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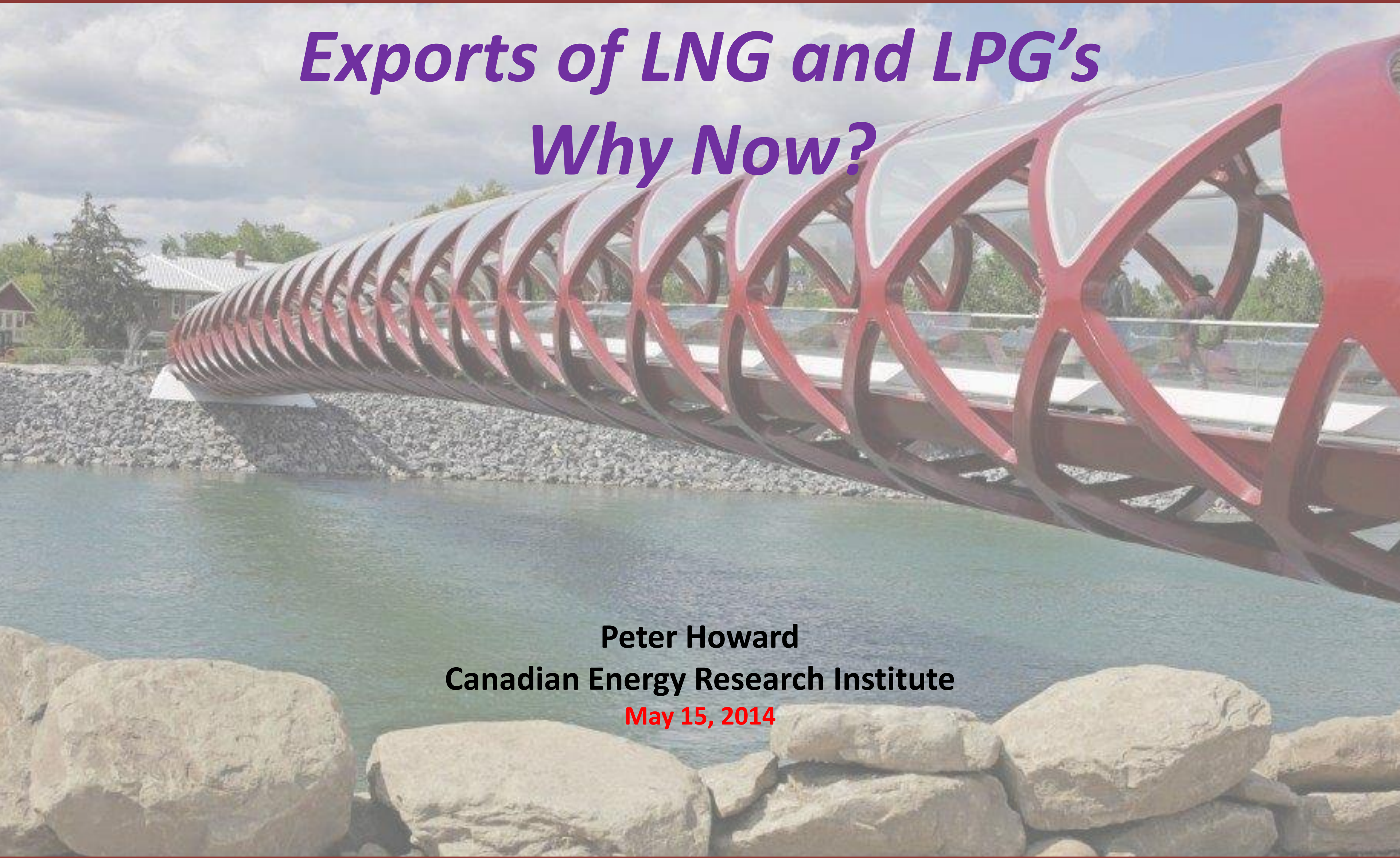

Exports of LNG and LPG’s
Why Now?

Peter Howard
Canadian Energy Research Institute

May 15, 2014

Canadian Energy Research Institute
Overview

Founded in 1975, the Canadian Energy Research Institute (CERI) is an independent, non-profit research institute specializing in the analysis of energy economics and related environmental policy issues in the energy production, transportation, and consumption sectors. Our mission is to provide **relevant, independent, and objective economic research** in energy and related environmental issues. A central goal of CERI is to bring the insights of scientific research, economic analysis, and practical experience to the attention of **government policy-makers, business sector decision-makers, the media, and citizens in Canada and abroad.**

Core members of the Institute include the Canadian Government, the Government of the Province of Alberta, the University of Calgary, and the Canadian Association of Petroleum Producers (CAPP). In-kind support is also provided by the Alberta Energy Regulator (formerly the Energy Resources Conservation Board).

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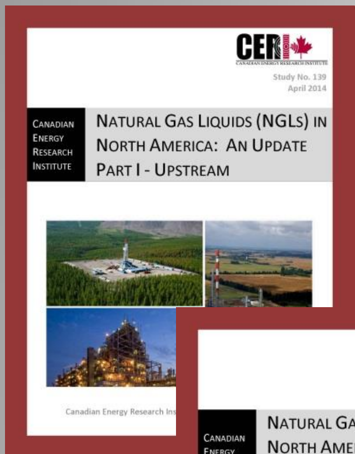
Canadian Energy Research Institute

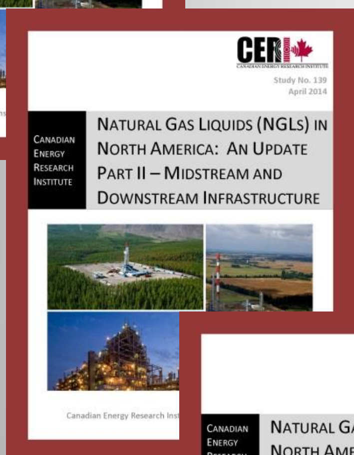
Upcoming Study Releases



Natural Gas Liquids (NGLs) in North America: An Update

Part I – Upstream

Released May 7, 2014



Natural Gas Liquids (NGLs) in North America: An Update

Part II – Midstream and Downstream Infrastructure

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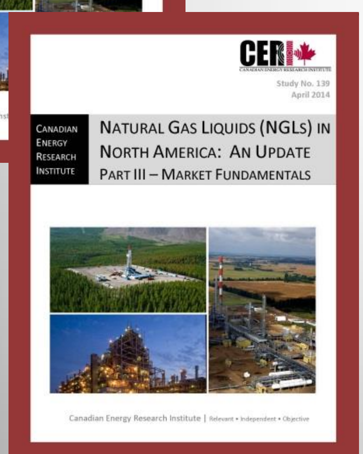

Natural Gas Liquids (NGLs) in North America: An Update

Part III – Market Fundamentals

Released May 7, 2014

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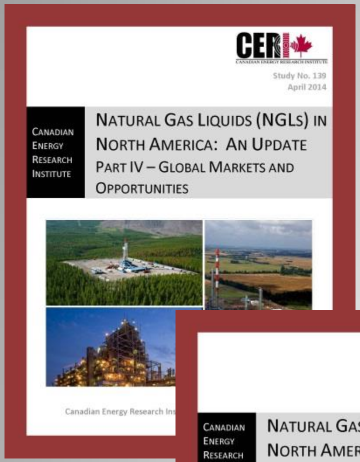
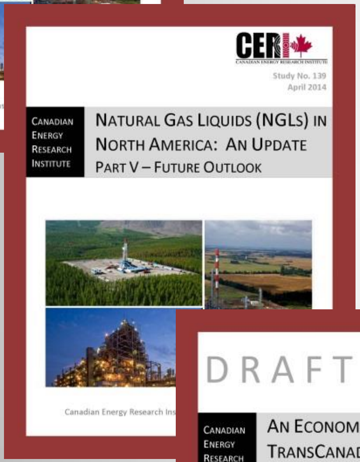
Upcoming Study Releases



Natural Gas Liquids (NGLs) in North America: An Update

Part IV – Global Markets and Opportunities

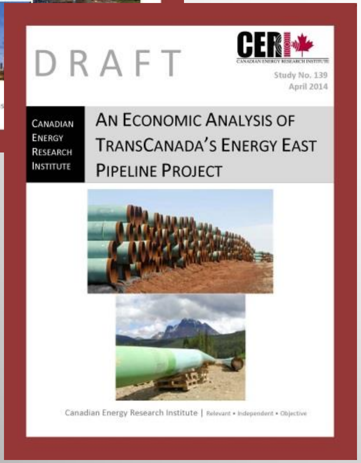
Released May 7, 2014



Natural Gas Liquids (NGLs) in North America: An Update

Part V – Future Outlook

Forthcoming May 2014



An Economic Analysis of TransCanada's Energy East Pipeline Project

Released May 7, 2014

Canadian Energy Research Institute

Upcoming Study Releases

Canadian Oil Sands Supply Costs and Development Projects (2013-2047)
Forthcoming May 2014

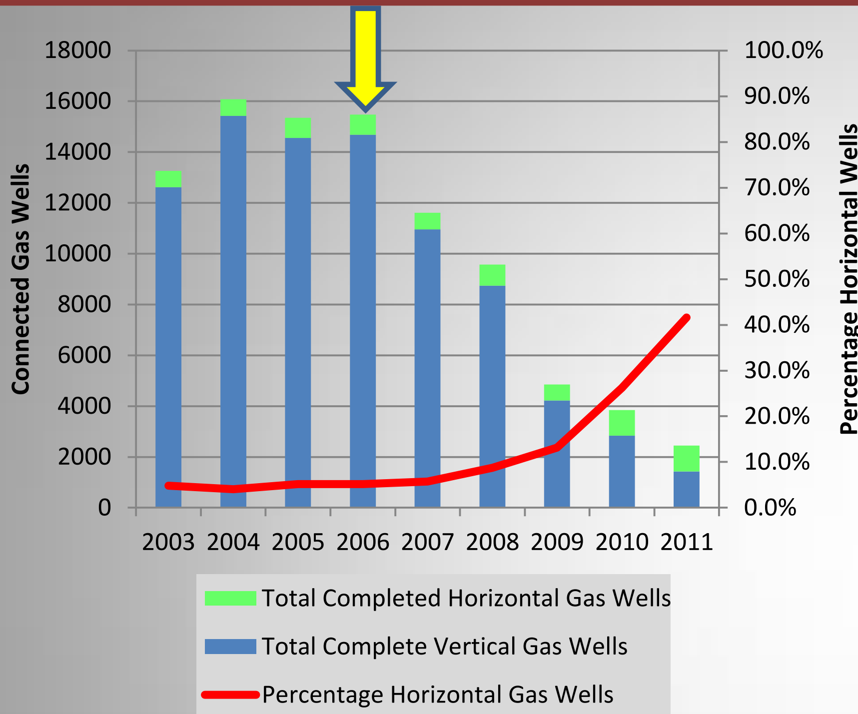
Oil Pathways
Forthcoming June 2014

The Story Starts Here!

North American Natural Gas Market (2013-2030)

North American Natural Gas Industry

"A Tale of Two Countries"



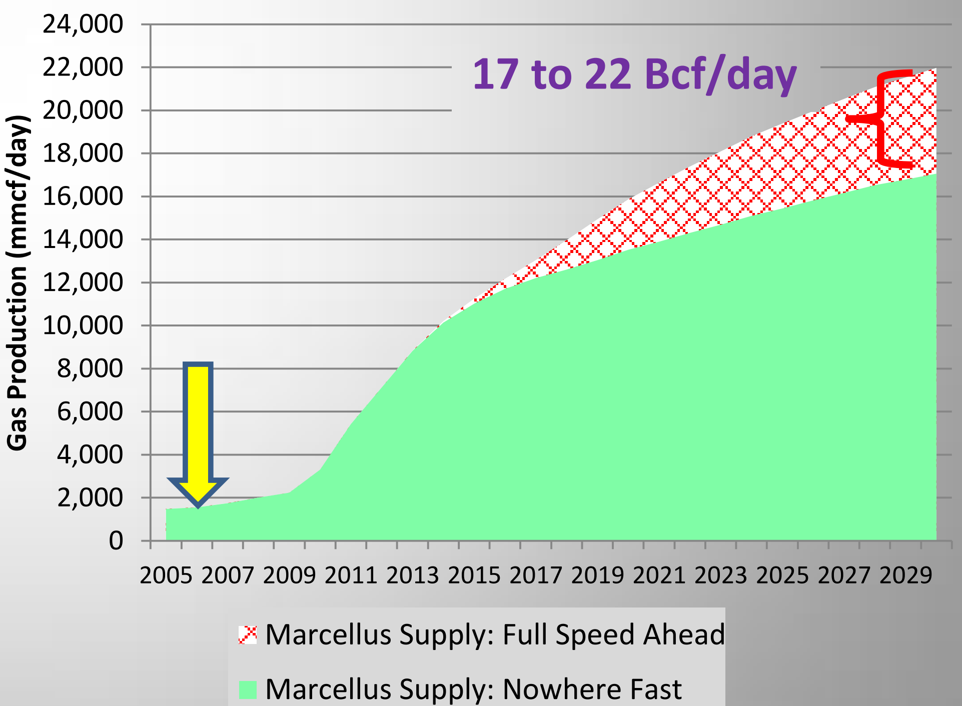
2013 Alberta Gas Well Licenses

- **1077 Horizontal Wells (76%)**
- **244 Slant/Deviated (17%)**
- **89 Vertical (6%)**

