

**JOINT TRANSPORTATION COMMITTEE
EVALUATING THE USE OF LIQUEFIED NATURAL GAS
OCTOBER 19, 2011**



**CONSULTANT TEAM:
CEDAR RIVER GROUP
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2011 legislature directed the Joint Transportation Committee to:

- Investigate the use of liquefied natural gas (LNG) on existing Washington State Ferry (WSF) vessels as well as the new 144-car class vessels and report to the legislature by December 31, 2011 (Transportation Budget)

The study is to:

- Assess WSF's work and studies
- Identify the full range of issues
- Analyze the cost, risk, timeline, and related implications of
 - Changing the design of the new 144-car vessel to LNG
 - Retrofitting Issaquah class vessels

WSF Reports

144-Car Ferry Conversion
Issaquah Class Conversion

Concept Design & Life-Cycle Cost
Schedule

Other Reports

California Energy Commission
Danish Ministry of Environment
Det Norske Veritas
Fjord1

MIT
US Energy Information Admin.
Washington State - Commerce
WA State Utilities & Transportation
Commission

Interviews

BC Ferries
Energy Providers
Fjord1

Poten & Partners
US Coast Guard

Fleet Acquisition and Deployment Plan

- 22 vessel fleet with planned 2 new-144 car vessels
- First new 144-car vessel (2014)
 - 2011-13 budget – diesel ferry
 - *Evergreen State* retires
- Second new 144-car vessel (if diesel 2015)
 - 16-year financial plan – vessel is either diesel or LNG
 - *Hiyu* retires
 - Increase service capacity – San Juans, Mukilteo, Fauntleroy-Vashon-Southworth

WSF

- Mix of ultra low sulfur diesel (ULSD)/biodiesel
- 2010 – used 17.3 million gallons (21 boat fleet)
 - 41% 5 Jumbo Mark I and II
 - 27% 4 Super Class
 - 22% 6 Issaquah Class
 - 10% 6 small vessels
- Issaquah class ferries – 3.7 million gallons in 2010
 - Ranges by vessel from 0.5 million gallons to 0.8 million gallons per year depending on the route
- Cost – 29% of 2011-13 biennium budget - \$135.2 million
 - June forecast \$4.30/gallon FY 2012 - \$4.33/gallon FY 2027
 - Sales tax eliminated July 1, 2013

Takes Effect in 2012 – Sulfur & nitrous oxide content requirements

- Little impact on WSF
- WSF uses ULSD - meets sulfur oxide content regulations
- WSF engines meet the nitrous oxide requirements
- Tier III compliant engines required after 2016 for new construction and/or major engine upgrades in existing vessels may have some impact

LNG

- Natural gas cooled to -259 degrees Fahrenheit
- Must be kept at that temperature or returns to gas

LNG Fueled Vessel

- 300 LNG carriers worldwide – none US flagged

LNG Fueled Ferries

- Operating in Norway only
- First LNG ferry built in 2000 –now approximately 16
- Fjord1 experience – operates 12 LNG ferries

Capital cost – 20% higher

Fuel cost – slightly higher than diesel

Single fuel (LNG only) engine

Bunkering – by truck or storage tanks

Maintenance cost – 10-20% higher

Crew size – same as diesel

Economics Different Than Norway

- LNG less expensive in U.S. than Europe

US Natural Gas – 89% Domestic

- 9% pipeline imports from Canada & Mexico
- 2% LNG imports mainly from Trinidad and Tabago

