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Liquefied Natural Gas As Marine Fuel

April 04, 2017

Port of Vancouver

16,000 hectares

WE ARE RESPONSIBLE FOR MANAGING OVER 16,000 HECTARES OF WATER AND OVER 1,000 HECTARES OF LAND

16 municipalities

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Our Vision

The Vancouver Fraser Port Authority vision: *to be the world's most sustainable por*

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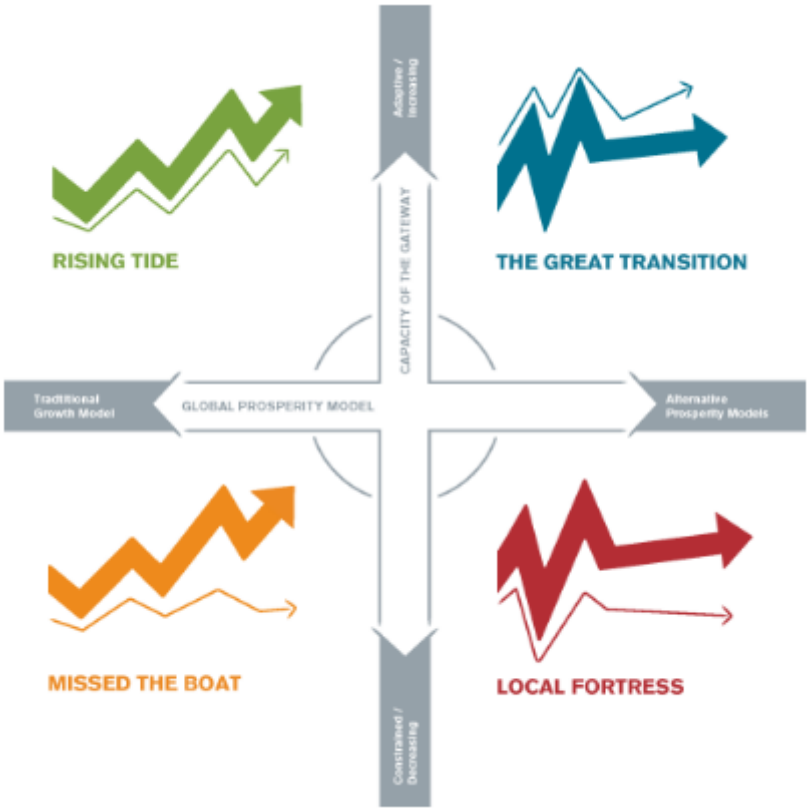
Port 2050 Scenario Planning Process

Our long range scenario planning – ***Port 2050*** – imagined what the port could look like in the next 35 years.

The Great Transition was identified as our desired future scenario which represents a shift toward a low carbon economy.

Energy transition was identified a one of the key drivers of future change.



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http://www.portvancouver.com/about-us/sustainability/

Northwest Ports Clean Air Strategy

Collaborative strategy launched in 2008 with Ports of Seattle and Tacoma, with participation from Canadian and U.S. regulatory agencies, to reduce port-related emissions in Puget Sound – Georgia Basin airshed.

Emissions reduction targets:

- *80% reduction in diesel particulate matter emissions per tonne of cargo by 2020*
- *15% reduction in GHG emissions per tonne of cargo by 2020*

Includes annual progress reporting on sector specific objectives.

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http://www.portvancouver.com/environment/air-energy-climate-action/clean-air-strategy/

Port Emissions Inventories

The Vancouver Fraser Port Authority prepares a comprehensive activity-based emissions inventory every five years and is currently completing the 2015 inventory.

- Includes marine, rail, trucking, cargo handling equipment and administrative operations
- For information on the 2010 Port Emissions Inventory please visit http://www.portvancouver.com/environment/air-energy-climate-action/clean-air-strategy/