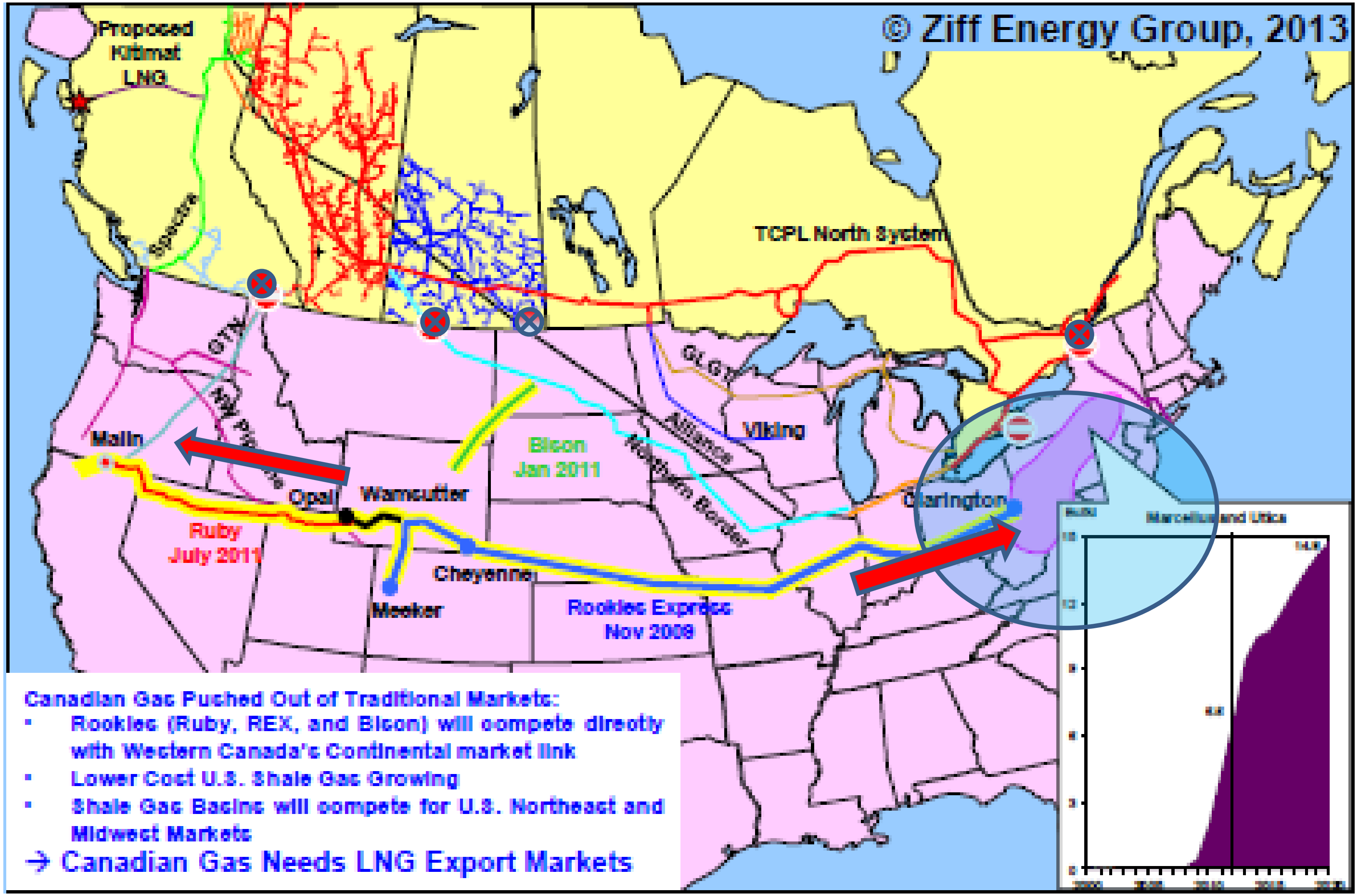
Total 1410 Gas Directed Well Licences

2012 Marcellus

- **2,000 capped gas wells**
- **2,100-2,300 new wells per year**
- **NGLs 30-35 bbls/mmcf**
- **4,5,6 wells per pad**
- **90% horizontal**



Emerging Supply Sources
Inter-basin Gas-on-Gas Competition



Canadian Gas Pushed Out of Traditional Markets:

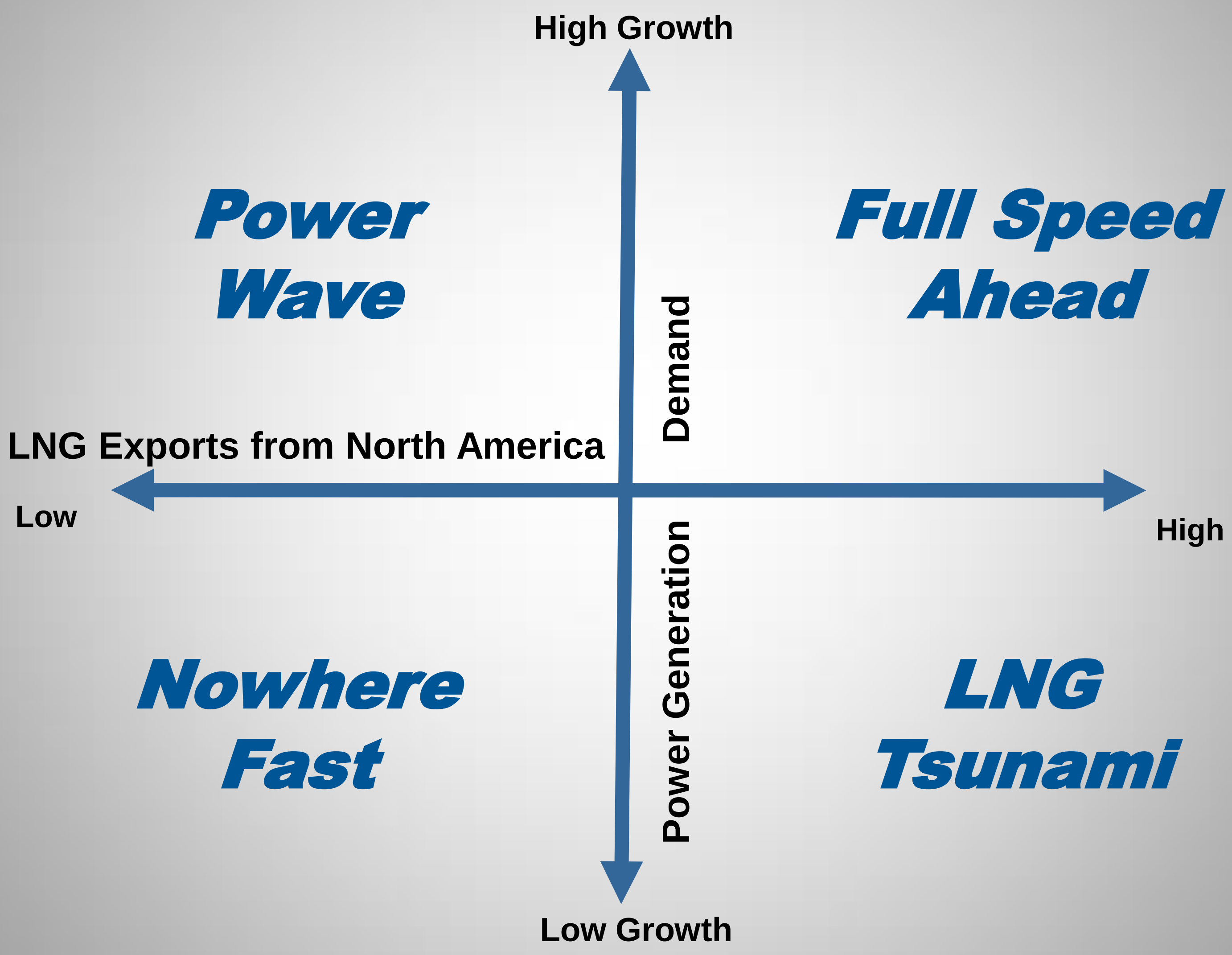
- Rockies (Ruby, REX, and Bison) will compete directly with Western Canada's Continental market link
- Lower Cost U.S. Shale Gas Growing
- Shale Gas Basins will compete for U.S. Northeast and Midwest Markets

→ Canadian Gas Needs LNG Export Markets

Images from US EIA and Ziff/NEB

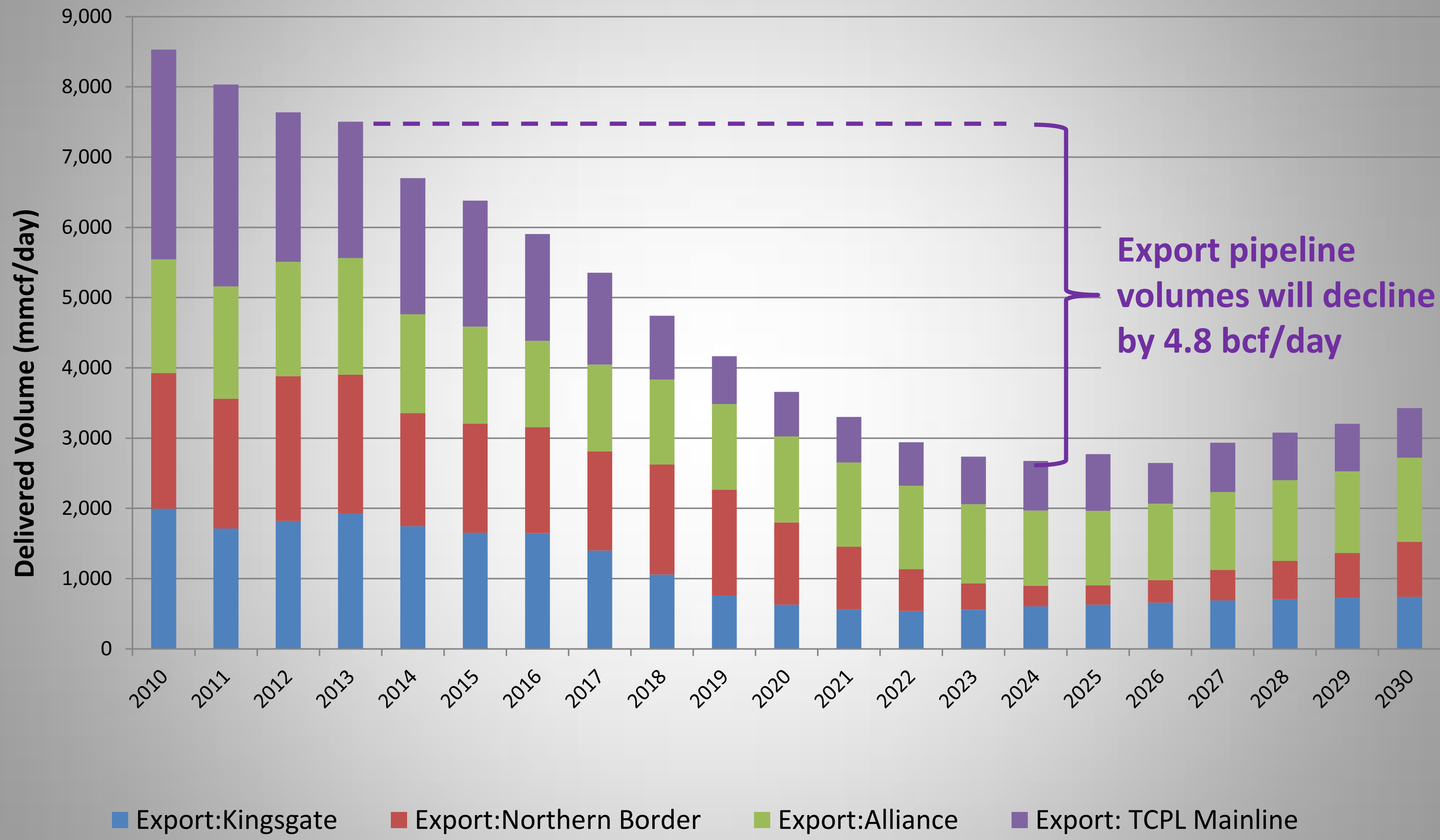
North American Natural Gas Demand Pathways

Narratives



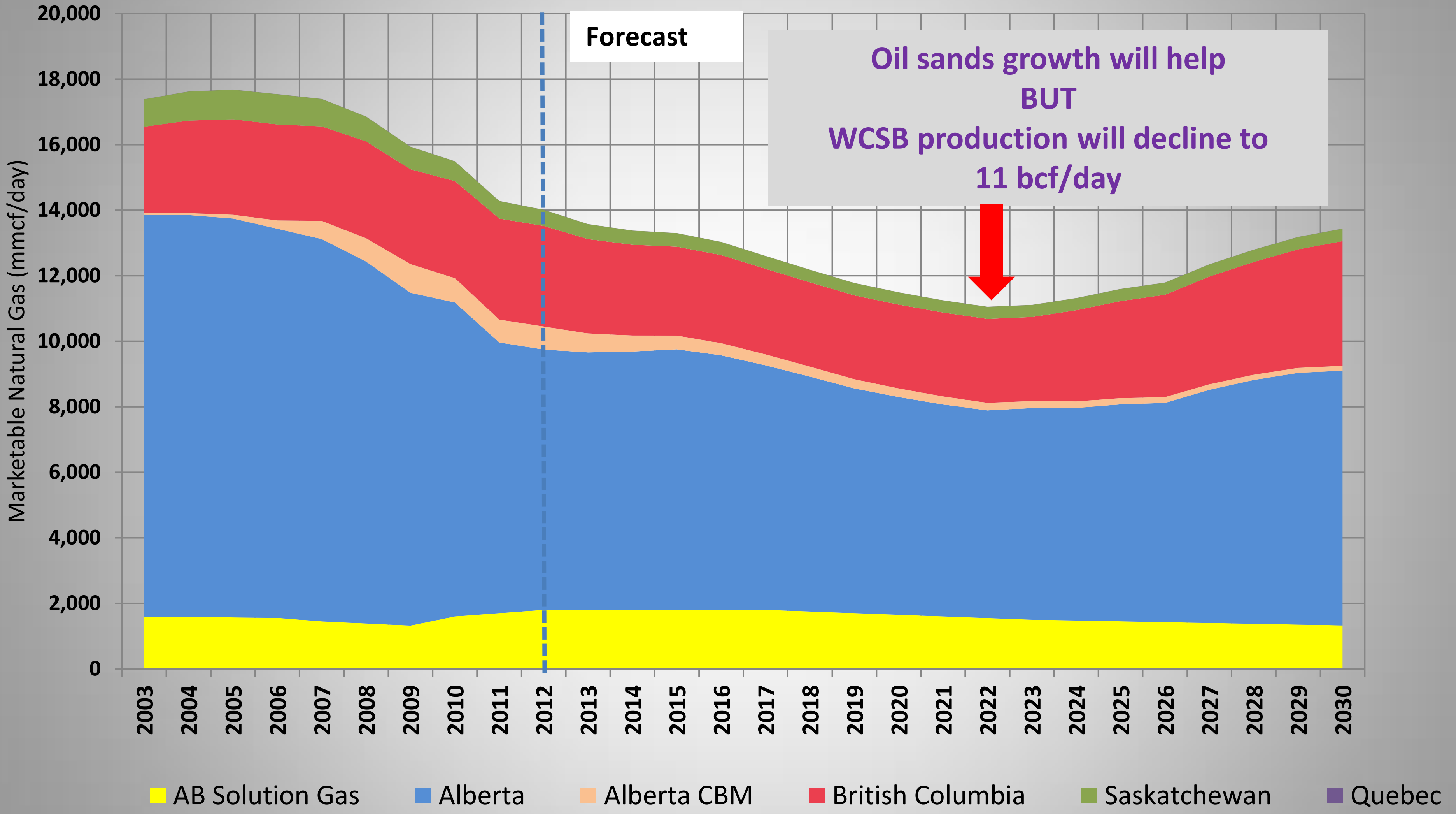
North American Natural Gas Demand Pathways

