EXHIBIT NO. ___(MFB-3HC)
DOCKET NO. UG-15____
WITNESS: MELISSA F. BARTOS

BEFORE THE
WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION

In the Matter of the Petition of **PUGET SOUND ENERGY, INC.** **for (i) Approval of a Special Contract for Liquefied Natural Gas Fuel Service with Totem Ocean Trailer Express, Inc. and (ii) a Declaratory Order Approving the Methodology for Allocating Costs Between Regulated and Non-regulated Liquefied Natural Gas Services**	**DOCKET NO. UG-15____**

SECOND EXHIBIT (HIGHLY CONFIDENTIAL) TO THE PREFILED DIRECT TESTIMONY OF MELISSA F. BARTOS ON BEHALF OF PUGET SOUND ENERGY, INC.

HIGHLY CONFIDENTIAL PER
WAC 480-07-160

AUGUST 11, 2015

MARKET ASSESSMENT OF LIQUEFIED NATURAL GAS AS A DISTRIBUTED FUEL IN WASHINGTON STATE

Prepared for:

Puget Sound Energy

September 19, 2012

I. EXECUTIVE SUMMARY

Puget Sound Energy ("PSE") is evaluating liquefied natural gas ("LNG") as a fuel option for certain markets in the Pacific Northwest, specifically the state of Washington and the western Columbia River Port ("market area"). PSE retained Concentric Energy Advisors, Inc. ("Concentric") to provide a market assessment for several potential LNG markets including heavy duty on-road transportation, marine, rail, and industrial conversion markets.[1] In addition, PSE requested that Concentric assess the market for LNG to compressed natural gas ("CNG") in on-road and off-road fleet applications. Last, Concentric considered PSE's strategic advantages and the roles of potential competitors and/or partners to PSE in serving these markets.

Concentric provides this report to supplement PSE's decision criteria regarding LNG market demand and strategic positioning. Major price and supply assumptions and certain of Concentric's findings are summarized as follows:

- Basing oil prices on the Energy Information Administration ("EIA") Long Term Energy Outlook ("AEO") dated June 2012, Reference Case oil prices, the resulting Ultra Low Sulfur Diesel ("ULSD") prices in the market area will remain significantly above the expected cost of LNG from PSE's proposed greenfield LNG facility to allow customers to payback investments for conversion of engines and related equipment. The EIA's Reference Case Long Term Energy Outlook, August 2012 forecasts crude oil prices to rise to 170 USD per barrel by 2025. ULSD, which sells at a premium to crude prices, is currently used in the heavy duty trucking market, and its price will drive economic considerations for future industry conversions. Beginning in 2015, marine vessels operating in the North American Emission Control Area or ECA [2] must use marine oil that contains only 0.1% sulfur. For purposes of this report, the forecast assumes on-road ULSD and 0.1% sulfur marine fuel are equal in price.

- While there is LNG production in Washington and northern Oregon, this LNG supply is generally part of the integrated resource portfolio of the local distribution companies serving the region, including PSE. These LNG facilities could be used to provide bridging supply for the new, distributed LNG markets that develop until a new LNG facility is built. PSE has collaborated with potential bridge suppliers of LNG, notably Fortis BC in Vancouver, BC, as sources of LNG supply in the event demand for LNG from new markets precedes the availability of LNG from a new liquefaction facility in the market area.

- Only two markets, marine and heavy duty trucking, will contribute measurably to distributed LNG demand in PSE's market area:

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1 Initially, Concentric was retained to consider electric and gas peak shaving markets, microgrid markets and LNG supply context and alternatives associated with serving potential markets. Through mutual agreement with PSE, in early July 2012, PSE and Concentric reduced the work scope to consider only the stated markets.

2 The ECA is any area within 200 nautical miles of the North American coastline.

- Marine customers in the market area that must comply with ECA regulations are numerous. Excluding ocean traffic (vessels that operate internationally and largely outside the ECA), Concentric estimates that the ECA-compliant shipping market could consume as much as 1,000,000 LNG gallons per day[3] of fuel if 100% of the vessels operating in the market area converted to LNG. PSE is advantaged to possibly serve marine LNG markets that are significantly more active than elsewhere in the United States. Specifically, LNG as a marine fuel has been publically endorsed by two major marine customers in PSE's market area, Washington State Ferries ("WSF") and Totem Ocean Trailers Express ("TOTE"). Both potential customers have implementation plans and, to a large degree, have regulatory support to convert a portion of all of their marine-based fleets to LNG over the next few years. In addition, several other large marine customers could convert to LNG based on LNG's availability in the Puget Sound area, emulating conversion activities of WSF and TOTE. By 2020, Concentric forecasts demand in the marine market to exceed 170,000 LNG gallons per day or a market penetration level of about 20%.[4]

- Based on Concentric's analysis, demand for LNG in the heavy duty truck (Class 7&8) transportation market could to grow over the next several years from its current level to over 100,000 LNG gallons per day by 2020. The majority of demand comes from national and interstate long-haul fleets and assumes an adaption rate of between 5-8% in these two segments. Overall, Concentric forecasts a 2020 market area adoption rate in the Class 7&8 segment of approximately 7%.

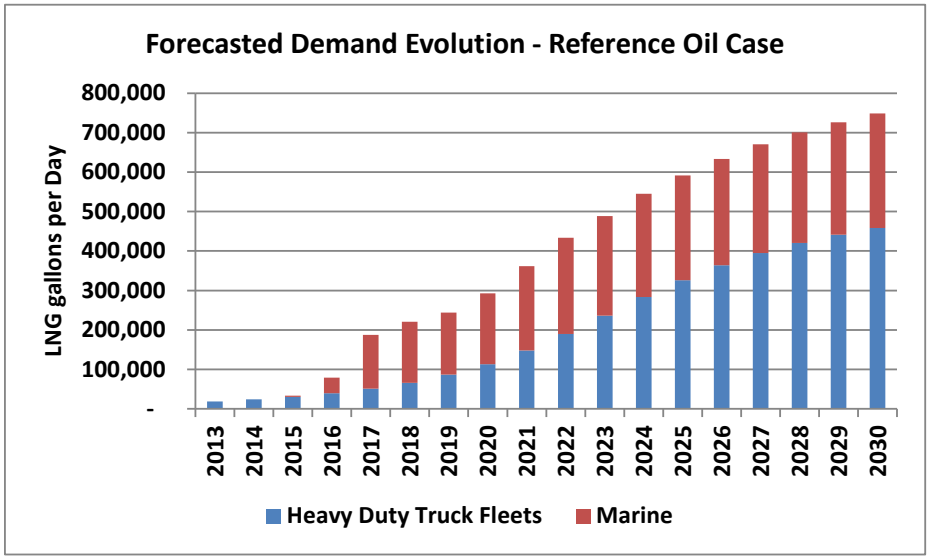
	LNG gallons per day	
EIA on-highway diesel use - 2010	2,838,873	
Est. diesel use in western Washington	2,129,155	
Class 7&8 use in western Washington	1,596,866	
Concentric forecasted market penetration by 2020	113,399	7.1%

- The trucking market demand, when combined with marine demand, could total 300,000 LNG gallons per day by 2020 and provide PSE with enough market demand to construct and operate a LNG production facility with a capacity of up to 300,000 LNG gallons per day.

[3] This includes the summer-only cruise ship market of approximately 500,000 LNG gallons per day.

[4] Since cruise ships provide summer-only demand, average daily demand on a 365-day basis is about 750,000 LNG gallons per day.

Figure 1



- Demand for LNG in the thermal conversion market is extremely limited. Most industrial customers in the market area currently use gas or, if not gas, then self-provided biomass. Only 1-2 larger industrial customers in the market area could be targets for on-site LNG as a fuel option.

- Demand for LNG in the rail segment could be viable in later years (2025+) but will not be developed in the short or medium term due to slower developing dual fuel (gas and diesel) locomotive engine technology. The rail industry needs high horsepower engines and LNG fueling along major rail routes in order to become a significant market for PSE's LNG.

- There is demand for CNG in the market area consisting of lighter duty vehicle applications and return to base/slow fill heavier duty applications (transit buses, garbage trucks). LNG to CNG does not appear to compete favorably against pipeline CNG and therefore does not contribute significantly to LNG demand unless CNG is produced at an existing LNG fueling stations (the LNG is already on-site; CNG is produced from the on-site LNG). In addition, if fleets commit to CNG under medium to long term contracts prior to the in-service date of PSE's LNG facility, it will be difficult for PSE to capture market share. Concentric has not included CNG demand from LNG in its LNG demand evolution.

- Regulatory oversight and permitting of LNG are critical factors in the success of LNG as a distributed fuel. Regulations for LNG use as a vehicle fuel are developed and known; National Fire Protection Association ("NFPA") 57 and 59A are currently used by the industry and its regulators. Rules and procedures for LNG as a marine fuel are still being developed. It is in PSE's interest to understand existing regulations for LNG as well as participate in the development of any new requirements.

- Federal, state and local tax and other incentives that encourage the use of LNG as a distributed fuel are currently very limited with the majority of federal tax incentives for fueling infrastructure and fuel tax having expired at the end of 2011. Of note, LNG as a transportation fuel currently suffers from two tax *penalties* – a) a penalty associated with the lower energy content of an LNG gallon versus a diesel gallon yet both are taxed equally on a volumetric basis ("gallon tax penalty") and b) a second penalty associated with the excise taxes on the higher gross cost of LNG engines versus diesel engines ("excise tax penalty"). While Concentric believes that the gallon tax penalty will be resolved in early 2013, it believes the excise tax penalty will remain. In summary, tax and funding incentives could materialize but currently do not play a significant role in expected LNG demand evolution.

II. RESEARCH AND ANALYSIS

Purpose of the Report

PSE retained Concentric to assist PSE with the evaluation of certain distributed LNG and LNG to CNG markets. The report contains the following five sections:

1. **Market Context –** This section identifies the relative competitiveness of LNG and LNG to CNG as a competing fuel against diesel and ULSD in the market area.

