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The Uncertain Future of Global LNG Trade

Presented to:
LSI Natural Gas for Transportation
and LNG Markets Conference

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Agenda

Past to Present: Recap of market developments since early 2000s

- Shale gas “revolution” and stranded assets
- Global LNG developments
- Pricing in current LNG markets

Future: Outlook for LNG trade

- Demand uncertainty
  - How might LNG trade evolve? Where does China fit in the evolution?
- Supply Competition
  - Lower 48, British Columbia, Alaska, Australia
- What are the prospects for global price convergence?

Shale Gas Recap

Substantial increase in shale gas production in past 5-7 years

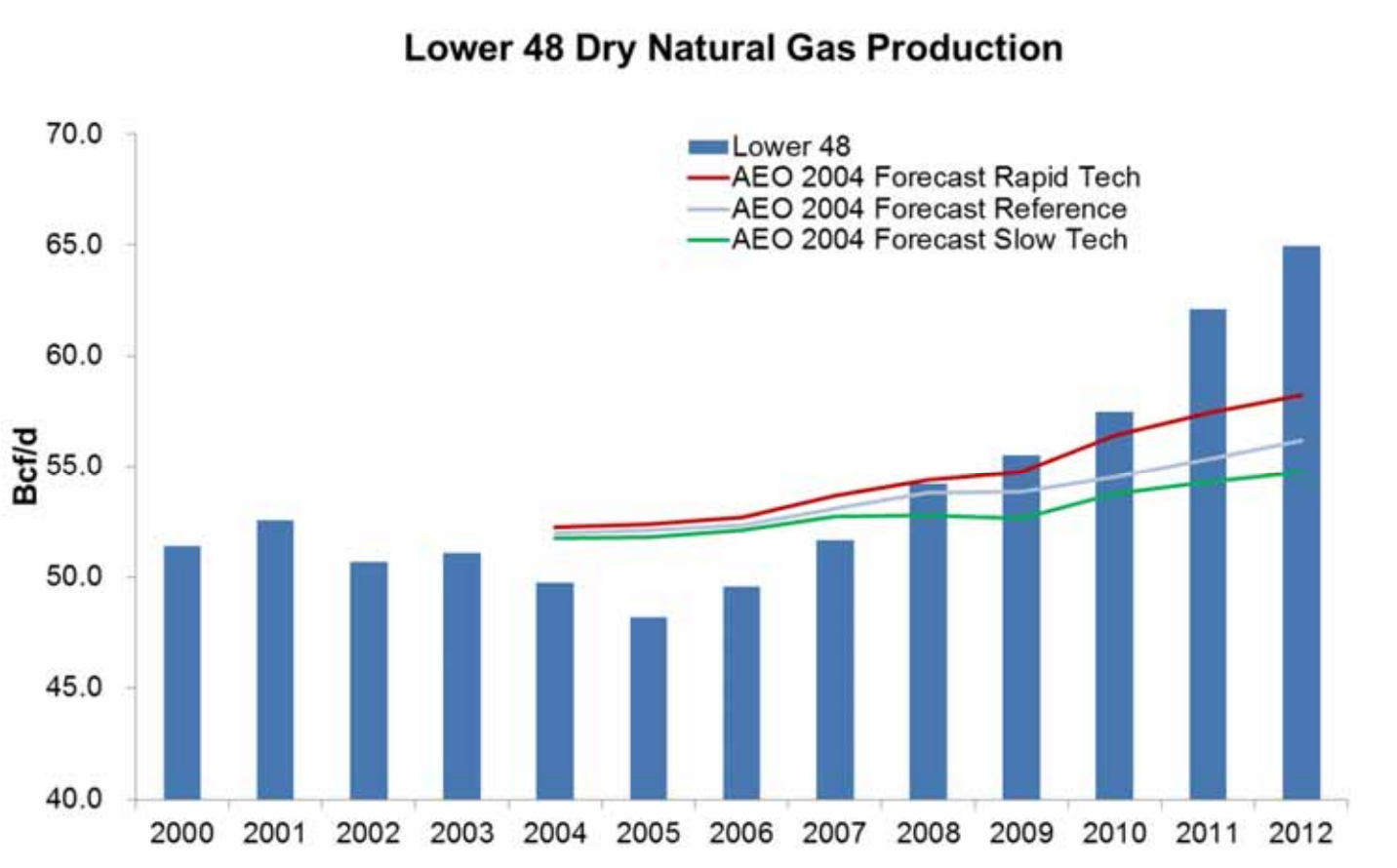
- Changed the economics of North American natural gas markets
- Stranding (even recent) investments in pipeline and LNG regas infrastructure
- Leading to the development of LNG export terminals
- Spawning a resurgence in petrochemicals and on-shore manufacturing

Is it permanent, or the next temporary boom in a series of boom-bust cycles?

- It is technology-driven, so one would think it is permanent
- But, depends on the long-run shape of the North American supply curve for natural gas

