EXHIBIT NO. ___(MFB-4~~H~~C)
DOCKET NO. UG-151663
WITNESS: MELISSA F. BARTOS

BEFORE THE
WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION

In the Matter of the Application 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-151663**

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

CONFIDENTIAL PER PROTECTIVE ORDER IN WUTC DOCKET NO. UG-151663

~~**AUGUST 11, 2015**~~
REVISED SEPTEMBER 23, 2015

CONCENTRIC ENERGY ADVISORS

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

UPDATE

Prepared for:

Puget Sound Energy

January 2015

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I. INTRODUCTION

In September 2012, Concentric Energy Advisors, Inc. ("Concentric") provided Puget Sound Energy ("PSE") a report titled, "Market Assessment of Liquefied Natural Gas as a Distributed Fuel in Washington State" (the "2012 Market Assessment"). In the 2012 Market Assessment, Concentric evaluated the potential for liquefied natural gas ("LNG") as a fuel for marine transportation, heavy duty trucking, rail transportation, industrial conversion markets, and compressed natural gas ("CNG") applications in Washington State.

PSE has now retained Concentric to provide an update to the 2012 Market Assessment associated with its application to build an LNG liquefaction plant in Tacoma, Washington. The purpose of this report is to provide updated information with regard to the potential market evolution for LNG in Washington State through 2030, and is focused on the two markets that were identified in the 2012 Market Assessment as having meaningful potential demand (i.e., marine and heavy duty trucking).

This report is organized into five sections. This introductory section is followed by Section II – Market Context, which provides current expectations regarding fuel price spreads. Section III describes the LNG potential for marine markets. Section IV describes the LNG potential for heavy duty trucking markets. Section V contains conclusions.

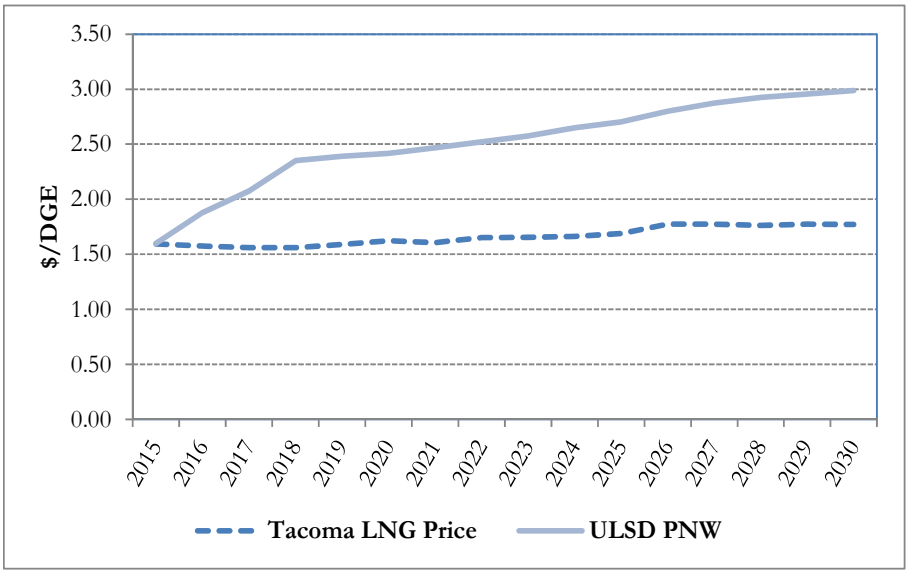
II. MARKET CONTEXT

As discussed in the 2012 Market Assessment, there are two major factors driving market demand for LNG as an alternative to oil-based fuels: 1) economic considerations; and 2) compliance with environmental requirements. Changes in the relevant environmental requirements aimed at addressing concerns about emissions will be discussed in the marine-specific and heavy duty trucking-specific sections of this report. Changes in economic considerations are addressed below.

The long term spread between the cost of natural gas (feedstock for LNG) and oil (feedstock for ultra-low sulfur diesel ("ULSD")) is a major factor influencing the decision to convert from oil-based fuels to LNG. A sustained price spread is required to recover the up-front premium associated with LNG equipment. With the reduction in the price of natural gas as a result of significant increases in domestic natural gas production over the last decade, fueling with natural gas based fuels has become more economic than it was in the past. However, converting to LNG is a function of both the price of natural gas, as well as the price of the oil-based alternative, in this case ULSD. Subsequent to the preparation of the 2012 Market Assessment, the expected price differential between LNG and ULSD has significantly decreased. In addition, the recent drop in oil prices in the second half of 2014 has changed the outlook of the expected price differential between natural gas and oil, especially in the short term.

PSE retained Wood Mackenzie to develop a market area fuel price forecast for LNG (specific to the proposed Tacoma LNG facility) and ULSD (for the Pacific Northwest region) to be used in determining the potential evolution of LNG demand in Washington. Wood Mackenzie's fuel price forecast is illustrated in Figure 1.

Figure 1: Forecasted Fuel Prices ($/Diesel Gallon Equivalent)



As shown in the graph, Wood Mackenzie forecasts that the price of LNG (i.e. the price of gas at Sumas, plus adders for transport, liquefaction, storage and delivery) and the price of ULSD in the market area will be equivalent in 2015, making it difficult to recover LNG equipment premiums in the near term. However, the forecasted price spread in the market area is expected to increase over time. Concentric relied on Wood Mackenzie's assessment of the long range price forecast for Tacoma LNG and ULSD (the expected primary fuel used in the heavy duty transportation market and a proxy for marine fuel) in developing our LNG demand evolution for the marine and heavy duty trucking markets.

