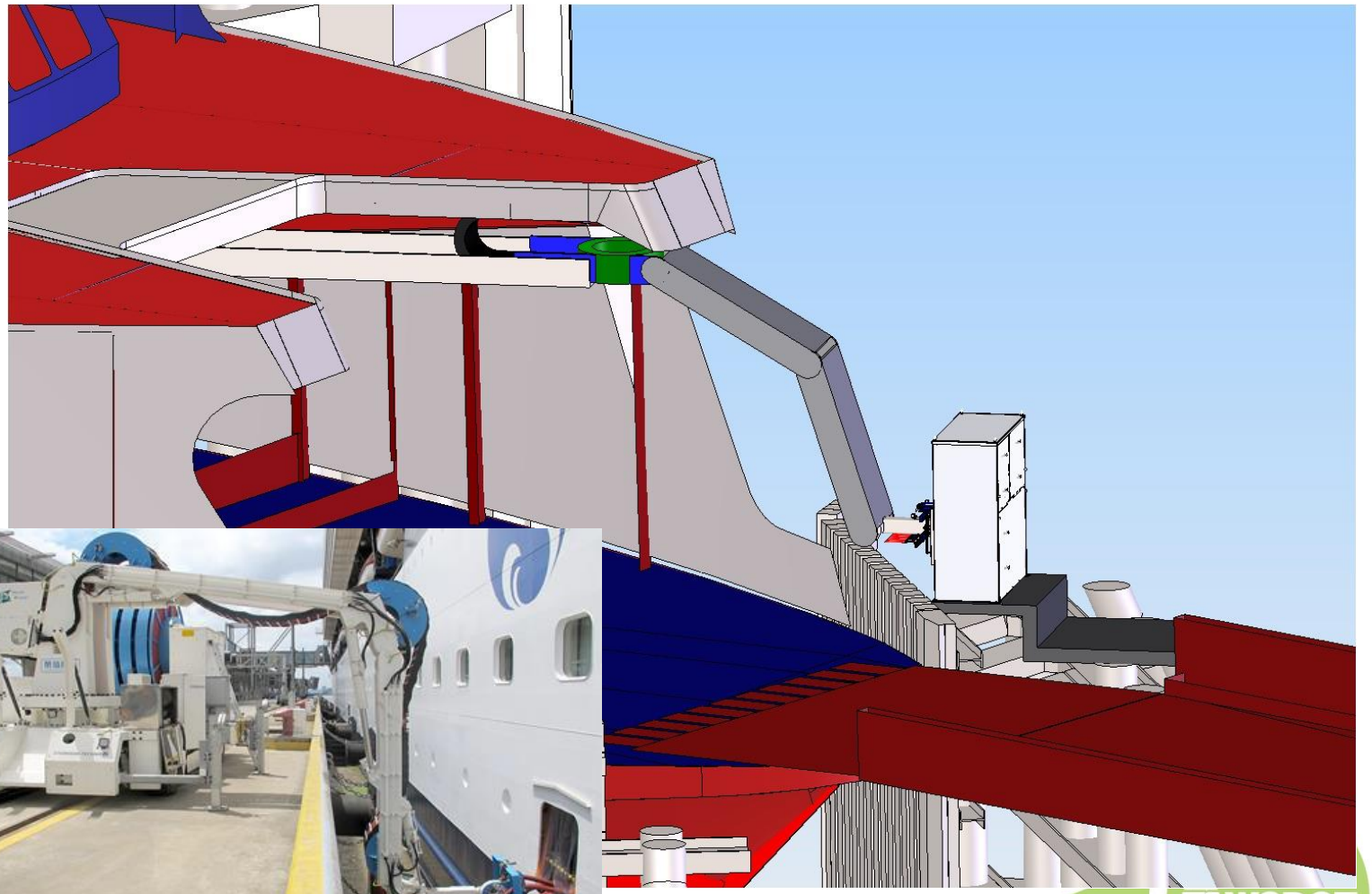
Concept 11: Movable Arm 2 under the pickle-fork - High water, min. load



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Charging arm video

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What's Next by Route

- Electrify Clinton for HEOC vessels 1 and 2 (Mukilteo/Clinton) Design 2021-23
- Electrify Kingston Terminal for JMII (Edmonds/Kingston) Design 2023-25
- Electrify Bremerton for HEOC vessels 3 and 4 (Seattle / Bremerton) Design 2023-25
- Begin design work on Triangle Route: new vessel, trade-off study and radiated noise study

Questions

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