Substantial Growth in U.S. Gas Production Driven by Shale Gas Development

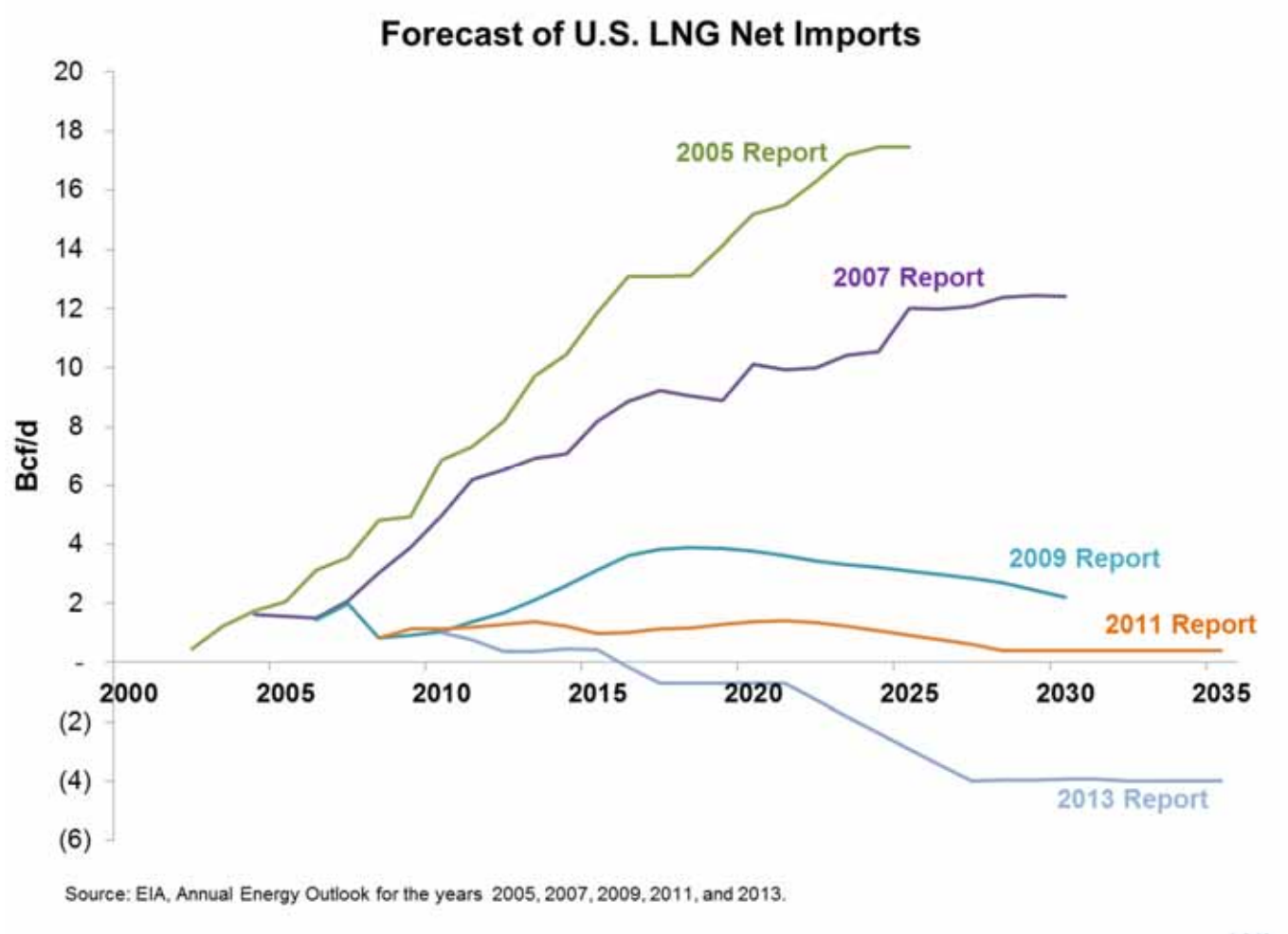
Lower 48 gas production has grown by over 15 Bcf/d since 2005 – driven by shale gas development



Source: EIA, historical gas production 2000 - 2012, forecasts are from AEO 2004.
Note: Lower 48 dry production is calculated as total US dry natural gas production less Alaskan natural gas production. 2012 dry Alaskan production is calculated as the average of 2010 and 2011.

Shale Changes U.S. Outlook in World Gas Markets

Pre-shale EIA outlook of 12-18 Bcf/d of imports by 2025; Current outlook of 4 Bcf/d of exports by 2030



Source: EIA, Annual Energy Outlook for the years 2005, 2007, 2009, 2011, and 2013.

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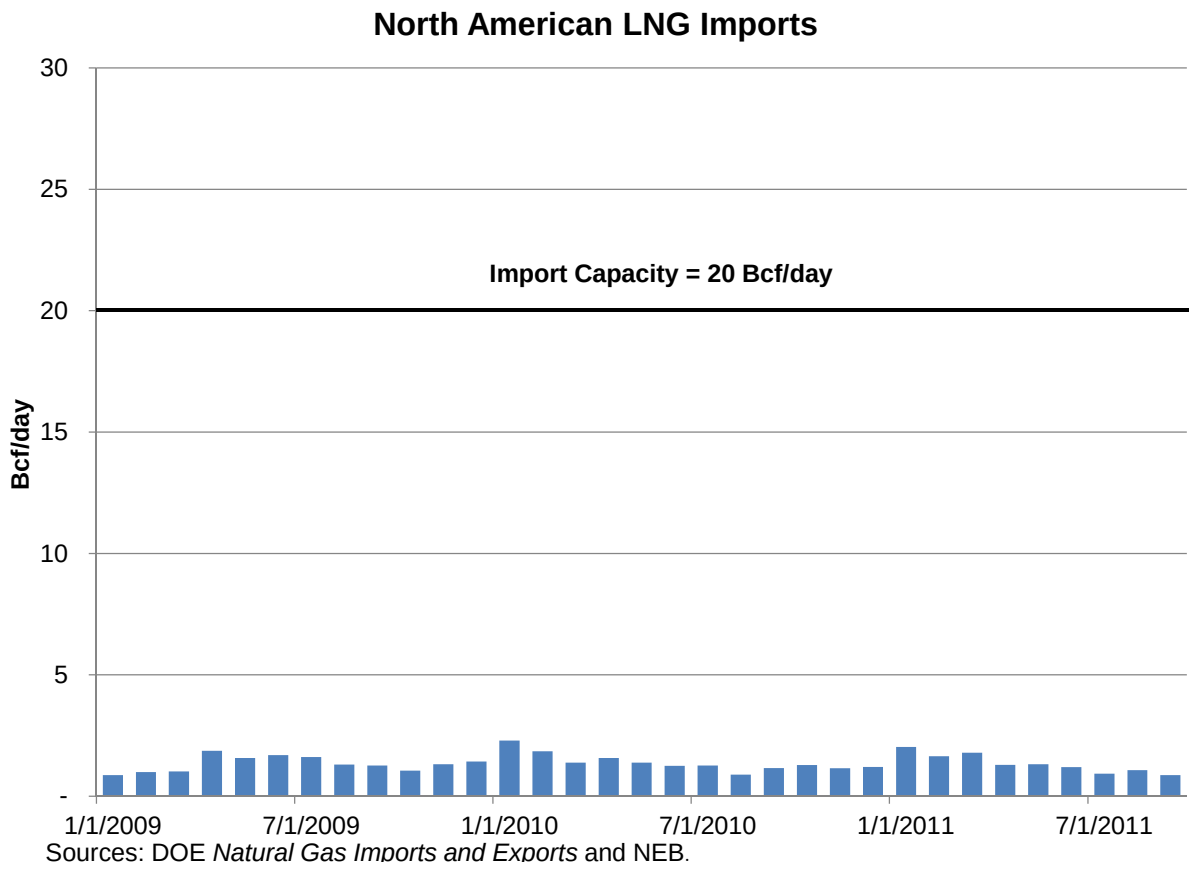
North American LNG: Stranded Regas Capacity



Sources: DOE *Natural Gas Imports and Exports* and NEB.