III. LNG POTENTIAL FOR MARINE MARKETS

A. Factors Affecting LNG Conversions

As discussed in the 2012 Market Assessment, marine vessels operating in designated emission control areas ("ECAs") are required to make a decision to install new equipment and/or change fuels to comply with new environmental restrictions.[1] As a result, the decision to convert marine vessels to LNG is less dependent on economic considerations, and more focused on environmental compliance. In other words, the decision to act is less sensitive to the price spread between marine diesel fuel and LNG because there is an immediate need to comply with environmental regulations on fuel sulfur content and NOx emissions.

The environmental regulations applicable to marine vessels operating in the Tacoma area have not materially changed since the 2012 Market Assessment. In summary, domestic marine vessels operating in ECAs must comply with more stringent fuel sulfur content requirements (no more than 0.1%) starting in January 2015 and with engine restrictions on NOx emissions by January 2016.[2] There are three primary options to comply with these environmental regulations: [3]

- **Install Exhaust Scrubbers.** Vessels can choose to continue using conventional (less expensive) bunker fuels and install equipment to address fuel sulfur content and NOx emissions. Selecting this cleanup technology approach requires the capital investment of a scrubber retrofit for SOx, the addition of selective catalytic reduction technology to remove NOx, and additional operations and maintenance costs. These cleanup technologies also introduce challenges related to disposing of the hazardous waste they collect from the ship's exhaust.[4]
- **Use Low-Sulfur Distillates.** Vessels can choose to use low-sulfur distillate fuels, which are highly refined products similar to ULSD or heating oil that comply with the environmental regulations. This option will significantly increase annual fueling costs compared to traditional bunker fuel. In addition, TOTE Maritime has expressed concerns with the limited availability of low sulfur fuel in the quantities it would need for large cargo ships.
- **Convert to LNG.** Vessels can choose to convert to LNG (or dual fuel capability), which would comply with the environmental regulations due to the low emissions profile of LNG. Converting to LNG (or purchasing new vessels that are fueled by LNG) requires considerable investment. Approximately one-sixth of the cost relates to conversion of the vessel engines and the rest is for installation of LNG storage tanks and related safety systems and ship modifications.[5]

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1 The North American ECA includes up to 200 nautical miles off the U.S. and Canadian Pacific, Atlantic and Gulf Coasts (including waters around Hawaii).

2 In May 2013, the Marine Environmental Protection Committee ("MEPC") of the International Maritime Organization ("IMO") approved a draft amendment that would delay the international NOx limits for marine vessels until 2021. The U.S. joined with Canada, Denmark, Germany, and Japan in challenging the amendment. In April 2014, the MEPC agreed to retain the 2016 effective dates for NOx limits for the North American and U.S. Caribbean Sea ECAs.

3 "LNG Opportunities for Marine and Rail in the Great Lakes, Gulf of Mexico, and Inland Waterways," Gladstein, Neandross and Associates, October 2014, at 16.

4 Ibid.

5 American Clean Skies Foundation, "Natural Gas for Marine Vessels, U.S. Market Opportunities," April 2012, at 20.

Each of these options is costly, and cost estimates for environmental compliance vary significantly across the industry. For example, Norden has indicated that installation of a scrubber costs close to $6 million per vessel whereas the conversion of a vessel to LNG costs approximately $7.5 million.[6] Another article estimates the cost for retrofitting a vessel to install a scrubber at between $3 million and $5 million.[7] Carnival Cruise Lines recently announced plans to retrofit 70 cruise ships with scrubbers at a total cost of $400 million, or $5.7 million per ship. The American Clean Skies Foundation estimates that the cost to convert a ship to LNG or dual-fuel capacity varies based on the type and size of the vessel - approximately $7 million to convert a medium-sized tugboat, $11 million to convert a large car or passenger ferry, and $24 million to convert a Great Lakes bulk carrier. The specific costs will depend upon the specific type, size and age of the vessel. Regardless of the exact cost, it is clear that the capital expenditures are significant, requiring shipping companies to carefully evaluate their options for compliance with the environmental restrictions. In addition to significant capital costs, shipping companies must also weigh ongoing O&M costs as well as other considerations (e.g., disposal of waste collected by scrubbers).

While shipping companies will be required to make a change to their fueling practices regardless of natural gas and oil prices, the choice they make will likely be influenced by the expected price spread. For example, the premium associated with converting to LNG compared to installing scrubbers becomes a greater hurdle to overcome when the price spread between natural gas and oil diminishes.

B. Evolution of Potential Marine Demand for LNG

Similar to the 2012 Market Assessment, Concentric analyzed the timing and magnitude of marine conversions to LNG separately for major companies and types of vessels. Since the 2012 Market Assessment, several major shipping companies operating in the Seattle-Tacoma area have announced or clarified their plans regarding the potential to comply with new environmental requirements, as summarized below.

