

Addressing Barriers to LNG as a Marine Fuel in Canada

**LNG Bunkering
North America Conference**

June 3, 2014 - Vancouver, BC

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Canadian Natural Gas Vehicle Alliance

National not-for-profit trade association

- Focus on use of natural gas as a transportation fuel for on- and off-road applications
- 45 corporate members with interests spanning natural gas production, distribution, and end use including vehicle and station equipment manufacturers
- www.cngva.org

West Coast Joint Industry Project

Liquefied Natural Gas:
A Marine Fuel for Canada's West Coast



April 2014

- First phase of 3 phase Canadian project
- Upcoming regulatory changes & stakeholder interest were primary catalysts for project
- Clear challenge given need to adapt existing Canadian regulations that do not include LNG

Project Context



North American ECA

- North American ECA compliance options as of January 2015:
 1. Switch to distillate fuel
 2. Install scrubber technologies
 3. Switch to LNG:
 - Estimated 80% less NO_x and PM
 - Estimated 90% less SO_x
 - Greenhouse gas (GHG) reductions of 15% or more
 - Potential to reduce fuel costs

Project Approach

1. Determine LNG technology readiness
2. Quantify economic benefits of LNG use
3. Identify environmental benefits for West Coast
4. Model LNG bunkering and infrastructure options
5. Document human resource challenges
6. Identify regulatory impediments to LNG use
7. Develop implementation scenarios
8. Assess overall benefits for Canada
9. Communicate key findings

Project Participants

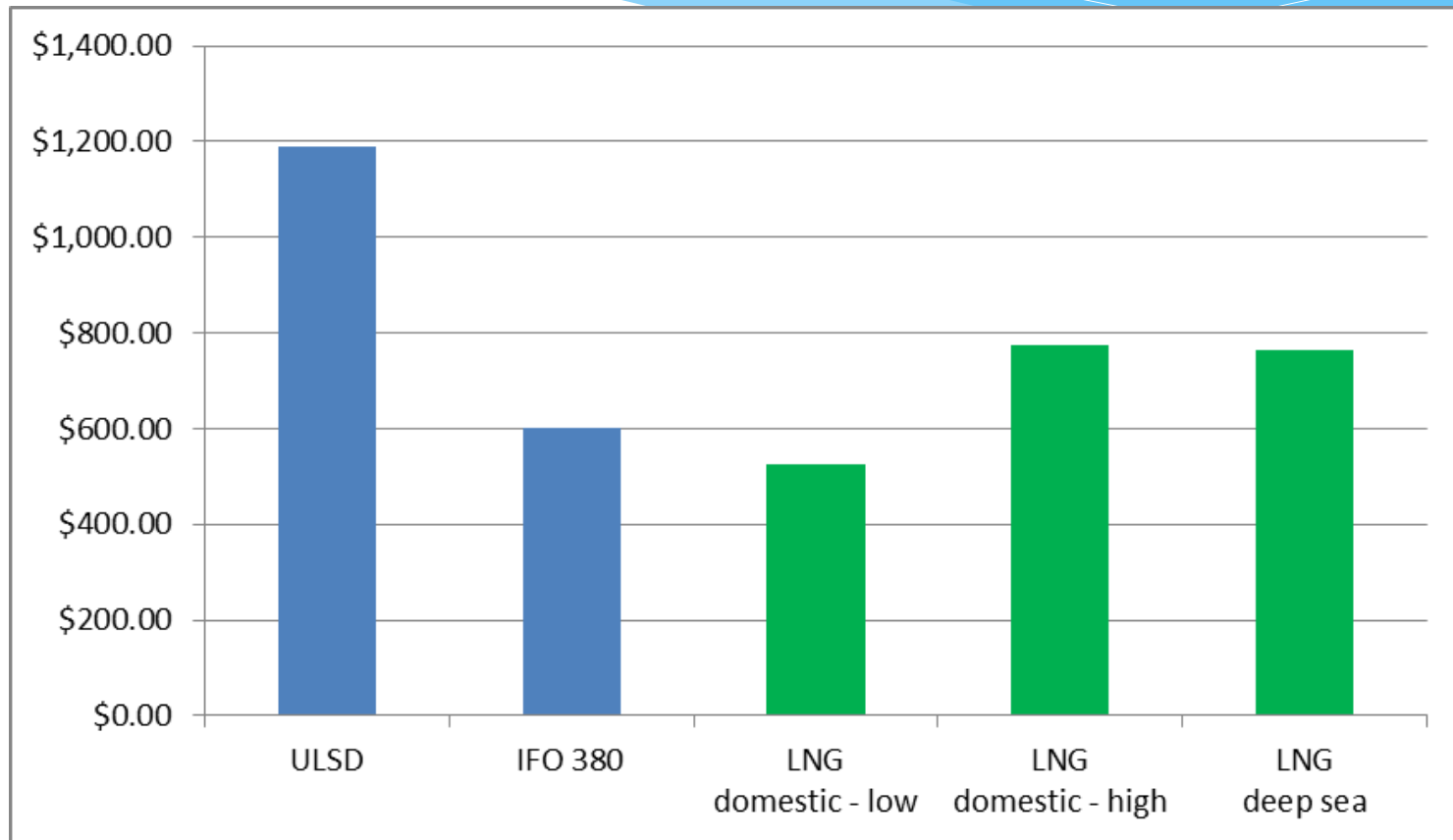
1. American Bureau of Shipping
2. BC Ferries
3. BC Institute of Technology
4. BC Ministry of Transportation – Pacific Gateway
5. CNGVA/Canadian Natural Gas Initiative
6. Canadian Standards Association
7. Encana Corporation
8. FortisBC
9. Government of Canada
(Transport Canada, Environment Canada, Natural Resources Canada)
10. Lloyd’s Register
11. Port Metro Vancouver
12. Rolls-Royce
13. Seaspan
14. Shell
15. STX Marine
16. Teekay
17. Wartsila
18. Westport Innovations