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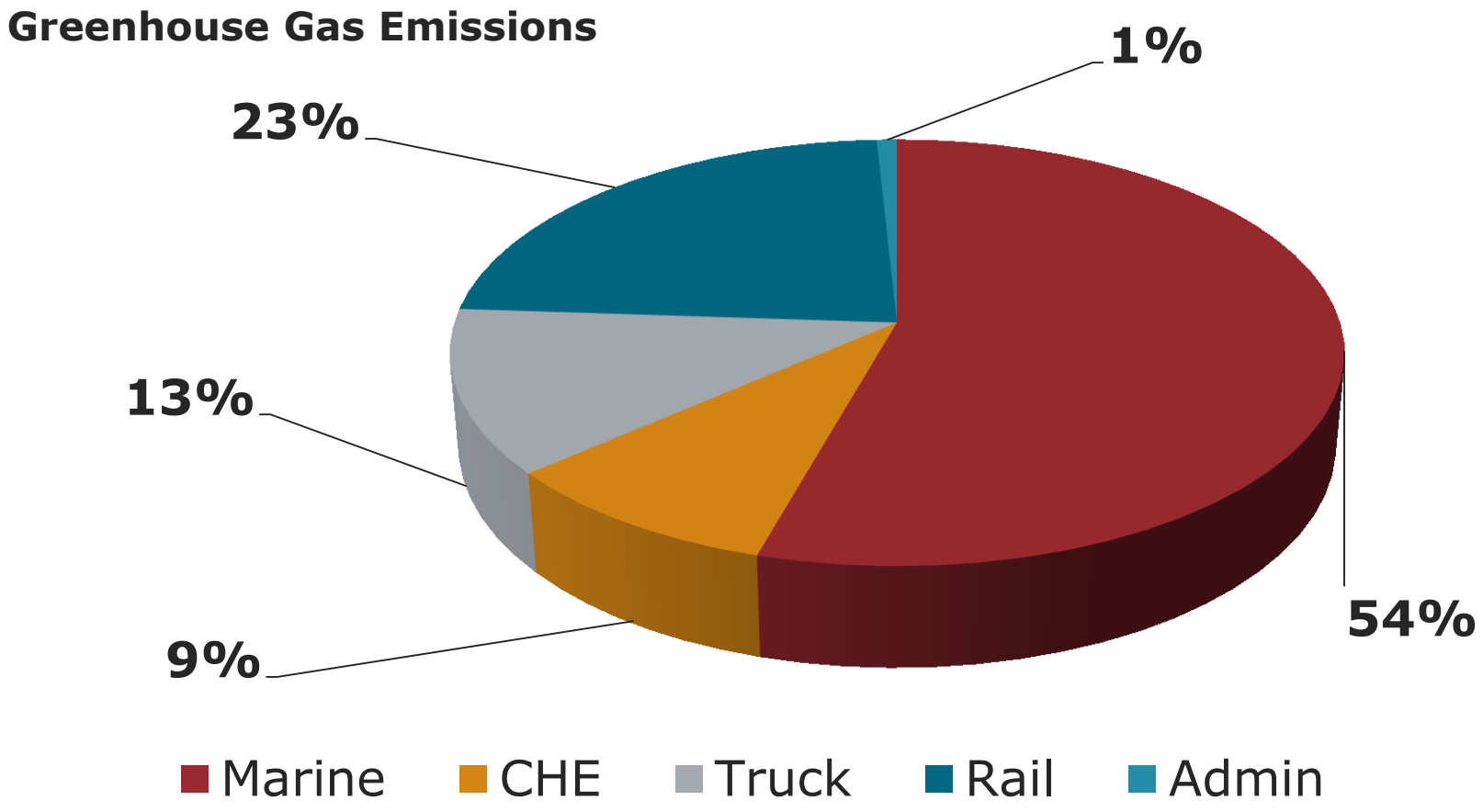
2010 Port Emissions Inventory GHG Overview



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EcoAction Program for Ships

We provide discounted *harbour dues* for ships that have implemented emission reduction measures or other environmental practices, such as:

- Clean fuels (e.g. LNG) and technologies including scrubbers or shore power, and third-party designations for ship efficiency (e.g. ESI, RightShip)

bluecircle AWARD

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http://www.portvancouver.com/environment/air-energy-climate-action/marine/

Vessel Call Statistics

VANCOUVER FRASER PORT AUTHORITY | STATISTICS OVERVIEW (2016)