Forecasts – Stable & Growing Domestic Supply

- Shale gas supply discovery
- Allowing import terminals to export domestic LNG

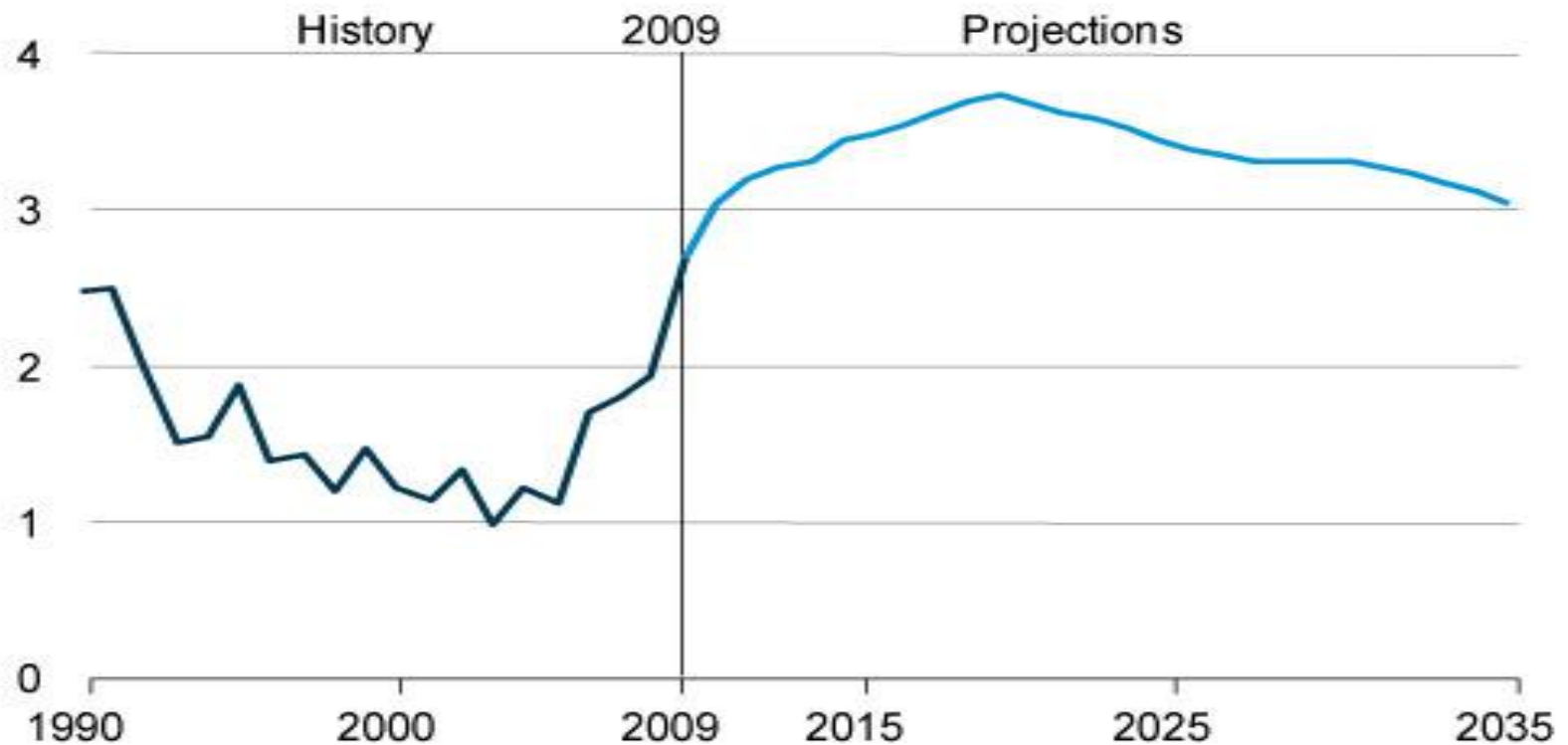
Forecasts – Stable Price – Lower Than Diesel

Natural Gas/LNG Prices Volatility

- Spikes 2000-1, 2005, 2008
- Factors could increase future prices – difficulties extracting shale oil, drilling restrictions, US policy change to encourage natural gas autos

US ENERGY INFORMATION ADMINISTRATION – DIESEL PRICES PROJECTED TO BE APPROXIMATELY 3.5 TIMES HIGHER THAN NATURAL GAS

Figure 87. Ratio of low-sulfur light crude oil price to Henry Hub natural gas price on an energy equivalent basis, 1990-2035



Integrated Resource Plans

- Required every two years by Washington State Utilities & Transportation Commission of 5 utilities operating in Washington State
- 2010 & 2011 IRPs show lower prices than IRPs filed in 2008-09
- All IRPs project relatively stable natural gas prices through 2030

