Technical Advisory Group Meeting #2

Guemes Island Ferry Replacement

Review of Propulsion Studies

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Guemes Island Ferry Propulsion & Power Study

Feasibility of All-Electric Replacement for M/V Guemes

– Prepared by Art Anderson Associates, June 2016

– Presented to Skagit County Commissioners June 21, 2016

Purpose of the Study

- Assess feasibility of all-electric propulsion
- Evaluate battery technologies
  - (Lithium-ion vs. Vanadium Redox Flow)
- Compare alternatives
  - (diesel, hybrid, LNG, hydrogen fuel cell)
- Ensure compliance with US Coast Guard regulations
- Support Skagit County's goals: reliability, capacity, sustainability

Key Findings – Energy Needs

- Average trip: **77.4 kWh**
- High-current trip: **118.2 kWh**
- Daily operations: **~3.2 MWh** required
- Opportunity charging during the day is essential for efficiency

Key Findings – Battery Options

Battery Type	Pros	Cons
Vanadium Redox Flow (VRF)	Lower cost, no degradation	Very heavy (~265 tons), unproven in marine use
Lithium-ion	Light (~8–10 tons), proven, flexible charging	Higher cost, degrades if fully discharged

Recommendations

- Adopt all-electric propulsion
- Use Lithium-ion batteries
- Add opportunity charging station
- Lengthen vessel +25 ft → 30 cars, 150 passengers
- Install azimuthing thrusters
- Keep under 100 gross tons (Subchapter T)
- Hydrogen & LNG not advised

Guemes Island Ferry Replacement Concept Design Report

Section 3 Propulsion Analysis

– Prepared by Glosten, December 2017

– Presented to Guemes Island Public Forum January 25, 2018

Propulsion Analysis

Five Propulsion Options

- Geared Diesel (baseline)
- Diesel Electric
- Series Hybrid
- All-Electric
- Plug-in Hybrid

Propulsion Analysis

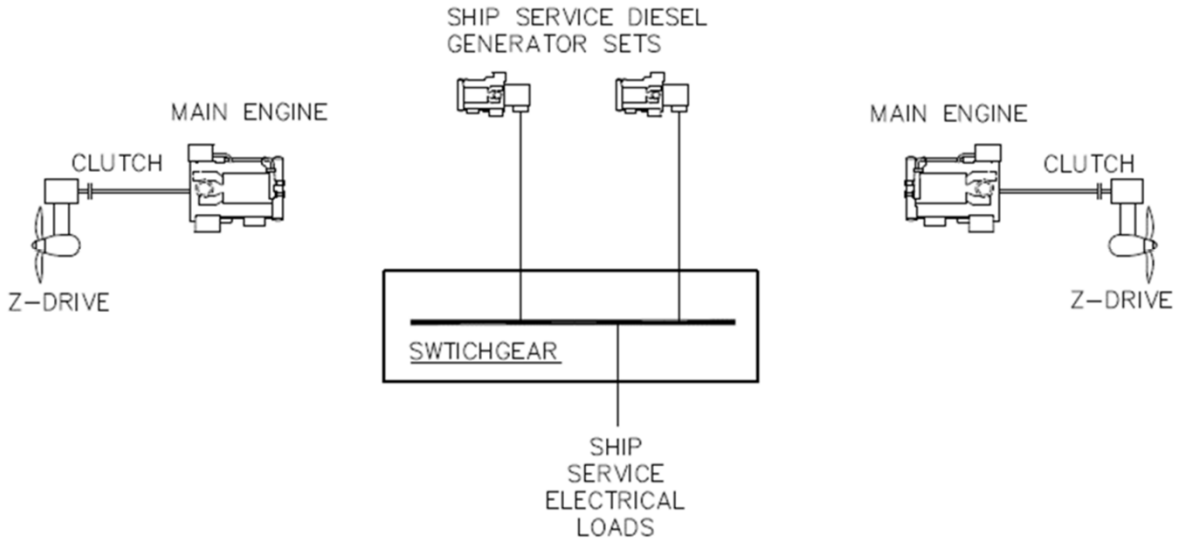
Considerations/Criteria

- Operating Profile/Emergency Services
- Power Requirements
- Emissions
- Lifecycle
  - Upfront Capital Cost
  - Ongoing Operating Cost
  - Repower