Foreign Vessel Traffic

Vessel Type		2014	2015	2016	% Change
Bulk Carrier	Vessel Arrivals	1,588	1,500	1,463	-2%
	GRT*	60,070,980	57,562,320	55,871,916	-3%
Container	Vessel Arrivals	759	760	748	-2%
	GRT*	49,510,364	50,091,738	51,040,413	2%
Ro-Ro	Vessel Arrivals	265	256	243	-5%
	GRT*	13,511,258	13,101,019	13,312,023	2%
Tanker	Vessel Arrivals	215	222	248	12%
	GRT*	5,538,051	5,224,132	5,168,116	-1%
Passenger	Vessel Arrivals	255	237	233	-2%
	GRT*	17,277,192	17,311,298	17,967,675	4%
Miscellaneous	Vessel Arrivals	86	151	170	13%
	GRT*	212,809	276,716	323,523	17%
GRAND TOTAL	**Vessel Arrivals**	**3,168**	**3,126**	**3,105**	**-1%**
	GRT*	**146,120,654**	**143,567,223**	**143,683,666**	**0%**

* Gross Registered Tonnage in Metric Tonnes

http://www.portvancouver.com/about-us/statistics/

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LNG Bunkering at Port of Vancouver

Vancouver Fraser Port Authority is exploring opportunities for LNG as a marine fuel in the Port of Vancouver

- LNG can represent a safe, cost competitive and cleaner fuel alternative for vessels calling at the Port of Vancouver
- Regulations are driving industry toward cleaner fuel alternatives, e.g. IMO global application of (0.50%) sulphur limit in 2020, and Emissions Control Areas
- In 2016, VFPA retained Lloyd's Register ("LR") to conduct an LNG Bunkering Study to develop an estimate of future demand for LNG as a marine fuel in Port of Vancouver

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LNG Demand Forecasts

Lloyd's Register structured the forecast into 3 demand scenarios: low demand, base demand, and high demand.

- Created two sets of comparative demand estimates:
  - 1) a set using LR global study data, and;
  - 2) a set using Port of Vancouver customer survey data
- LNG volumes reported in cubic meters

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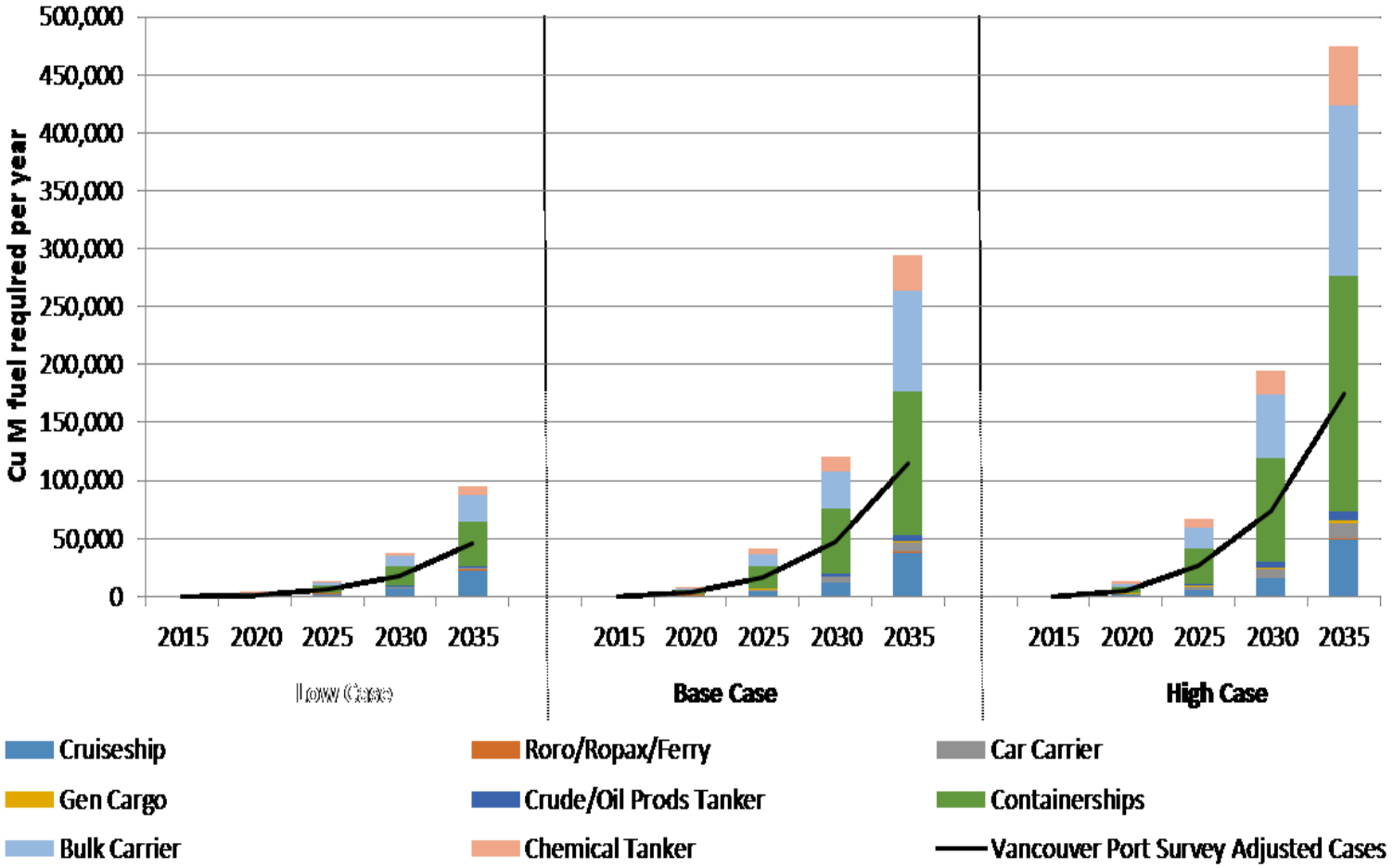
LNG Demand Forecast using LR Global Study