- **TOTE Maritime.** Totem Ocean Trailer Express ("Totem Ocean"), an operating company of TOTE Maritime, provides twice-weekly cargo service on dedicated routes between Tacoma, Washington and Anchorage, Alaska using two Tacoma-based Orca-class cargo ships: the Midnight Sun and the Northern Star. In 2012, TOTE Maritime announced plans to convert its maritime fleet to operate on LNG. In October 2014, Totem Ocean announced that it had signed a fuel supply agreement with PSE for LNG to fuel Totem Ocean's two Tacoma-based cargo ships, which are being converted to LNG to exceed new, stricter emission standards in the maritime shipping industry. The cost to convert to LNG is approximately $40 million per ship, while the cost to install scrubbers would have been approximately $20 million per ship, plus additional operating and maintenance costs associated with the scrubbers, according to TOTE.[8]

  Totem Ocean's 2,900 nautical mile seven day round-trip voyage from Tacoma to Anchorage and back lies entirely within the North American ECA. Based on the size of the ships, schedule, and route traveled, it is expected that each ship will use

[6] Norden, "New sulphur regulations may lead to distortion of competition in the shipping industry," August 12, 2014, at 6.
[7] "Are Scrubbers a relevant solution for shipping industry?," as posted on weblog Schneider-electric.com/energy –management-energy-efficiency, January 21, 2014
[8] Press Release: "Totem Ocean, PSE Sign Fuel Supply Agreement", October 27, 2014.

approximately 58,500 LNG gallons per day. One ship is expected to be converted to LNG in 2016, with the other to follow in 2017. Therefore, Concentric included approximately 58,500 LNG gallons per day of demand associated with TOTE starting in 2016, and a total of approximately 117,000 LNG gallons per day starting in 2017 in the LNG market evolution for marine demand.[9]

- **Washington State Ferries.** Washington State Ferries ("WSF") is a government agency that operates automobile and passenger ferry service between Puget Sound and the San Juan Islands on 22 vessels as part of the Washington State Department of Transportation. Several years ago, WSF announced that it was considering converting six Issaquah ferries from marine diesel to LNG to comply with new environmental regulations. In March 2012, the Washington State Legislature appropriated funds for WSF to undertake the safety and security assessments and planning processes that would be necessary to gain U.S. Coast Guard approval for the operation of LNG fueled vessels. Since the 2012 Market Assessment, WSF has continued to pursue the LNG conversion option, as shown in the following excerpt from a June 2014 report by WSF to the Washington State Department of Transportation:

> WSF believes that LNG provides an opportunity to significantly reduce both fuel costs and pollutant emissions. WSF burns nearly 18 million gallons of fuel each year. Fuel is WSF's fastest growing operating expense. The fuel budget in 2012 was nearly 30% of WSF's operating budget at a cost of $67.3 million. That's $51.7 million more than it was 12 years ago. WSF anticipates achieving very substantial savings on fuel over the remaining life of the six vessels by converting to LNG. It could also significantly reduce propulsion related emissions. Modeling of the emission benefits indicate reduction of 89% in particulate matter, 59% in sulfur dioxide (SO2), approximately 61% in nitrous oxides (NOx) and 28% in carbon dioxide (CO2).[10]

The economic analysis behind the WSF decision was also described in an October 2014 report:

> LNG vessels can cut expenses and reduce emissions for long-term operations, despite the required incremental investment required for natural gas engine and fuel system conversions, and North American operators are starting to take note. For instance, Washington State Ferries, which is currently considering the conversion of six of their Issaquah-class ferries to LNG, projects that the total costs of switching the vessels will be $75.2 million, including design, shipyard, construction, engineering, and owner furnished equipment. Over the 30-year life of the retrofitted vessels,

[9] TOTE Maritime has also announced plans to convert two other cargo ships which sail from Jacksonville, Florida to Puerto Rico under the Sea Star Line operating company. In January 2015, SNL Financial reported that AGL Resources subsidiary Pivotal LNG and midstream energy development company WesPac Midstream LLC have signed a long-term agreement to supply LNG to TOTE's new container ships serving the route between Jacksonville and Puerto Rico. The Marlin class container ships are expected to be delivered in late 2015 and early 2016, and the new LNG plant in Jacksonville is expected to be operational by mid-2016 (SNL Financial, "Pivotal LNG, WesPac to fuel LNG-powered container ships," January 7, 2015.)

[10] WSF report to Washington State Department of Transportation, "Executive Summary of Washington State Ferries' Liquefied Natural gas (LNG) Project (updated June 27, 2014)", at 1.

however, Washington State Ferries projects that the vessels will produce $256 million in total benefits, including $149 million in reduced fuel costs.[11]

WSF recently filed an application with the U.S. Coast Guard to evaluate the safety of its design plans for locating LNG storage tanks on the six ferries. The USCG public comment period on WSF's application ends in January 2015.

Absent any indications that WSF has made alternate plans to address emissions restrictions, Concentric has assumed that WSF will continue the process to obtain approval to convert to LNG. Concentric has assumed that WSF will convert one of its Issaquah ferries per year to LNG and will follow by converting one ferry per year for the rest of its fleet. Due to potential delays associated with the required legislative, regulatory, and financial support, Concentric has assumed the conversion will begin in 2017. Each Issaquah ferry is expected to use approximately 3,100 LNG gallons per day based on their size and operating schedule. Other ferries are expected to use between 4,200 and 9,800 LNG gallons per day.

- **Horizon Lines.** Horizon Lines owns a fleet of 13 ocean going container vessels and operates five port terminals in Alaska, Hawaii, and Puerto Rico. Horizon's Alaska shipping operations deploy three diesel powered container ships serving port terminals in Anchorage, Kodiak and Dutch Harbor. Horizon's Alaska service consists of two weekly voyages from Tacoma to Anchorage, and a weekly sailing to Dutch Harbor. In addition to the three vessels deployed, Horizon has a reserve steam powered containership in drydock relief.