Geared Diesel

Benefits

- *Simple*
- *Robust*
- *Common*
- *Efficient*



Drawbacks

- *Engine Size*
- *Main Engine Redundancy*
- *Torque Limitations*

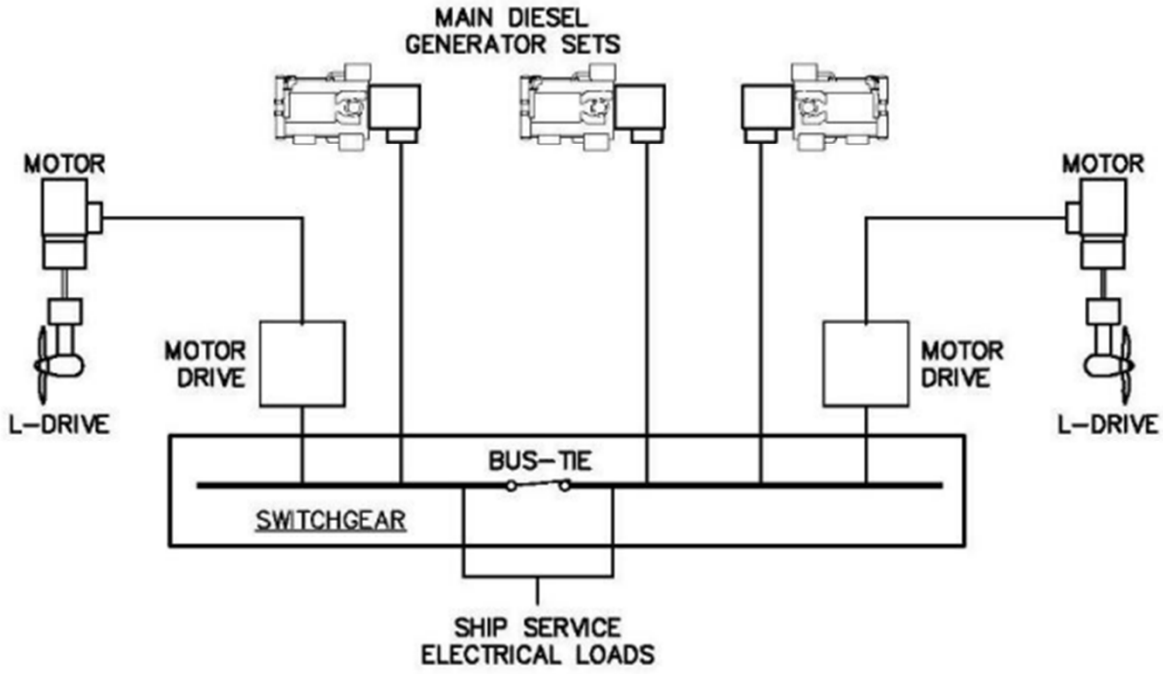
Diesel-Electric