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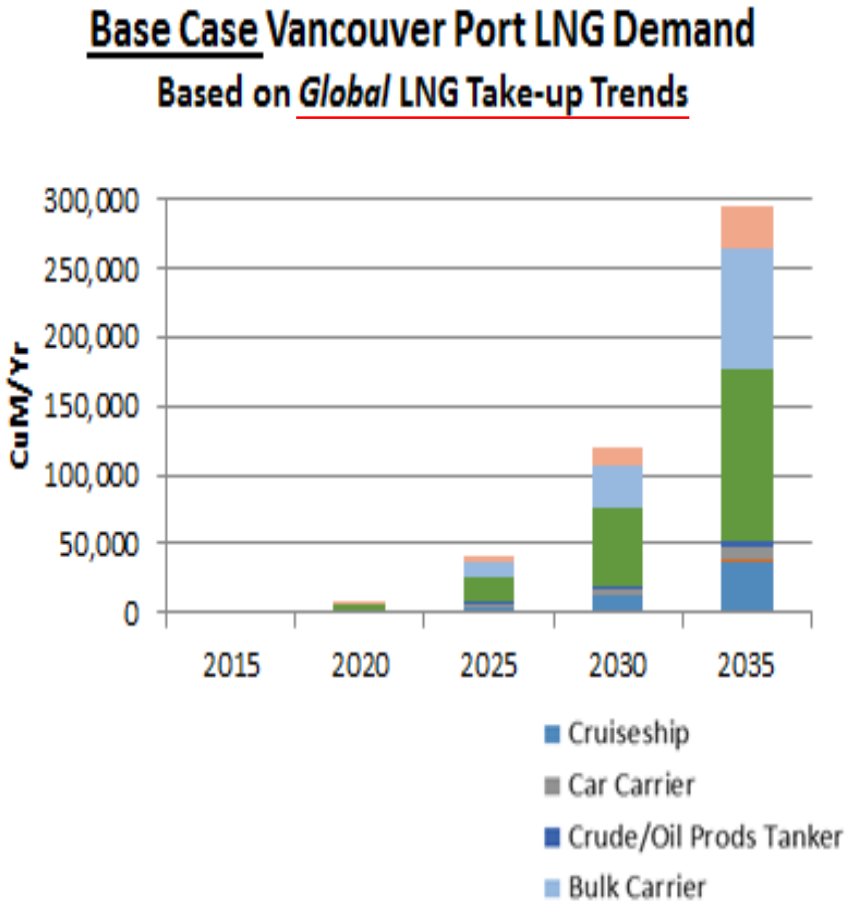
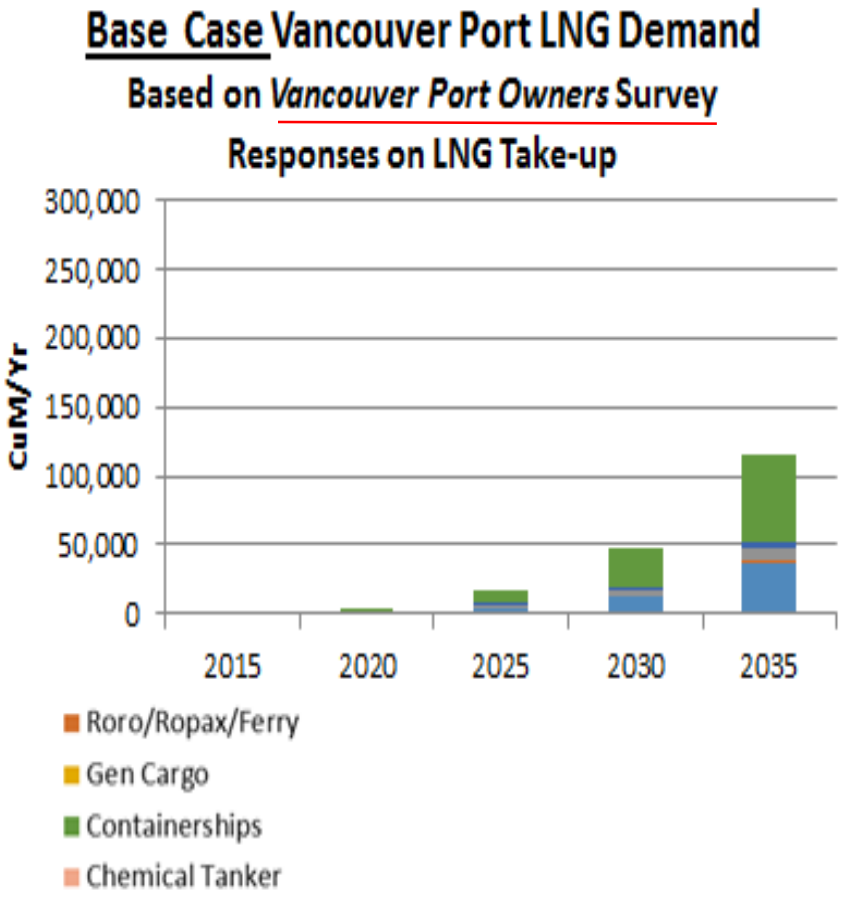
Base Demand Forecast