- Following 2000-2001 prices spikes, U.S. started planning for LNG imports
- Brought back and expanded mothballed LNG import terminals
- Built a substantial amount of new LNG imports capacity
  - Freeport (1.5 Bcf/d)
  - Sabine Pass (4.0 Bcf/d)
  - Cameron (1.8 Bcf/d)
  - Golden Pass (2.0 Bcf/d)
  - Gulf LNG (1.5 Bcf/d)
  - Canaport (1.0 Bcf/d)
  - Northeast Gateway (0.8 Bcf/d)
  - Neptune (0.4 Bcf/d)
- LNG import capacity largely unused
- Shale has also stranded pipeline capacity (*e.g.*, TransCanada Mainline)

LNG Trade – 2003 vs. 2012

LNG trade doubled in past decade, led by demand growth in Asian-Pacific markets and supply increases in the Middle East

Total LNG Exports for 2003 vs 2012 (Bcf/d)

Country/Region		2003	2012
[1]		[2]	[3]
North America	[a]	**0.2**	**0.1**
South & Central America	[b]	**1.2**	**2.4**
Europe/Eurasia	[c]	**-**	**2.2**
Middle East	[d]	**3.4**	**12.7**
Africa	[e]	**3.9**	**5.2**
Asia Pacific	[f]	**7.7**	**9.1**
TOTAL	[g]	**16.3**	**31.7**

Sources:
[2]: BP Statistical Review of World Energy June 2004
[3]: BP Statistical Review of World Energy June 2013

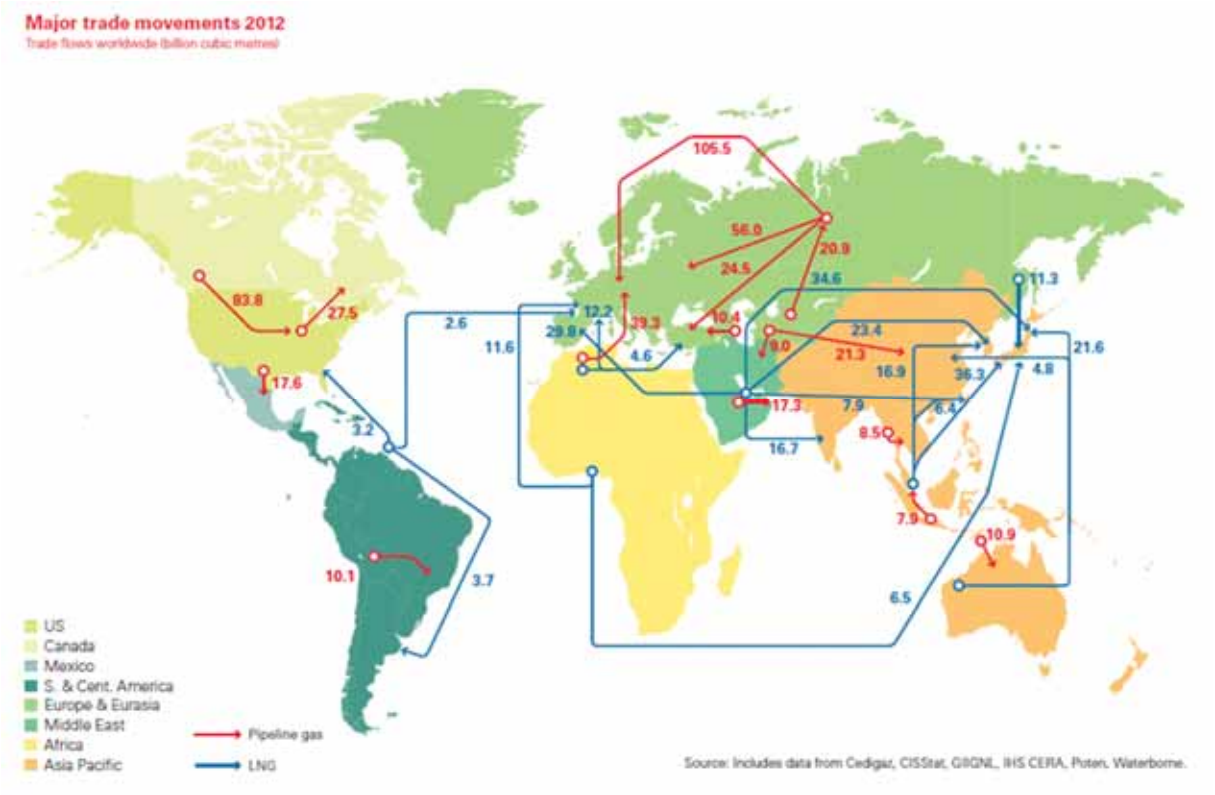
Total LNG Imports for 2003 vs 2012 (Bcf/d)

Country/Region		2003	2012
[1]		[2]	[3]
North America	[a]	**1.4**	**1.1**
South & Central America	[b]	**0.1**	**1.5**
France	[c]	1.0	1.0
Spain	[d]	1.5	2.1
United Kingdom	[e]	-	1.3
Other Europe/Eurasia	[f]	1.5	2.3
Sub-Total for Europe/Euras	[g]	**3.9**	**6.7**
Middle East	[h]	-	0.4
China	[i]	-	1.9
India	[j]	-	2.0
Japan	[k]	7.7	11.5
South Korea	[l]	2.5	4.8
Taiwan	[m]	0.7	1.6
Thailand	[n]	-	0.1
Sub-Total for Asia Pacific	[o]	**11.0**	**22.0**
TOTAL	[p]	**16.3**	**31.7**

Sources:
[2]: BP Statistical Review of World Energy June 2004
[3]: BP Statistical Review of World Energy June 2013

The Present-Major Natural Gas Trade Flows in 2012

- Three distinct regional markets, Asia (oil-linked contract prices), Europe (mix of oil-linked and spot gas pricing), and North America (Henry Hub + “basis” pricing)
- Some diversions of spot cargoes between regions (limited spot market)



Source: BP Statistical Review of World Energy 2013.