WCSB Export Volumes: LNG Tsunami (without LNG)

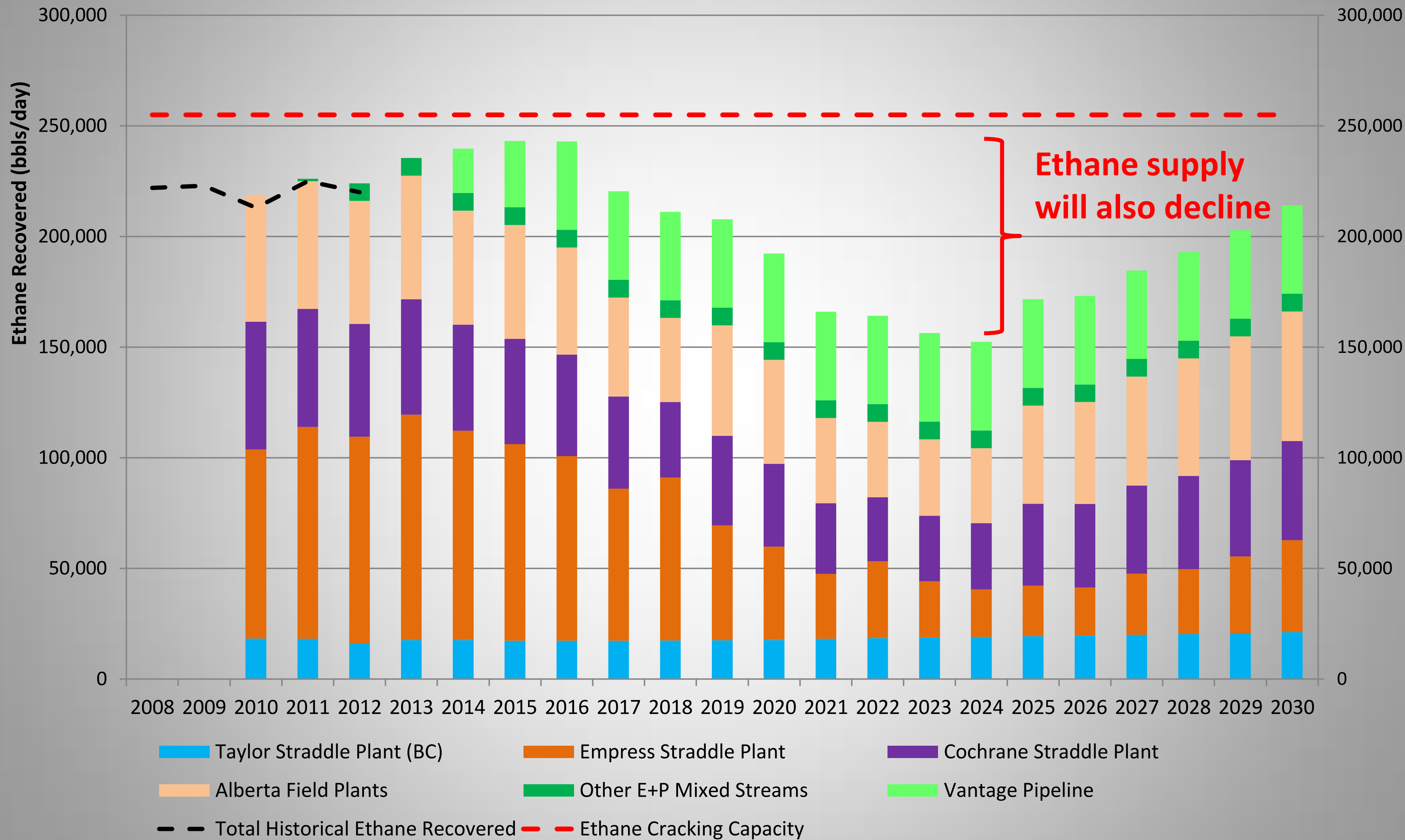


North American Natural Gas Demand Pathways

WCSB Production Forecast: LNG Tsunami (without LNG)

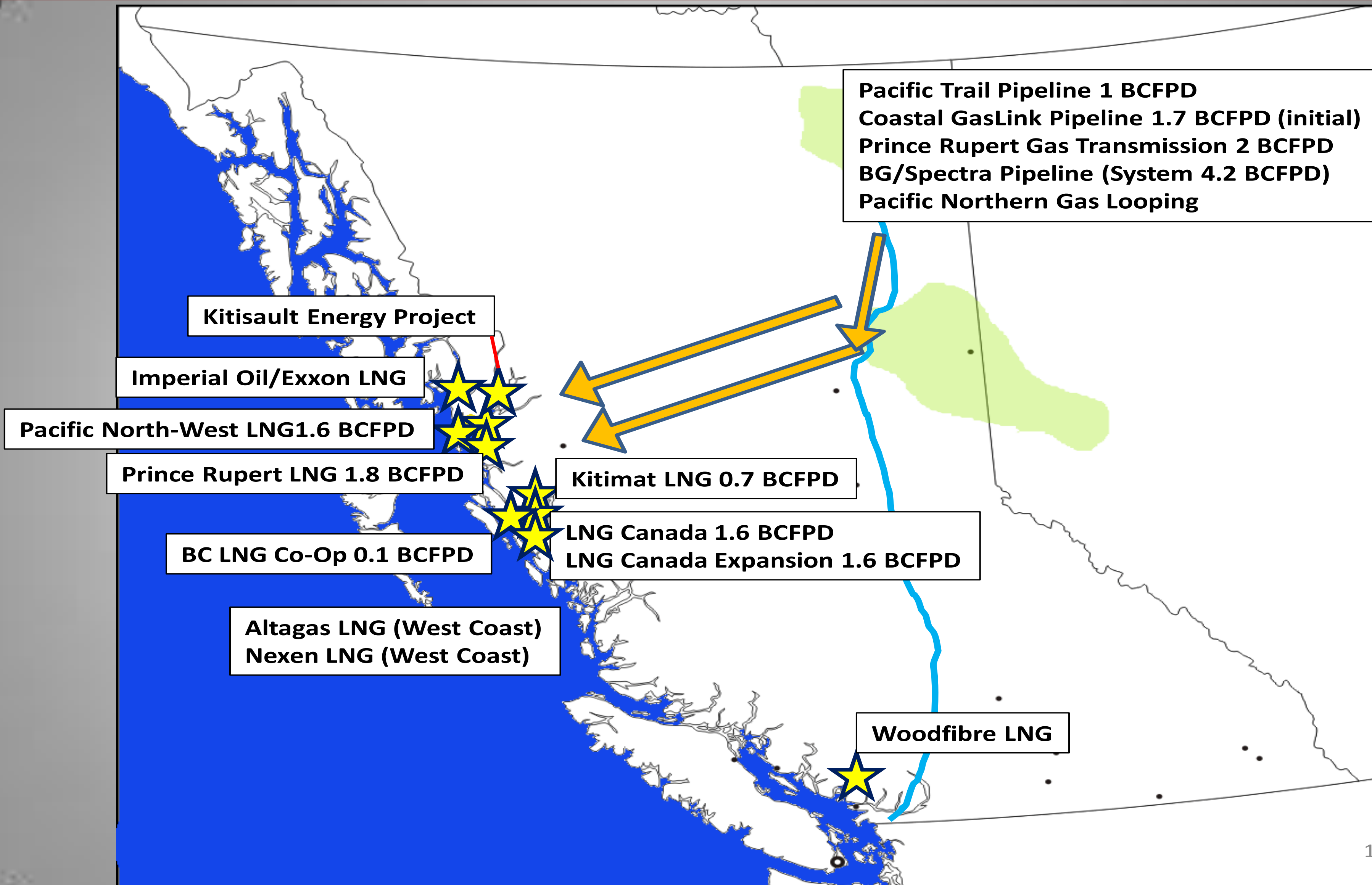


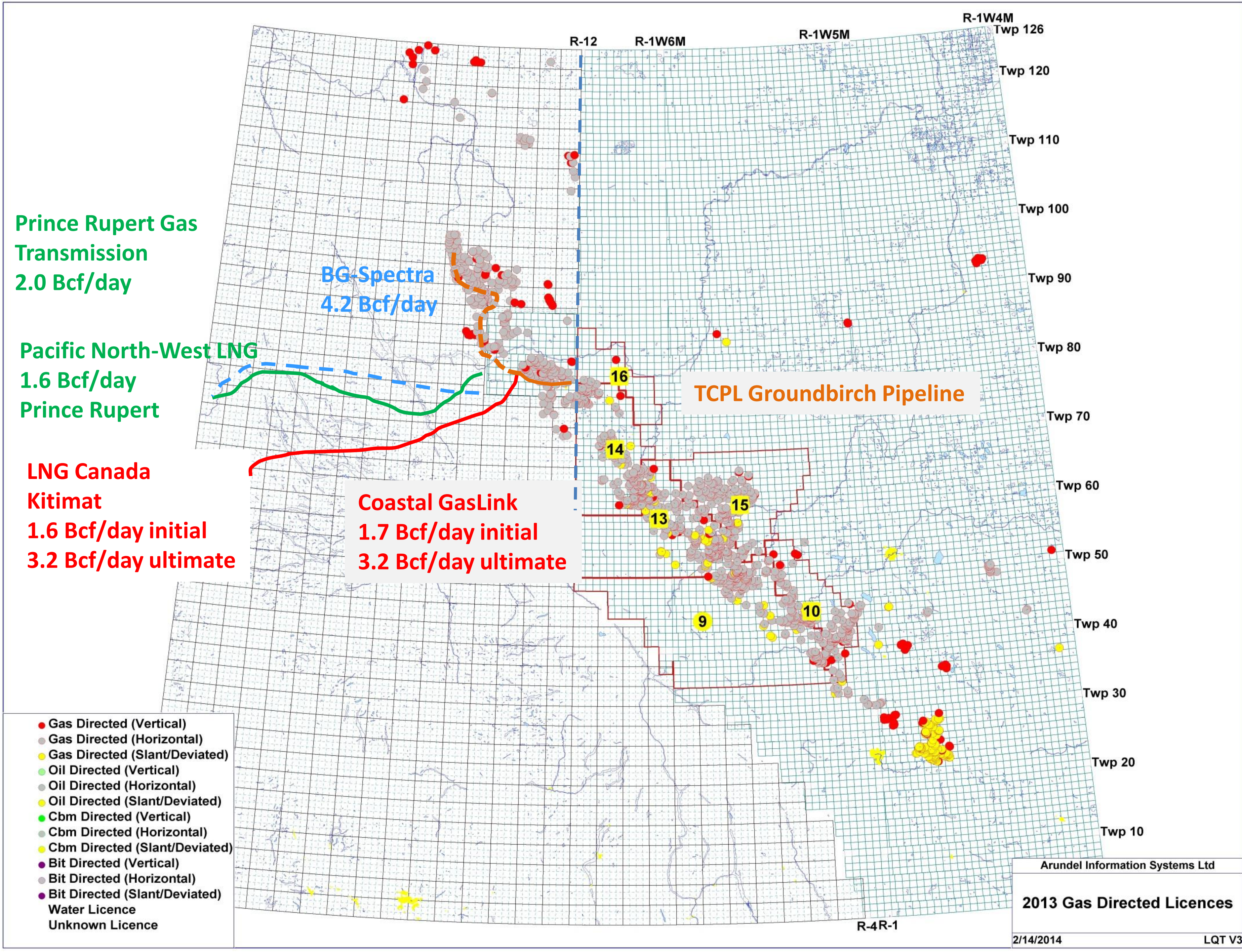
North American NGL Pathways
WCSB NGL Recovery Forecast: Ethane



Global Competition for the Asia-Pacific Market

North American Natural Gas Demand Pathways
BC LNG Projects





Prince Rupert Gas Transmission 2.0 Bcf/day
BG-Spectra 4.2 Bcf/day
Pacific North-West LNG 1.6 Bcf/day Prince Rupert
LNG Canada Kitimat 1.6 Bcf/day initial 3.2 Bcf/day ultimate
Coastal GasLink 1.7 Bcf/day initial 3.2 Bcf/day ultimate
TCPL Groundbirch Pipeline
R-12
R-1W6M
R-1W5M
R-1W4M
Twp 126
Twp 120
Twp 110
Twp 100
Twp 90
Twp 80
Twp 70
Twp 60
Twp 50
Twp 40
Twp 30
Twp 20
Twp 10
R-4
R-1
16
14
13
15
9
10
Gas Directed (Vertical)
Gas Directed (Horizontal)
Gas Directed (Slant/Deviated)
Oil Directed (Vertical)
Oil Directed (Horizontal)
Oil Directed (Slant/Deviated)
Cbm Directed (Vertical)
Cbm Directed (Horizontal)
Cbm Directed (Slant/Deviated)
Bit Directed (Vertical)
Bit Directed (Horizontal)
Bit Directed (Slant/Deviated)
Water Licence
Unknown Licence
Arundel Information Systems Ltd
2013 Gas Directed Licences
2/14/2014
LQT V3

North American Natural Gas Demand Pathways

New Gas Directed Licences (2013)

Alberta

Encana	292
Peyto	116
Shell	84
Paramount	67
Tourmaline	70
Bonavista	61
Apache	48
Husky	43
Seven Generations	44