2. **Evolution of demand –** This section will quantify the demand forecast and certain scenarios for each of the following markets:

    a. **LNG as a transportation fuel in the marine segment**

    b. **LNG as a transportation fuel in the heavy duty truck segment**

    c. **LNG in the rail segment**

    d. **LNG industrial thermal conversion segment**

    e. **LNG to CNG for use as a transportation fuel primarily in lighter duty fleets**

    Each market analysis will contain methodology for establishing the fleet inventories, expected annual fuel use of vessels/vehicles in the fleet, and projected evolution for LNG to capture market share under three price scenarios. In addition, factors that PSE can successfully influence in this demand evolution will be discussed.

3. **Competition and partners –** This section provides a high level summary of major competitors or partners for PSE to consider to profitably capture market share for LNG in the market area.

4. **Conclusion** – This section provides a summary of conclusions and findings based upon the research and market analysis conducted for this assignment.

5. **Appendix A-E** – This section provides price scenarios and information regarding the data and models that underlie the analysis. All data and models will be provided to PSE.

III. MARKET CONTEXT

There are two major factors driving expected demand for LNG as an alternative to oil-based fuels such as on-highway diesel oil, marine diesel and residual oil, and propane.

Economic

Demand for LNG as a distributed fuel in the market area is largely being driven by the price spread between natural gas products including LNG and CNG and refined oil products including marine fuels and on-road diesel.

Concentric and PSE collaborated in determining the long range price forecast for ULSD, the expected primary fuel used in the heavy duty transportation market and a proxy for marine fuel after 2015. The process was as follows:

- To forecast crude oil prices, for the period from 2012 and 2013, Concentric used the July 2012 EIA Short Term Energy Outlook oil price forecast; for 2014, Concentric extrapolated the oil price between EIA's short and long term outlooks. For 2015 and beyond, Concentric relied on the AEO 2012 Reference forecast for Low Sulfur Light Crude Oil ("LSLCO").
    - In order to approximate a forecast for the Washington state wholesale price for ULSD, Concentric reviewed historical spreads between EIA-reported historical LSLCO prices and North Slope Crude Oil prices. North Slope Crude is the feedstock for refiners in the market area that produce ULSD. Historical data shows little spread between LSLCO and North Slope Crude. As such, Concentric adopted the EIA short and long term forecasts for LSLCO as a proxy for North Slope Crude.
    - Based on market intelligence provided by PSE, given existing refining capacity in the Seattle-Tacoma area combined with higher demand from marine markets beginning in 2012 and tightening again in 2015, ULSD prices were set at 25% above North Slope Crude prices (red line in Figure 2 below). This price is at, or close to, the forecast for US transportation diesel fuel published by the EIA[5] (green line in Figure 2 below). Concentric and PSE also considered i) ULSD price forecasts produced by WSF in their late 2011 analysis of fleet conversion to LNG,[6] ii) TOTE's assumed ULSD price forecasts (not explicitly provided to PSE) which are much higher than the WSF forecast and iii) the potential for increased ULSD refining capacity in the Puget Sound area[7] which could decrease the relative ULSD price premium versus LSLCO. After considering several alternatives, Concentric and PSE agreed to use LSLCO AEO 2012 Reference prices at the 25% premium as the basis for the market

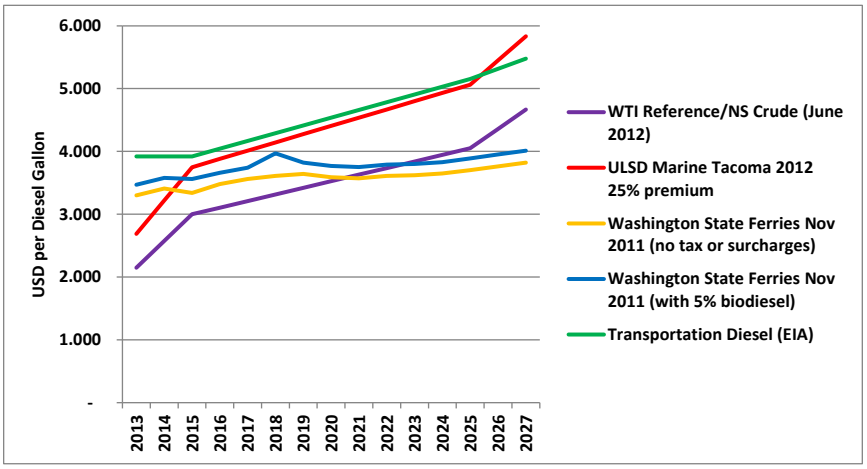
5 AEO 2012

6 Evaluating the Use of Liquefied Natural Gas in Washington State Ferries, Washington Joint Transportation Committee, January 2012, Exhibit 7

7 Incremental ULSD refining capacity is very expensive to build and very complex to operate. This adds significant risk to refiners who may be considering increasing ULSD capacity in the Puget Sound area. Refiners will try to recover these large investments through increased margins but there is no guarantee of investment recovery.

area ULSD price forecast ("ULSD Reference"). This forecast is shown in red in Figure 2 below.

Figure 2

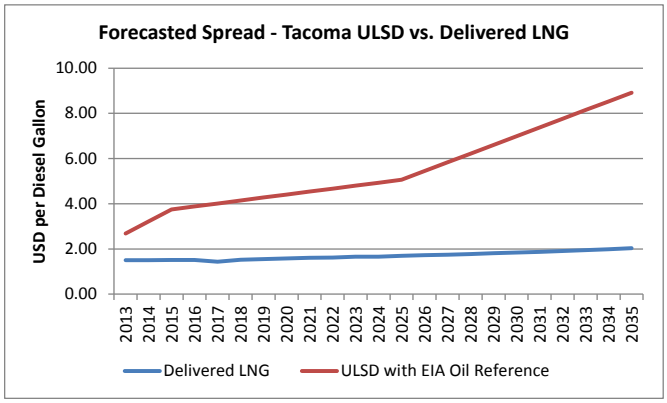


- Natural gas and LNG price forecasts were provided by PSE.

- The forecast used by Concentric also assumes that distributed LNG customer will be able to purchase LNG from existing LNG sources at a price of 10.00 USD per MMBtu for the period 2013 through Q3 2016, prior to the expected start date for new proposed liquefaction facility.

Figure 3

The forecasted spread between ULSD Reference and PSE LNG ("Reference Case Spread"), as expressed in USD per diesel gallon equivalent ("DGE"), is significant and can support investment in engine conversion and LNG fueling infrastructure in the heavy duty trucking, and as explained below, the marine markets.



- The marine market currently uses slightly heavier and therefore slightly less expensive grades of marine fuel oil than ULSD. This is expected to change in 2015 when local and coastal marine fleets must use fuels that emit <0.1% sulfur content when burned. Beginning in 2015, the forecast assumes that the price of 0.1% marine fuel equals the price of ULSD Reference. The spread between marine fuel and LNG and ULSD Reference and LNG will be significant enough to support conversion of vessels to LNG.[8]

- Forecasted price spreads between LNG and ULSD under the AEO2012 EIA "High Oil" and "Low Oil" cases are shown in Appendix A.

Environmental

- In the marine and heavy duty trucking markets, in addition to economic advantages of natural gas as a fuel, environmental regulations are also driving the move towards cleaner fuels such as natural gas.

- For the marine market, the US Environmental Protection Agency ("EPA") sets air emission standards under MARPOL Annex VI rules. These rules provide for limits for emissions of sulfur oxides ("SOx"), nitrogen oxides ("NOx") and particulate matter ("PM") applicable to US-flagged ships and foreign-flagged ships operating in US waters.[9]

- For the trucking market, as of December 2010, all heavy duty tractors are required by the EPA to use ULSD in order to comply with EPA standards. Some states further restrict air emissions, requiring national and interstate fleets to comply with the most restrictive standards in their operating area.[10]

- The reliance on higher grade fuels in these two markets puts upward pressure on cleaner diesel, such as ULSD. While crude oil and natural gas have strong price spreads, refined oil products, particularly ULSD command an additional premium above the crude price as refining costs are factored into the price and demand for ultra-light diesel grows. As such, stricter environmental regulations further expand the price spread between oil and natural gas-based transportation fuels.

- Both the marine and trucking market must rely on cleaner fuels such as natural gas to meet future sulfur and nitrogen oxide emission standards or they must rely on add-on technology, such as exhaust gas scrubbers, along with lighter grades of diesel fuel, to comply with the standards. These clean air standards, combined with the price spread between oil based fuels and natural gas based fuels, make conversion to LNG and CNG (for lighter transportation vehicles such as cars and light duty trucks) very attractive to reduce emissions and costs as compared to other alternatives to meet emissions requirements.

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8 See Figure 4 and Figure 6 below

9 As of August 1, 2012, the maximum sulfur content of fuel oil used within the Emissions Control Area ("ECA") around North America (generally 200 miles from the coast) will be limited to 1%. As of January 1, 2015, this falls to 0.1%. NOx emissions will be further restricted as of January 1, 2016.

10 For example, trucks operating in California must comply with California standards for reduction in particulate matter that are slightly more restrictive than in other states. Given that the major transportation corridor leaving the market area is interstate highway I-5, heavy duty long-haul trucks leaving the market area will likely have to comply with California air emissions standards.