14 Vessels Modelled

	Vessel	New Build or Conversion
1	100 CEU ferry	New build
2	375 CEU ferry	Conversion
3	125 CEU ferry	Conversion
4	Coastal roll-on/roll off	New build
5	Bulk carrier	New build
6	Dry bulk carrier	New build
7	Crude oil tanker	New build
8	Oil/chemical tanker	New build
9	2,200TEU container ship	Conversion
10	6,500TEU container ship	New build
11	6,500 CEU car carrier	New build
12	6,500 CEU car carrier	Conversion
13	Passenger ship	New build
14	Escort tug	New build

- Mix of new build and converted vessels
- 8 vessels spend 100% of time in ECA
- 6 vessels spend only 20% of time in ECA and are bunkered half of time on West Coast & half in Asia

Fuel Price Assumptions (\$/tonne)



Pilot fuel assumed to be ULSD

Other Modelling Assumptions

- Upfront cost (conversion or new build) determined based on research & industry input
- Incremental crew training costs were factored in along with engine efficiency, loading, vessel life
- Assumed no change in vessel maintenance costs
- Modelling did not include:
 - Cost of lost cargo space for LNG-related systems
 - Cost of taking vessel out of service if converting

KEY PROJECT FINDINGS

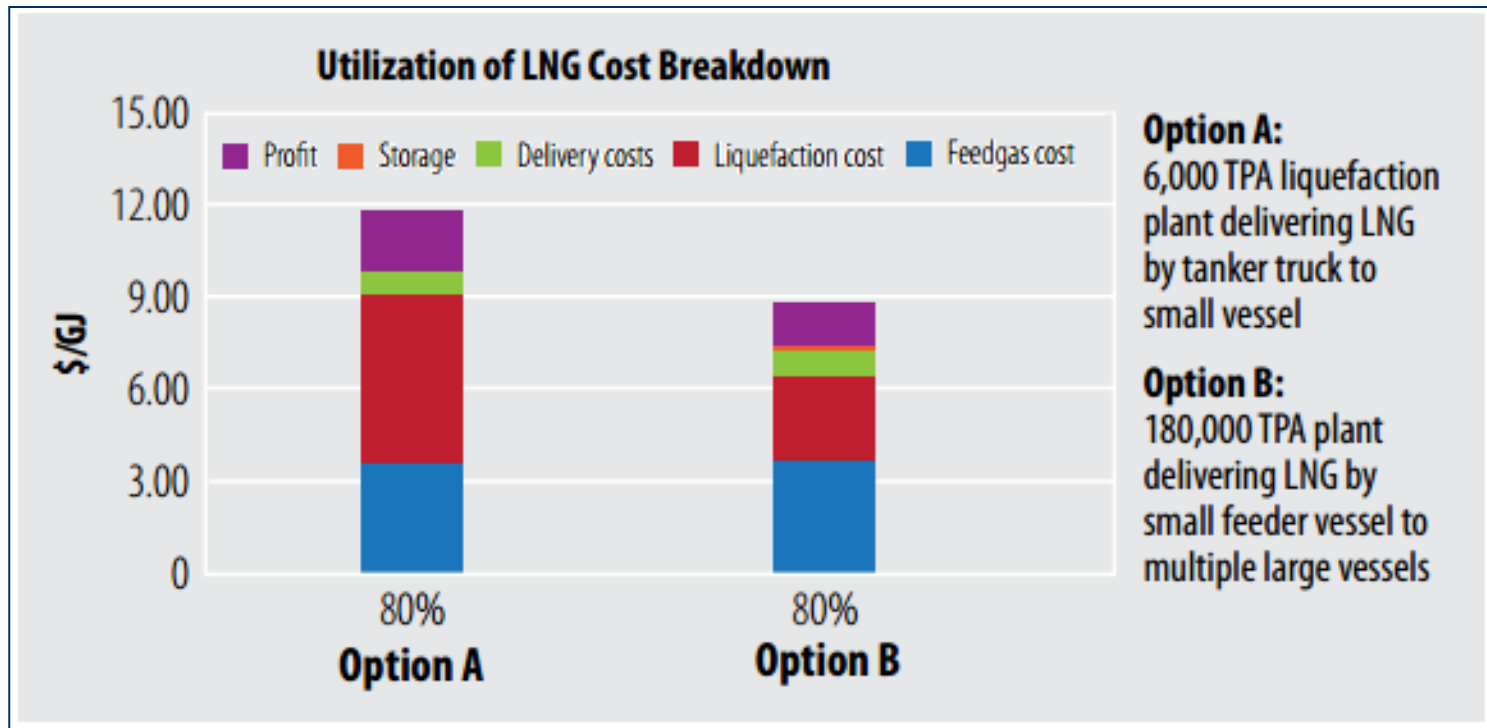


1. Technology Readiness

- **KEY FINDING - There are no technology barriers to the use of LNG as a marine fuel**
 - Commercial dual fuel and pure gas engines are available
 - Range of power options available, but limited below 1,000 kw
 - Engine & fuel storage technologies continuing to develop
 - Costs for LNG engines and components are higher
 - Ship impacts related to designing for fuel storage and use are significant particularly given LNG's lower energy density