Benefits

- *Fast Response*
- *Constant Torque*
- *Load Sharing*

Drawbacks

- *Efficiency*



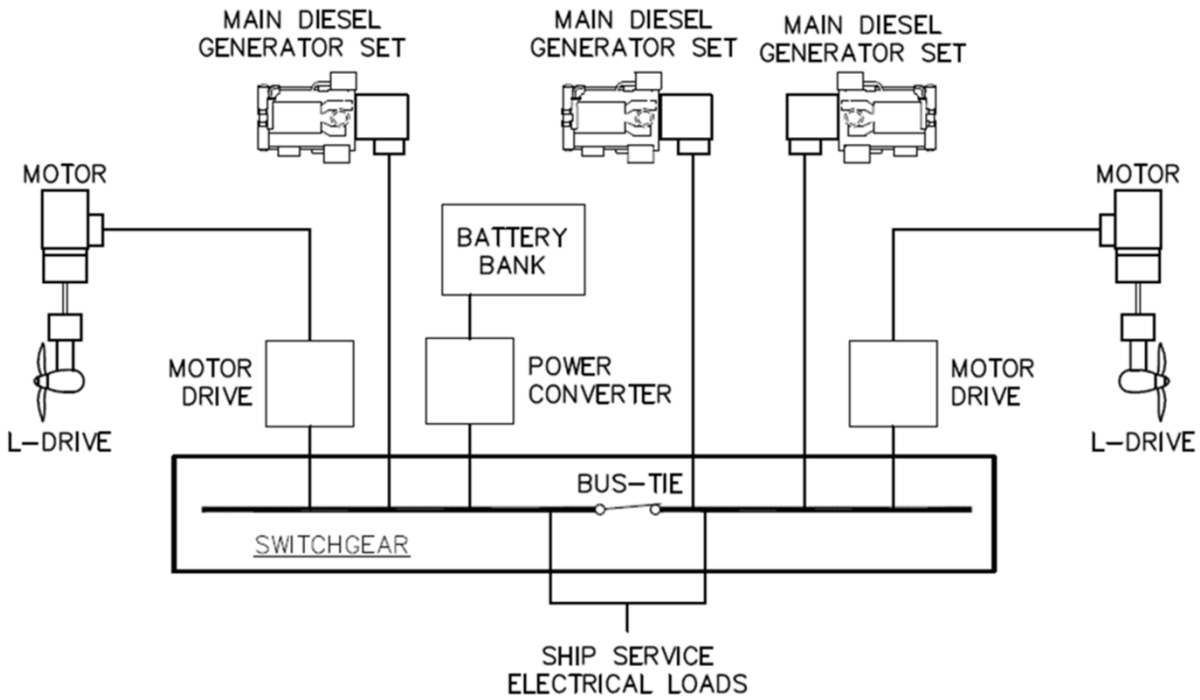
Series Hybrid

Benefits

- *Load Sharing*

Drawbacks

- *Complexity*
- *Cost*