Three Types of Facilities

- Terminals
 - East & Gulf Coast
 - FERC approved import terminal at Coos Bay
 - ✓ Not under construction
 - ✓ Controversial – not included in any IRP forecasts
- Liquefaction facilities – convert natural gas to liquid
- Storage facilities – store LNG
- Six liquefaction &/or storage facilities in the Pacific Northwest
 - Support utilities

Two supply options

- Participate in a liquefaction facility
- Truck to WSF by third party
- Recommend – trucked by third party
 - Experience in Norway, Phoenix Transit
 - Liquefaction facilities – expensive, difficult to permit

Price forecast for WSF LNG

- Consultants forecast – \$1.25 per gallon 2014 trucked (outside Northwest) to \$1.52 per gallon in 2027
- Energy equivalent basis (i.e. it takes more LNG to get same energy as diesel)
 - 47% less cost than June diesel forecast 2014 / 40% less in 2027
- Annual savings will depend on vessels and routes
- Forecast basis
 - Transportation Revenue Forecast Council + factors from Poten & Partners – independent energy consultants

Other Agencies

- Phoenix – 315 LNG fueled buses
 - 2011 - \$1.05 per gallon delivered (pre-tax)
 - Prices peaked in 2008 at \$1.60 per gallon
- BC Ferries – considering a conversion
 - Anticipate a 60% savings
 - Nearby liquefaction facility (Fortis)

Bunkering (i.e. refueling)

- Two options
 - Truck delivers to a terminal facility
 - Truck drives on to ferry
- Norway – operators prefer terminal facility

Impact on Vessel Speed, Performance, Maintenance

- Minimal impact on speed and performance
- Maintenance – based on Norway's experience – higher cost

Engine

- Two options
 - Single fuel (LNG only) – more fuel efficient, greater emissions reduction, operationally more certain
 - Dual fuel (LNG/Diesel) – allows to change fuels if price or supply problems with either LNG or diesel

Regulatory Requirements - Design

- No US rules so Coast Guard using alternative approval authorization & international rules
- WSF work – most advanced for LNG passenger vessel in the U.S.
- USCG has provided letter as basis for design review with caveat that there may be more requirements
- Risk analysis required for LNG vessels
- Potential – Major conversion application for Issaquah class retrofit

USCG

- USCG not yet begun to develop operational rules
- Design letter – states will most likely require clearing vehicle deck during fueling
- Rules for LNG carriers – bunkering
 - USCG supervision
 - Training of ship and shore personnel
 - Specification of a person in charge
 - Fuel staffing requirements
 - Length of duty restrictions on fueling staff
 - Restricted areas of operation

Final report - consultants will compare WSF findings with our independent findings

WSF New 144-car Vessel

- USCG letter provide basis for design review
- Design basis – Seattle-Bremerton
- Dual and single fuel engine options considered
- Fuel tanks above passenger deck (Norway below)
- Bunkering assumed – by truck at night
- Auxiliary generators – remain diesel