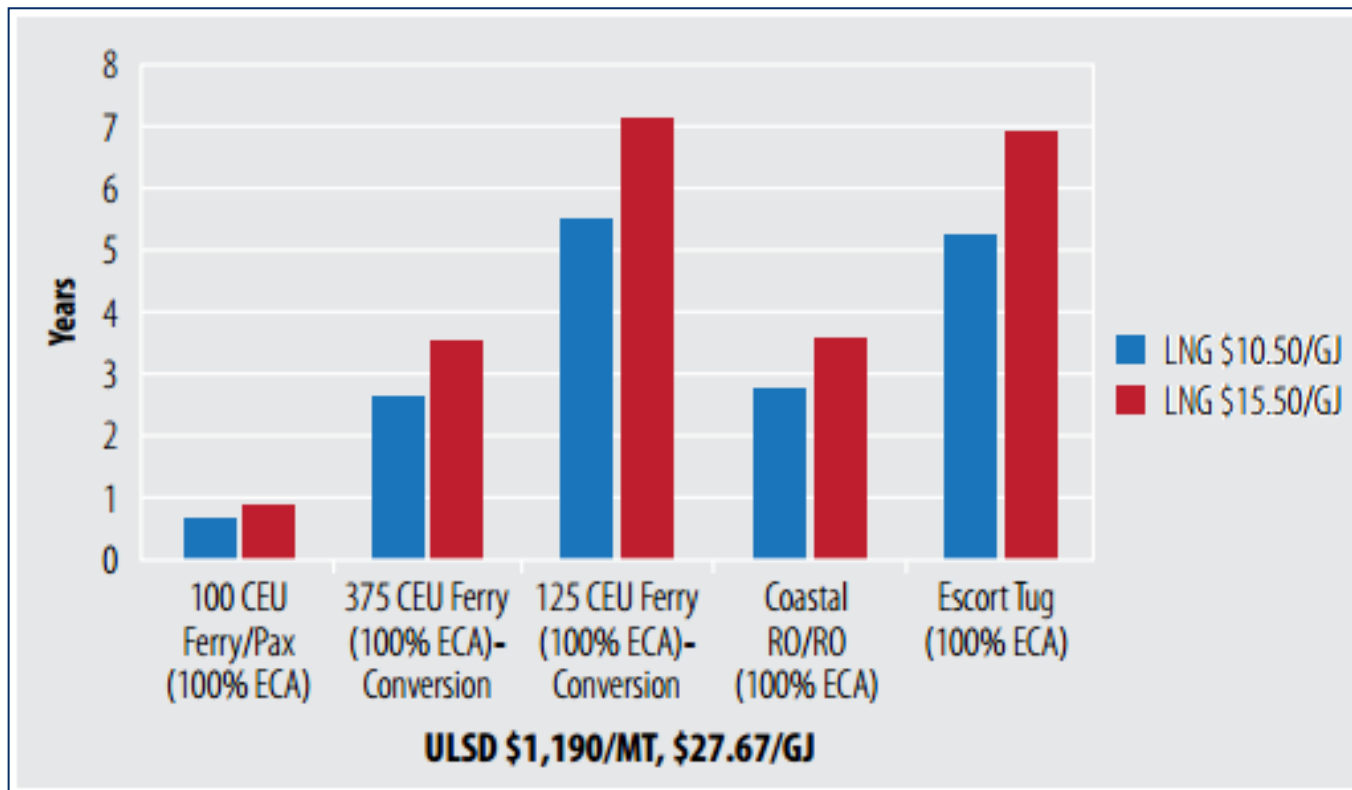
2. Economic Potential LNG Pricing

- **KEY FINDING - LNG fuel pricing is attractive even considering different scales of LNG production**