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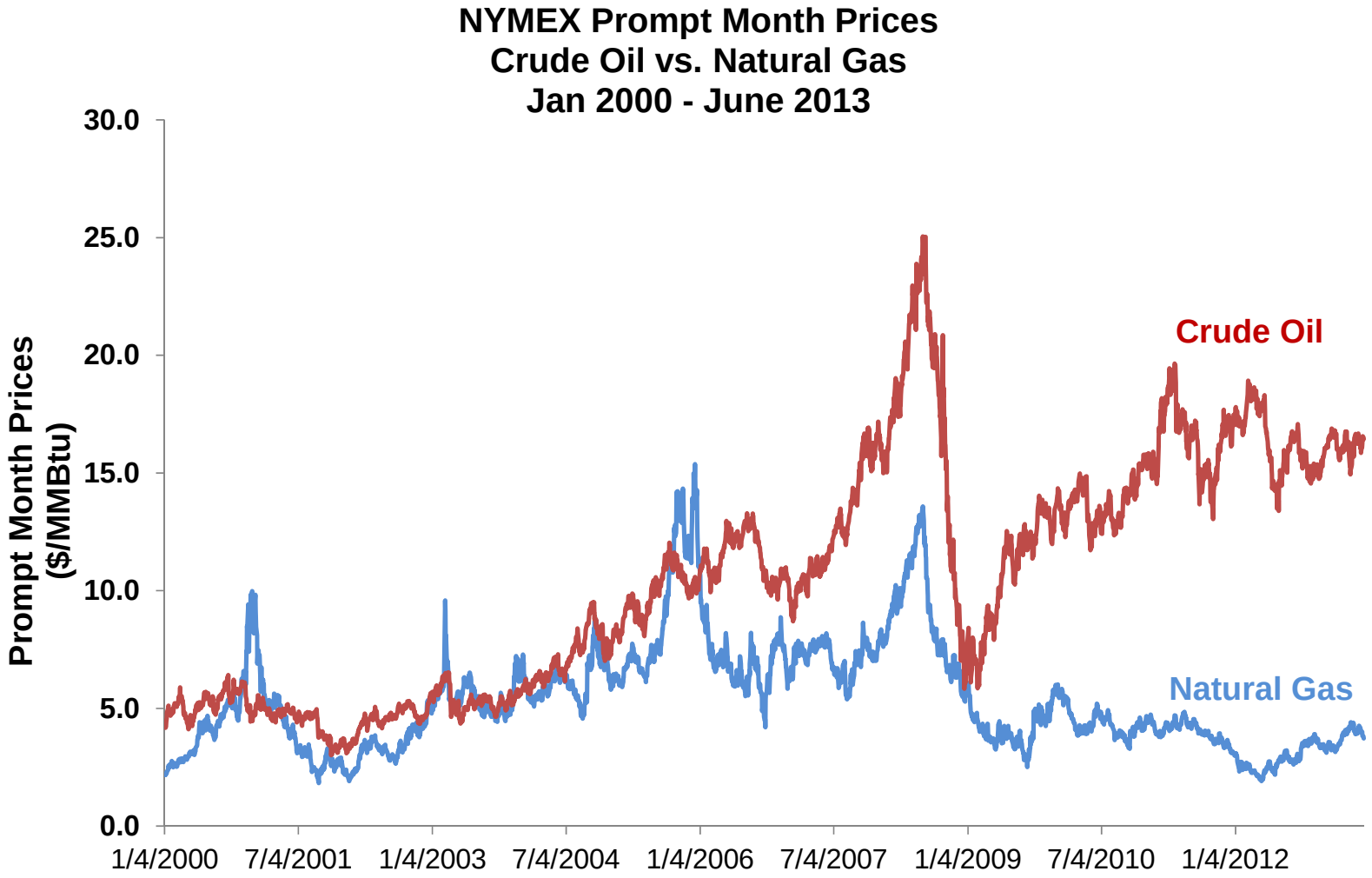
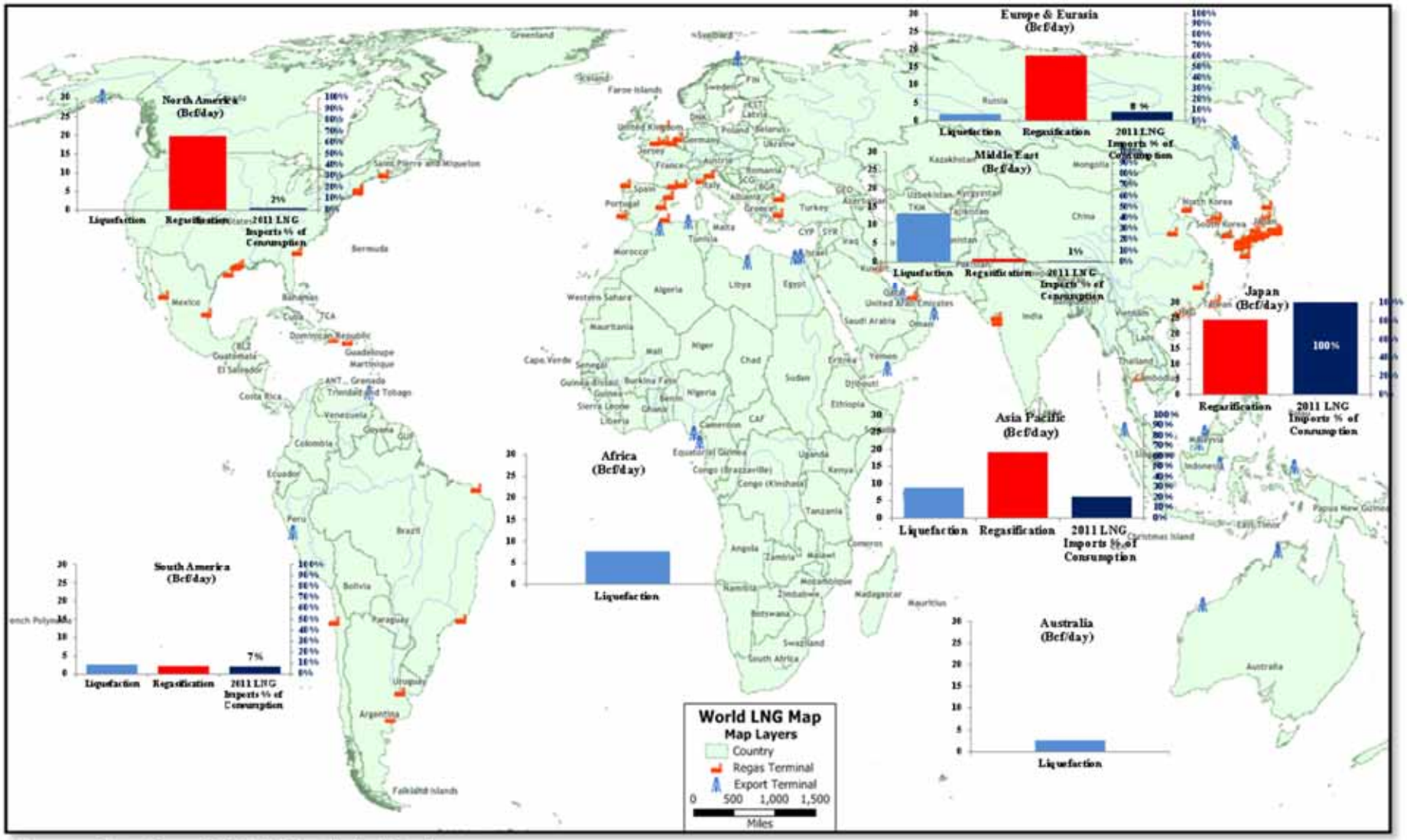
Recent Large Oil/Gas Price Differential Makes Oil Price-linked LNG Exports Look Attractive