- 9 producers 825
- 60% of total licences

- **Total Gas Licences (AB) 1410**

British Columbia

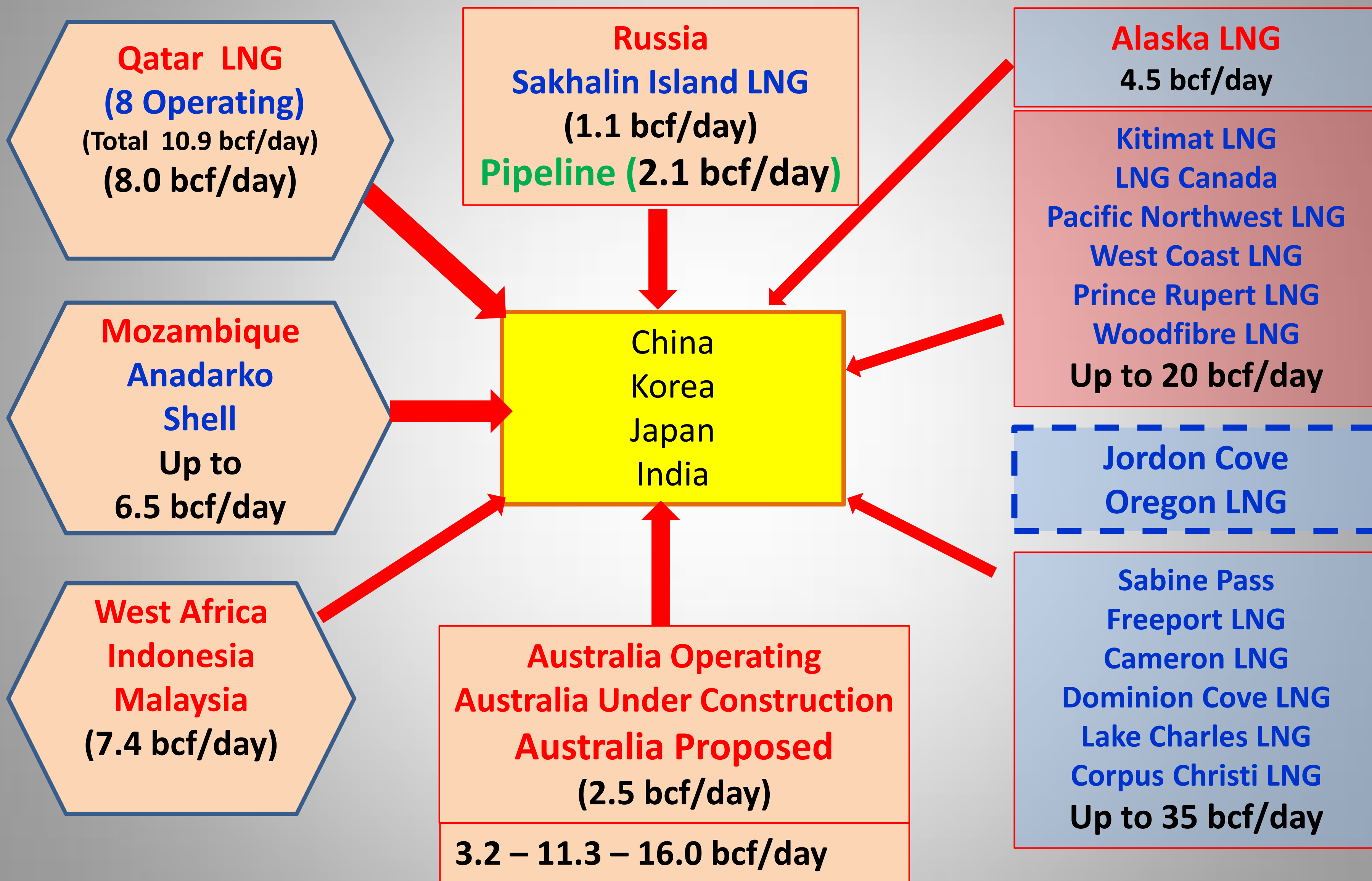
Shell	219
Progress Energy	180
Encana	94
CNRL	59
ARC Resources	74

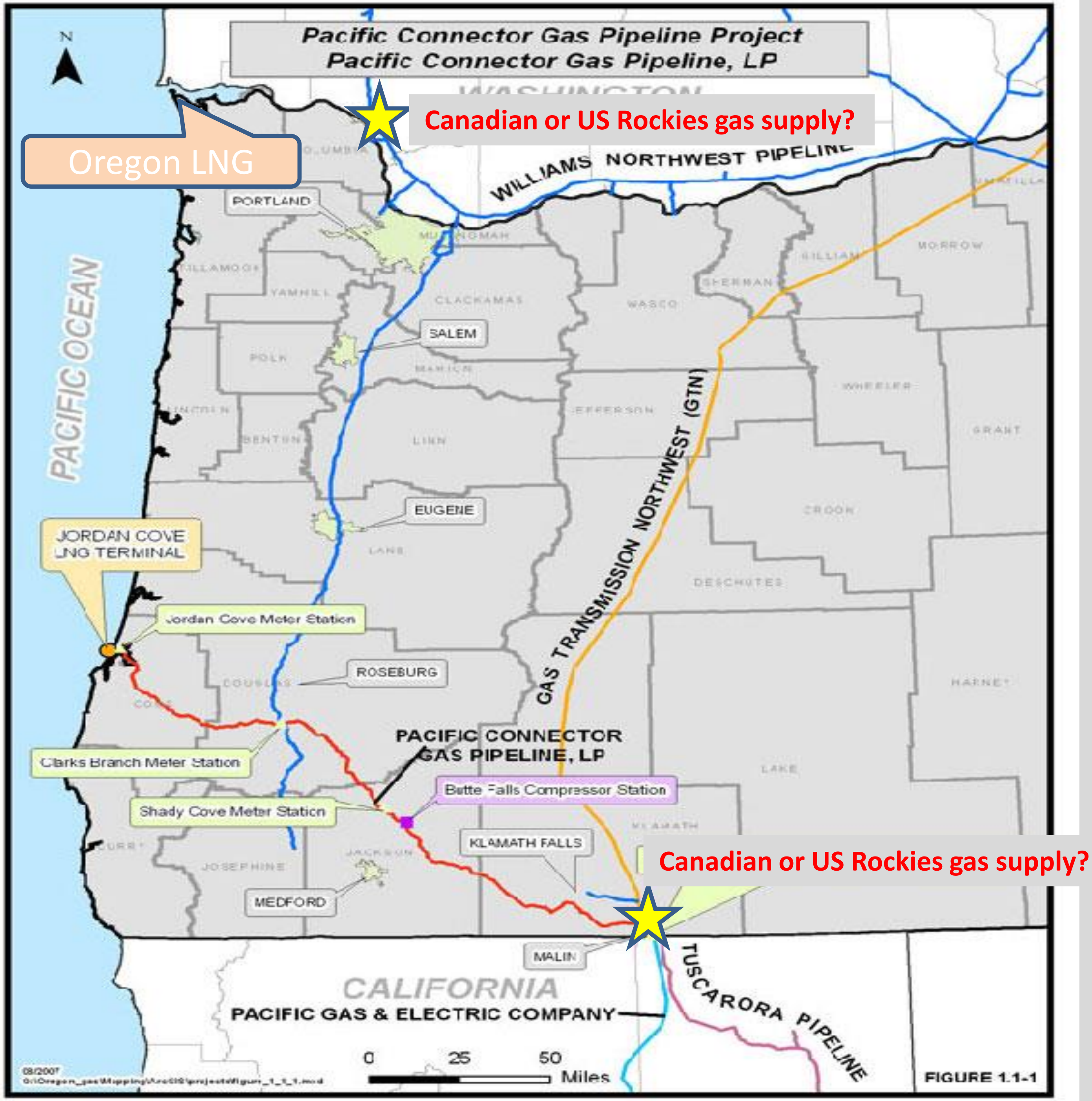
- 5 producers 626
- 70% of total licences

- **Total Licences (BC) 901**

Competition to Supply LNG in the Asia-Pacific Basin

2012 LNG Trade (average per day)





Pacific Connector Gas Pipeline Project
Pacific Connector Gas Pipeline, LP
Canadian or US Rockies gas supply?
Oregon LNG
WILLIAMS NORTHWEST PIPELINE
PACIFIC OCEAN
PORTLAND
SALEM
EUGENE
JORDAN COVE LNG TERMINAL
Jordan Cove Meter Station
ROSEBURG
Clarks Branch Meter Station
PACIFIC CONNECTOR GAS PIPELINE, LP
Butte Falls Compressor Station
Shady Cove Meter Station
KLAMATH FALLS
MEDFORD
GAS TRANSMISSION NORTHWEST (GTN)
Canadian or US Rockies gas supply?
MALIN
CALIFORNIA
PACIFIC GAS & ELECTRIC COMPANY
TUSCARORA PIPELINE
0 25 50 Miles
FIGURE 1.1-1

How Competitive is Western Canada?

Economic Viability of Gas Developments in the WCSB

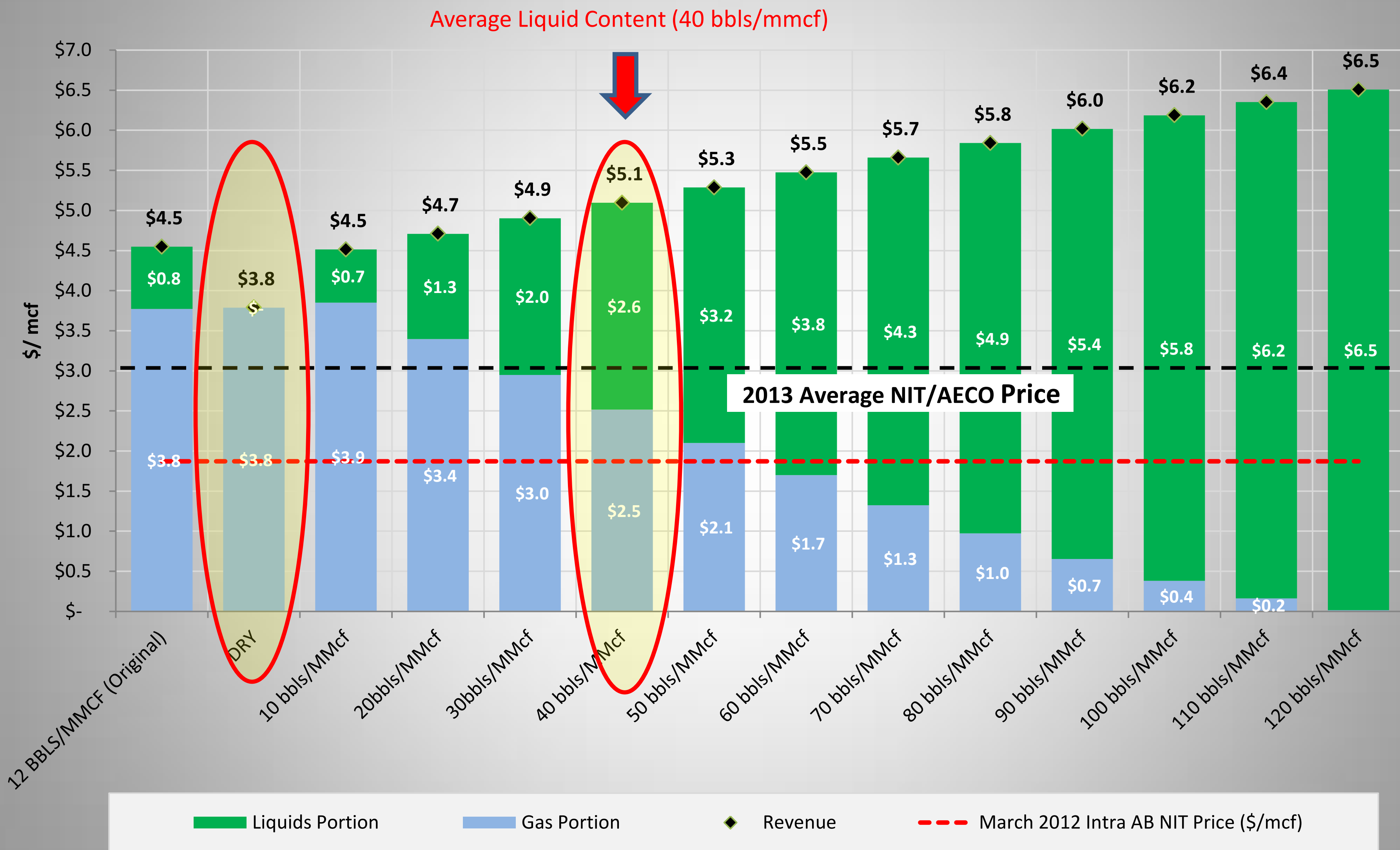
A Supply Cost Comparison

- The Supply Cost value represents the natural gas price that is required to cover all costs (capital, operating, royalties and taxes) and earn a minimum return on investment (10 percent real).

- The Supply Cost calculation includes the uplift value of producing, capturing and selling natural gas liquids in concert with natural gas production.

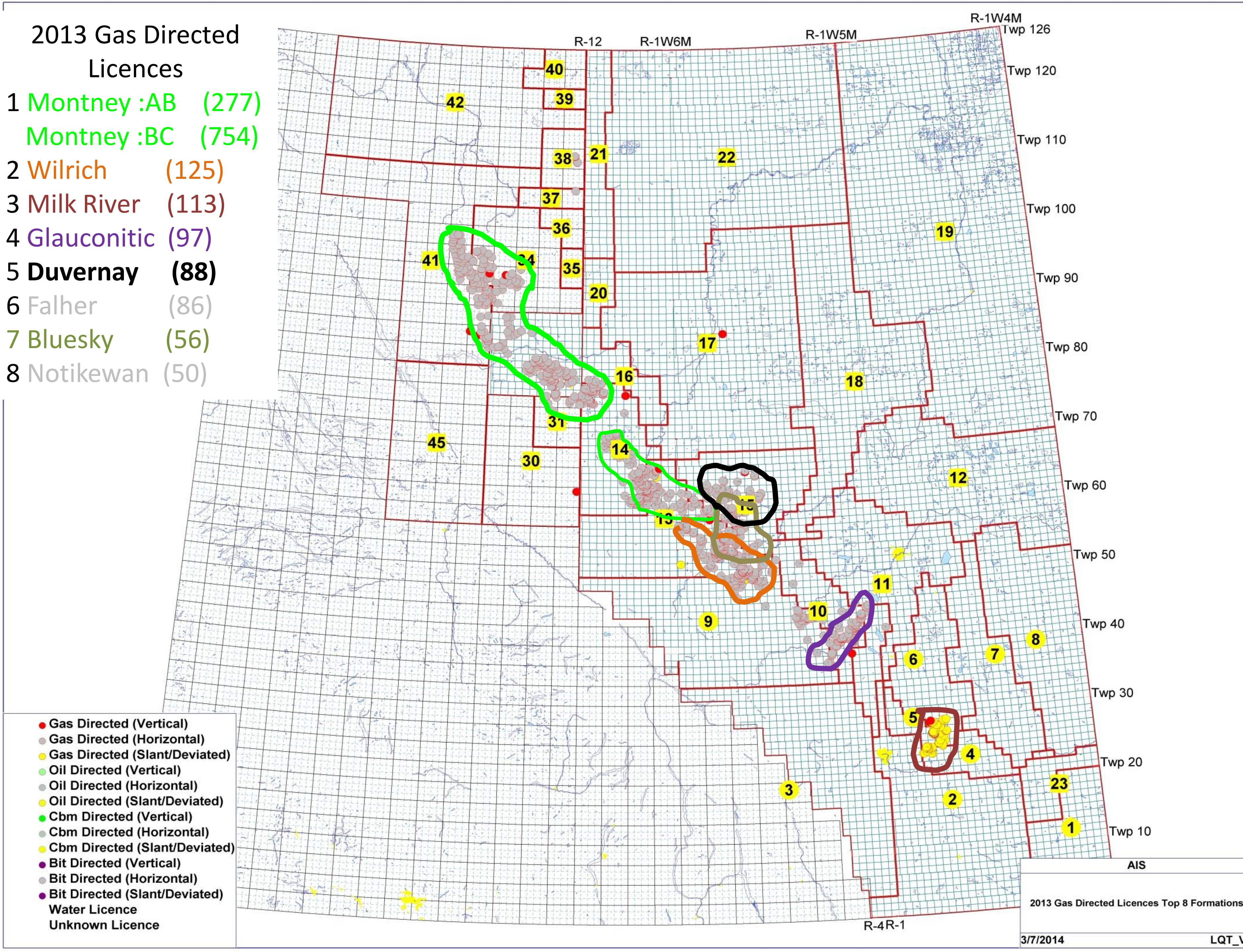
Western Canada What Makes the Gas World Work