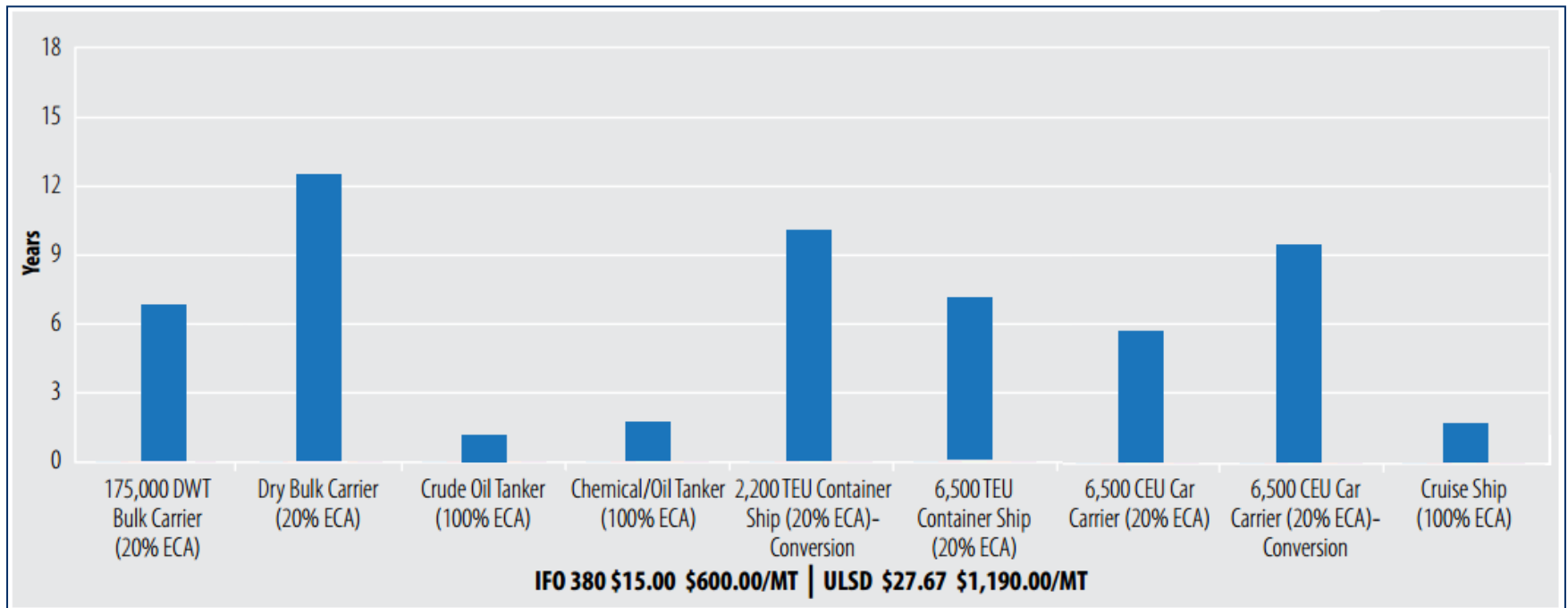
2. Economic Potential – Short Sea Payback

- **KEY FINDING** – Good payback for coastal vessels with annual fuel savings >50% and ranging from \$500K/yr to \$5.0 million/yr