WSF Issaquah Class

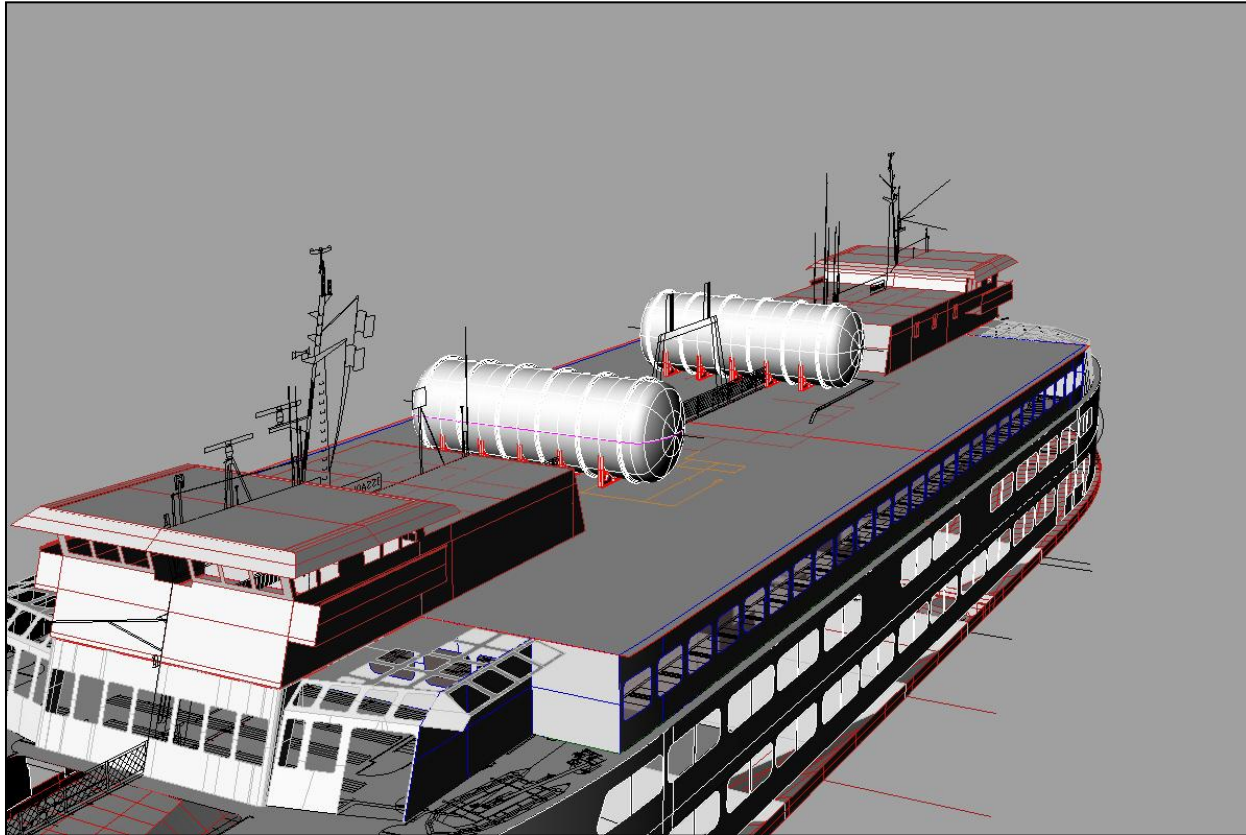
- Request for regulatory review – submitted Sept. 2011
- Similar design to new 144-car LNG vessel

NEW 144-CAR LNG VESSEL

LNG fuel storage tanks



ISSAQUAH CLASS LNG CONVERSION



WSF LNG COST ESTIMATE – 144-CAR VESSEL

Per vessel New 144 (\$ millions)	Duel Fuel Diesel/LNG	Single Fuel LNG	Diesel
Construction	\$8.5	\$9.9	\$2.5
Design (one-time)	\$0.8	\$0.8	
Total with design	\$9.3	\$10.7	\$2.5
Operation First Year			
Diesel (\$3.65/gallon)	\$0.1		
LNG (\$1.05/gallon)	\$1.4	\$1.3	
Engine M&R	\$0.3	\$0.1	\$0.2
Total	\$1.8	\$1.4	\$2.7
Life -Cycle Cost– 30 years			
	\$47.5	\$40.8	\$61.2

WSF Analysis

Over 30 year life, single fuel LNG engine option is the least expensive.

Assumes LNG costs \$1.05/gallon

Six vessels

- Capital cost - \$65 million
- Annual fuel savings - \$9.8 million
- Payback – 7 years

New 144 Schedule

- First diesel – 2014
- Second LNG – 2016

Issaquah Class

- 18 months review, design, bid
- 6 months construction each

FULL RANGE OF LNG CONSIDERATIONS THAT WILL BE CONSIDERED BY CONSULTANTS

- Fleet plan
- Design
- Capital cost
- Operation cost
- Security
- Life-Cycle cost
- Public reaction

Norway research

- Design
- Retrofit
- Fueling
- Staffing

Cost Estimate

- Use Norway data to develop independent construction cost estimate
- Total project cost
- Norway data – project preservation & operation maintenance cost
- Fuel – confirm price projection

Implementation

- Sequencing – affect on fleet plan and out-of-service time/preservation
- Security
- Public outreach