BC Montney Supply Cost Example



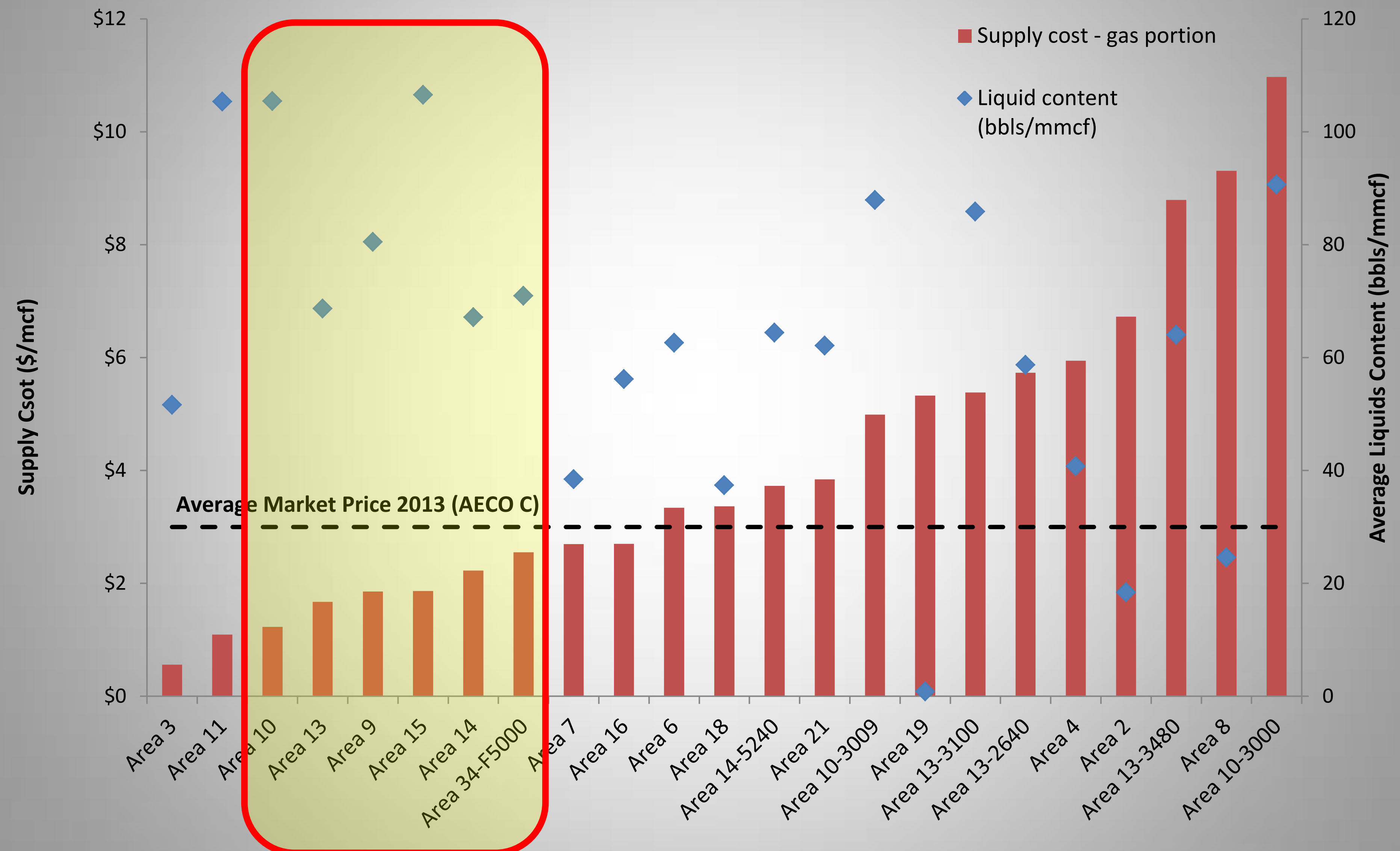
2013 Gas Directed Licences

1 Montney :AB (277)
Montney :BC (754)
2 Wilrich (125)
3 Milk River (113)
4 Glauconitic (97)
5 **Duvernay (88)**
6 Falher (86)
7 Bluesky (56)
8 Notikewan (50)



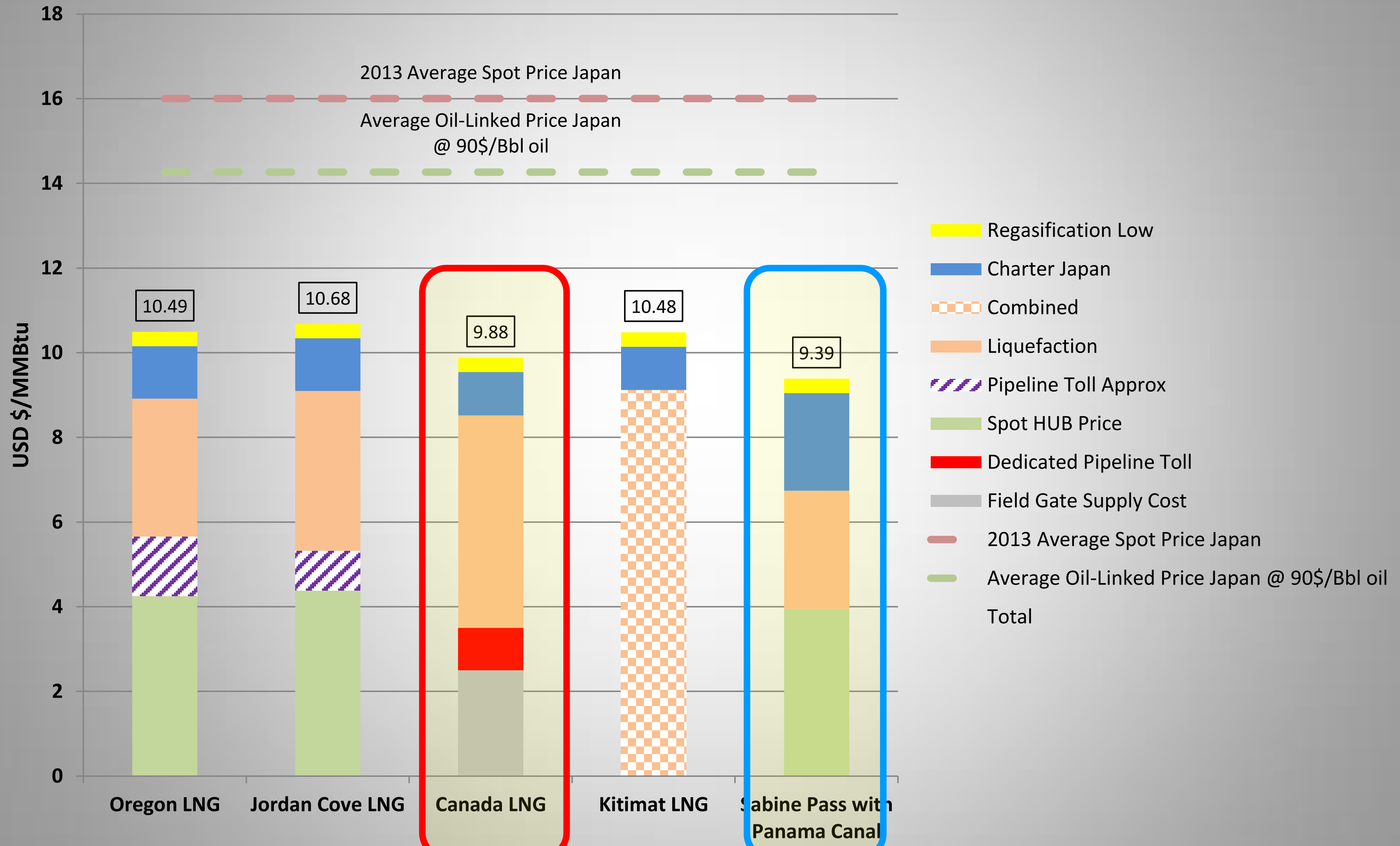
Economic Viability of Gas Developments in the WCSB

Supply Cost Results



North American Natural Gas Demand Pathways

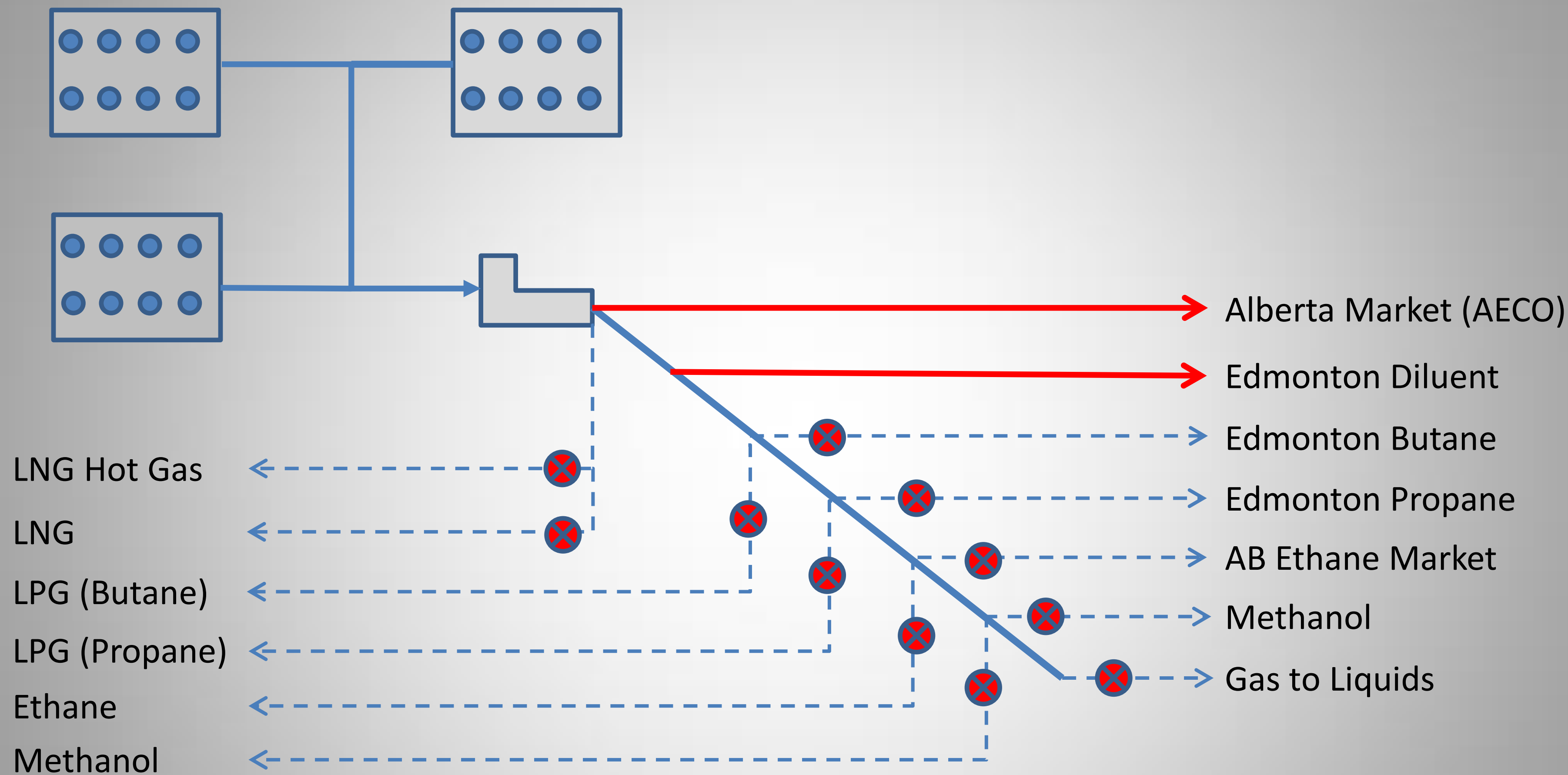
West Coast Competition: Canada versus the United States



Producer Optionality?