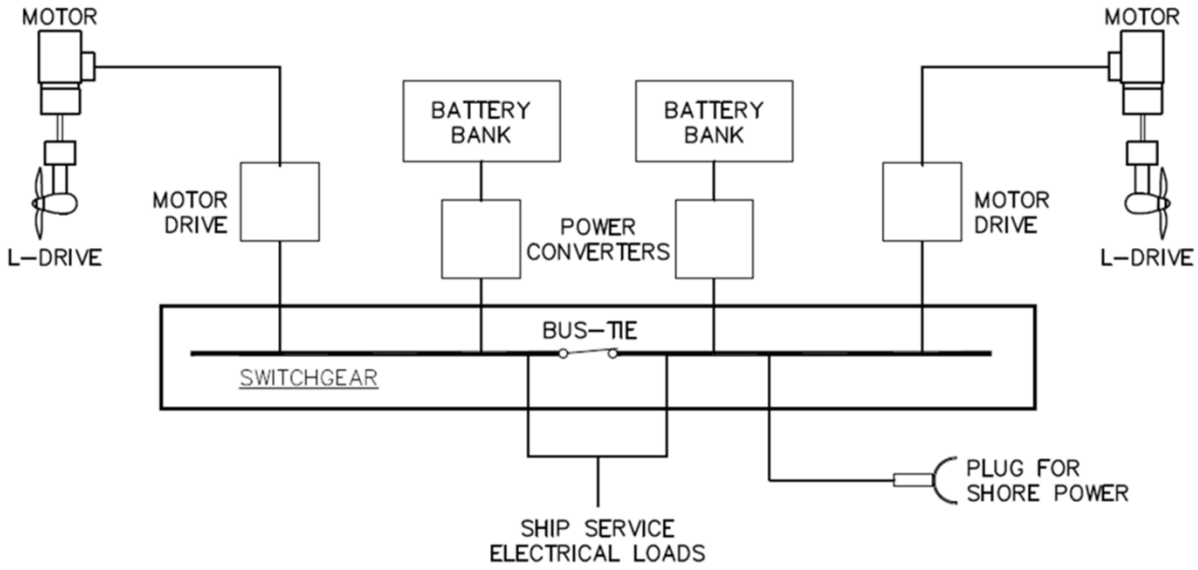
All-Electric

Benefits

- *Fast Response*
- *Emissions*
- *Noise*
- *Maintenance*
- *No Diesel Fuel*

Drawbacks

- *Shore Charging*
- *Vessel Range*