  In 2013, Horizon Lines announced plans to convert the power plants on two of its steam turbine cargo vessels and four container vessels to LNG to reduce fuel consumption and lower emissions. However, in November 2014, Matson Inc., Horizon Lines new owner, announced plans to install main engine exhaust scrubbers on the three active diesel powered vessels in the Alaska fleet that Matson acquired from Horizon. The estimated capital cost per vessel was estimated to be $6-8 million, along with increased operating costs.[12]

  There is some potential that when the vessels in the Alaska feet retire in the mid-2020s that they could be replaced with LNG fueled ships; however, Matson will likely wait to observe expectations about future fuel price spreads before making a decision. Because the current owners of the Horizon Alaska fleet have indicated that they plan to install scrubbers, and because of the high degree of uncertainty associated with replacement vessels in 10 years, demand associated with the Horizon Alaska fleet was not included in Concentric's potential LNG market evolution.

- **Matson.** Matson is a leading U.S. carrier in the Pacific, with service between the U.S. West Coast, Hawaii, Guam, and China. Matson has two ships that travel between

[11] "LNG Opportunities for Marine and Rail in the Great Lakes, Gulf of Mexico, and Inland Waterways," Gladstein, Neandross and Associates, October 2014, at 17. The cited passage first appeared in September 2012, in a presentation to the High Horsepower Applications for Natural Gas Summit in Houston, Texas. The original report by Endicott Fay was titled "Washington State Ferries LNG Retrofit."

[12] Matson Investor Presentation, May 2014, at 10.

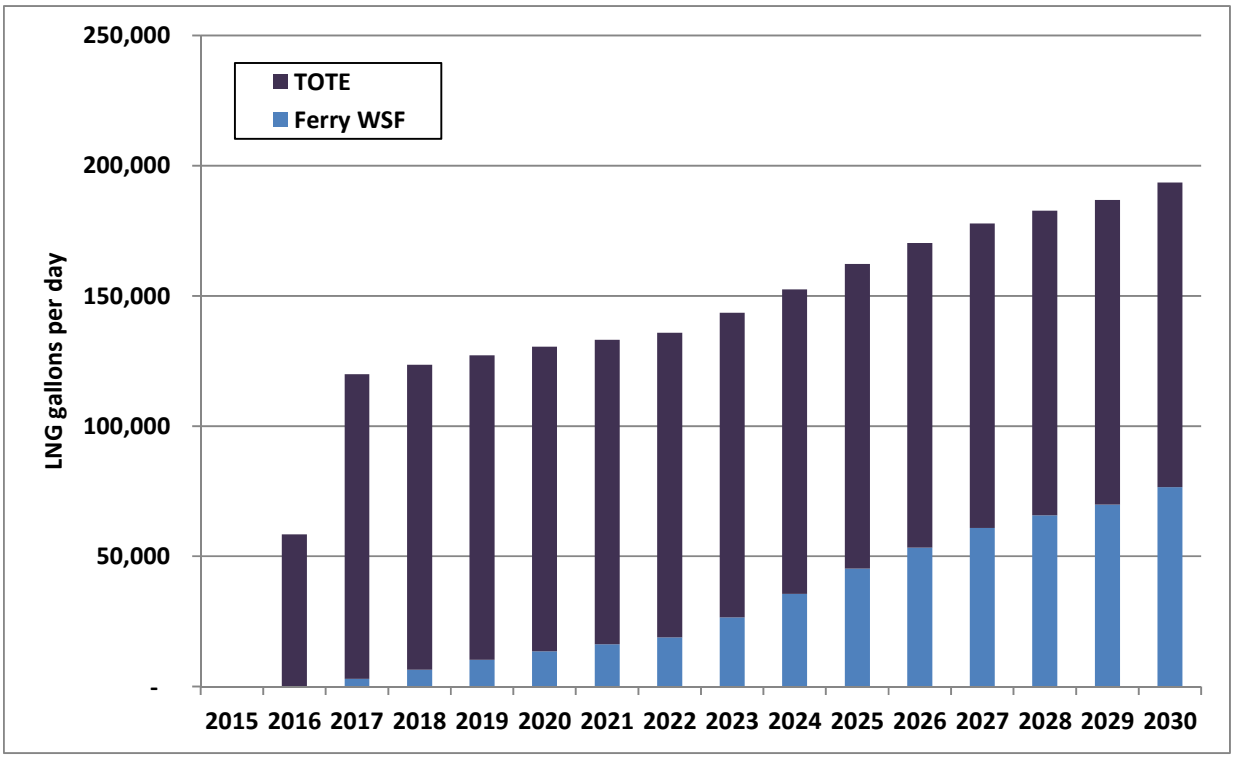
Seattle, Oakland and Honolulu. In November 2013, Matson signed a contract with Aker Philadelphia Shipyard to construct two 850 ft. vessels for $418 million to be delivered in late 2018.[13] These vessels are termed the "Aloha Class" and will be part of Matson's Hawaii routes. The Aloha Class vessels are designed to be dual-fueled; however whether Matson will exercise the LNG option at an additional cost of $20.5 million per vessel has yet to be determined, with the decision to be based on availability of LNG at U.S. West Coast Ports.[14] If exercised, each ship will have capacity for approximately 790,000 gallons of LNG, enough to sail round-trip from the West Coast to Hawaii once a week. Because of the degree of uncertainty associated with whether Matson will exercise the option to install the LNG engines, the potential LNG demand associated with Matson's Aloha Class has not been included in Concentric's potential LNG market evolution.

