Conversion to LNG
Challenges and Opportunities for Washington State Ferries

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System Overview

- More than 22 million riders per year
- 10 million vehicles carried per year
- Fleet of 23 ferries that carry 34-202 cars and 750-2,500 passengers
- 20 terminals on 10 routes
- 450 daily departures
- 1,800 employees
World Leader

• Largest system in the United States
• Fourth largest carrier of passengers in the world
• Largest carrier of vehicles in the world
## Route Characteristics

<table>
<thead>
<tr>
<th>Route</th>
<th>Commuter</th>
<th>Tourist</th>
<th>Island link</th>
<th>Commercial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anacortes/Sidney</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anacortes/San Juan Islands</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Port Townsend/Coupeville</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Mukilteo/Clinton</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Edmonds/Kingston</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Seattle/Bainbridge Island</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seattle/Bremerton</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fauntleroy/Vashon/Southworth</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Point Defiance/Tahlequah</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>
**Fuel Costs**

- WSF burns more than 17 million gallons of ultra-low sulfur diesel each year.
- Fuel is the fastest growing operating expense – more than 29% of 2011-2013 budget compared to 12% in 2000-2001.
- WSF’s 2013 fuel budget is $74.3 million – $58.7 million more than 13 years ago.
Fuel Initiatives

WSF has embarked on several fuel initiatives:

- Slowing as sailing schedules allow
- Operating on fewer engines
- Exploring ways of holding vessels in the dock with less power
- Fuel hedging
- Hyak hybrid pilot project
- Liquefied natural gas
Exploration of LNG

- WSF is exploring an option to use LNG as a source of fuel for propulsion.
- This is an opportunity to reduce fuel costs and decrease emissions.
- Conceptual approval has been received from the U.S. Coast Guard to retrofit propulsion systems with new engines on all six Issaquah Class ferries.
- U.S. Coast Guard ruled LNG not considered a major conversion.
# Potential Fuel Savings

**Issaquah Class**

<table>
<thead>
<tr>
<th>Vessel</th>
<th>Usual Route</th>
<th>3-year Avg. Annual Diesel Gallons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Issaquah</td>
<td>Fauntleroy - Vashon – Southworth</td>
<td>601,000</td>
</tr>
<tr>
<td>Kitsap</td>
<td>Seattle - Bremerton</td>
<td>755,000</td>
</tr>
<tr>
<td>Kittitas</td>
<td>Mukilteo - Clinton</td>
<td>450,000</td>
</tr>
<tr>
<td>Cathlamet</td>
<td>Mukilteo - Clinton</td>
<td>514,000</td>
</tr>
<tr>
<td>Chelan</td>
<td>Anacortes - Sidney</td>
<td>764,000</td>
</tr>
<tr>
<td>Sealth</td>
<td>Anacortes – Friday Harbor</td>
<td>633,000</td>
</tr>
</tbody>
</table>

**Total average annual diesel gallons**

3,717,000

**85% of diesel gallons converted***

3,159,000

**Projected Annual savings**
(approx. $2/gal. of diesel replaced)

$6.4 million

**Projected LNG gallons**

5,370,000

* Approximately 15% diesel remaining for ship service and emergency generators
## Overall Financial Benefits

<table>
<thead>
<tr>
<th>Project Element</th>
<th>Discounted Values (3% Discount Rate)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Six Issaquah Class Vessels NPV Fuel Savings for 23-25 years</td>
<td>$112.1</td>
</tr>
<tr>
<td>Social Benefits of Carbon reduction</td>
<td>$5.3</td>
</tr>
<tr>
<td>Social Benefits of particulate matter reduction</td>
<td>$61.3</td>
</tr>
<tr>
<td>Social Benefits of NOx reduction</td>
<td>$21.7</td>
</tr>
<tr>
<td><strong>Total Benefits</strong></td>
<td><strong>$200.5</strong></td>
</tr>
<tr>
<td>Design</td>
<td>$0.3</td>
</tr>
<tr>
<td>Shipyard Contract and Integrator</td>
<td>$36.5</td>
</tr>
<tr>
<td>Construction Engineering</td>
<td>$0.9</td>
</tr>
<tr>
<td>Owner Furnished Equipment</td>
<td>$34.6</td>
</tr>
<tr>
<td>Risk and Escalation</td>
<td>$8.9</td>
</tr>
<tr>
<td><strong>Total Costs</strong></td>
<td><strong>$81.2</strong></td>
</tr>
</tbody>
</table>

- Benefit Cost Ratio: 2.47
- NPV, fuel + emission benefits: $119.2
- NPV, fuel benefits only: $30.9
- ROI, fuel + emission benefits: 8.5 years
- ROI, fuel only: 14 years
- Average Annual fuel savings per vessel: $1.1 million
Challenges of Retrofit - Physical

- Upper deck tank location reduces available space for passengers on classes other than Issaquah
- Fuel lines run in existing casing in a double wall configuration; bunkering from main deck requires pumping LNG from truck to upper deck
- Installation of new gas engines:
  - Gas engines are larger and heavier
  - Engine performance – critical for maneuvering, crash stop, acceleration – is lower for a gas engine than a diesel engine
- Maintaining system safety with the use of a cryogenic fluids as fuel. Handling and storage of LNG requires:
  - Double-walled piping, double-walled tanks and cold box for leak containment
  - Ventilation and gas supply monitoring
  - Nitrogen purge system for gas supply and lines
  - Dry chemical fire extinguishing system
- Dependable access to reasonably priced LNG sources is critical to successful conversion
Tank Location on Upper Deck

Issaquah Class

Advantages
- Ease of Installation: no major structural modifications
- Leaks naturally dissipate into the atmosphere
- Maintenance
  - Easy access to all components
  - Flexible arrangement of piping and vent systems
- Area is isolated from passenger space on Issaquah class

Disadvantages
- Bunkering requires a dedicated cryogenic pump
- Glycol vaporization system run from the engine room
- Tanks separated from the engine room crew
- Pumping LNG adds heat to the fluid reducing the fueling rate
Above Deck Arrangement

Two tanks: 24,440 gallons each. Total: 48,880 gallons
Challenges of Retrofit - Other

- Initial capital investment – $84.5 million
- LNG availability
- Crew training
- Crew acceptance
- Improve internal/external communication
- Public perception
- Lack of U.S. Coast Guard regulation for vessel and terminal LNG operations (i.e. training, credentials, potential refueling). Unknows could significantly affect operating budgets.
Next Steps

• Complete Safety and security assessments and plans
• Obtain U.S. Coast Guard approval for detail design
• Complete final design
• Obtain Funding for retrofit construction
• Train crews
Questions?

For more information about the WSDOT Ferries Division, please contact:

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