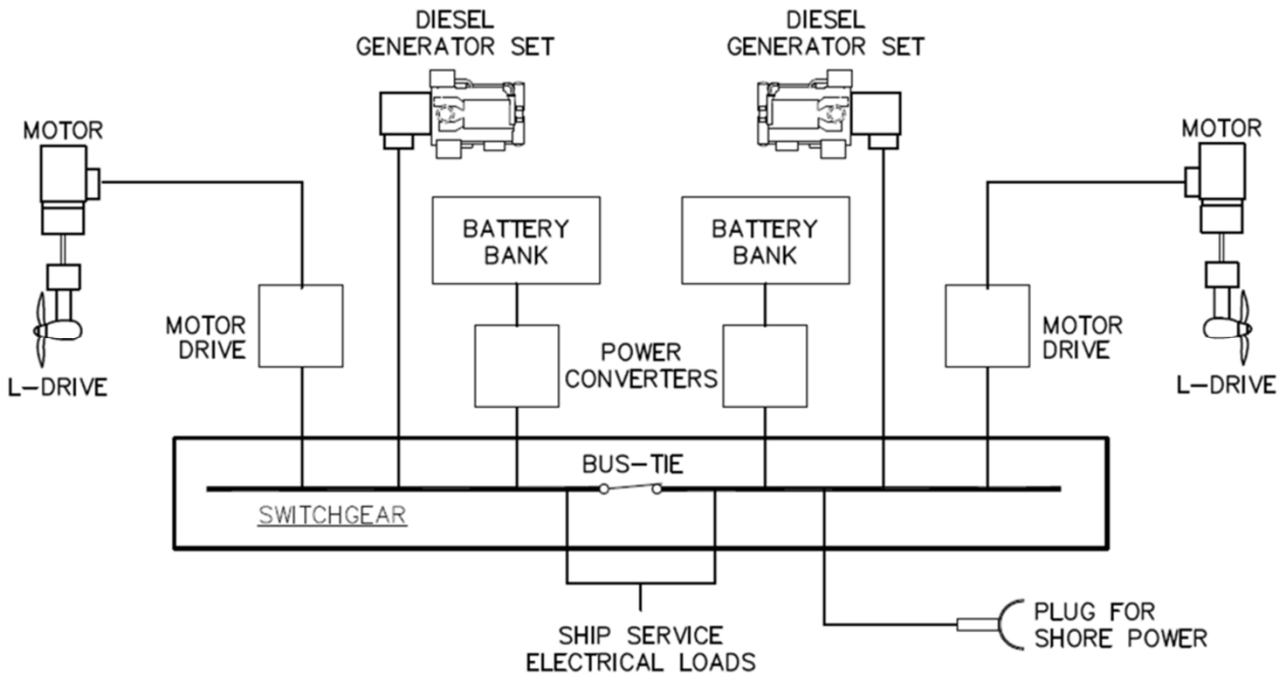
Plug-In Hybrid

Benefits

- *Capital Cost*

Drawbacks

- *Complexity*



Life Cycle Cost – 40 Year

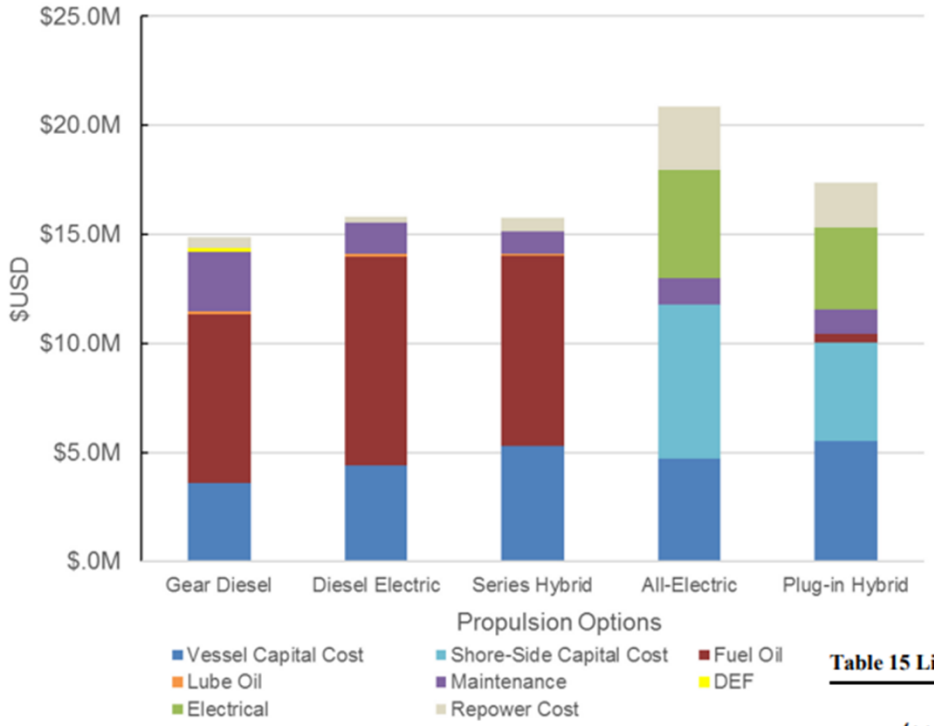
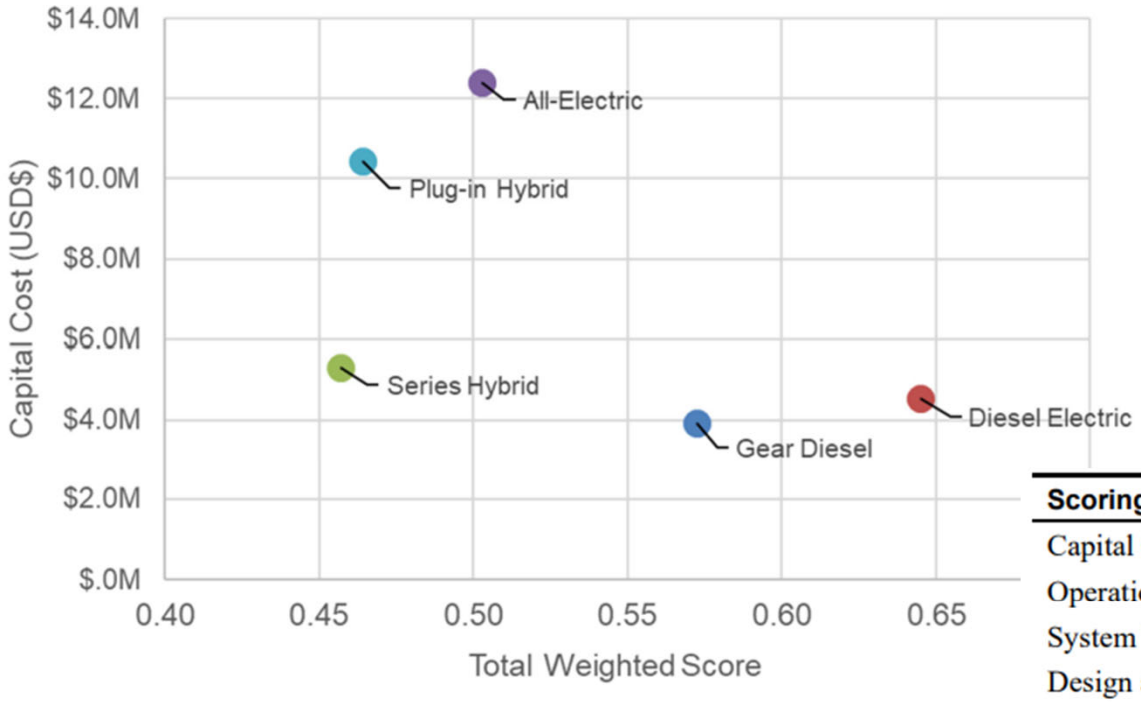