- **Other Possible Sources of Future Marine LNG Demand.** There are several other types of vessels that travel in the ECA in the Tacoma area that will be required to decide how to comply with the emissions restrictions. These vessels include cruise ships, assist and escort vessels, tugboats and pushboats, which are discussed below:
    - Cruise Ships: Many of the cruise ship companies serving the Seattle/Tacoma region have announced plans to install exhaust scrubbers rather than convert the engines to LNG. In particular, Carnival Cruise Lines (which operates Carnival, Princess, and Holland America) has announced that it plans to install scrubbers on 70 ships over the next three years. Celebrity Cruises (which operates Celebrity and Royal Caribbean) also has announced that it plans to install scrubbers on 19 cruise ships over the next eight months. Finally, Norwegian Cruise Lines has indicated that it plans to install 28 scrubbers on six ships. Based on these announcements, Concentric has not included any demand associated with cruise ships in the evolution of LNG demand through 2030.
    - Assist and Escort Vessels, Tugboats and Pushboats: Based on an October 2014 report that examines projected LNG conversions in the Gulf of Mexico, it is not expected that these types of vehicles will convert to LNG in the near term. Some of the reasons include lack of deck space for LNG storage tanks and potential safety concerns about where to place the storage tanks. There is some potential that as old vessels retire, new vessels may be capable of being fueled by LNG, but shipping companies have not yet announced intentions to purchase LNG fueled vessels. Therefore, Concentric has not included demand with assist and escort vessels, tugboats and pushboats in the evolution of LNG demand through 2030.

As discussed previously, the evolution of demand for LNG in the marine sector will be driven primarily by environmental regulations. Based on current information from shipping companies operating in the Seattle/Tacoma area, Concentric expects that the potential demand for LNG in the marine sector through 2030 will be driven by TOTE and WSF. As shown in Figure 2, the LNG marine fuel market could exceed 130,000 LNG gallons per day by 2020 and could approximate 194,000 LNG gallons per day by 2030.

[13] Matson also has an option to purchase three additional vessels from Aker Philadelphia Shipyard.
[14] Matson Investor Presentation, May 2014

Figure 2: Evolution of Marine LNG Demand



IV. LNG POTENTIAL FOR HEAVY DUTY TRUCKING MARKETS

A. Factors affecting LNG Conversions

As discussed in the 2012 Market Assessment, the demand for LNG from heavy duty trucking is primarily a function of economics, availability of equipment, and the availability of infrastructure.

- **Economics.** The heavy duty trucking market does not have the same need to comply with new, stricter environmental regulations like the marine market, so the economics of conversion becomes a much more important factor. The economic portion of LNG conversion decisions will depend on whether companies believe that they can recover the up-front incremental cost of the LNG vehicle through the expected fuel savings over the life of the vehicle. Therefore, the two components of the conversion economics are the vehicle premium and the fuel price spread.
  - Vehicle Premium: There is a wide range of incremental cost estimates associated with a LNG tractor as compared to a diesel truck, and costs will also vary by the size of the tank. According to a Brookings Institute report, the incremental cost of LNG tractors is approximately $70,000 above diesel tractors, including excise tax.[15] The incremental vehicle cost assumptions used by the U.S. Energy Information Administration ("EIA") in their transportation model ranges from $50,000 to $80,000, primarily due to various tank size configuration assumptions.[16] Overall, these cost ranges are similar to what was expected when the 2012 Market Assessment was prepared.
  - Fuel Price Spread: As discussed in Section II, fuel price expectations have significantly changed since the preparation of the 2012 Market Assessment. The most dramatic change relates to the price of oil. The price of oil began to decline significantly in the summer of 2014 and is currently (as of mid-January 2015) trading at half of what it was last summer. As a result, current oil price expectations are significantly lower than they were a few years ago. Lower fuel price spreads produce more challenging conditions for LNG conversions. However, Wood Mackenzie expects that the forecasted price spread in the market area will increase over time and will be approximately $0.80/DGE by the time the Tacoma LNG facility becomes operational in 2019.
- **Availability of Equipment.** The availability of Original Equipment Manufacturer ("OEM") LNG engines and vehicles is an important determinant of the evolution of the LNG demand from heavy duty trucking. Availability of LNG trucks is lagging behind earlier expectations. The engines currently used in LNG tractors in North America are manufactured by Cummins Westport Inc., a joint venture between Cummins and Westport Innovations. According to NGV Today, increased production of Cummins Westport's ISX12 G 12-liter natural gas engine was expected to increase the adoption of LNG, however, most of the orders for these engines have now been installed in trucks

[15] Brookings Institute, Energy Security Initiative, "Liquid Markets: Assessing the Case for U.S. Exports of Liquefied Natural Gas." Policy Brief 12 01, May 2012, at 19.
[16] Communications with Patricia Hutchins, Transportation Energy Analyst, U.S. Energy Information Administration, January 2015.

that utilize CNG instead of LNG.[17] Additionally, both Cummins and Westport Innovations separately announced that they were stopping taking orders and halting production for their respective 15-liter LNG engines in late 2013/early 2014.[18,19]

- **Availability of Infrastructure.** As discussed in the 2012 Market Assessment, the conversion decision is highly dependent on the availability of LNG fueling infrastructure, and lack of fueling infrastructure is often cited as a deterrent to LNG conversion by trucking companies. LNG fueling infrastructure requires significant upfront investment and a complicated supply chain that consists of liquefaction facilities, distribution trucks, and LNG fueling stations. In 2011, as a part of its "America's Natural Gas Highway" plan, Clean Energy Fuels announced that it would build 150 LNG fueling stations (70 in 2012 and 80 in 2013);[20] however, only 34 of those stations are open today.[21] According to the Alternative Fuels Data Center ("AFDC"),[22] there are currently approximately 100 operational LNG fueling stations (62 public and 38 private) in the US, with one in Washington State, and one in northern Oregon. In addition, there are another 74 LNG fueling stations in the planning stages (1 in Washington and 4 in Oregon). The majority fueling stations in the planning stages have been constructed and are ready to operate, but have not opened due to lack of trucking demand.