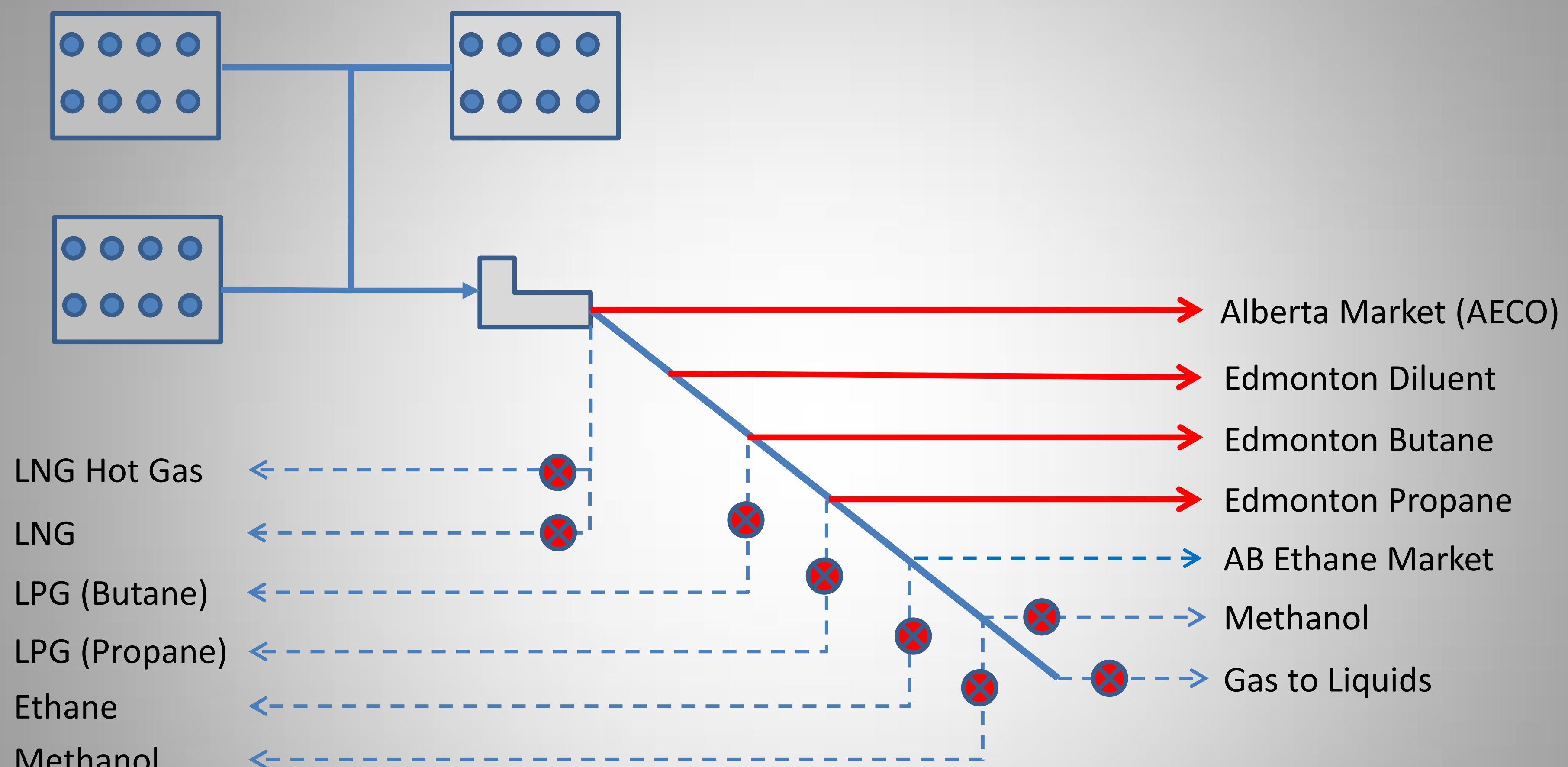
North American NGL Pathways

Producer Options: Alberta Market (Field Separation)



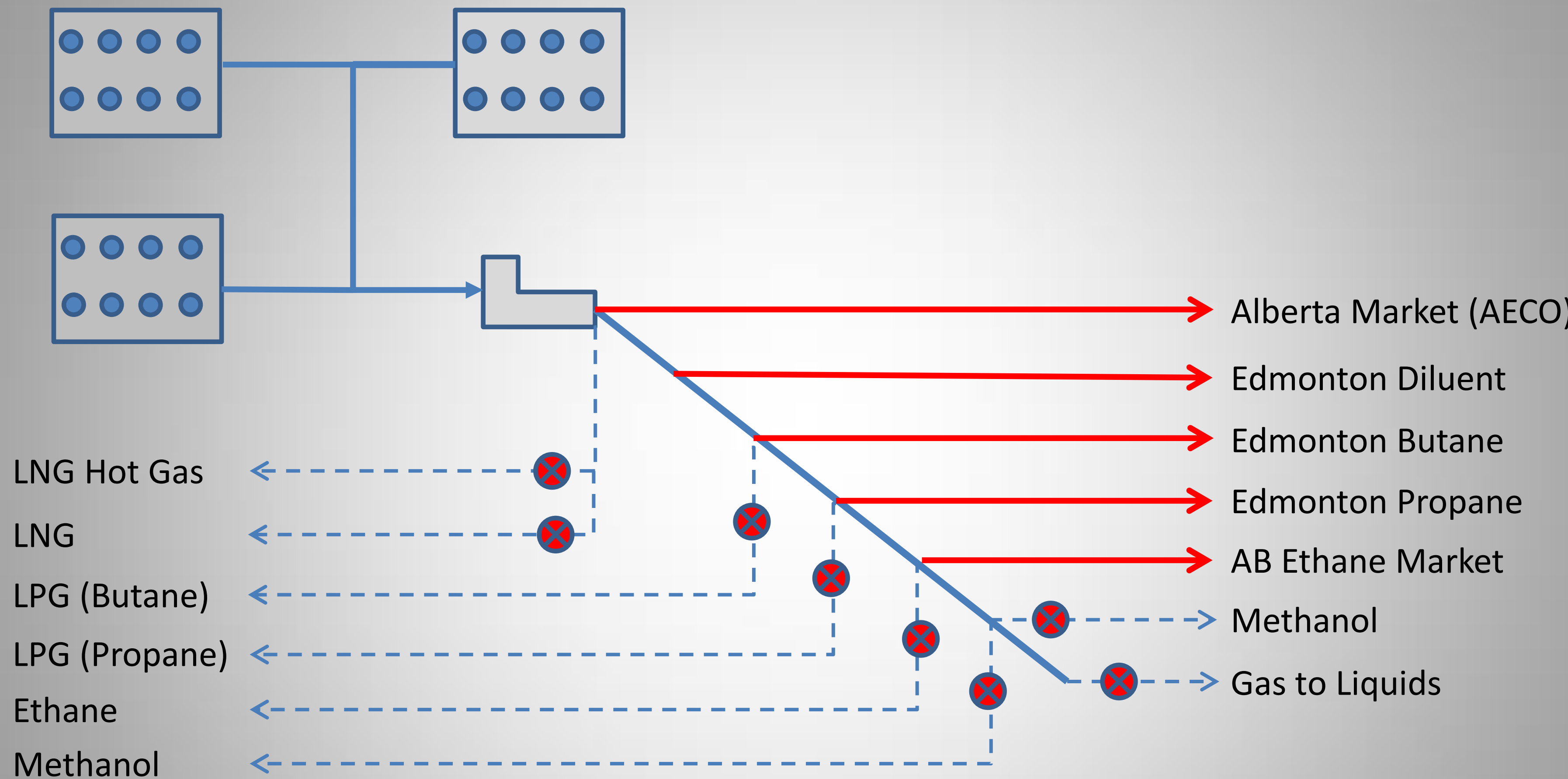
North American NGL Pathways

Producer Options: Alberta Market (Field Shallow-cut Plant)



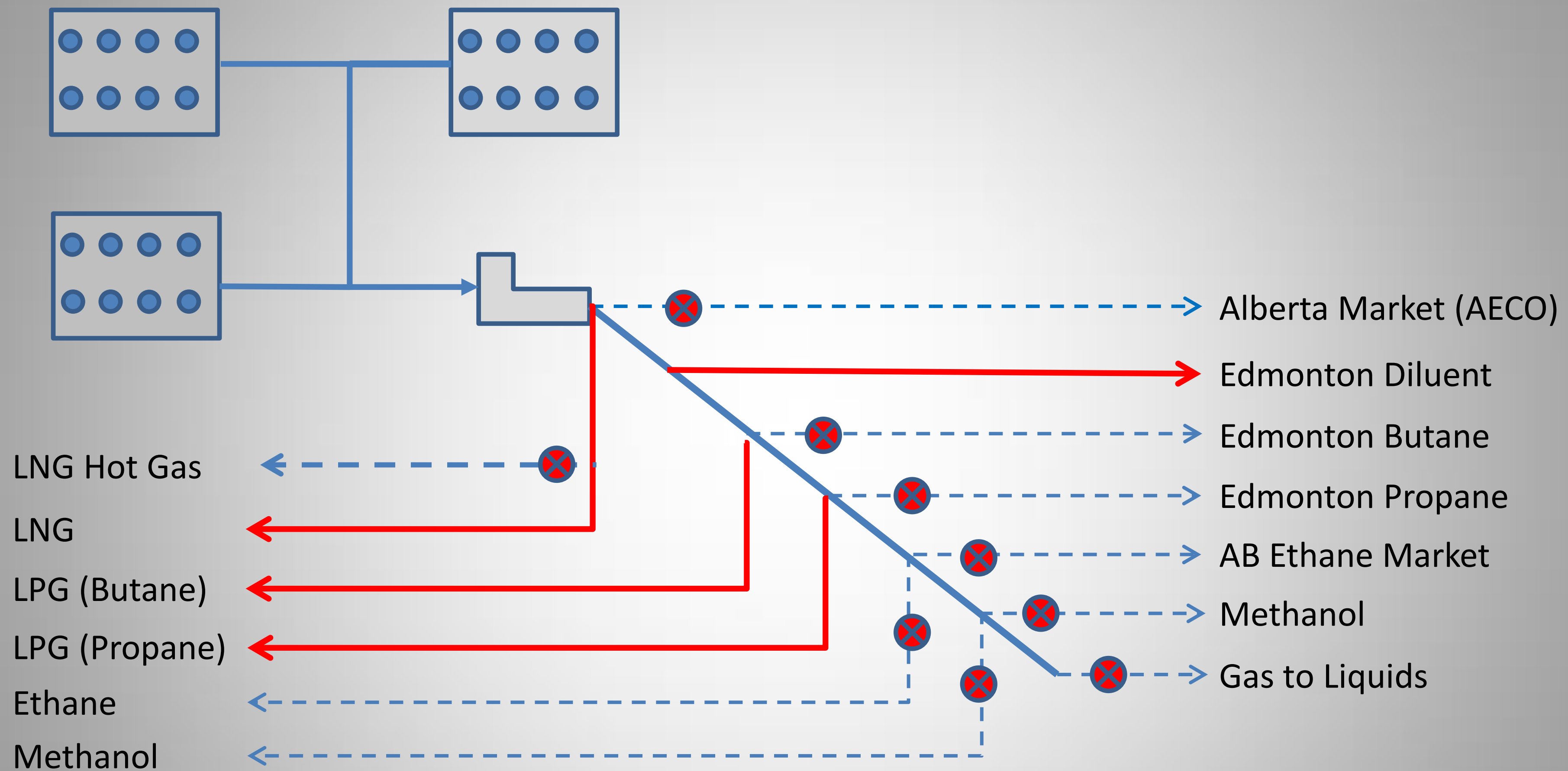
North American NGL Pathways

Producer Options: Alberta Market (Field Deep-cut Plant)