IV. EVOLUTION OF DEMAND

a. Marine market

Factors influencing evolution

The evolution of demand for LNG in the marine sector is driven by several factors including:

- The forecasted sustainable price spread between oil-based clean marine fuel and LNG.
    - This includes a pricing structure between buyer (fleet owner) and seller (PSE) that allows, under multiple oil and gas price scenarios, recovery of invested capital costs of both parties over a reasonable payback period.
- PSE's willingness and ability to produce LNG for use in the market area.
    - The partnership and risk balance that is evolving between PSE, in contemplating the construction of LNG production capacity, and the potential marine customer base is a key driver in this sector's market evolution. The marine market is relatively concentrated, with few major players dominating the potential LNG conversion market (as compared to trucking fleet markets which are disaggregated). Both parties (PSE and the marine customer) must invest significant capital in infrastructure – PSE in liquefaction and storage, the customer in delivery methods, on-board engine retrofit and storage – for LNG to be considered a reliable, available alternative to oil-based marine fuel.
- The implementation of more restrictive EPA emissions requirements
    - Fleets will have several choices to make regarding compliance including the cost of installing emissions reducing equipment on-board the vessel. Maritime Executive recently reported that emission reduction equipment has technological and other challenges (deck space, increased fuel consumption) that may make LNG a better compliance alternative.
    - PSE's LNG plan is important to marine vessel owners to provide evidence to EPA and United States Coast Guard ("USCG") that implementation of LNG fueling is a viable option for compliance. In TOTE's case, an LNG implementation plan was an important factor for TOTE to gain approval from the EPA and USCG for a small but important delay in ECA compliance. This delay could give vessel owners the necessary permitting, engineering, design and construction window to convert to LNG versus install emissions reduction equipment.

- PSE's support of vessel owners in any EPA or USCG regulatory review of LNG conversion plans will help PSE gain market share in this sector.

- The ability for the converted fleet to find sources of LNG in expected trade routes and in the aftermarket.

  - Similar to truck fleets that travel outside the market area, marine fleets must have refueling options in the expected trade where fleet is or may be deployed. If LNG is not widely available in North America and around the world, vessels reliant on LNG fueling may have lower portfolio value[11] and resale value than vessels relying on traditional oil-based marine fuels. The development or lack of development of LNG fueling in other global markets will also affect the re-sale value of LNG ships.

- Marine fleet owners must account for the incremental cost of conversion including the capital cost of LNG engine and on-board fueling system and/or the incremental cost of new builds

Fleet owners must take into account all expected capital and expense-related costs associated with conversion to LNG and weigh those against fuel and technology costs associated with burning an oil-based fuel. Costs for LNG conversion include i) capital costs for LNG storage and fuel systems, ii) expense costs associated with any reduction in ship commercial space resulting from on board storage, fuel and environmental compliance systems, iii) the commercial time lost during the conversion process (either loss of incremental sailing time during conversion or time spent in a shipyard), iv) training time for mariners and fuel handlers, and v) incremental costs associated with regulatory oversight of new fueling or compliance systems. In looking at fleet conversion costs, Concentric has not estimated costs for items (ii) through (v) as there is little or no publically available information associated with such costs and each fleet and vessel will consider these costs differently[12] and review them against similar costs they will alternatively incur to install and operate exhaust gas scrubbers and Selective Catalytic Reduction ("SCR") on-board the vessels. As such, Concentric does not believe these other factors will substantially diminish forecasted LNG demand in this sector.

11 Fleet owners rely on the flexibility within their fleet to meet financial goals. If parts of the fleet cannot be used in multiple locations due to fuel availability restrictions, the overall value of the fleet is reduced.

12 This will be information that PSE will likely gather in conversations with its customers.

PSE's Role

- The demand for LNG as a marine fuel resides in a very concentrated set of customers. It is therefore important for PSE to understand the unique needs and wants of each potential customer.

- Capital investment by the customer and by PSE must be tightly coordinated. Given the demand from individual vessels once converted to LNG and the impact this demand can have on PSE's expected return from the proposed LNG facility, PSE and its potential marine customer must work in tandem to ensure LNG supply and LNG demand are as closely coordinated as possible.

- PSE should take an active role in the operational requirements associated with fueling marine vessels. Rules and regulations regarding marine fueling using LNG are under review with formal and informal stakeholders such as USCG, classification societies such as DNV and ABS, the International Maritime Organization ("IMO"), ship owners, fuel providers, LNG suppliers, equipment manufacturers, and consultants. Although PSE may ultimately play the role of LNG supplier and leave others technically, operationally and legally responsible for the custody transfer of LNG onto vessels, during this stage of LNG adoption, PSE must understand the requirements of LNG fueling and on-board storage of LNG. This is important in the timing of a customer's requirements for LNG; such timing will affect the demand growth served and economics of PSE's proposed LNG production facility.

- PSE can also work with other regional and national LNG suppliers that may provide LNG outside PSE's market area. Certain fleets need assurance that LNG will be available to vessels at multiple locations in their forecasted trade. For example, Horizon operates its fleet out of multiple locations along the Pacific coastline including Tacoma, Oakland, and Los Angeles as well as in Alaska and Hawaii. PSE can work with other utilities and LNG marine fuel providers to promote the development of marine fuel infrastructure in major ports within the ECA of the western US, Alaska and Hawaii. In addition, cruise ships operating within the ECA on the US west coast are also interested in converting to LNG but cannot do so unless LNG as a port fuel is developed in both the PSE market area (for Seattle/Vancouver to Alaska voyages in the winter) and the Southern California and Mexico markets (for winter voyages).

Determining inventory and expected fuel use of potential conversion fleets

Concentric relied on multiple sources to determine an inventory of marine fleets and vessels in the market area[13] including:

[13] Detailed marine fleet inventories, characteristics, owners, annual mileage estimates and evolution calculations will be provided to PSE in an Excel workbook. Data is summarized in Appendix C.

- Puget Sound Maritime Emissions Survey, 2007
- Washington Legislature Joint Transportation Committee report, 2012
- Washington State Ferries – Glosten Associates reports and presentations dated 2010, 2011 and 2012
- US Army Corps of Engineers Waterborne Statistics
- American Association of Port Authorities – Port Industry Statistics
- Northwest Ports Association
- Company websites

Vessels were then cross-referenced via United States Coast Guard (USCG) Vessel Documentation Database and Marine Traffic Database

Concentric then determined annual fuel requirement of certain vessels operating in the market area using multiple forecast methodologies and references including:

- Horsepower and annual mileage of vessel[14]
- Estimates from various industry reports including American Clean Skies Natural Gas for Marine Vessels, April 2012
- Route and schedule of vessel
- Multiple industry websites and presentations

Concentric then assumed that that any net incremental investments[15] in on-board LNG engine and fuel systems equipment would be recovered over a ten year period at a discount rate of 15% based on the annual estimated mileage for the vessel. Based on forecasted Reference Case Spread, [16]annual diesel use should be at or above the breakeven annual DGE threshold in order for the investment to make economic sense.

Figure 4 shows the approximate annual diesel gallon equivalent ("DGE") consumption that is necessary to break even on the conversion investment. Investment period is assumed to be ten years with IRR of 15%. This assumed IRR represents a relatively conservative assumption with regard to the break-even analysis.

Figure 4

		Reference Oil Case	
	Investment	Breakeven Annual DGEs	Breakeven Annual LNG Gallons
Tugs	$7.2M	239,679	402,660
Ferries	$12M	399,464	671,100
Ships	$20M	665,774	1,118,500
	$30M	998,661	1,677,751
	$40M	1,331,548	2,237,001

14 Information provided in the Puget Sound Maritimes Inventory report is based on 2005 reported figures. An updated report and inventory should be available in late 2012 but was not yet available for this assessment.

15 Investment estimates based on industry sources including American Clean Skies Foundation, Natural Gas for Marine Vessels, April 2012

16 Since marine vessels in North America must comply with a 0.1% sulfur cap starting in January 2015, the analysis assumes that 0.1% marine fuel and ULSD have the same commodity price in the market area for the period 2015 forward.

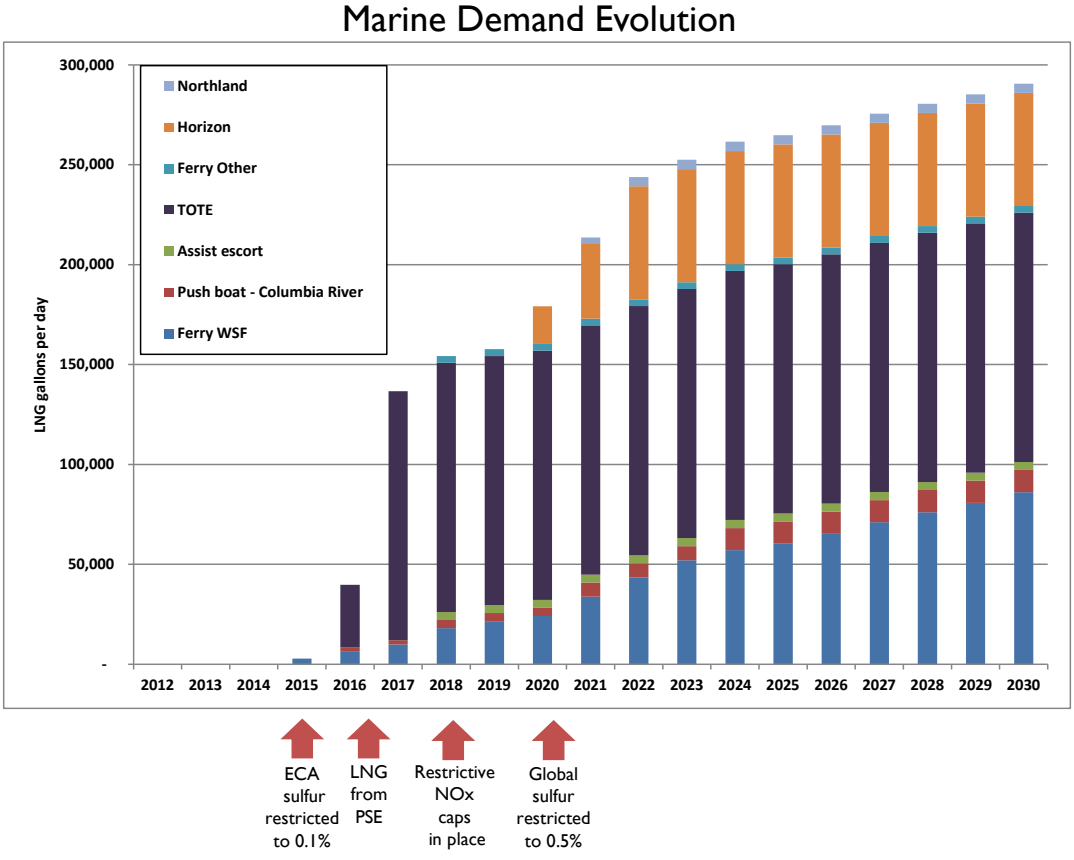
Of the vessels meeting annual estimated mileage needed to cover conversion investment costs, conversion dates for fleets and vessels are then estimated based on:

- Public information regarding intent to convert (WSF and TOTE)
- Environmental regulation drivers
- Regulatory or technical considerations associated with the use of LNG
- Availability of LNG from PSE or other market sources in vessel's anticipated trade route

Reference Case Evolution - Marine

- As shown in Figure 5 below, the LNG marine fuel market could exceed 170,000 LNG gallons per day by 2020.
- Cruise, ocean going, and other vessel conversions (designated "not active" below) may take place after 2020, but the location of LNG fueling alternatives in North America and around the world is currently the limiting factor.