Due to a number of factors, the evolution of LNG demand for heavy-duty trucking has not materialized as was once expected. According to a NGV Today report, market participants were quite bullish regarding the evolution of LNG demand from the heavy-duty trucking sector; however, conversions have not met original expectations.[23]

B. Evolution of Potential Heavy Duty Trucking Demand for LNG

To assess the economics associated with conversion to an LNG tractor, Concentric analyzed payback periods under different vehicle premium and miles travelled assumptions. Assuming 2015 as the base year and using the forecasted fuel price spread provide by Wood Mackenzie, the payback period is less than 5 years if the vehicle premium is $50,000 and if the annual mileage is close to 200,000, as shown in Figure 3. Because a $50,000 LNG vehicle premium is on the low end of the range, and because almost all heavy duty trucks travel less than 200,000 miles per year, it was assumed that there would be no demand for LNG from heavy duty trucking in the near term due to the low fuel price spread.

17 NGV Today, "SPECIAL REPORT: Sizing up the LNG as a transportation fuel market", July 23, 2014. http://ngvtoday.org/2014/07/23/special-report-sizing-up-the-lng-as-a-transportation-fuel-market/
18 http://www.truckinginfo.com/channel/fuel-smarts/news/story/2013/10/westport-dropping-15-liter-lng-engine-for-north-america.aspx
19 http://www.ngtnews.com/e107_plugins/content/content.php?content.9408#.VL1SG9LF_To
20 http://www.cleanenergyfuels.com/pdf/CE-OS.ANGH.012412.pdf
21 http://www.afdc.energy.gov/
22 http://www.afdc.energy.gov/
23 NGV Today, "SPECIAL REPORT: Sizing up the LNG as a transportation fuel market", July 23, 2014. http://ngvtoday.org/2014/07/23/special-report-sizing-up-the-lng-as-a-transportation-fuel-market/

Figure 3: Payback Associated with Various Vehicle Premium and Mileage Assumptions

Payback (Years)		Annual Mileage						
		50,000	65,000	75,000	100,000	125,000	150,000	200,000
Vehicle Premium ($)	50,000	10	8	7	6	5	5	4
	55,000	10	9	8	7	6	5	5
	60,000	11	9	8	7	6	5	5
	65,000	11	10	9	7	6	6	5
	70,000	12	10	9	8	7	6	5
	75,000	13	11	10	8	7	6	5

Note: Assumes 2015 as the base year; proxy LNG price prior to Tacoma LNG coming online assumed to be Sumas natural gas price plus Tacoma specific adders for transport, liquefaction, storage and delivery.

Additionally, Concentric examined the payback period associated with various assumptions associated with fuel price spreads and vehicle miles travelled. For reference, approximately 4% of heavy duty trucks travel over 150,000 miles per year, and approximately 25% of heavy duty trucks travel over 100,000 miles per year. Assuming a vehicle premium of $60,000, the payback period for trucks that travel at least 100,000 miles per year is less than five years when the fuel price spread is at or above $0.75 on a diesel gallon equivalent basis, as shown in Figure 4.

Figure 4: Payback Associated with Various Fuel Spread and Mileage Assumptions

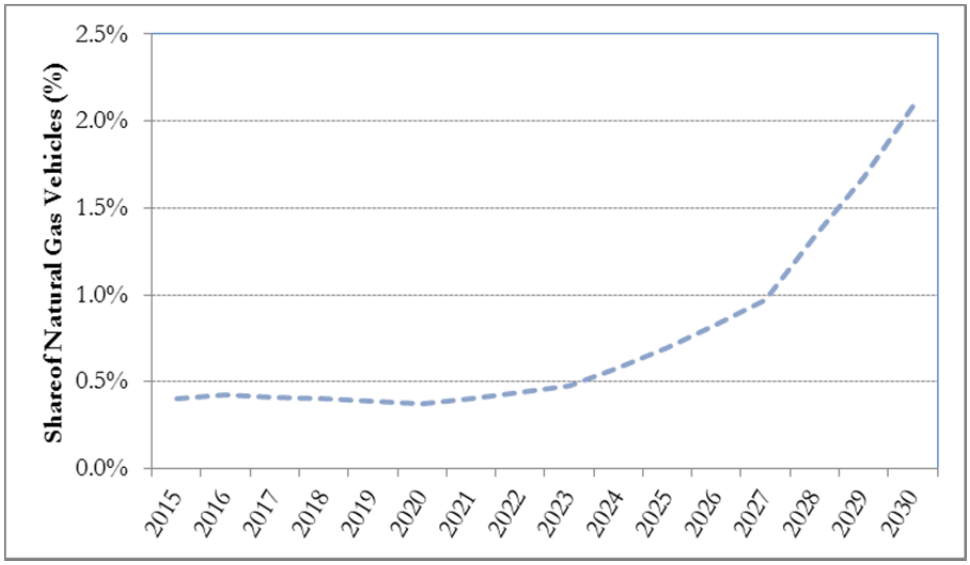
Payback (Years)		Fuel Spread ($/DGE)						
		0.25	0.50	0.75	1.00	1.25	1.50	1.75
Annual Mileage	50,000	16	14	9	7	5	4	4
	65,000	16	11	7	5	4	3	3
	75,000	16	9	6	4	3	3	2
	100,000	14	7	4	3	2	2	2
	125,000	11	5	3	2	2	1	1
	150,000	9	4	3	2	1	1	1
	175,000	8	4	2	2	1	1	1
	200,000	7	3	2	1	1	1	1

Note: Assumes a vehicle premium of $60,000.