Sources/Notes: NYMEX data downloaded from EIA. The crude oil prices are for WTI Cushing, OK Crude Oil Future Contracts.

LNG Terminal Locations and Capacities



Source: Data from 2012 BP Statistical Review.

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IEA World Energy Outlook 2012 Scenarios

Golden Rules Case

- Significant unconventional development globally (~1 million+ new unconventional wells drilled before 2035)
- Diverse mix of sources of gas in most markets, suggesting an environment of growing confidence in the adequacy, reliability and affordability of natural gas supplies
- An increased volume of gas, particularly LNG, looking for markets in the period after 2020 stimulates more liquid and competitive international markets

Low Unconventional Case

- Lack of public acceptance leads to only a small share of unconventional gas resources being accessible for development (unconventional gas production rises only slightly above 2010 levels by 2035)
- The competitive position of gas in the global fuel mix deteriorates as a result of lower availability and higher prices
- The requirement for imported gas is higher and some patterns of trade are reversed, with North America needing significant quantities of imported LNG, and the preeminent position in global supply of the main conventional gas resource-holders is reinforced

IEA Gas Demand Forecast (Golden Rules Case) Shows Largest Demand Growth in Asia

Natural Gas Demand by Region in the Golden Rules Case (Bcf/d)

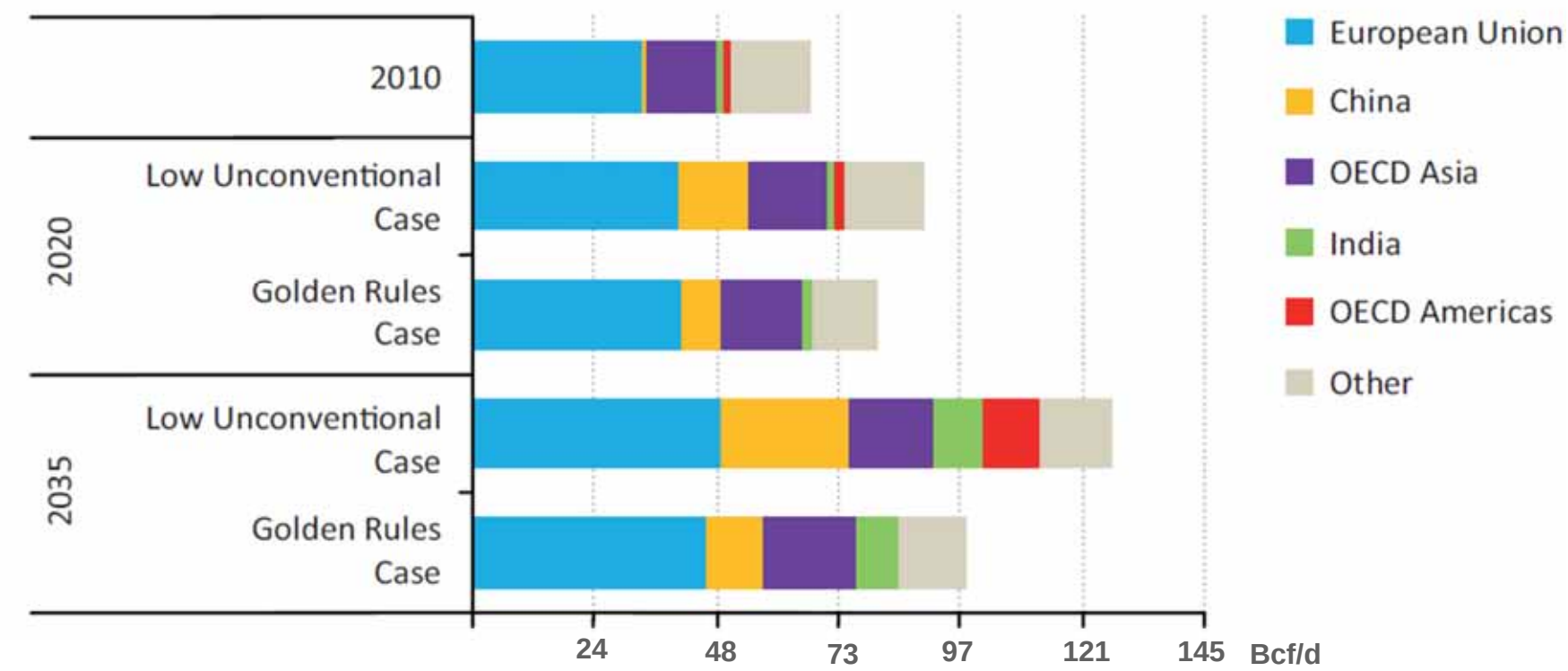
Region/Country		2010	2035	2035 Demand less 2010 Demand
[1]		[2]	[3]	[4]
Americas	[a]	**81**	**102**	**20**
United States	[b]	66	76	10
Europe	[c]	**56**	**67**	**11**
Asia Oceania	[d]	**17**	**23**	**6**
Japan	[e]	10	13	3
OECD	[f]	**155**	**192**	**37**
E. Europe/Eurasia	[g]	**64**	**84**	**20**
Russia	[h]	43	54	11
Asia	[i]	**39**	**116**	**77**
China	[j]	11	57	47
India	[k]	6	19	13
Middle East	[l]	**35**	**62**	**27**
Africa	[m]	**10**	**16**	**6**
Latin America	[n]	**14**	**24**	**10**
Non-OECD	[o]	**162**	**303**	**141**
World	[p]	**316**	**495**	**178**