2. Economic Potential Deep Sea Payback

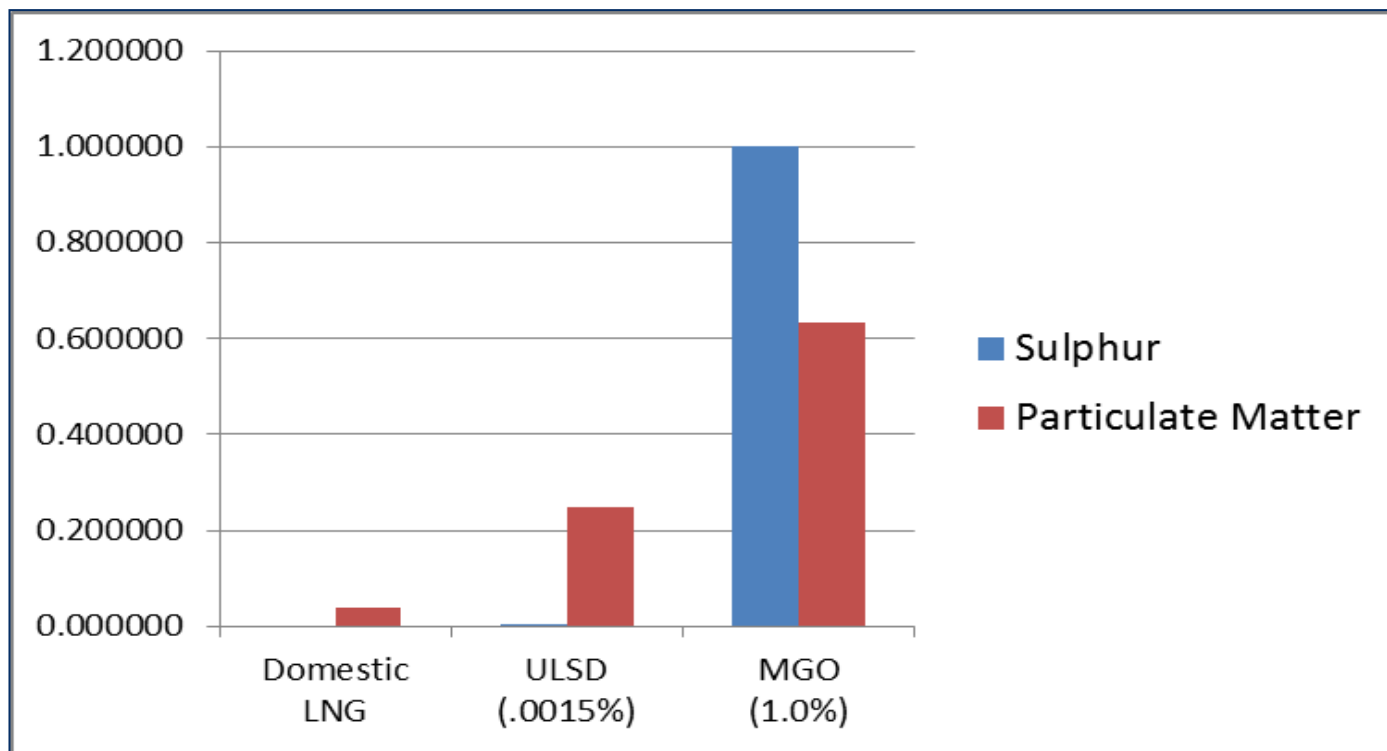
- KEY FINDING – Time in ECA critical to payback for deep sea vessels based on use of IFO 380 outside of ECA zone**