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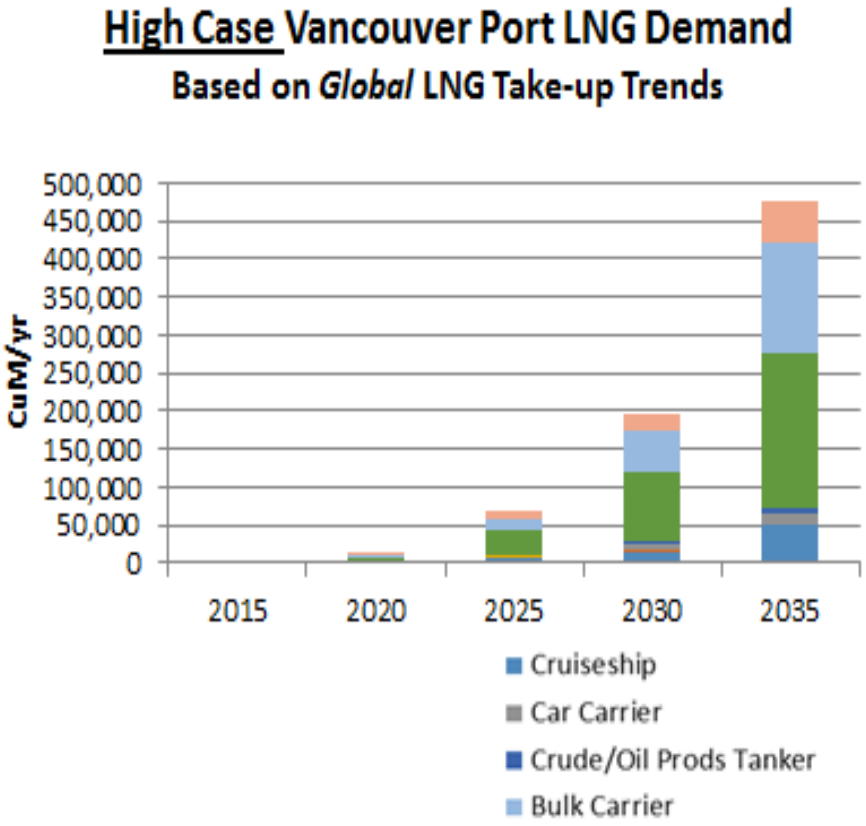
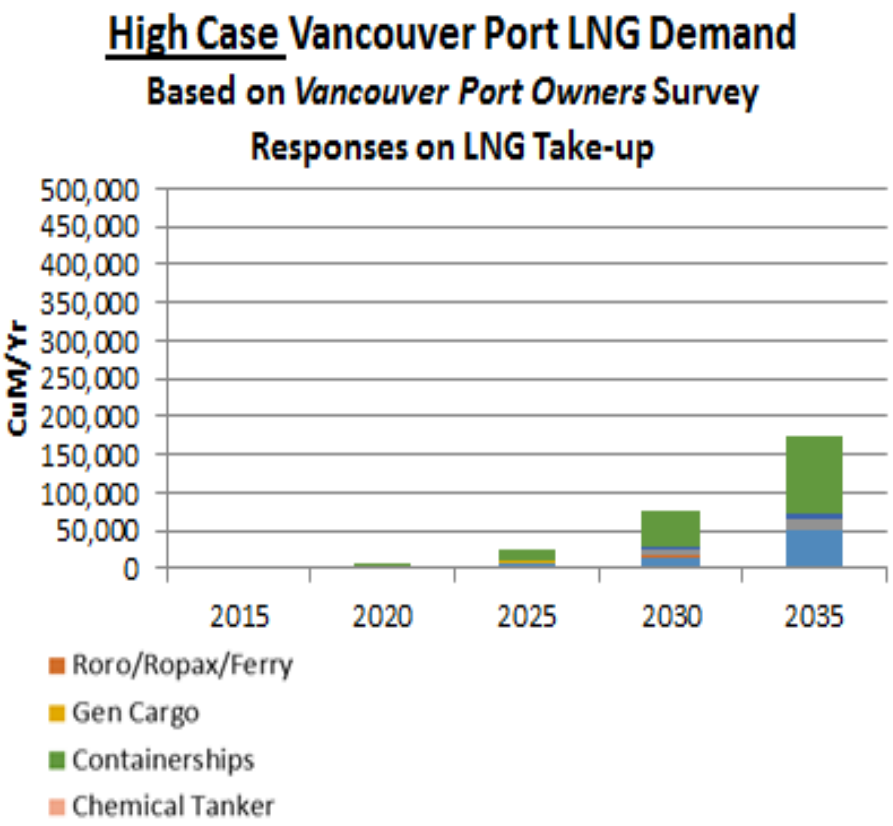
High Demand Forecast