Sources:
[2] - [3]: World Energy Outlook 2012_GoldenRulesReport p78

- Gas demand growth to 2035 expected to be particularly strong in China (47 Bcf/d), Middle East (27 Bcf/d), and India (13 Bcf/d)
- But gas demand growth is highly uncertain and can be met by indigenous production, pipeline imports and/or LNG imports
- Part of the uncertainty relates to electric sector gas demand (and the future generation mix of nuclear, coal, gas and renewables)
- LNG market growth likely to depend heavily on China and India demand growth
- Japan and South Korea (currently ~50% of LNG demand) forecasted to grow at much slower pace

Growth in Global Net Imports Also Makes LNG Exports Attractive

Figure 2.12 ▷ Major natural gas net importers by case

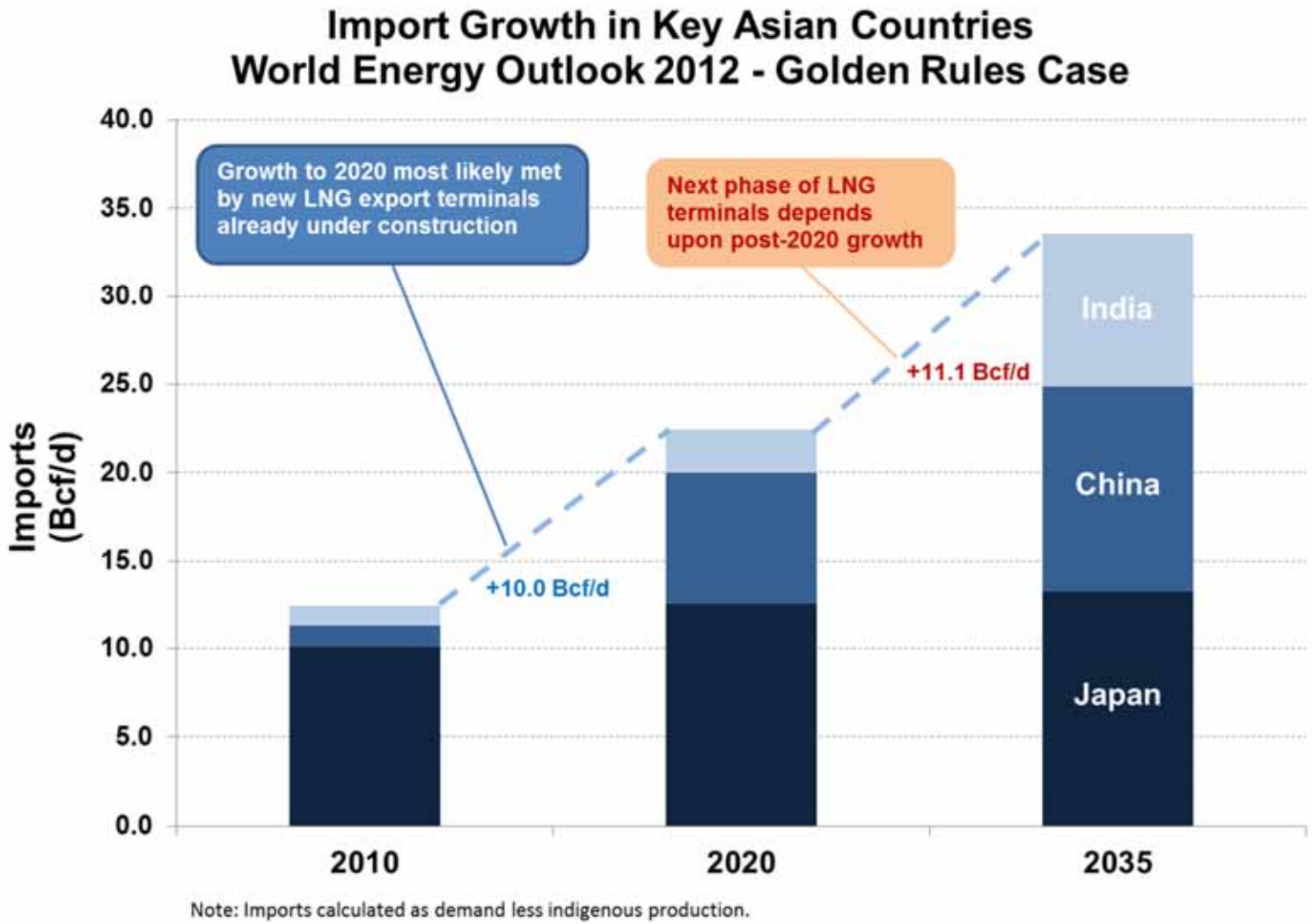


Source: Golden Rules for a Golden Age of Gas, World Energy Outlook Special Report on Unconventional Gas, IEA, 2012, p.97

Demand growth expected in non-OECD countries, particularly China

- China's net gas imports only ~1.4 Bcf/d in 2010
- IEA - China' net imports could reach ~7 Bcf/d to 14 Bcf/d by 2020 and ~ 12 Bcf/d to 25 Bcf/d by 2035