Figure 5



b. Heavy duty trucking market

Factors influencing evolution

The evolution of demand for LNG in the heavy duty trucking sector is driven by the following primary factors:

- The forecasted sustainable price spread between ULSD and LNG
  - This includes a pricing structure between buyer (fleet or fueling station owner) and seller that allows, under multiple oil and gas price scenarios, recovery of invested capital costs of both parties over a reasonable payback period.
- In addition to the availability of LNG for use as a distributed fuel in the market area, the development of LNG fueling infrastructure outside the market area to support conversion of national and interstate fleets.
  - There is a certain amount of risk sharing that must take place among the LNG producer, the LNG distributor, and the LNG customer for the LNG truck transportation market to develop in the market area. The availability of LNG along major transportation routes outside the market area will have strong influence on demand evolution.
  - As shown later in this document, national fleets show the highest initial and overall potential for conversion to LNG. This is largely because of their ability to absorb financial and operating risks associated with LNG conversion, technology and training synergies among national operating fleets, and cost benefits of large scale conversion to a more economic fuel supply. In order to serve the needs of the national fleets, PSE should consider becoming part of a larger network of LNG suppliers to the market. Cooperation among LNG suppliers and distributors is necessary to build up the regional infrastructure that will support demand for LNG. This may result in PSE's role in the LNG fueling supply chain to be either more or less than originally expected.[17]
- The incremental cost of LNG engines/vehicles and LNG fueling station
  - LNG tractors currently cost approximately 30% more, or approximately $75,000 (including excise tax), than diesel tractors.
    - The analysis assumes that the incremental cost (and excise tax) of the LNG tractors is borne entirely by the customer

[17] PSE could simply play the role of LNG supplier or, in order to stimulate market adoption, PSE may have to work with partners or the customers themselves to develop fueling infrastructure to serve potential marine and transportation customers.

- The analysis also assumes that the tax "penalty" (LNG engines/fuel systems cost more than diesel; excise tax is paid on the total cost of the LNG system) continues throughout the forecast period.

- The analysis projects that there is no "salvage penalty" for the LNG tractor aftermarket. Given the LNG tractor market is in the early stages of development, there is the risk that the aftermarket for LNG tractors (primarily resale to overseas trucking companies) does not develop. Concentric believes that this aftermarket issue is offset by the industry expectation that LNG tractors will have a longer useful fleet life in North America.[18]

- As shown in Figure 6 below, using ULSD Reference prices, fleet owners could recoup their incremental investment (IRR would be greater than 0%) if the tractor averaged between 20,000 and 40,000 miles annually over a five-year period.

Figure 6

IRR	Annual Mileage					
	20,000	40,000	60,000	80,000	100,000	120,000
Low Case	(49.27%)	(36.43%)	(26.62%)	(18.13%)	(10.35%)	(2.98%)
Reference Case	(1.41%)	46.74%	113.38%	241.55%	679.17%	NA
High Case	40.73%	215.18%	NA	NA	NA	NA

- Assumes public fueling station charges minimum of $0.10 per LNG gallon[19] to recover the investment of the public fueling facility
- Low Case Breakeven at 170,000 miles

- A private, single fleet LNG fueling station can cost as much as 1-2 MUSD.
  - A fleet customer absorbing this cost must have significant centralized diesel requirements (either multiple trucks or multiples of miles per truck (as shown above in Figure 6) or combinations of the two as shown in Figure 7) in order to pay off the cost of the fueling station.
  - Figure 7 below provides indicative IRR on investment to gauge whether fleets can support the cost of private, centralized fueling

[18] In August 2011, Chuck Gordon, President and Chief Operating Officer of Heckmann Resources, stated that their expectation is that an LNG tractor purchased by Heckmann Resources in 2011 will have a useful life of over seven years versus a diesel tractor that has a useful life of only five years.

[19] The 2012 NACS Retail Fuels Report stated that retail fuel distributors have a 5-year average mark-up of 15.8 cents per gallon. This equates to approximately 10 cents per LNG gallon.

Figure 7

IRR	Annual Mileage					
Number of Trucks in Fleet	30,000	55,000	80,000	105,000	130,000	155,000
5	(42.64%)	(29.30%)	(18.42%)	(8.56%)	0.86%	10.15%
10	(30.80%)	(12.41%)	3.91%	20.07%	37.07%	55.73%
15	(23.27%)	(0.83%)	20.48%	43.28%	69.53%	101.73%
20	(17.81%)	8.06%	34.09%	63.92%	101.43%	153.12%
25	(13.60%)	15.27%	45.77%	83.00%	133.98%	213.57%
30	(10.22%)	21.28%	56.05%	100.98%	167.88%	287.41%
35	(7.43%)	26.42%	65.22%	118.12%	203.61%	380.82%
40	(5.09%)	30.87%	73.51%	134.57%	241.60%	503.65%
45	(3.09%)	34.78%	81.06%	150.45%	282.24%	673.16%
50	(1.35%)	38.24%	87.98%	165.82%	325.96%	922.86%

Based on fueling station cost of $1.5 M, payback period of 5 years, Reference Case Oil

- Availability of public LNG fueling stations
  - Availability of LNG along high-traffic trucking routes is essential to the development of the heavy-duty trucking market. LNG tractors can currently travel approximately 200-600 miles per LNG fill-up using currently available LNG tractor equipment. Most national and long haul fleets will want a network of LNG refueling stations every 100-200 miles in order to ensure adequate refueling capability.
- Availability of Original Equipment Manufacturer ("OEM") heavy duty LNG truck engines
  - The analysis assumes that demand in the LNG trucking market will be stimulated by the availability of high performance, mass-produced LNG OEM engines beginning in late 2013 and early 2014 from Westport, Cummins, Navistar and Volvo.
  - Mass production of LNG engines and tractors should serve to drive down incremental costs of LNG tractors. Concentric has not assumed such a benefit in this analysis.
- Cost and availability of compliance options regarding EPA clean fuel requirements
  - Concentric does not explicitly quantify the implementation of tighter clean air standards as they relate to the demand evolution for heavy duty trucking. However, the impact of the clean air standards is accounted for in the ULSD Reference price premium expectation and therefore, a larger spread between ULSD and LNG.
- DGE tax penalty for LNG
  - Since an LNG gallon has energy density 40% lower than diesel yet is taxed on a per volumetric gallon basis, LNG currently has an effective federal tax penalty as compared to diesel.

- The analysis assumes this will be resolved in 2013 making the tax applicable to both diesel and LNG on an energy (versus volumetric gallon) equivalent basis. This serves to slightly increase the spread between ULSD and LNG.

While a sustained price advantage of LNG over ULSD is the most important determining factor in the evolution of demand in the trucking sector, Concentric also identified other key events that will influence the timing and magnitude of demand growth. PSE requested Concentric estimate the evolution of demand over the ten year period starting in 2015 (beginning with demand prior to the in-service date of a proposed liquefaction facility in late 2016 and including demand during the first 8-10 years of the investment cycle), Concentric focused on short and medium term key events that will influence market growth.

2012:	National fleets (UPS, Ryder, FedEx) start adopting LNG technology creating more public and fleet awareness of price benefits, technology advancements and LNG availability
2013:	The elimination of the LNG gallon tax penalty creates more economic incentive for fleets to convert
2014:	New widely mass-produced engines and technology improvements in performance could make the switch to LNG more realistic for longer haul trucking fleets
2015:	New emission regulations will increase the demand and consequently the cost of ULSD in the Puget Sound area, making LNG more economical for many fleets
2017:	Supply from a proposed new LNG facility could be available (the analysis assumes LNG is available from existing sources of supply prior to 2017). This stimulates growth in all segments but, in particular, local fleets
2018:	The dispersion and spacing of on-highway LNG refueling stations will encourage more fleets to consider LNG (dissipating fear of running out of fuel while on a run). This can also eliminate fueling facility capital costs for smaller customers interested in converting.

PSE's Role

By developing local LNG production capacity, PSE could facilitate the market development of fleet use of LNG. Since fleet owners identified "lack of LNG infrastructure" as the most critical factor they consider in conversion to LNG, providing LNG to the market and/or supplying LNG to fuel distributors sends a critical positive signal.

Effort put forth by PSE to support LNG as a vehicle and marine fuel infrastructure in the market area as well as on a regional and national basis is a key factor in helping develop LNG as a transportation fuel. This support can take the form of:

1) coordination among utilities in Washington, Oregon, Northern California and southern British Columbia to supply LNG and/or build LNG fueling infrastructure,

2) providing LNG supply to developers of LNG fueling infrastructure such as Shell, Clean Energy, Linde and others.[20]

Supporting federal, state and local economic and environmental incentives for fleet owners and infrastructure providers is also an important role for PSE.

1) On a national level, PSE can establish and maintain contacts with industry organizations that promote the use of natural gas as a transportation fuel such as NGVAmerica, American Clean Skies Foundation, and the National Petroleum Council.

2) On a state and local level, PSE can work with governmental and environmental organizations such as Washington's Joint Transportation Committee and other industry organizations to promote market adoption of LNG.

