NEW NORTH BAY FERRY

Alternative Propulsion Study

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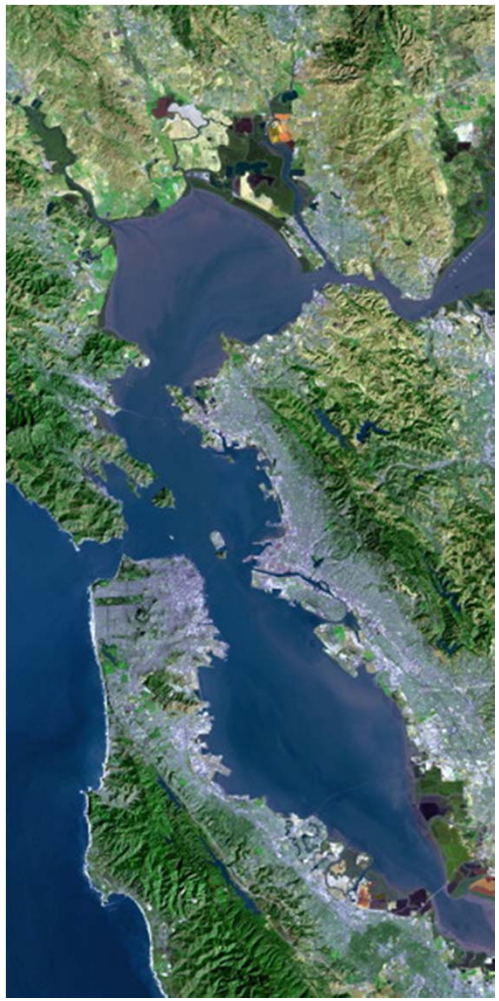
Elliott Bay Design Group

North Bay Routes



- Commuter ferry operating between Richmond, Vallejo and San Francisco
- 4.5 hours continuous operation
- 34 knots required to keep schedule

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Propulsion Evaluation Factors

- Displacement: The overall total weight of the vessel
- Commuters: The number of passengers that can be carried
- Commonality: The similarity of the vessel to the existing fleet for crew/terminal interchangeability
- Cost: The capital and lifecycle cost of the vessel
- Emissions: The ability of the vessel to meet regulatory requirements.
- Regulatory Environment: The maturity of the applicable regulations to facilitate design and construction.

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Baseline Vessel

- AMD386 aluminum catamaran hull
  (43.6 m Length x 12.0 m Beam x 1.65 m Draft)
- Diesel engines driving waterjets (6866 HP)
- Capacity (446 passengers)
- Integrated SCR to achieve Tier 4 emission requirements

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Alternative Propulsion Systems

- Fuel Cell: electric propulsion with power generated from liquid hydrogen
- Hybrid: combined diesel-electric propulsion for higher overall efficiency of operation
- LNG / LPG: mechanical propulsion using cleaner fuel for improved emissions
- Wind / Wind Assist: renewable energy to assist vessel mechanical propulsion

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Fuel Cell

- Potential benefits
  - Zero emissions (water and heat only)
  - Silent operation
- Vessels in operation
  - Predominantly limited to small inland water taxi/ferry operations (no known US certified K-vessels)
- North Bay vessel application
  - Significantly heavier vessel (42 LT), equivalent to 505 passengers
  - Fuel is expensive to manufacture, shoreside infrastructure would be required
  - Fuel storage and cell location restricts passenger space and places weight high on vessel
  - Construction standards still under development

Hybrid

- Potential benefits
  - Improved fuel consumption and emissions
- Vessels in operation
  - A number of electric/hybrid vessels in service, no high speed catamarans
  - Peak shaving or Low speed operation options
- North Bay vessel application
  - Increased capital costs and complexity
  - Depending on arrangement, may require shore-side charging
  - Decreased fuel consumption not realized on North Bay routes
  - Significantly heavier than baseline (27 LT), could maintain displacement with reduction of 328 passengers

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LNG / LPG

- Potential benefits
  - Reduced emissions and maintenance
  - Fuel is inexpensive and naturally abundant in North America
- Vessels in operation
  - Numerous, but only one high speed ferry… not US, much larger, carries 1000 passengers, 150 vehicles, powered by dual fuel gas turbines
- North Bay vessel application
  - Complex fuel storage systems, gas boil-off can result in methane release, methane slip in operation
  - Fuel infrastructure and availability limited
  - Fuel has lower energy density per gallon and cannot be stored below accommodation spaces
  - Significantly heavier than baseline (21LT), could maintain displacement with reduction of 132 passengers

Wind/Wind Assist

- Potential benefits
  - Energy is free and renewable
  - No emissions or operational noise
- Vessels in operation
  - Current applications predominantly limited to large cargo vessels
  - Wind+Wing Technologies demonstration vessel on SF Bay
- North Bay vessel application
  - Route, wind profile, and operational speed limit the wind assist to limited vessel headings
  - Increases drag (when wind reduced)
  - Wind inconsistency requires full power to be installed on vessel
  - Heavier than baseline (15 LT), could maintain displacement with reduction of 87 passengers

Comparison

	Baseline	Fuel Cell	Hybrid	LNG/LPG	Wind
Displacement 190 LT					
Commuters 446		-60	118	314	359
Commonality Current					
Cost Capital/Lifecycle					
Emissions EPA Tier IV					
Regulatory Known					

Recommend Baseline Propulsion for WETA North Bay Ferry

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Environmental / Technology Initiatives

- Foil assist
- Interceptors*
- LEDs*
- Solar power+
- Fabrics+
- Reduced use of paint*
- Thermal insulation*
- High efficiency motors*
- Variable frequency drives*
- Multiple pane windows (or low-emissivity films*)

* - Included in solicitation for North Bay Vessels

+ - Considering and under review

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Future Opportunities for alternative propulsion

- Ideal for operations such as:
  - Shorter routes with lower service speed
  - Vessels with low weight sensitivity
- Potential Example:
  - Treasure Island route
- Opportunity for alternate propulsion methods in other applications such as sight-seeing and excursion vessels

Questions?

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