Potential Import Growth in Key Asian Countries



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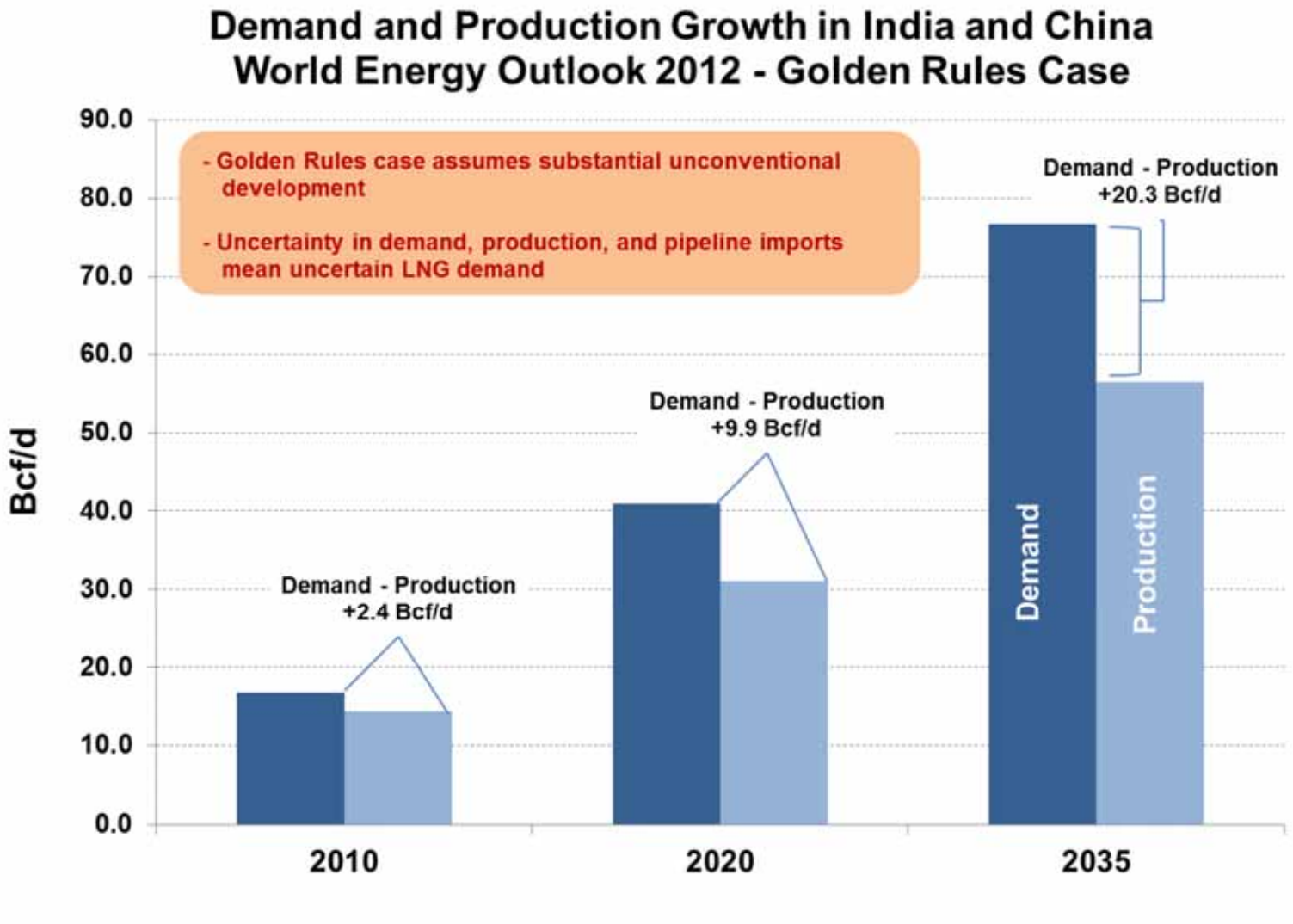
Uncertainty in LNG Demand Driven by Uncertainty in Natural Gas Demand and Indigenous Production Growth



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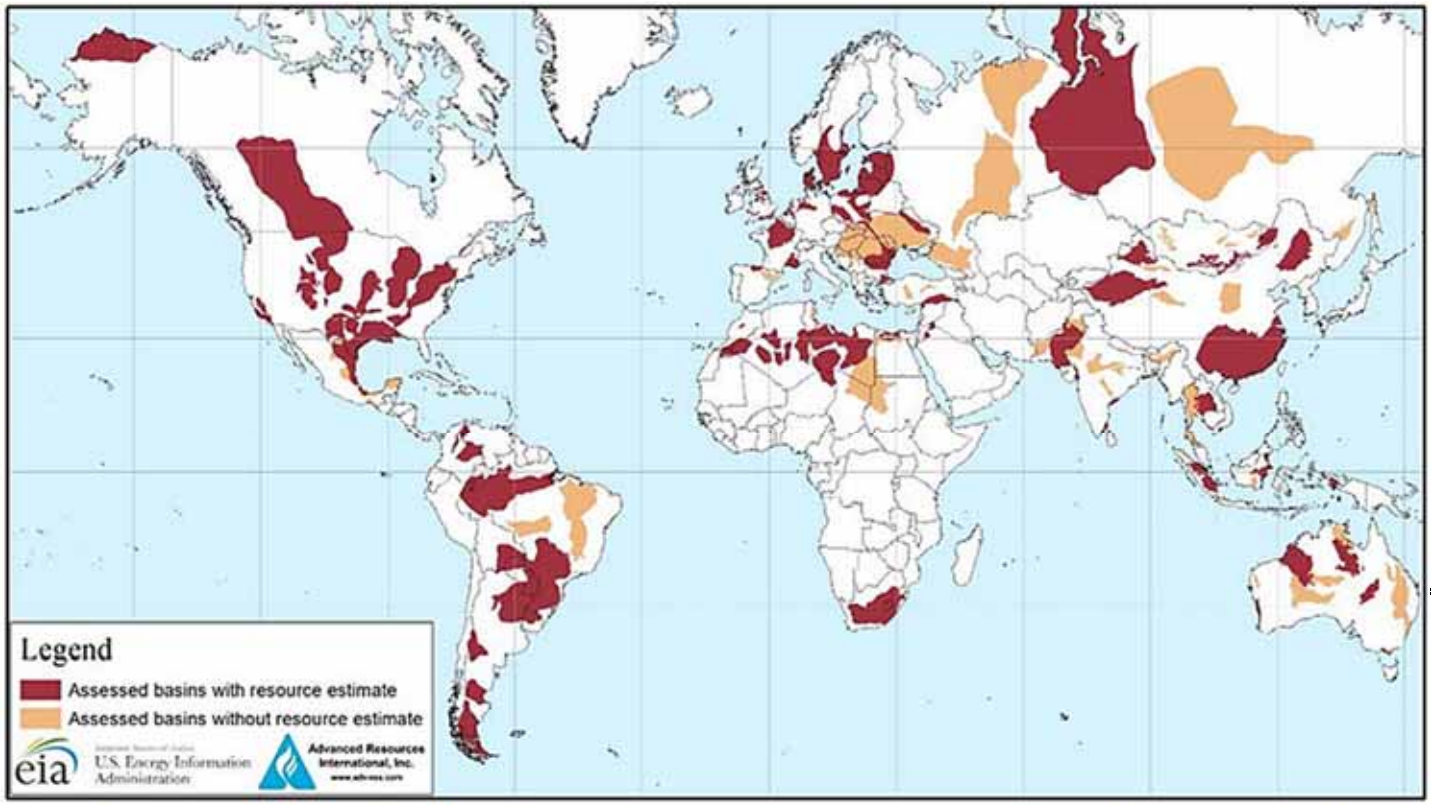
Global Shale Gas Assessment