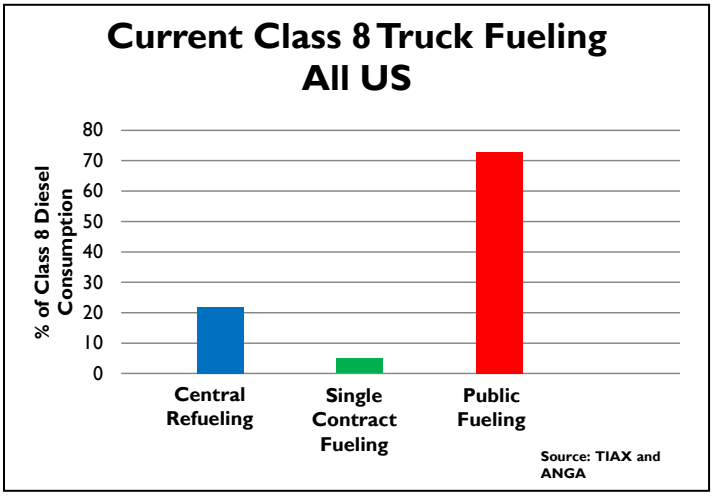
PSE can also work to ensure LNG safety and security is a perceived benefit, not a deterrent, to large scale adoption of the fuel. LNG has low market penetration and is widely perceived by the general public as a dangerous fuel. Large scale LNG import and export facilities proposed in the Pacific Northwest have received significant negative publicity, with safety and security driving local opposition to these facilities. PSE and its customers and partners must work jointly to ensure the public is well informed about LNG safety and security.

Last, the existing diesel fuel supply distribution chain is important in understanding customer behavior and preferences. The majority of heavy duty fleets refuel at public diesel fueling stations. While private fueling may be PSE's preferred distribution method – return to based fleets with on-site private LNG fueling infrastructure – the market's existing preferences for public fueling will likely drive demand.

[20] Clean Energy is developing "America's Natural Gas Highway" and plans to install up to 150 LNG fueling stations in the United States by the end of 2013. Shell has developed a partnership to provide LNG fueling at Pilot Flying J facilities across Canada.

Figure 8

PSE must consider existing fleet refueling habits in order to understand potential demand. As shown in Figure 8, most fleets refuel at public stations. As such, PSE may consider partnerships with current fuel distributors, national gasoline companies, and natural gas and diesel distributors like Shell and Clean Energy.



Determining inventory and expected fuel use of potential conversion fleets

Concentric relied on various local and national fleet databases, government references and industry sources to compile an inventory of fleets in PSE's market area. Included in this information is source data from.

- U.S. Department of Transportation, Federal Motor Carrier Safety Administration
- Department of Transportation, Washington State
- Washington Trucking Association
- EIA
- TIAX report for America's Natural Gas Alliance, "Liquefied Natural Gas Infrastructure"
- Clean Energy Fuels 2011 Annual Report; Clean Energy website information on America's Natural Gas Highway ("ANGH")
- CenterPoint Energy, "Building a Business Case for NGV's"
- National Petroleum Council, "Advancing Technology for America's Transportation Future." August 2012
- PLS Logistic Service, "Use of LNG-Powered Vehicles for Industrial Freight"
- National Energy Policy Institute, "What set of Conditions Would Make the Business Case to Convert Heavy Trucks to Natural Gas? – A Case Study", November 2010
- University of Chicago, "Natural Gas and the Transformation of the U.S. Class 8 Trucking Fleet." May 2012

The summary data provides fleet name, location and estimated or actual size of fleets doing business in the market area based. Size of national fleets doing business in the market area is based on per capita income of Washington versus other US states. In addition, interstate and intrastate fleet data

is used to estimate market growth based on location, number of tractors per company,[21] estimated annual miles driven per tractor,[22] percentage of fleet owned versus leased, the type of cargo carried,[23]

Concentric divided the fleet data into the five categories below and assessed the evolution of demand in each of the categories separately.

Figure 9

Fleet	Characteristics	Impact on Demand Evolution
National	Overall size determined for national fleets, fleet size per state estimated/researched	More total tractors, could rely on internal network of fueling stations for long range trips/not necessarily reliant on NGHW, converting to LNG has marketing appeal
Interstate long range	Interstate fleets with majority of trips greater than 100 miles, DOT	Needs NGHW to convert, but will convert quickly once it is established because of economics/ # of tractors
Interstate short range	Interstate fleets with majority of trips less than 100 miles, DOT	Needs NGHW to convert, not as economical as long range fleets due to lower mileage, slower adoption rate
Intrastate long range	Intrastate fleets with majority of trips greater than 100 miles, DOT	Hesitant without NGHW, but higher mileage makes converting more economical
Intrastate short range	Intrastate fleets with majority of trips less than 100 miles, DOT	No broad scale LNG infrastructure required, but less mileage and generally smaller fleets make adoption less economical and therefore much slower

Reference Case Evolution – Heavy Duty Trucking

Based on the economics of conversion (total cost, miles driven) combined with the key milestones shown in Figure 9 Concentric estimated market demand for LNG from the heavy duty transportation market to reach over 100,000 LNG gallons per day by 2020 and over 520,000 LNG

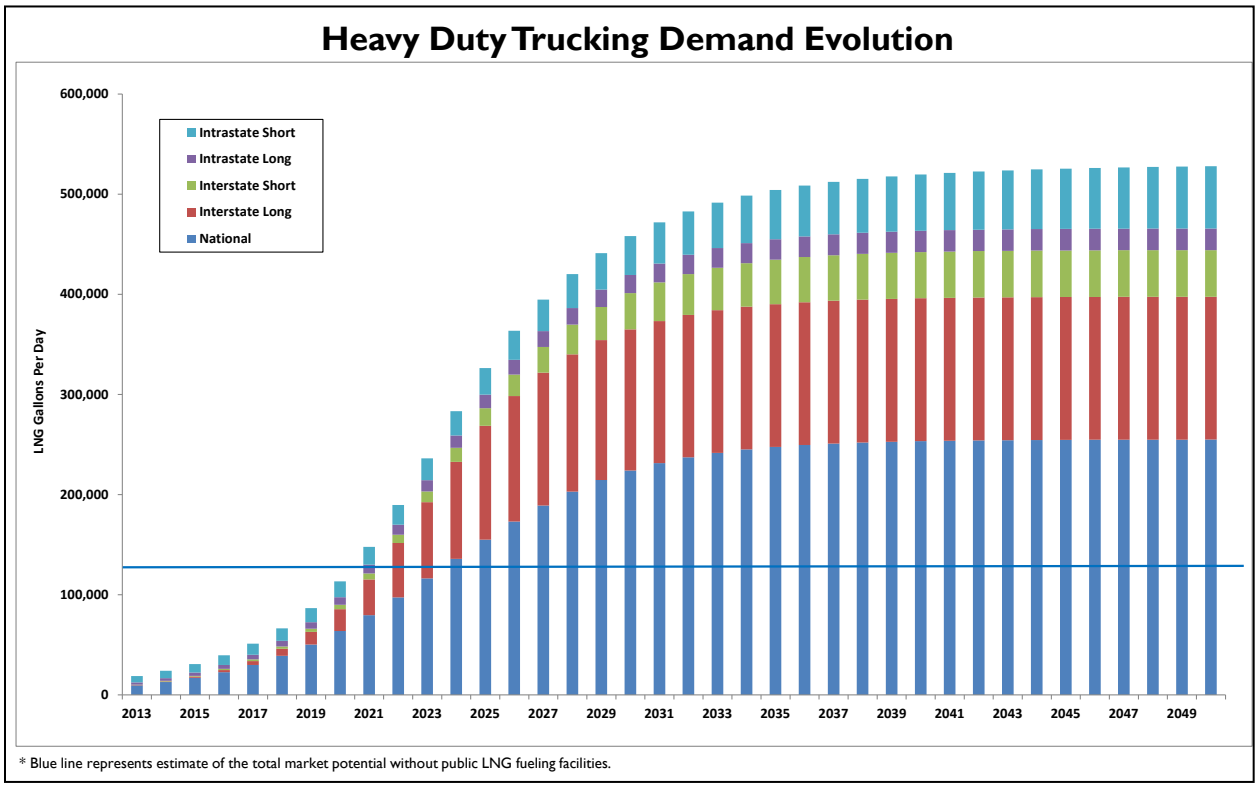
[21] Tractors per company location is an important metric to determine the financial viability of on-site LNG fueling. Since the cost of an LNG fueling station is between 1-2 MUSD, there must be sufficient fleet size (and miles per tractor) to pay for the cost of the fueling station. The analysis assumes the fueling station capital investment must be paid back over 5 years to coincide with the life of the LNG tractor(s).

[22] Miles driven per tractor is also an important metric to determine the financial viability of the higher cost of LNG tractor.

[23] Type of cargo carried can help PSE determine whether the fleet is return-to-base and/or has fueling characteristics that may allow for overnight refill such as CNG slow fill.

gallons per day by 2050. The majority of this demand occurs in the national and interstate long haul fleet categories.

Figure 10

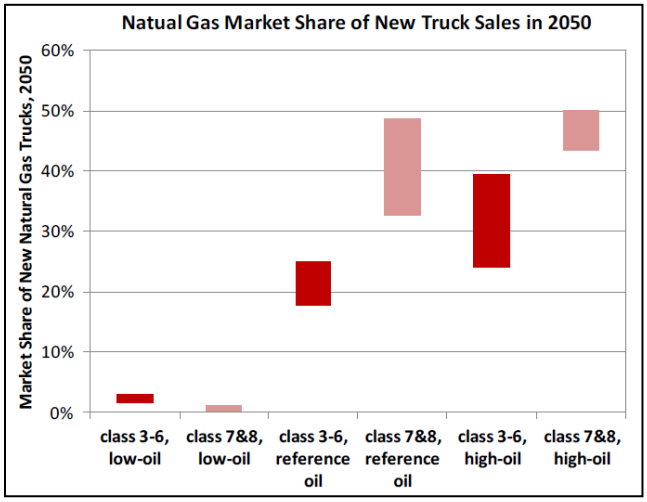


Concentric believes that the establishment of regional and national fueling infrastructure is a key element for successful adoption of LNG by the trucking industry. If demand were limited to fleets dependent **only** on on-site fueling, demand growth is probably limited to approximately 120,000 LNG gallons per day as shown by the blue line in Figure 10 above.