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Lloyd's Register Study Findings

LNG capable vessels are likely to begin calling at Port of Vancouver in the 2020-2025 time period.

- Ships are unlikely to be retrofitted; dual-fuel (LNG capable) new builds can be anticipated for:
  - ro-ro auto service ships, container ships, cruise ships
  - Forecast differences using LR global study and Vancouver study (e.g. bulk and tanker demand)
- Early demand volumes may be modest, e.g. roughly 10,000m3 - 50,000m3 in 2025, increasing toward 2030-2035, e.g. ~100,000m3 by 2030
  (note: figures are indicative only)

LNG Bunkering Options

Based on the Lloyd's Register demand forecast, and corresponding fuel volumes, it was recommended that the following LNG bunkering options be considered:

- Option A: 1+1 LNG bunkering barge (1,000m3 or 2,000 m3 each) with optional small-scale storage facility to support operations
  - Scalable option as operations can commence with 1 barge and be increased as demand requires
- Option B: LNG feeder vessel (up to 7,000 m3 capacity)
  - Offers greater maneuverability and operability in poor weather and for transiting from fuel supply (i.e. Tilbury)

Next Steps

- Facilitate ongoing engagement with customers on LNG bunkering at Port of Vancouver (validate demand)
- Engage Transport Canada to improve transparency on and involvement in the development of LNG bunkering requirements
- Conduct a preliminary assessment of LNG bunkering for key sites within Port of Vancouver to determine initial feasibility and identify operational issues requiring further investigation
- Investigate best practices in management of fugitive methane emissions associated with LNG bunkering operations (Natural Gas Futures Consortium – UBC CERC)