3. Environmental Benefits

Criteria Contaminants

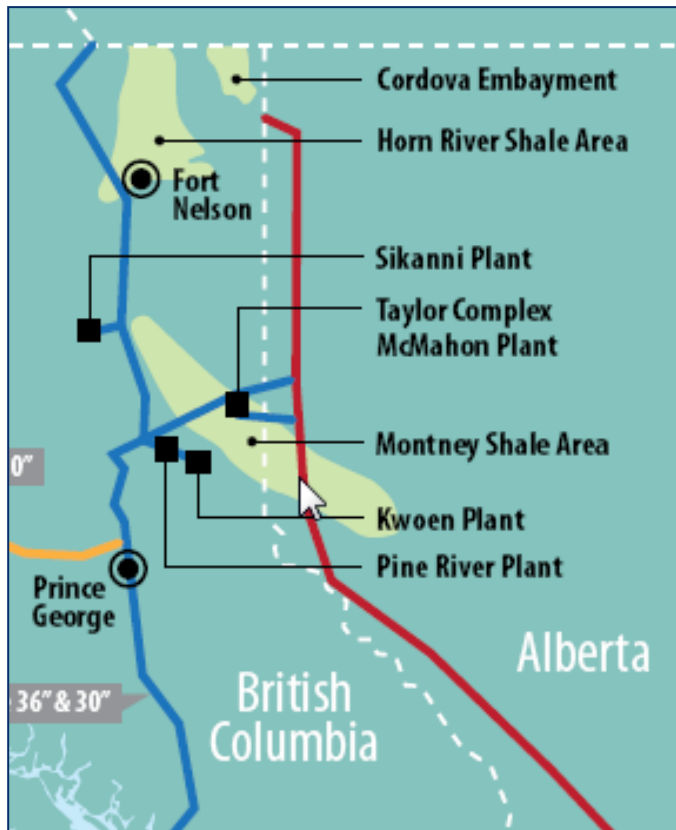
- KEY FINDING – Major reductions in SO_x, NO_x and PM**
NO_x benefit depends on engine type (Otto or diesel cycle)



3. Environmental Benefits Greenhouse Gases

- **KEY FINDING – Up to 19% reduction in GHGs on a CO₂e basis**
 - Finding incorporates carbon dioxide (CO₂) and methane (CH₄)
 - Energy inputs used to liquefy natural gas was found to have greatest effect on overall GHGs, rather than engine efficiency
 - IMO's Energy Efficiency Design Index assigns following values:
 - 0.875 carbon value for distillate fuel
 - 0.750 carbon value for LNG (14% lower)
 - Use of LNG can assist with current and known future regulatory requirements for marine vessel emissions