In its recent study,[24] the National Petroleum Council ("NPC") estimates that natural gas (mostly in the form of LNG) will capture between 32 and 49% of the heavy duty truck transportation new truck sales by 2050.[25]

24 Advancing Technology for America's Transportation Future dated August 1, 2012
25 Using EIA Reference Price Scenario oil prices

Figure 11



Source: National Petroleum Council

Based on current diesel use for on-road transportation in Washington State of 1.7 million diesel gallons per day[26] or 2.8 million LNG gallons per day, and assuming 65% of this consumption occurs in PSE's market area, Concentric's projection for 2050 of approximately 520,000 LNG gallons per day of demand (approximately 28% of the 2010 consumption) falls under the low end of the NPC Reference Case forecast.[27]

26 EIA Independent Statistics and Analysis, On-Highway Diesel Use 2010

27 The analysis assumes that increases in heavy duty truck miles driven in the market area through 2050 are offset by fuel efficiency improvements

c. Rail market

Factors influencing evolution

The evolution of demand for LNG in the rail sector is driven by several factors including:

- The forecasted sustainable price spread between ULSD and LNG (see above)
- Available LNG in the market area but also along major rail routes serving the Pacific Northwest and to the east and south
- Stricter EPA rules regulating air emissions for rail locomotives
- Development of rail engine technology
    - Advancements in LNG locomotive engine technology remain in the pilot stage. A good example of this is in eastern Canada where GazMetro and Canadian National Railroad will develop a prototype hybrid locomotive (diesel and LNG) that *could* begin operation in 2013. The project proponents believe pilot testing is far in advance of commercial use of LNG as a locomotive fuel.
    - GE and Shell have also formed a research project to develop dual-fuel rail locomotives but no commercial development timelines have been publically announced
    - No commercially available dedicated LNG or dual fuel engines are at commercial stages of development at this time

Determining inventory and expected fuel use of potential conversion fleets

Concentric assessed the railroad demand for diesel use in Washington. BNSF is the primary rail service provider in western Washington; Union Pacific operates mostly in the eastern half of the state.

Concentric estimates demand for LNG in the market area could be as high as 50,000 LNG gallons per day[28] if LNG replaced diesel fuel on major rail routes.[29]

Figure 12

Rail service provider	Route	Miles	Freight train frequency	Passenger train frequency	Total Miles	High Level Estimate LNG Gallons per Day	Per Train
BNSF	Seattle-Everett	30	40	8	1,440	4,608	96
BNSF	Everett-Spokane	300	25		7,500	24,000	960
BNSF	Seattle-Portland	177	50		8,850	28,320	566

Rail demand has not been included as part of the demand evolution for PSE. Current technology limitations cannot be overcome in the short term. Demand could start to develop after 2020 but in limited form.

[28] Based on an average mile per gallon of diesel at 0.5.

[29] Major rail routes in western Washington are Seattle to Everett, Everett to Spokane and Seattle to Portland. BNSF is the operator of all conversion routes studied.

Last, rail transportation of goods competes directly with over-the-road trucking. To the extent LNG is widely adopted as a transportation fuel in the heavy duty trucking market, any development of LNG use in rail could indirectly reduce demand for LNG as a trucking fuel.

d. Industrial thermal conversion market

Factors influencing evolution

The evolution of demand for LNG in the industrial thermal conversion sector is driven by several factors including:

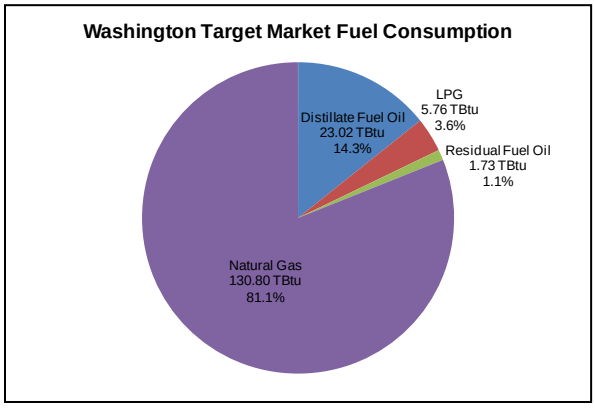
- The forecasted sustainable price spread between oil based stationary fuels such as distillate oil and propane, and natural gas. Natural gas can take the form of pipeline gas, distributed LNG or distributed CNG depending on the customers distance from the natural gas source and the annual load of the customer.
- Ability of customer or fuel supplier to change out on site equipment and provide site space for LNG or CNG equipment.

Determining inventory and expected fuel use of industrial conversion customers

Concentric assessed the industrial thermal conversion demand by reviewing PSE's market area. In that effort, Concentric:

Figure 13

- Assessed natural gas market share relative to other fuels consumed in Washington. Natural gas consumption is relatively high as a total percentage compared to other US states.



Source: EIA

- Gathered a comprehensive list of fuel burning facilities in the PSE market area based on air emissions

- Eliminated certain facilities based on pre-determined filters:
  - Companies located in an existing LDC service territory
  - Companies located within 10 miles of the LDC territory or a natural gas pipeline
  - Low energy intensive industries such as financial services, retail
  - Companies using self-provided biomass to generate energy (paper, lumber)

- Inventory remaining consisted of only two potential customers - Nippon Paper Industries in Port Angeles and TransAlta Centralia Mining in Centralia (currently not operating)

- Industrial conversion does not present a viable LNG demand source for PSE at this time

e. LNG to CNG

Factors influencing evolution

In the light duty vehicle market, there is demand for CNG in the PSE market area. Lighter duty trucks (Class 3-6), car fleets, and small vehicles such as forklifts and other operating equipment do not need the range or density of LNG in order to use natural gas as a fuel

CNG made from LNG saves power costs associated with compression. However, producing LNG at a central location, trucking it to an off-site fueling facility, then converting the LNG back to CNG is not economical as compared to producing CNG from pipeline gas.

Determining inventory and expected fuel use of potential conversion fleets

Concentric considered potential CNG demand for trucking. Certain short range truck and bus fleets could find CNG to be an acceptable transportation fuel as compared to LNG if the vehicles make short trips, return to base each day, and spend off-hours at slow-fill CNG fueling stations. As stated above, CNG from LNG may not initially compete with CNG from pipeline gas. Concentric has not included demand from this segment in forecasted LNG demand growth.

Concentric also surveyed yard vehicles in ports – forklifts, yard tractors, and cranes – as potential CNG conversion targets. Currently, there is only one commercially available CNG forklift available in the market. However, to the extent LNG and CNG become more readily available in ports, manufacturers may look at this market for potential development. Most port vehicles have long lives (over 10 years); as such, Concentric does not believe this market provides for growth opportunity for at least 10-15 years.

Other considerations

Clean Energy operates five public CNG fueling facilities in the Seattle-Tacoma area, with current delivered prices between 1.80 and 2.25 per CNG gallon

Although the CNG produced on-site at an LNG fueling facility could be competitive as compared to CNG produced from pipeline gas, Clean Energy and other CNG providers have already established contractual and locational relationships with existing and potential CNG fleet customers

There is opportunity to provide LNG to CNG as an additional on-site fuel to the extent PSE or its downstream partners are successful in capturing fleet markets served via on-site LNG fueling infrastructure; however, this on-site market is very limited.

While there may be some LNG to CNG demand that evolves over time, Concentric conservatively assumes that LNG to CNG is not a source of incremental LNG demand in the demand evolution projections.

V. COMPETITION AND PARTNERS

PSE is working to provide a source of LNG for use in the market area. Given the potential demand for LNG and the public announcements of both TOTE and Washington State Ferries regarding their intention to convert to LNG, PSE should expect significant competitive and cooperative interests from LNG and other fuel suppliers both regionally and nationally. Below is a summary of potential parties:

Shell
Shell is very active in distributed LNG applications, forming partnerships with potential LNG supply chain participants to develop and market the necessary equipment and infrastructure that supports LNG market growth. Shell recently acquired Gasnor, a provider of LNG and related services to the marine and trucking markets in Europe. Additionally, Shell announced a partnership with Pilot Flying J to develop LNG fueling infrastructure in Canada. Additionally, Shell has formed infrastructure partnerships with Westport Cummins for LNG truck engines, Wartsila for LNG marine applications and GE for LNG locomotive applications.

Shell owns and operates the Puget Sound Refinery in Anacortes, Washington and supplies refined oil products, including ULSD, to the region.

Shell could be a major competitor to PSE in the event Shell develops LNG production infrastructure in the market area. In the alternative, Shell could be a customer of PSE in the development of public LNG fueling stations in southern British Columbia and/or Western Washington.

BP
Although BP has not yet publically announced plans for distributed LNG demand and infrastructure development, BP is internally studying distributed LNG markets. BP owns the Cherry Point refinery located in Whatcom County. BP provides the majority of marine fuel to customers in the Puget Sound area.

BP has a long history in large scale LNG projects. Given the potential for BP to give up marine and trucking diesel market share to PSE's LNG, BP might attempt to develop LNG capabilities themselves. BP may also contract for PSE's plant capacity and distribute the LNG to end users in the area.

Both BP and Shell have large international energy portfolios and are both actively pursuing LNG export opportunities in Canada and Alaska. In order for PSE and its customers to ensure the spread between LNG and ULSD/low sulfur marine oil is sufficient, companies like BP and Shell may be able to take the risk of spread maintenance into these large financial portfolios. Smaller companies like PSE, Clean Energy, LNG customers and motor fuel distributors may not have the creditworthiness or risk tolerance to take such positions.

Clean Energy
Clean Energy is the US's largest developer of LNG and CNG infrastructure. Clean Energy owns multiple public CNG fueling stations in the market area and is considering developing at least two LNG fueling stations as part of the ANGH effort.