Table 15 Life cycle cost comparison of propulsion systems

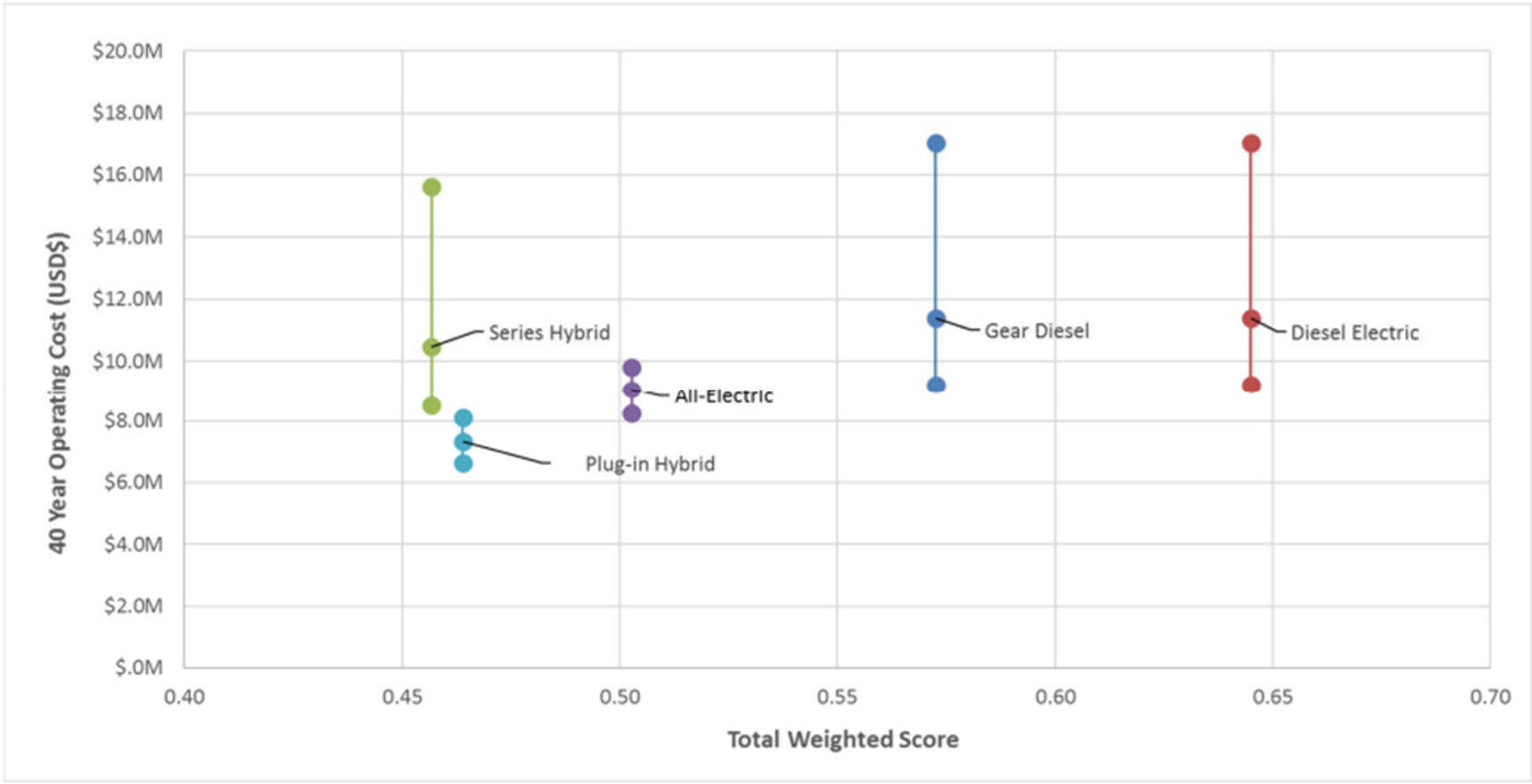
Relative Cost (compared to baseline)	Geared Diesel	Diesel Electric	Series Hybrid	All-Electric	Plug-in Hybrid
Capital Cost	-	23.0%	47.1%	227.7%	178.9%
Fuel, Lube, DEF, & Electrical	-	21.5%	10.2%	-39.5%	-50.3%
Operations & Maintenance	-	-48.5%	-63.6%	-56.2%	-58.8%
Repower (Engines & Batteries)	-	-43.8%	26.4%	452.9%	297.6%
Total Life Cycle Cost	**-**	**6.3%**	**6.0%**	**40.2%**	**16.8%**