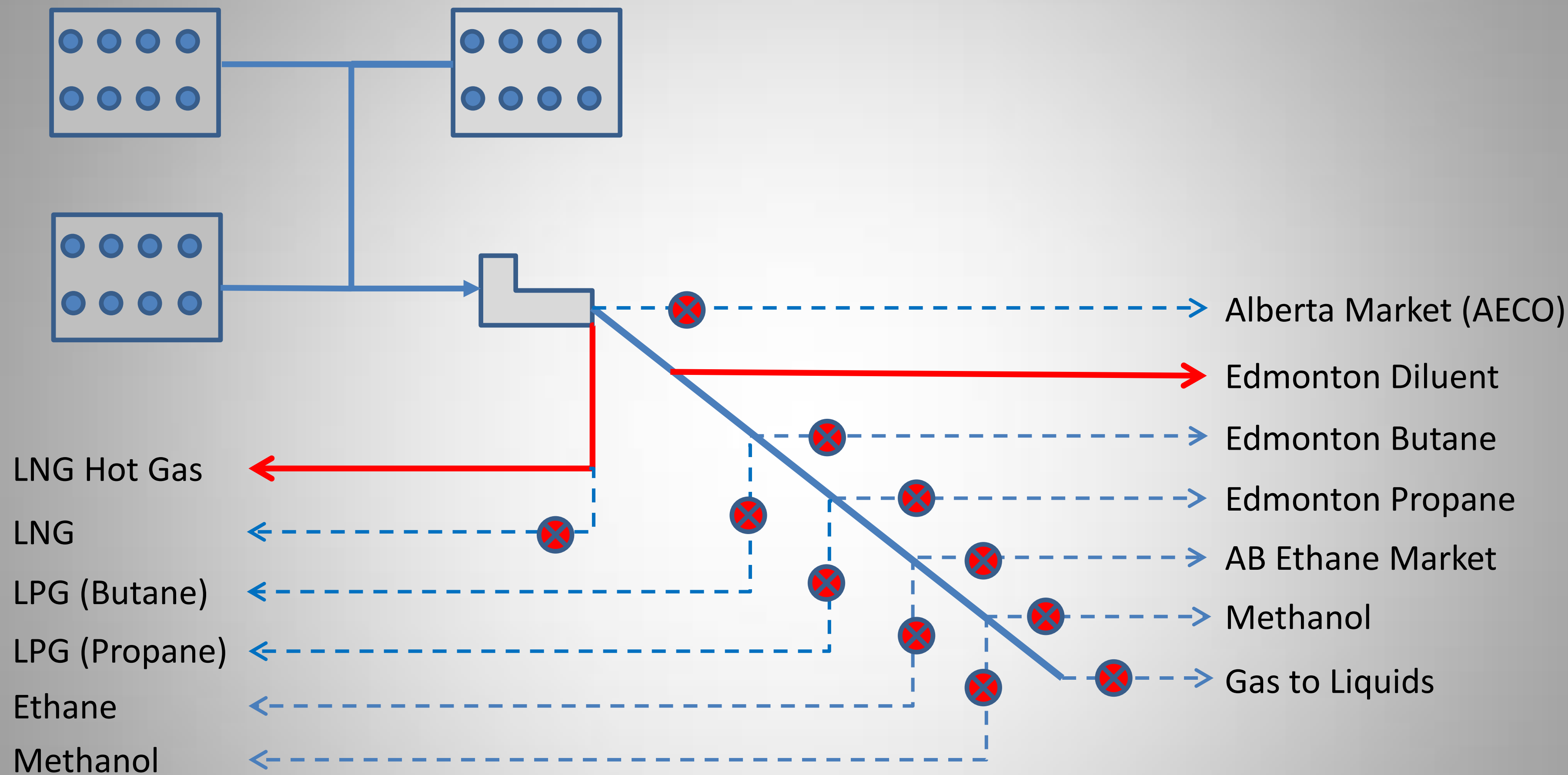
North American NGL Pathways

Producer Options: LNG Exports, LPG Exports



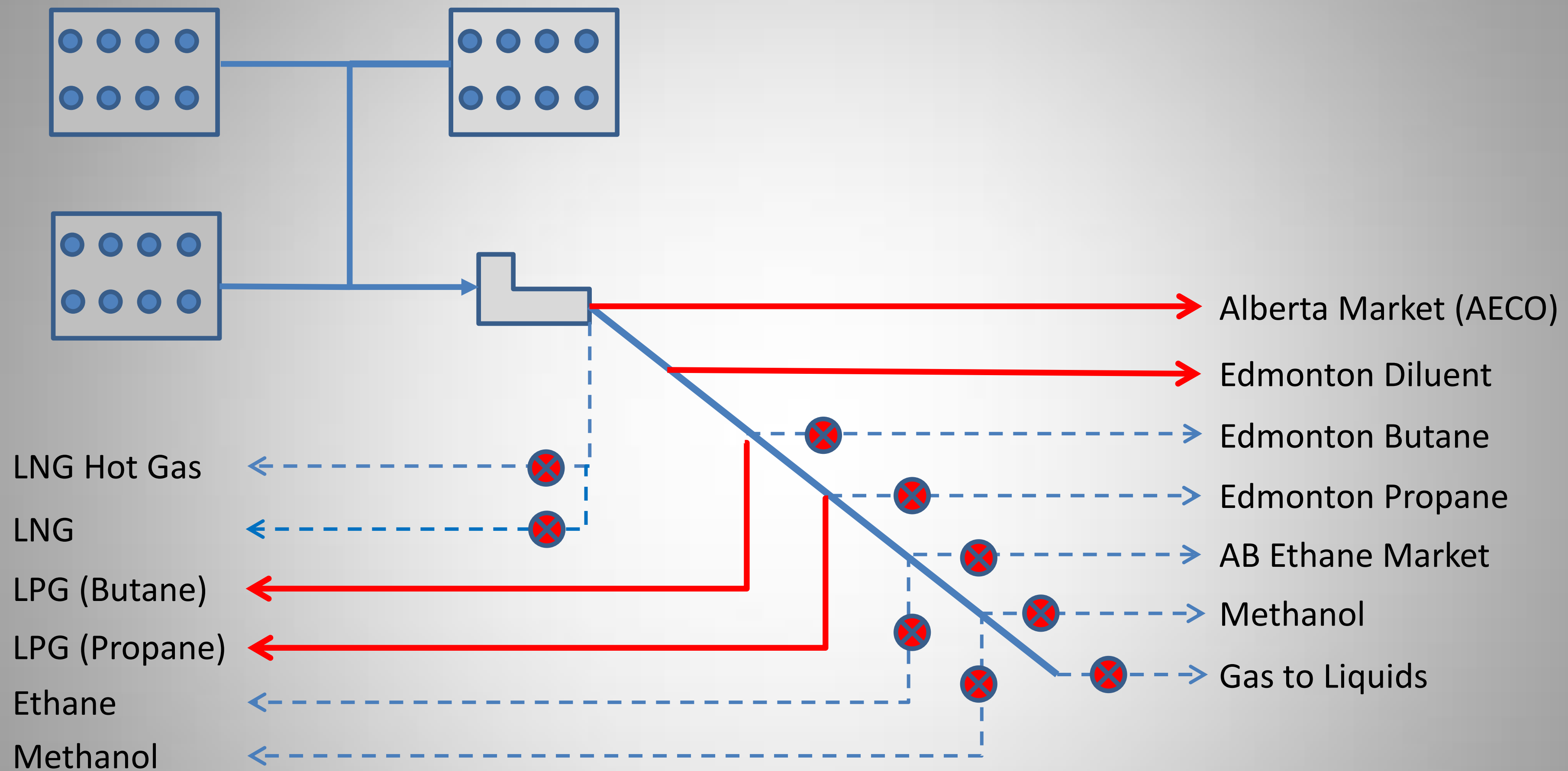
North American NGL Pathways

Producer Options: LNG Exports



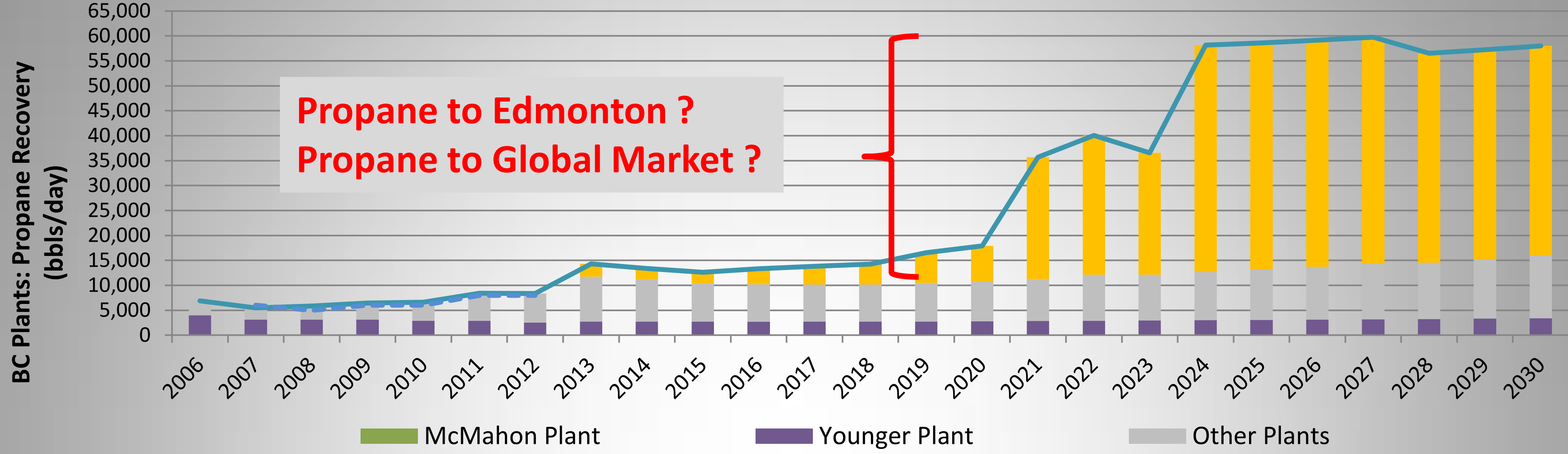
North American NGL Pathways

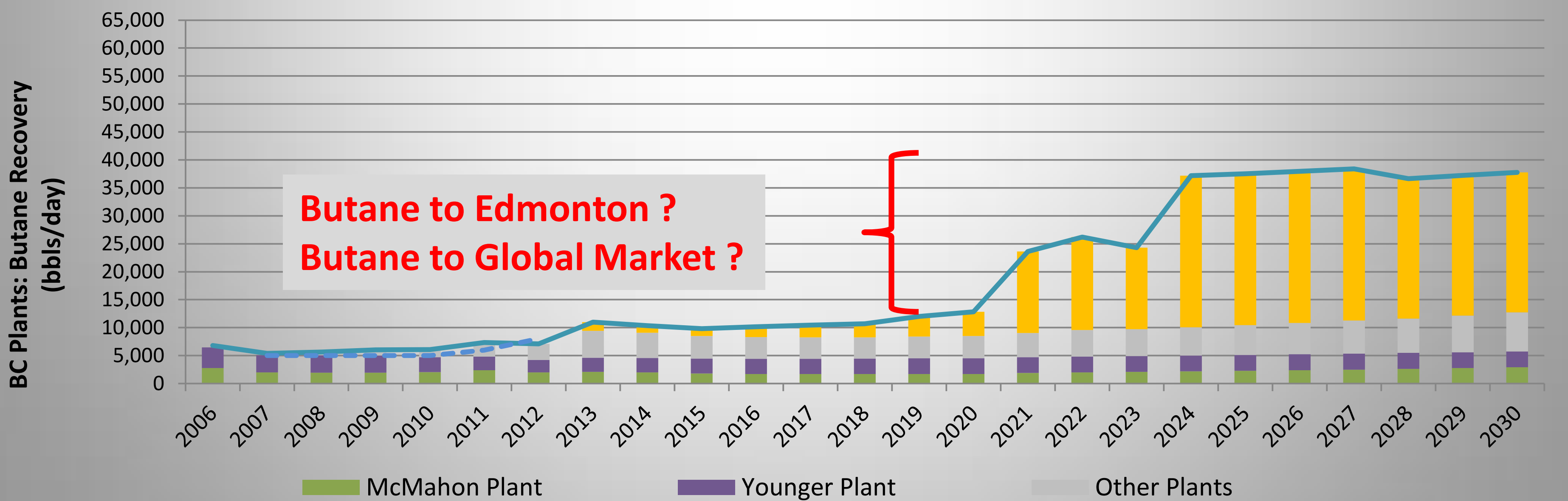
Producer Options: Alberta Market – LPG Exports



North American NGL Pathways

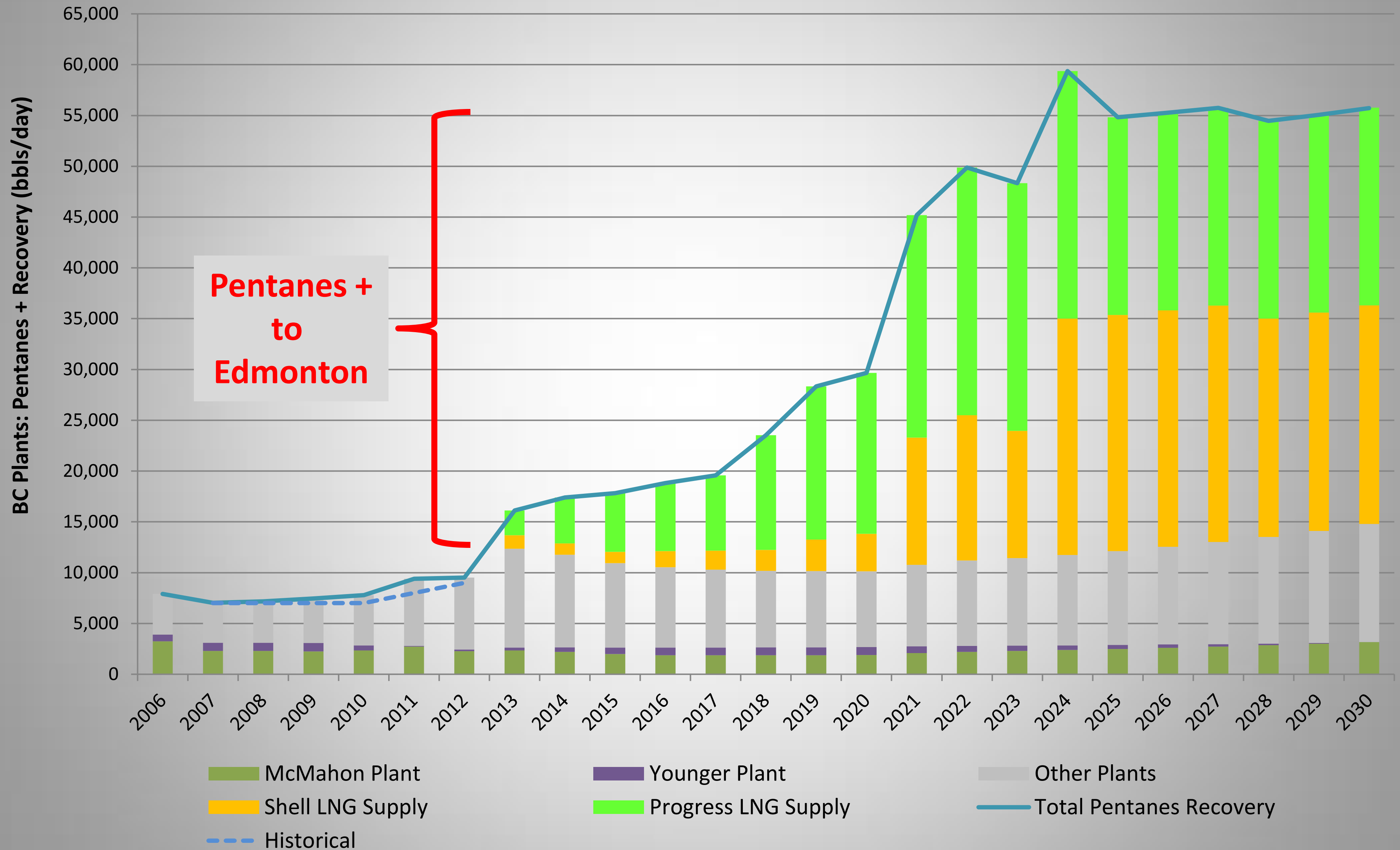
BC Montney NGL Recovery Forecast: Propane, Butane