Clean Energy should be considered both a competitor (Clean Energy owns and operates LNG liquefaction capacity in Boron, California) and a partner/customer. It is likely that Clean Energy will not develop LNG production capacity in the PSE market area. Instead, it is likely that Clean Energy could develop on-highway LNG fueling infrastructure and rely on PSE for LNG supply.

As of 2011, Clean Energy received and continues to receive significant funding from Chesapeake Energy to develop natural gas demand. As such, most of Clean Energy's recent LNG fueling station investments have been in gas producing regions in the Marcellus, Utica, Eagle Ford and Haynesville.

Motor fuels providers in the market area

There are multiple diesel providers operating the market area including Love's Truck Stops, Union 76, Chevron, and Texaco, as well as petroleum distributors such as Associated Petroleum and SC Fuels. It is possible that any of these current motor fuels providers could finance LNG fuelling infrastructure and distribute LNG to fleets.

Given the reliance by heavy duty truck fleets on the availability of fuel from public fueling stations (see Figure 8 above), PSE's ability to reach the on-highway trucking market via distributors is important to consider. Developing relationships with current motor fuels distributors could be important to PSE in accelerating the rate of market evolution in the heavy duty trucking markets.

Marine fuel distributors

Although marine fueling infrastructure could remain between PSE and the handful of potential LNG customers in the market area, marine fuel distributors such as ChemOil could be interested in playing a role in the marine LNG distribution chain.

VI. CONCLUSIONS

As stated above, projected costs of LNG versus oil-based fuels like ULSD and low-sulfur marine fuel, environmental initiatives, and LNG engine and storage technology advancements, all contribute to the potential for significant market growth of distributed LNG in PSE's market area.

Since availability of LNG infrastructure is viewed by the market as the largest factor preventing wide scale adoption of LNG as a distributed fuel, especially as it relates to the marine and heavy duty trucking market, PSE's proposed LNG production facility could provide the market with the promise of future regional LNG supply.

The timing of the in-service date of PSE's proposed LNG facility is critical since

1) the spread between oil and gas-based fuels is currently at a high level; interest in natural gas as a transportation fuel is building rapidly,

2) large marine customers interested in converting to comply with ECA emission requirements must begin permitting, capital allocation, engineering, design and fleet planning to begin using LNG three to five years from now, and

3) distributors interested in investing in LNG fueling infrastructure for the on-road transportation market can be assured of a local source of LNG supply in a little over four years.

PSE's coordination efforts with other regional LNG suppliers can provide a network of LNG supply, adding to the reliability of the fuel and reducing risks for both customers and suppliers.

The demand for LNG in PSE's market area should be sufficient by 2020 to absorb the LNG production capacity contemplated by PSE.

Although not part of Concentric's scope of work, Concentric makes additional observations as follows:

- Regulatory jurisdiction of the LNG facility is an important consideration for PSE given the accelerated market expectations for development and commercial operations. This must be weighed against the future flexibility PSE may want in supplying LNG to markets that may require the proposed LNG facility to fall under FERC jurisdiction.

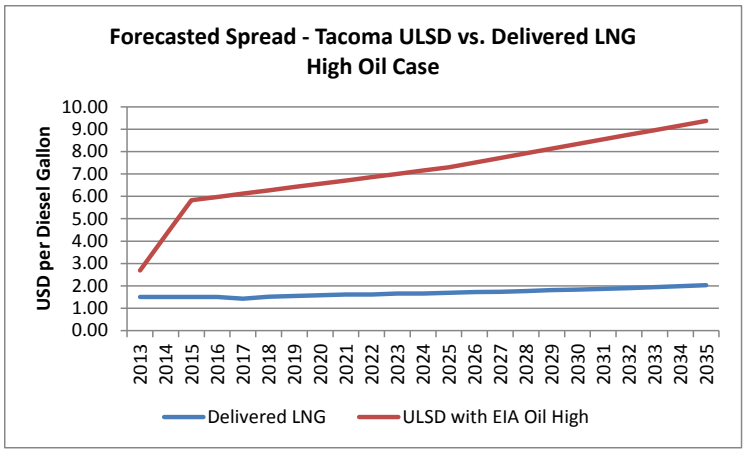
- Community outreach on a local and state level is important with regard to the siting of any energy facility. Given the history of LNG siting and past perception of the fuel as a safety and security threat, PSE may consider a comprehensive strategy to inform the public and government stakeholders that could support or oppose construction of the LNG production facility.

Appendix A – Alternative Price Scenarios

EIA High Oil

Figure 14

The high oil scenario shows a rapidly increasing the spread between gas and oil, especially during the period 2013 to 2015. In EIA high oil scenario, domestic natural gas prices remain decoupled from global oil prices. This is primarily due to North American supply dynamics - associated gas is abundantly available due to high levels of domestic oil drilling activity.

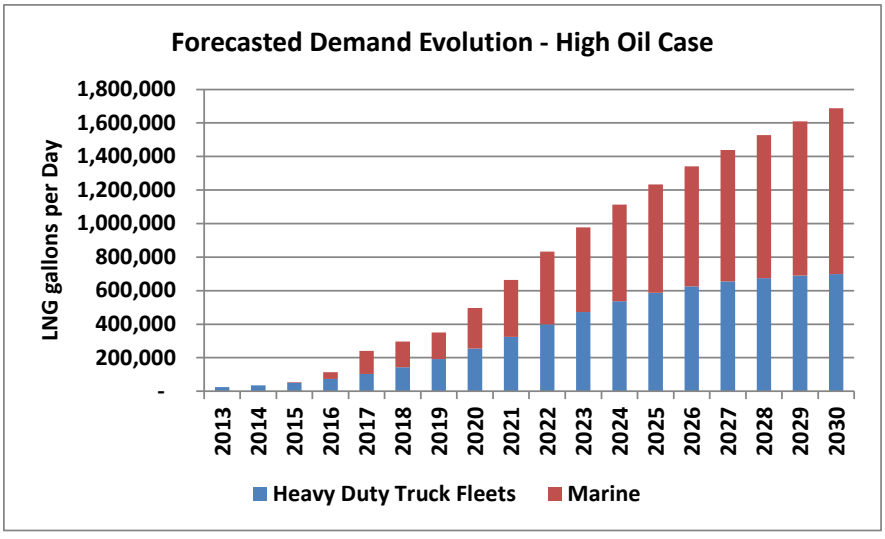


The increased spread leads to accelerated marine and heavy duty trucking adoption rates.

The forecast assumes the cruise sector begins conversion of fleets in 2020 as LNG as a marine fuel becomes available across North America. Global fleet conversion to LNG still lags as *global oil*, not *US natural gas*, drives LNG prices abroad.

The forecast also assumes trucking demand accelerates and increases as LNG becomes more available nationally and the spread widens.

Figure 15



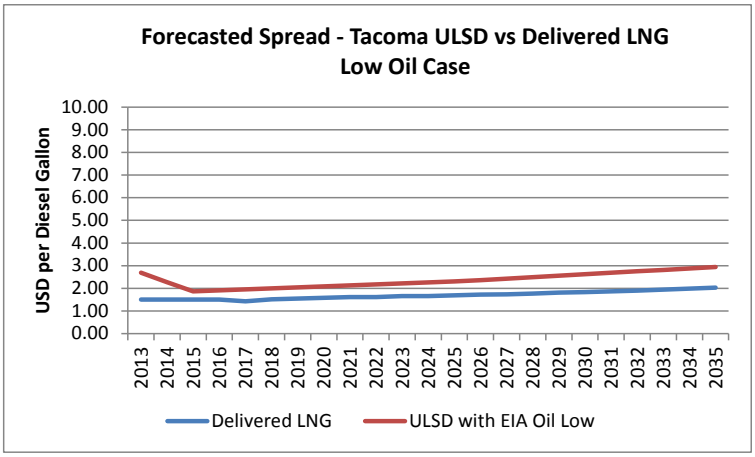
Appendix A – Alternative Price Scenarios (continued)

EIA Low Oil

The low oil scenario assumes the price of oil stabilizes at or below current levels and the spread between oil and gas remains at only an 8 USD per MMBtu level.

This spread slows significantly the wide adoption of LNG as a fuel as, in the trucking sector, the payback periods for incremental tractor costs are extended beyond the useful life of the tractor (5-7 years).

Figure 16



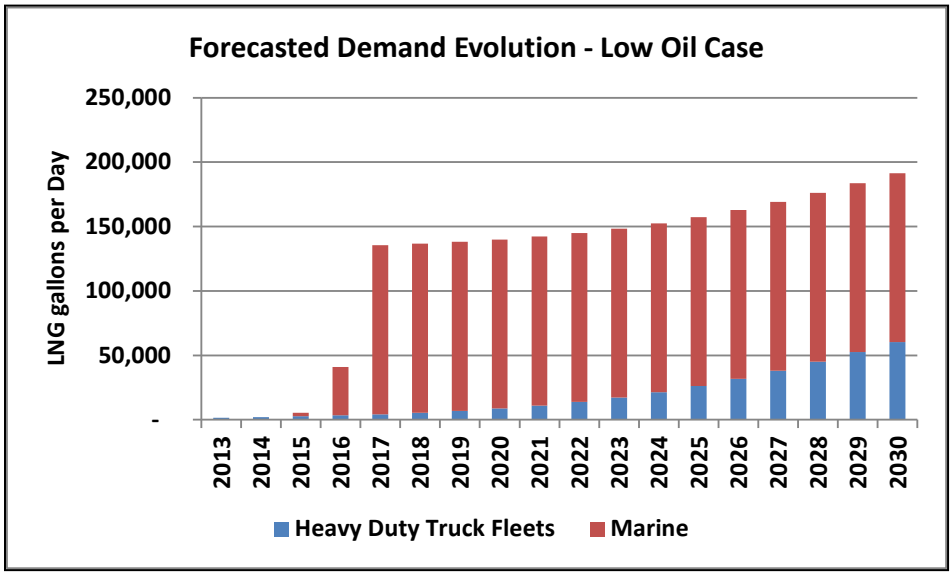
The decreased spread leads to very low marine and heavy duty trucking adoption rates.

The forecast assumes conversion of certain national fleets will continue but it is limited to 3-4 fleets in PSE's market area.