Weighted Scoring – Propulsion System

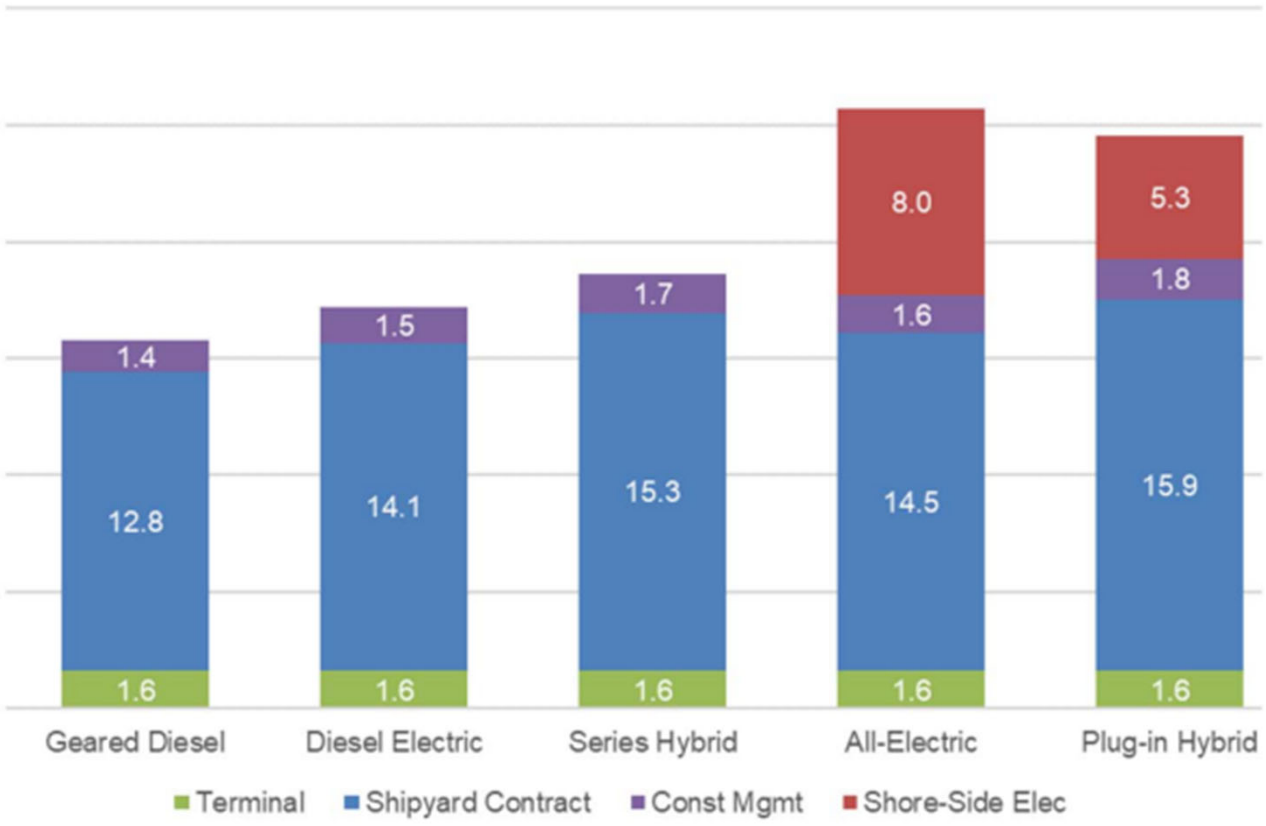


Scoring Category	Weighting Factor
Capital Cost	0%
Operations and Maintenance Cost	0%
System Weight	10%
Design and Build Complexity	20%
Reliability and Availability	45%
Airborne Noise	10%
Vessel Air Emissions	15%
TOTAL (must equal 100%)	**100%**

Operating Cost – Propulsion System



Engineer's Capital Cost Estimate (M)



Guemes Island Ferry
Lifecycle Valuation & Propulsion Study

– Prepared by Art Anderson Associates, March 2020

Purpose of the Study

Determine Guemes's fate based on three scenarios

1) Vessel retained longer than anticipated (new ferry is delayed)
2) Vessel retained for interim ferry when new e-ferry is out of service
3) The vessel sold when new e-ferry is online

Focus on the following to assist in decision-making

1) Vessel valuation & condition (as of 2019)
2) Hull condition
3) Propulsion study
4) Generator study
5) Recommended maintenance/modification
6) Risk assessment

Key Findings

Structural/Mechanical

- Overall excellent condition
- Steel structures - serviceable for 20 years
- Mechanical systems – serviceable for 10 years

Maintenance Expenses

Item	2-year outlook	5-year cost outlook	10-year cost outlook
Main Engines	$250,000.00	$500,000.00	$1,000,000.00
Z-drives	$250,000.00	$600,000.00	$1,200.000.00

Key Findings – Vessel Valuation

2-year Projection

The estimated costs/values of the M/V Guemes in two [2]-years (2021) is as follows:

Fair Market Value	$2,188,000.00
Cumulative Cost to Cure	$1,500,000.00
Difference of between cost and FMV	$688,000.00

5-year Projection

The estimated costs/values of the M/V Guemes in five [5] years (2024) is as follows:

Fair Market Value	$1,367,500.00
Cumulative Cost to Cure	$3,750,000.00
Difference of between cost and FMV	($2,383,500.00)

10-year Projection

The estimated costs/values of the M/V Guemes in ten [10] years (2029) is as follows:

Fair Market Value	$3,444,000.00
Cumulative Cost to Cure	$9,818,322.00
Difference of between cost and FMV	$(6,374,322.00)

Key Findings - Risk

Physical Risks (Machinery)

- Relatively low for next 10 years – thru 2029
- Increase with time

Regulatory Risks

- Major refit – excessive modifications to meet future regulations
- Increase with time

Financial Risks

- High regardless of option
- Increase with time