North American NGL Pathways

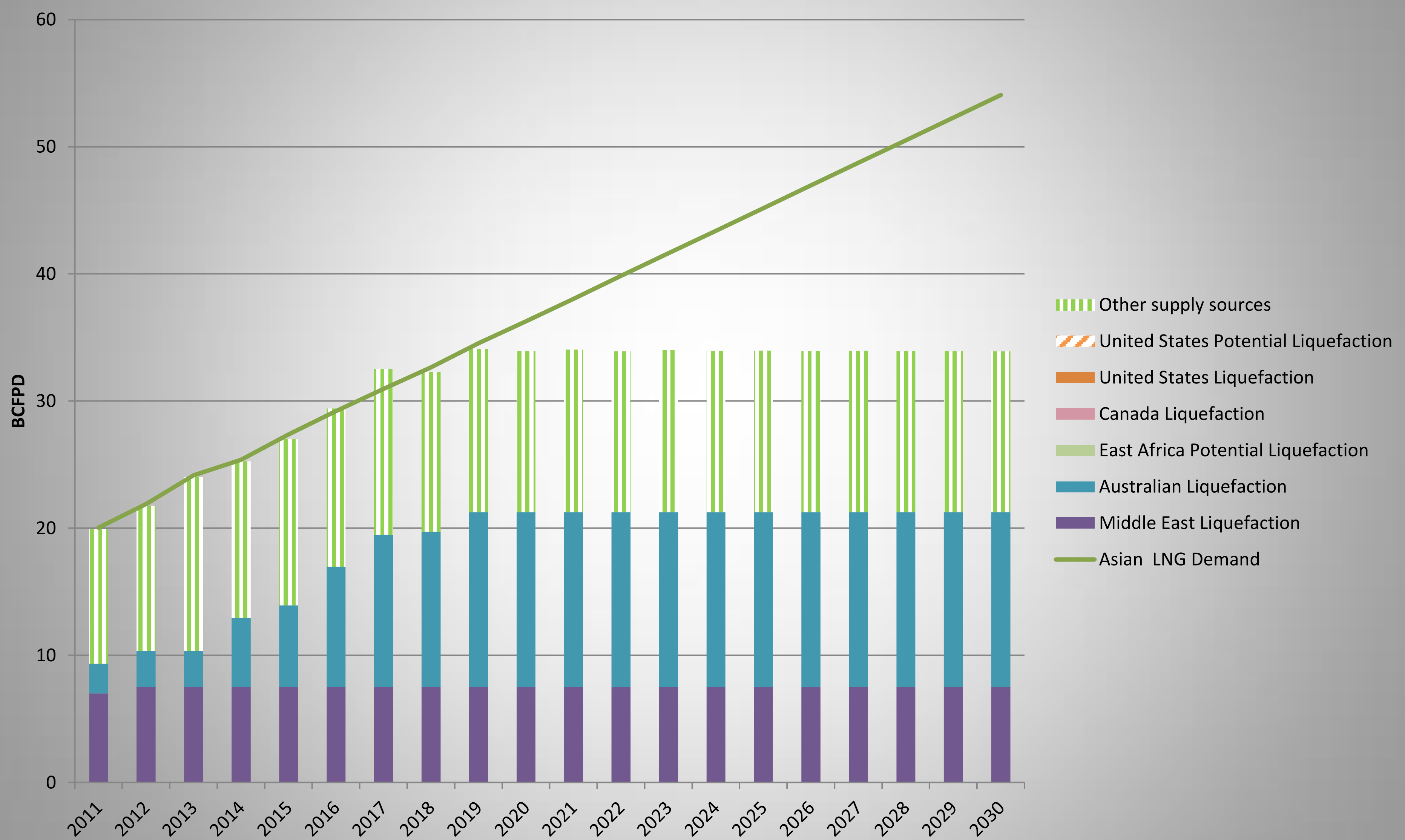
BC Montney NGL Recovery Forecast: Pentanes +



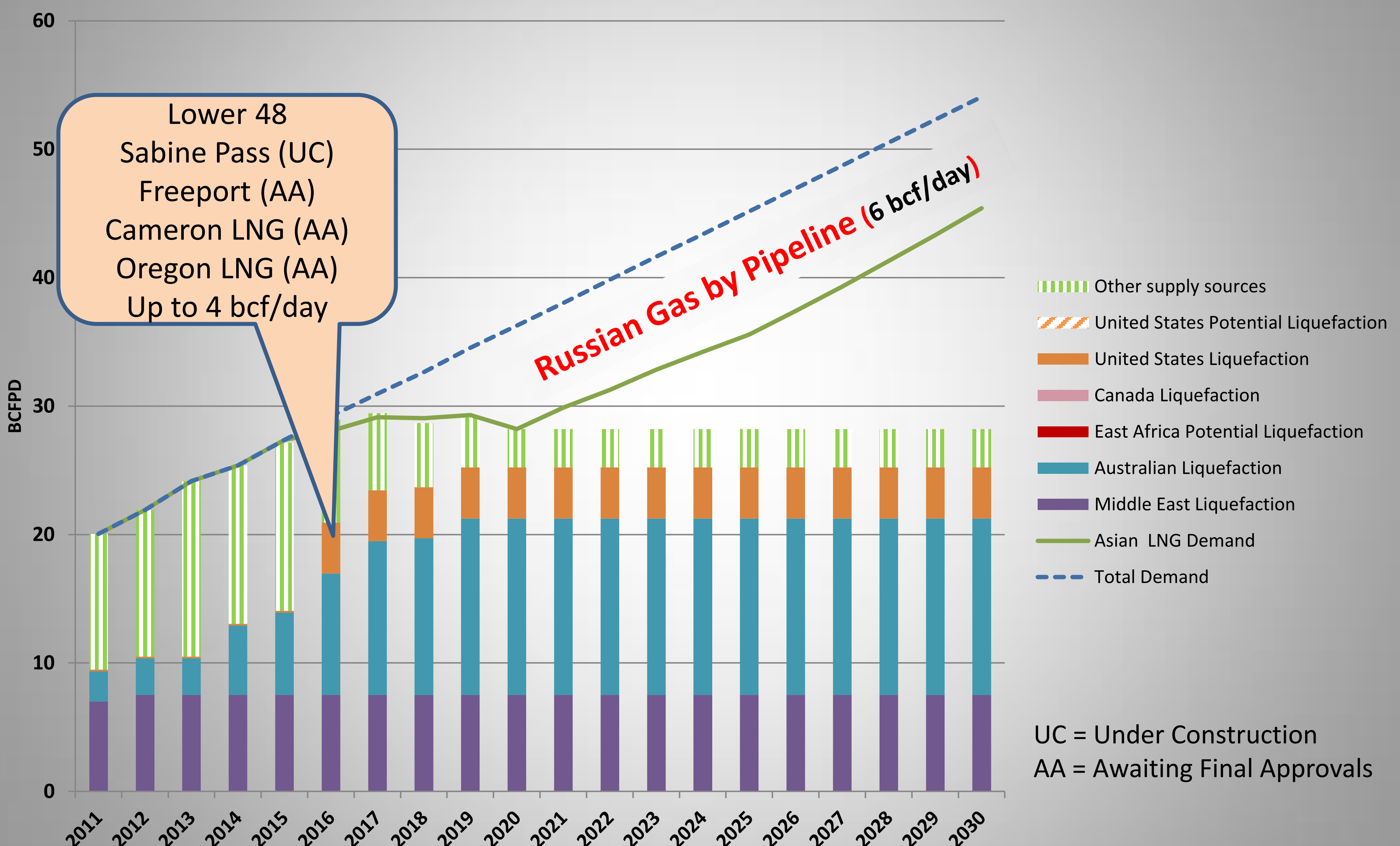
Let the Games Begin?

North American Natural Gas Demand Pathways

Reference Case: LNG Export Potential to the Pacific Basin

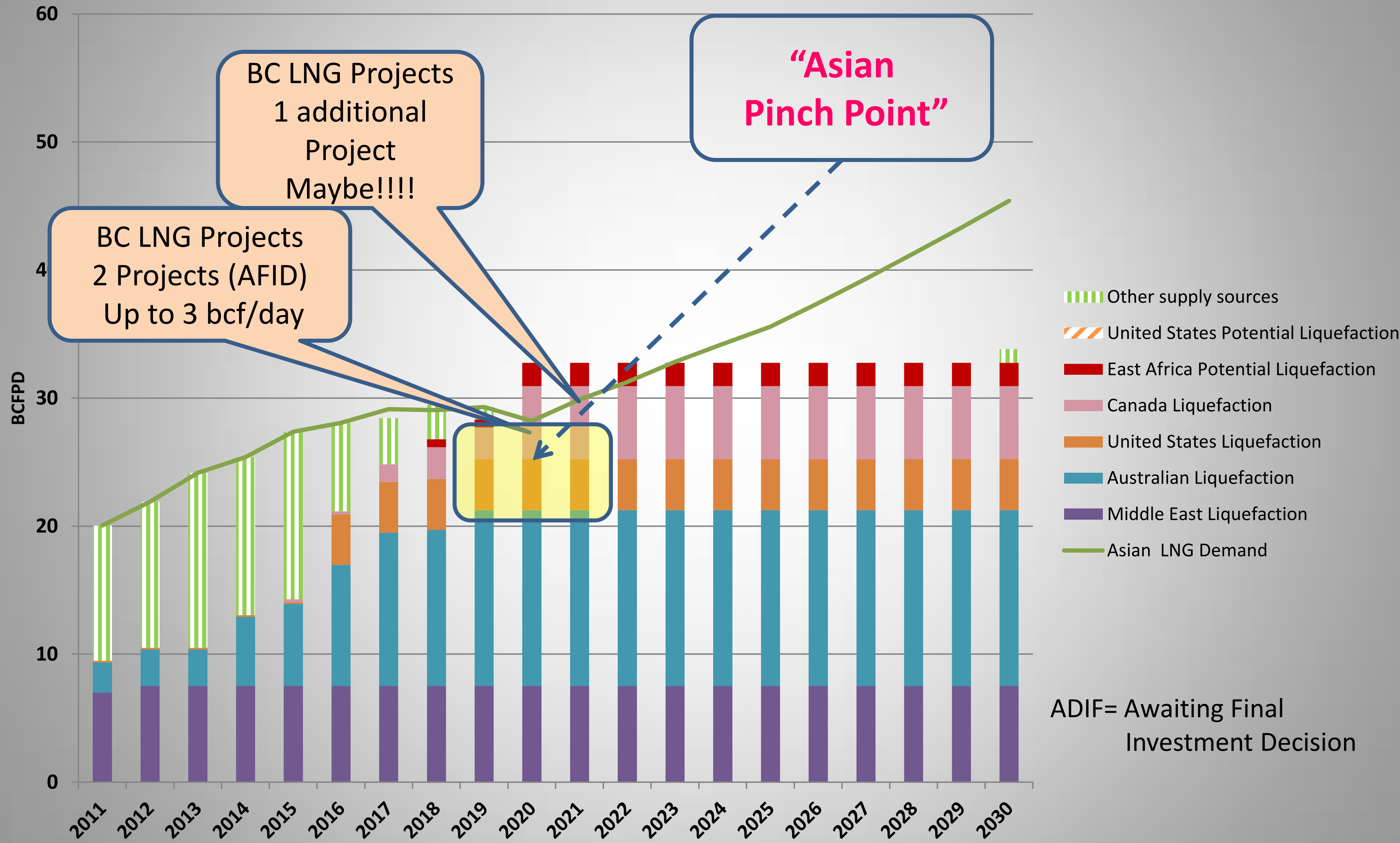


North American Natural Gas Demand Pathways
Reference Case: LNG Export Potential to the Pacific Basin



UC = Under Construction
AA = Awaiting Final Approvals

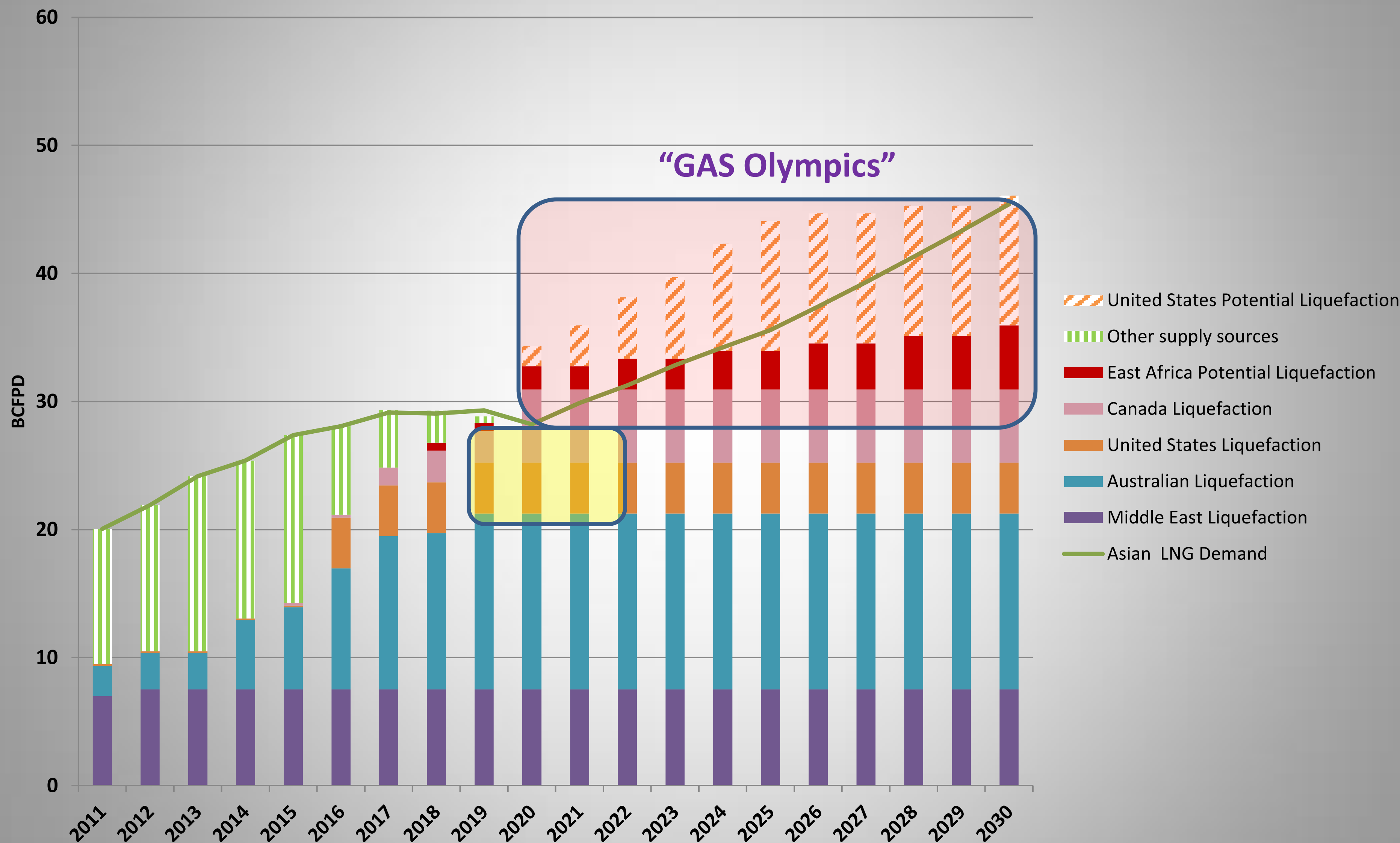
North American Natural Gas Demand Pathways
Reference Case: LNG Export Potential to the Pacific Basin



ADIF= Awaiting Final
Investment Decision

North American Natural Gas Demand Pathways

Reference Case: LNG Export Potential to the Pacific Basin



Risks Associated with BC LNG Projects

High

- **Competition in the Asia-Pacific Basin**
- **Changing Market Prices (decoupling from Oil)**
- **Capital Cost Overruns (Greenfield Projects)**
- **Upstream Development Costs**
- **Transportation Costs (Tanker)**
- **Pipeline Tolls**

Low

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