The forecast assumes TOTE completes its conversion to LNG and WSF converts two ferries. No additional marine demand transpires as options to meet clean air requirements can more economically be met by scrubbers and other technologies.

In this scenario, PSE's proposed LNG facility could be significantly underutilized.

Figure 17



Appendix B – Summary of Trucking Fleet Database

This database has multiple uses for PSE. First, the model includes all potential local and national fleets expected to do business in the market area. Expected demand from customers along with assumptions about market penetration of LNG, creates a market evolution forecasts for PSE. The evolution model can easily be adjusted if specific segments (national, interstate long haul etc) grow more rapidly or more slowly based on market information PSE is able to gather or scenarios PSE wishes to consider.

The tool also provides a comprehensive list of potential conversion customers including:

- Fleet size
- Location of fleet including relative to existing CNG infrastructure
- Cargo carried (trash, lumber etc)
- Estimated annual miles per tractor in the fleet
- Interstate or intrastate use of the fleet
- Number of tractors, buses/vans and other power units on site
- Lease or ownership of the equipment

The fleet model allows for sorting of the data - size, location, and type of goods, determination of IRR metrics for fleets, payback periods, and the impact of ULSD-LNG spread on conversion economics.

The fleet model provides the PSE sales team with specific information on each potential customer and can allow for scenario testing on each market segment or each fleet.

Inventory example

Legal Name	IRR	Tractors	Trucks, Vans, Buses	Total Power Units	Owned	Leased	% Leased	Miles/Tract	Miles/Van	Diesel Gallons	LNG Per Day	Miles/Vehicle
PACCAR INC		66	23	89	89	0	0.0%	50,000	50,000	733,333	3,375	10,494
RALPH'S CONCRETE PUMPING INC		64	11	75	75	0	0.0%	50,000	50,000	711,111	3,273	10,667
WASHINGTON TRUCKING INC		57	0	57	57	0	0.0%	130,000	50,000	1,140,000	5,247	58,683
TRIPLE B CORPORATION		56	88	144	144	0	0.0%	50,000	50,000	622,222	2,864	28,115
KING COUNTY SOLID WASTE DIVISION		55	10	67	65	0	0.0%	50,000	40,000	611,111	2,813	55,522
GARY MERLINO CONSTRUCTION CO INC		52	92	144	144	0	0.0%	50,000	50,000	577,778	2,659	10,861
M & M TRANSPORT INC		50	0	59	50	9	15.3%	80,000	50,000	727,273	3,347	76,446

Cargo	D&B #	Country	Street	City	County	State	Service Area?	ZIP	Shipper Type
General Freight	48341267	US	777 106TH AVE NE	BELLEVUE	33	WA	YES	98004	Carrier Interstate
Machinery, Large Objects	9504499	US	1529 RAINIER AVE SOUTH	SEATTLE	33	WA	YES	98144	Carrier Interstate
General Freight		US	2810 34TH ST	EVERETT	61	WA	YES	98201	Carrier Interstate
General Freight	173823147	US	4103 2ND AVE S	SEATTLE	33	WA	YES	98134	Carrier Interstate
Building Material	47848122	US	201 SOUTH JACKSON STREET SUITE 701	SEATTLE	33	WA	YES	98104	Carrier Intra/HazMat
General Freight	27452689	US	9125 10TH AVE SOUTH	SEATTLE	33	WA	YES	98108	Carrier Interstate
Logs, Poles, Beams		US	170 STATE HIGHWAY 508	CHEHALIS	41	WA	YES	98532	Carrier Interstate

Appendix B – Summary of Trucking Fleet Database (continued)

Scenario testing example

	Min # of Tractors	*Probability of Converison* 2013	2015	2016	2018	2020
Intrastate SR	11	10%	15%	20%	25%	30%
Interstate SR	8	0%	0%	0%	10%	15%
Intrastate LR	6	0%	10%	15%	20%	25%
Interstate LR	5	0%	0%	0%	0%	15%

Out of Top 200 National Fleets (# of Fleets Converting)

Top Percentile (#)	0	0	0	0	1
Avg National (#)	5	10	15	50	75

Tax Penalty Ends ISR Begin to Convert	Tech Improves ILR Convert	New Regs	Rough NGHW XSR Convert	Better NGHW XLR Convert

Appendix C – Summary of Marine Fleet Database

The information provided can be useful to PSE in determining overall market demand for marine LNG. In addition, when talking to companies who are considering conversion to marine LNG, PSE has a good understanding of fleet size, characteristics, and requirements for fuel.

Types and Companies

- Assist and Escort Vessels
- Harbor Tugs
- Pilot Boats
- Ocean Tugs
- Columbia River Ports – Tidewater Pushboats
- Columbia River Ports – Sause Brothers Shipping
- Washington State Ferries, other Puget Sound area ferries
- Cruise Vessels calling on Seattle
- Horizon Shipping
- TOTEM Shipping
- Northland Shipping

Information

- Name, vessel type, and USCG Vessel ID
- Owner
- Horsepower
- Hours in service per year
- Estimated diesel and LNG gallons per year
- Equipment age

Example

Vessel ID	Type	Hours	Age	HP	EPA Category	Propulsion Engines	Pounds of fuel per year	Diesel gallons of fuel per year	LNG gallons of fuel per year	With Engine Load Factor of 68%	Conversion Liklihood	Owner
559404	Ocean Tug	1500	1976	3500	1	2	2,625,000	330,189	554,717	377,208		Crowley
PSOTS	Ocean Tug	1423	1981	3070	1	2	2,184,305	274,755	461,589	313,881	*working on identifying owner*	
256829	Ocean Tug	5000	1974	850	1	2	2,125,000	267,296	449,057	305,358		Dunlap
567630	Ocean Tug	1620	1975	2150	1	2	1,741,500	219,057	368,015	250,250		Kirby
500126	Ocean Tug	3325	1980	900	1	2	1,496,250	188,208	316,189	215,008		Kirby
569517	Ocean Tug	1041	1986	1710	1	2	890,055	111,957	188,087	127,899		Dunlap
566082	Ocean Tug	1331	1975	1125	1	2	748,688	94,175	158,213	107,585		Dunlap

Appendix D – Summary of Rail and Industrial Database

The rail database summarizes the owner, routes traveled, and frequency of trips in order to estimate potential market demand for LNG. Although this market is not likely to generate measurable LNG demand in the market area in the immediate future, if engine technology advances and LNG fueling is more readily available along rail routes, there is potential for rail use of LNG in the next decade.

Example

Rail service provider	Route	Miles	Freight train frequency	Passenger train frequency	Total Miles	High Level Estimate LNG Gallons per Day	Per Train
BNSF	Seattle-Everett	30	40	8	1,440	4,608	96
BNSF	Everett-Spokane	300	25		7,500	24,000	960
BNSF	Seattle-Portland	177	50		8,850	28,320	566
BNSF	Portland-Pasco	233	31		7,223	23,114	
BNSF	Auburn-Pasco	227	6		1,362	4,358	
BNSF	Pasco-Spokane	147	33		4,851	15,523	
BNSF	Spokane-Sandpoint	69	46		3,174	10,157	
BNSF	Everett-Vancouver	155	24	4	4,340	13,888	
UP	Hinkle-Spokane	171	11		1,881	6,019	
UP	Spokane-Sandpoint	74	7		518	1,658	
					41,139		
			Diesel Gallons of Fuel per Day		82,278		
			LNG Gallons of Fuel per Day		131,645		

The industrial database provides customer listings, primary fuels and estimated load. Although this market is not likely to generate measurable LNG demand in the market area, the data is available for PSE's other research efforts.

Example

Facility Name	Location	Industry	SIC	NAICS	Issuing Body	Permit	Primary Fuel	EU1 Secondary Fuels	EU1	EU1 MMBtu/HR
Nippon Paper Industries	Port Angeles	Paper Products	2621		ORCAA	http://www.orcaa.org/	#6			236
TransAlta Centralia Mining, LLC	Centralia	Coal Mining Operations	1221	212111	SWCAA	http://www.swcleanair	Fuel Oil		NA	
City of Spokane - Northside Landfill	Spokane	Landfill	4953		SRCAA	http://www.spokanecl	Landfill Gas	Propane	NA	
City of Spokane - Spokane Regional Solid Wa	Spokane	Solid Waste Combustion	4953		SRCAA	http://www.spokanecl	Solid Waste	Natural Gas		183.33
KC Natl Resources Wastewater Treatment	Seattle	Municipal Wastewater Treatment	4952		PSCAA	http://www.pscleanair	Digester Gas	Propane		25.7

Appendix E – Summary of Port Vehicles Database

The port vehicle database provides information related to the potential for CNG to be used in various lighter duty equipment and vehicles that are part of port operations. Concentric relied on the Puget Sound Maritimes Emissions Survey 2007 to compile the data. Currently, CNG port vehicles are very limited in availability; only Toyota manufacturers an OEM natural gas forklift. Concentric does not yet consider the port vehicle market as immediately impacting the demand for LNG in the market area.

Example

Port	Terminal Number	High Use Vehicle	High Use Number in Port	Gallons per hour	Average annual hours	Average Annual Diesel Consumption per Vehicle (in gallons)	Annual CNG Consumption (in therms)	Annual CNG Consumption per Vehicle (in therms)	Annual CNG Consumption per Day in Port (in therms)
Everett	PSE020	Wheelloader	6			5,083	41,172	6,862	
	PSE020	Log Shovel	2			3,750	10,125	5,063	
									140.54
Tacoma									
	PST010	Forklift	2			1,900	5,130	2,565	
	PST010	Straddle carrier	4			2,130	11,502	2,876	
	PST010	Straddle carrier	13			10,749	188,645	14,511	
	PST020	Forklift	8	2.2	880	1,936	20,909	2,614	
	PST020	SidePick	5	2.8	1,850	5,180	34,965	6,993	
	PST020	Straddle Carrier	59	6.0	1,850	11,100	884,115	14,985	
	PST020	Yard Tractor	3	2.4	1,500	3,600	14,580	4,860	