Wood Mackenzie's fuel price forecast, as shown in Figure 1 in Section II above, indicates that the price spread is expected to reach $0.75 per diesel gallon equivalent in 2018, and will continue to increase beyond 2018. Based on this analysis, Concentric assumed that the conversion of heavy duty trucks will be delayed until 2018, when the fuel price spread is expected to recover. This assumption could be conservative, because the expected fuel price spread in 2017 could make the conversion to LNG economic for the small percentage of trucks that travel very long distances.

According to EIA's 2014 Annual Energy Outlook ("AEO 2014") the share of total vehicle miles travelled by natural gas vehicles in the heavy trucks segment is expected to be below 0.5 percent through 2023, and reach approximately 2 percent by 2030, as illustrated in Figure 5.[24]

Figure 5: EIA AEO 2014 Share of Heavy Truck Vehicle Miles Traveled by Natural Gas Vehicles



However, EIA's forecast was produced prior to the recent oil price declines. Based on the payback calculations discussed above, Wood Mackenzie's forecasted fuel price spread, and Concentric's market expectations, Concentric believes that the start of the market evolution predicted by EIA in the AEO 2014 will be delayed until 2018, with penetration reaching approximately 1 percent in 2030.

Figure 6 shows the total miles travelled by heavy-duty trucks in the state of Washington based on Federal Highway Administration ("FHWA") 2012 Highway Statistics.[25]

[24] EIA AEO 2014 - Table 68 - Freight Transportation Energy Use. (EIA classifies Class 3; 4-6; and 7-8 trucks as medium-light; medium-heavy; and heavy trucks, respectively.)

[25] Federal Highway Administration (FHWA) Highway Statistics 2012.

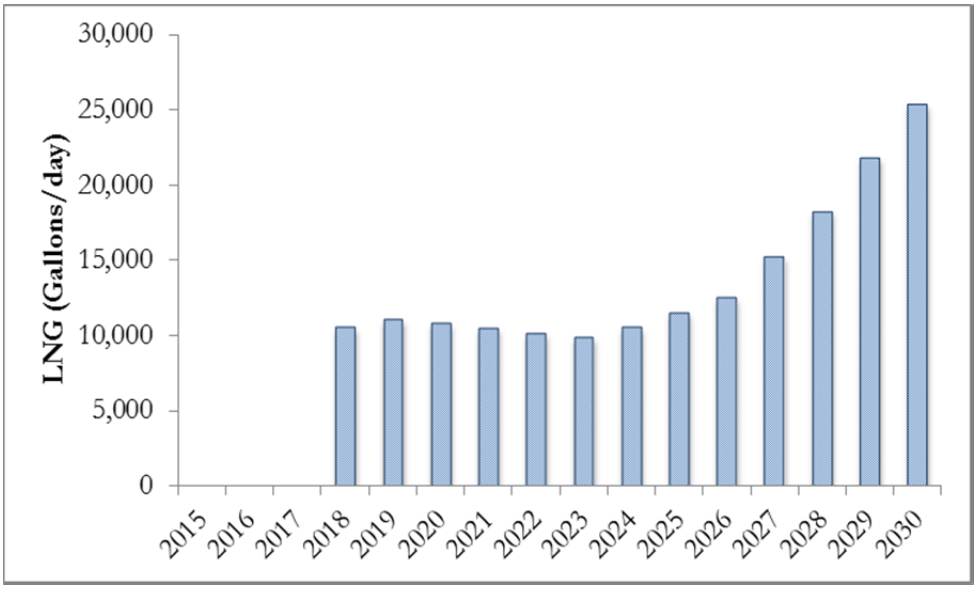
Figure 6: Vehicle Miles Travelled by Combination Trucks in Washington

Highway Type	All Vehicle Miles (Millions)	Combination Truck Share (%)*	Combination Truck Vehicle Miles (Millions)
Interstate Rural	4,579	19.80%	907
Other Arterial Rural	6,134	7.98%	490
Other Rural	6,234	3.99%	249
All Rural	16,947		1,645
Interstate Urban	10,864	7.35%	798
Other Urban	28,951	2.32%	673
All Urban	39,815		1,471
All Rural and Urban	**56,762**		**3,117**

** Based on 2012 National Data*

Using EIA's LNG market penetration assumptions, delayed to start in 2018 for the reasons described above, the vehicle miles travelled by heavy duty trucks in Washington State, and converting vehicle miles travelled to demand for LNG, Concentric estimated the annual LNG demand for heavy duty trucks in Washington State through 2030. The annual demand is estimated to be approximately 10,000 gallons per day in 2018 and increases to approximately 25,000 gallons per day by 2030, as shown in Figure 7.