4. Bunkering & Infrastructure Options



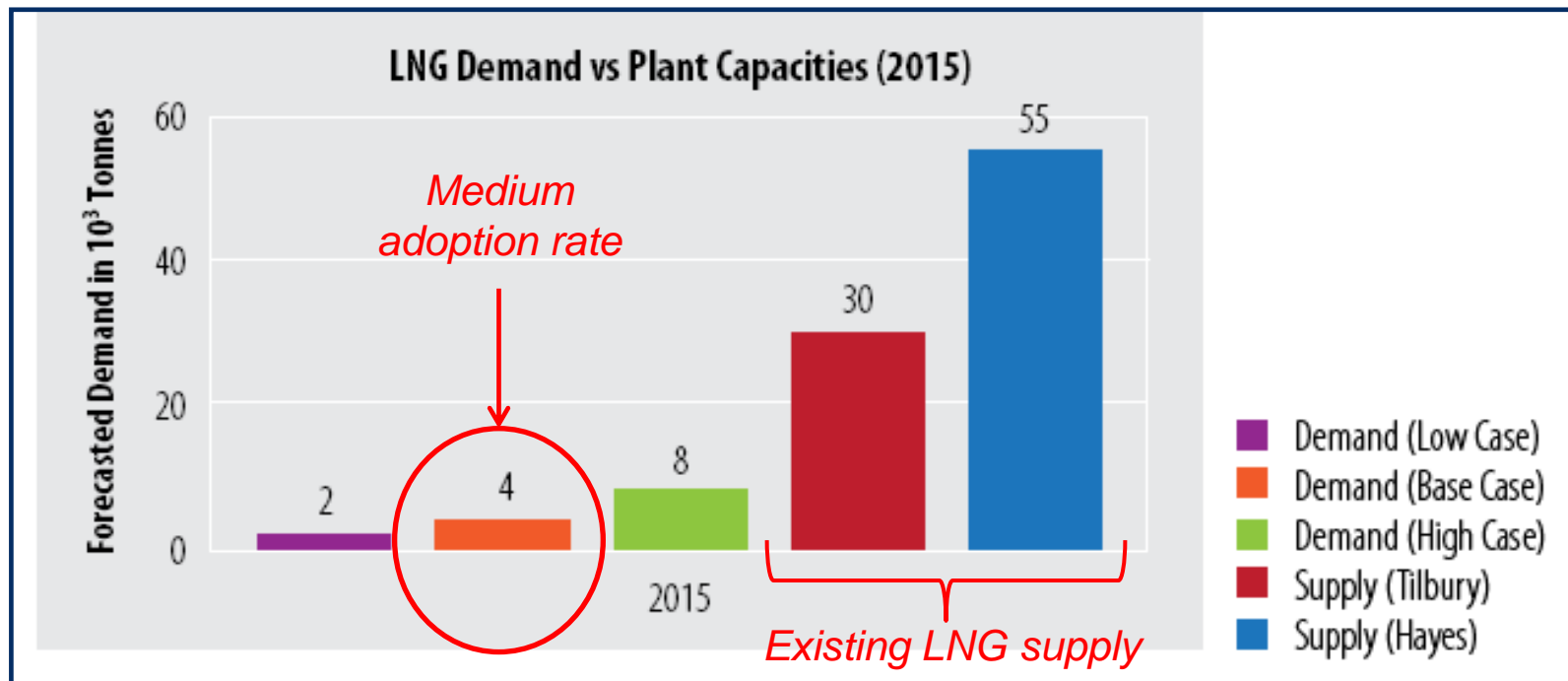
Existing BC Pipeline Infrastructure

KEY FINDING:

- The marine market offers an important new market for BC gas:
 - Medium adoption scenario
 - 150 vessels by 2025
 - New gas demand representing 8.5% of all natural gas used in BC in 2012
- Abundant BC natural gas resources already connected to demand areas via existing pipelines

4. Bunkering & Infrastructure Options

KEY FINDING: LNG supply is available to meet short term marine demand; investments in new capacity also planned



5. Human Resources Needs



Key Finding:

- Demand for trained personnel will increase gradually:
 - 2015 demand ~ 80 crew, officers, engineers for 5 LNG vessels
 - 2025 demand ~ 1,350 crew, officers, engineers for 150 LNG vessels
- Existing BC training providers could add LNG curriculum 19

6. Regulatory Challenges

KEY FINDING – Existing IMO guidelines, codes, and rules could be applied on an interim basis to approve Canadian LNG projects

- Canada does not currently have any regulations for LNG vessels
- Schedule XII of the Marine Machinery regulations prohibit use of natural gas as a low flashpoint fuel
- Project assessed regulations/safety management issues & gaps via hazards and risk identification workshops focused in 4 areas:
 - Ship design, construction and maintenance
 - Providing fuel to the ship
 - Operating the ship
 - Managing facilities and coastal waterways

6. Regulatory Challenges

- **KEY FINDING - In most areas, there are proven approaches than can be used to approve and certify projects in Canada**
- **12 recommendations including:**
 - That risk assessments be required for any project in Canada at least until international and national regulations are in place
 - Use the Marine Technical Review Board process to achieve compliance with *Canada Shipping Act (2001)*
 - Refer to the International STCW Convention to establish appropriate categories of personnel requiring training
 - Apply the principles of the ISM Code to LNG-fuelled ships

7. Implementation Scenarios



*FortisBC Mt. Hayes
LNG Production Plant*

KEY FINDINGS:

- Opportunity for \$2.5 billion of investment by 2025 to supply medium case of 150 LNG vessels
- Port Metro Vancouver can become a preferred LNG bunkering destination on West Coast of North America

8. Benefits for Canada

- **KEY FINDING – Extensive economic benefits:**
 - Affordable compliance option for marine sector with maximum benefit for vessels that operate in ECA
 - Estimated \$2.5 billion of investments in infrastructure can stimulate local economic development:
 - LNG bunkering equipment installation & maintenance
 - Shipyard activity in vessel conversion & maintenance
 - LNG vessel design work given early lead in this area
 - Enhanced Pacific Gateway offering LNG to international ships
 - New LNG infrastructure can provide cleaner, more affordable fuel for remote communities in BC

8. Benefits for Canada

- **KEY FINDING - Range of environmental benefits:**
 - Improved local air quality with reductions in SO_x, NO_x, and particulate matter which affect human health
 - Reduced climate change impacts with use of lower carbon fuel
 - Impact of a fuel spill much more environmentally benign with no long term impacts on wildlife or habitats

PROJECT RECOMMENDATIONS



7 Recommendations

1. **CONTINUE TO COLLABORATE** – Major benefits for BC and for Canada from using LNG in the marine market
2. **ESTABLISH ALTERNATE REGULATORY REVIEW PROCESS** – Based on existing IMO guidelines, codes, rules & Canadian needs
3. **DEVELOP TRAINING COURSES FOR USE ON AN INTERIM BASIS** – Deliver via existing Canadian marine training channels
4. **DESIGNATE LEAD FEDERAL & PROVINCIAL AGENCIES** – In order to ensure efficient review of marine LNG projects
5. **PROACTIVELY ADDRESS CSA CODES & STANDARDS GAP AREAS**
6. **CONSIDER HOW TO COMMUNICATE WITH THE PUBLIC** – Fact-based information is needed to ensure public confidence
7. **ADD LNG TO CANADA'S SHIPBUILDING STRATEGY**

REPORTS & NEXT STEPS



West Coast Project Reports

- **Condensed version** of report can be downloaded from:
 - www.newswire.ca/en/releases/archive/April2014/02/c8173.html
- **Comprehensive version** of report available upon request from Transport Canada's Transportation Development Centre:
 - TDCCDT@tc.gc.ca

New Project Phases

- **Phase 2 – Great Lakes and St. Lawrence**
- **Phase 3 – East Coast of Canada**
 - Both phases to be carried out in parallel
 - Consider both LNG & CNG as fuel options
 - Further effort and refinement related to Canadian regulatory framework including cross-border issues related to Great Lakes
- **Timing: June 2014 start; complete by early 2015**

Thank You & Questions

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