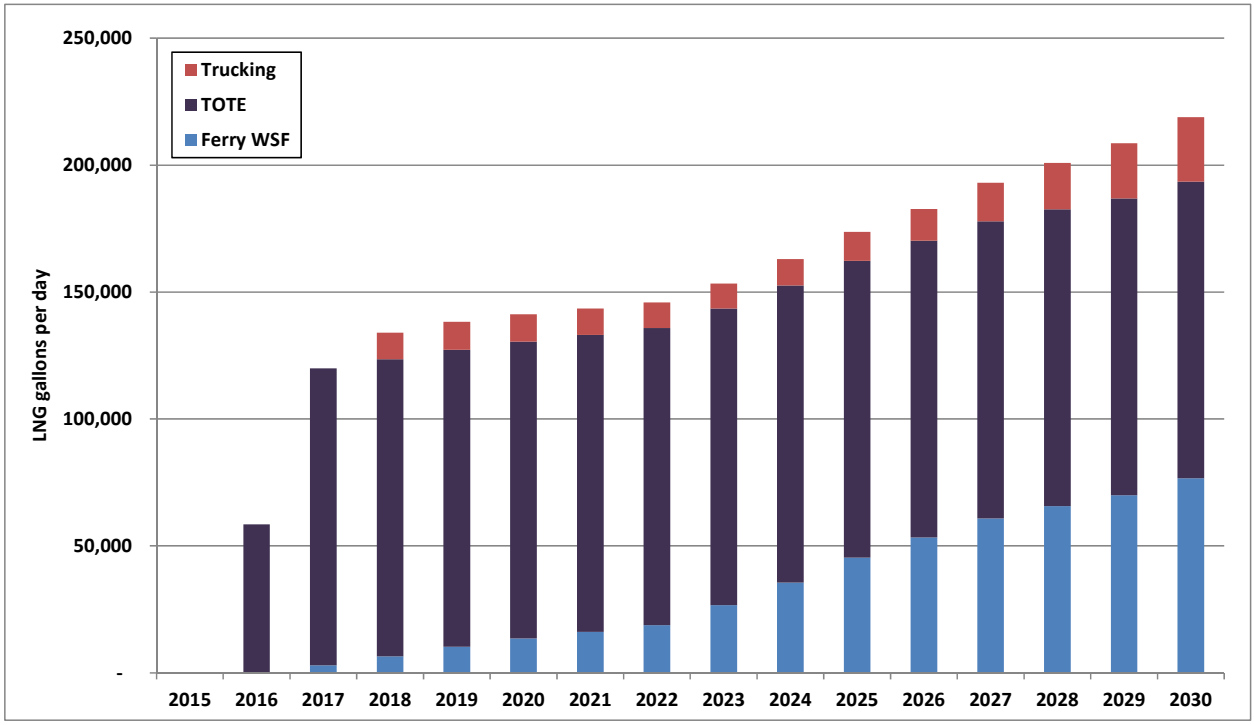
Figure 7: Evolution of LNG Demand from Heavy-Duty Trucking



V. CONCLUSION AND DISCUSSION

As shown in Figure 8, Concentric's analysis demonstrates that combined marine and heavy duty trucking demand for LNG could be over 140,000 gallons per day by 2020 and almost 220,000 gallons per day by 2030 based on currently available information.

Figure 8: Potential Evolution of LNG Demand from Marine and Heavy-Duty Trucking



As discussed above, the potential evolution of LNG demand from marine vessels is primarily driven by the need to comply with new, stricter environmental restrictions. The expected evolution of LNG demand is based on information provided by specific companies with marine operations in the Tacoma area indicating that they are planning to fuel with LNG to achieve compliance. To date, many of the other companies and types of vessels seem to plan to use the more expensive low-sulfur fuel to achieve compliance; however, if the spread between gas and oil prices rises considerably in the future, these vessels could be another source of LNG demand.

Conversely, the potential evolution of LNG demand from heavy duty trucking is primarily driven by the fuel price spread between LNG and ULSD. Concentric's demand evolution for heavy duty trucking presented above is based on Wood Mackenzie's current fuel price forecast. If low fuel price spreads persist for a longer period, the evolution will be delayed. If fuel price spreads are higher than anticipated, the evolution could be increased. Because there are no environmental regulations requiring investment, truck companies have the luxury of waiting to see what market conditions transpire before making an investment decision.

In addition to the new emissions requirements associated with ECAs, the International Maritime Organization ("IMO"), a specialized agency of the United Nations with responsibility for the safety and security of shipping and the prevention of marine pollution by ships, also has regulations limiting sulfur emissions by marine vessels to 0.5% globally starting in 2020. The implementation of the global regulation is subject to a feasibility study that will be conducted no later than 2018. Implementation of stricter global sulfur emissions may encourage additional LNG conversions of marine vessels, which has not been included in Concentric's evolution of LNG demand for Washington State.

Lastly, is important to note that there is growing enthusiasm that the railroad industry could account for increased LNG demand over the longer term. For example, in the 2014 AEO the EIA projects that "LNG energy consumption by freight rail locomotives grows to 148 trillion Btu by 2040, when it accounts for 35% of total freight rail energy consumption, with fuel cost savings offsetting the incremental capital costs of LNG locomotives."[26] Likewise, other industry participants have taken a favorable view of the rail market's potential demand for LNG. For example, NGV Today published an article in July 2014 that stated with regard to the rail market:

> If uncertainty prevails as to the pace of deployment of LNG trucks, a silver lining for LNG as a transportation fuel could well be found in the market for heavy horsepower natural gas for transportation applications. Dual-fuel LNG-diesel locomotives are being tested and will likely move into more widespread revenue service in the next few years as issues pertaining to how using LNG as a locomotive propulsion fuel will be regulated and the interoperability of LNG locomotives on track owned by different railroads are worked out and solutions found to installing the infrastructure needed to fuel LNG locomotives are resolved. The case for widespread adoption of LNG for locomotive propulsion is strong. Freight railroads account for 8 percent of the diesel consumed in the U.S., and fuel accounts for about 23 percent of U.S. Class 1 freight rail operating costs.[27]

While the rail market appears to represent potential future demand for LNG, Concentric has not included rail demand in our potential evolution of LNG demand at this time due to the uncertainty involved with when rail demand might materialize in Washington State. Therefore, Concentric's demand evolution for LNG could be conservative.

[26] U.S. Energy Information Administration, 2014 Annual Energy Outlook, MT-15.
[27] NGV Today, "Special Report: Sizing up the LNG as a transportation fuel market," July 23, 2014, at 10.