Source: United States basins from U.S. Energy Information Administration and United States Geological Survey; other basins from ARI based on data from various published studies.

Technically Recoverable Shale Gas Resouces Tcf	
1. U.S	1,161
2. China	1,115
3. Argentina	802
4. Algeria	707
5. Canada	573
6. Mexico	545
7. Australia	437
8. South Africa	390
9. Russia	285
10. Brazil	245
11. Others	1,535
Grand Total	**7,795**

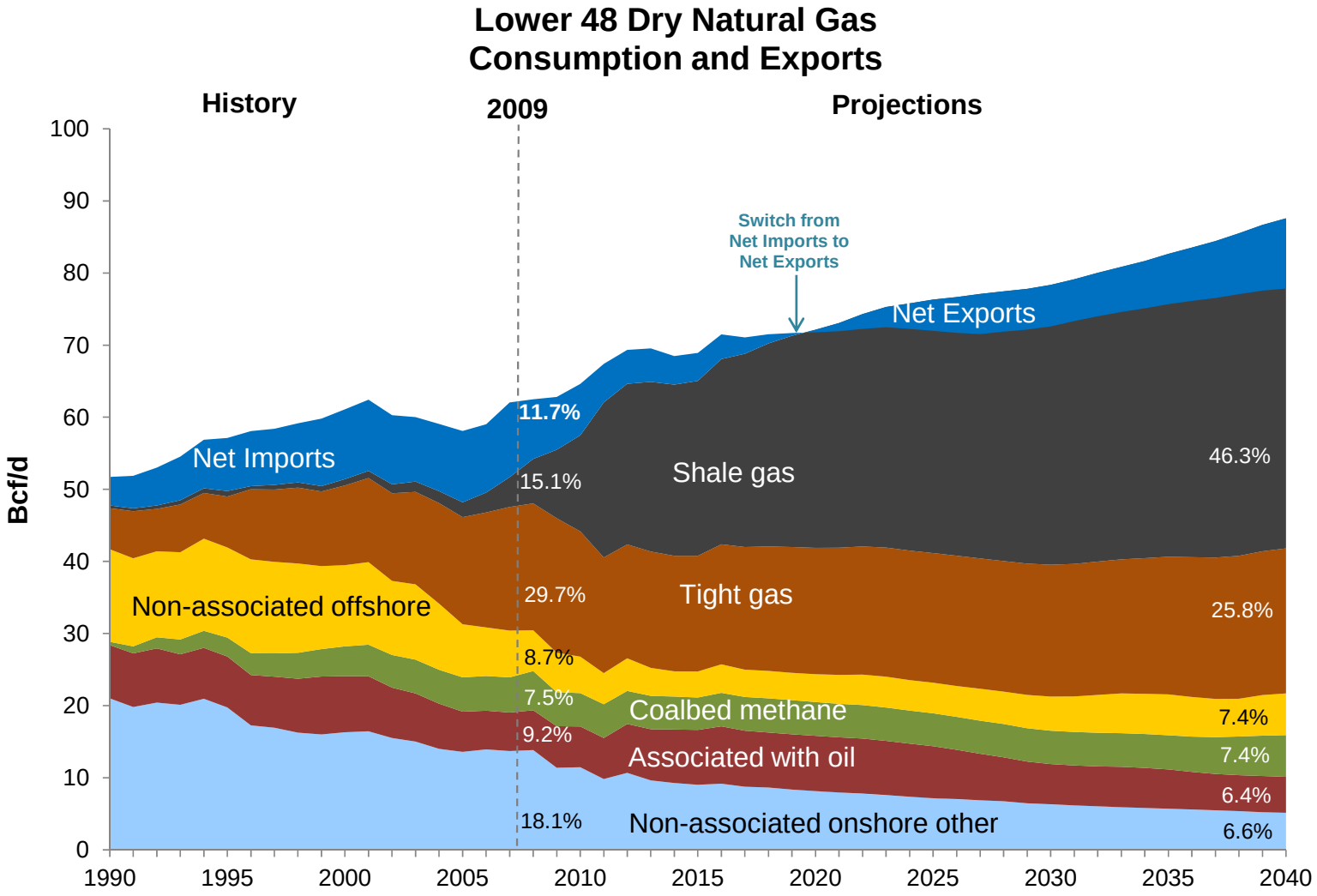
Source: "Technically Recoverable Shale Oil and Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries Outside the United States," EIA, June 2013.

Significant Uncertainty in Unmet Gas Demand Post-2020

Source: "China Keeps Import Options Wide Open," World Gas Intelligence, July 25, 2012

- Brookings: LNG shortfall of ~5 Bcf/d expected by 2020 (i.e., LNG supply < LNG demand)
- Global LNG outlook depends in part on supply-demand dynamics in China
  - China potentially has competitive alternatives for gas supply
  - Some estimates suggest China has 1,115 Tcf of shale gas reserves (~10x the size of Marcellus)
  - China is exploring several import options apart from LNG (*e.g.*, pipeline imports from Russia)

Shale Gas Dominates Forecasted U.S. Supplies



Source: EIA, Annual Energy Outlook 2013 Early Release. Excludes Alaska.. The percentages shown above are calculated as percent of total lower 48 natural gas demand. The shale gas percentage for 2040 is calculated as total shale gas production less net exports divided by lower 48 natural gas demand, assuming that shale gas is the source of the net exports.

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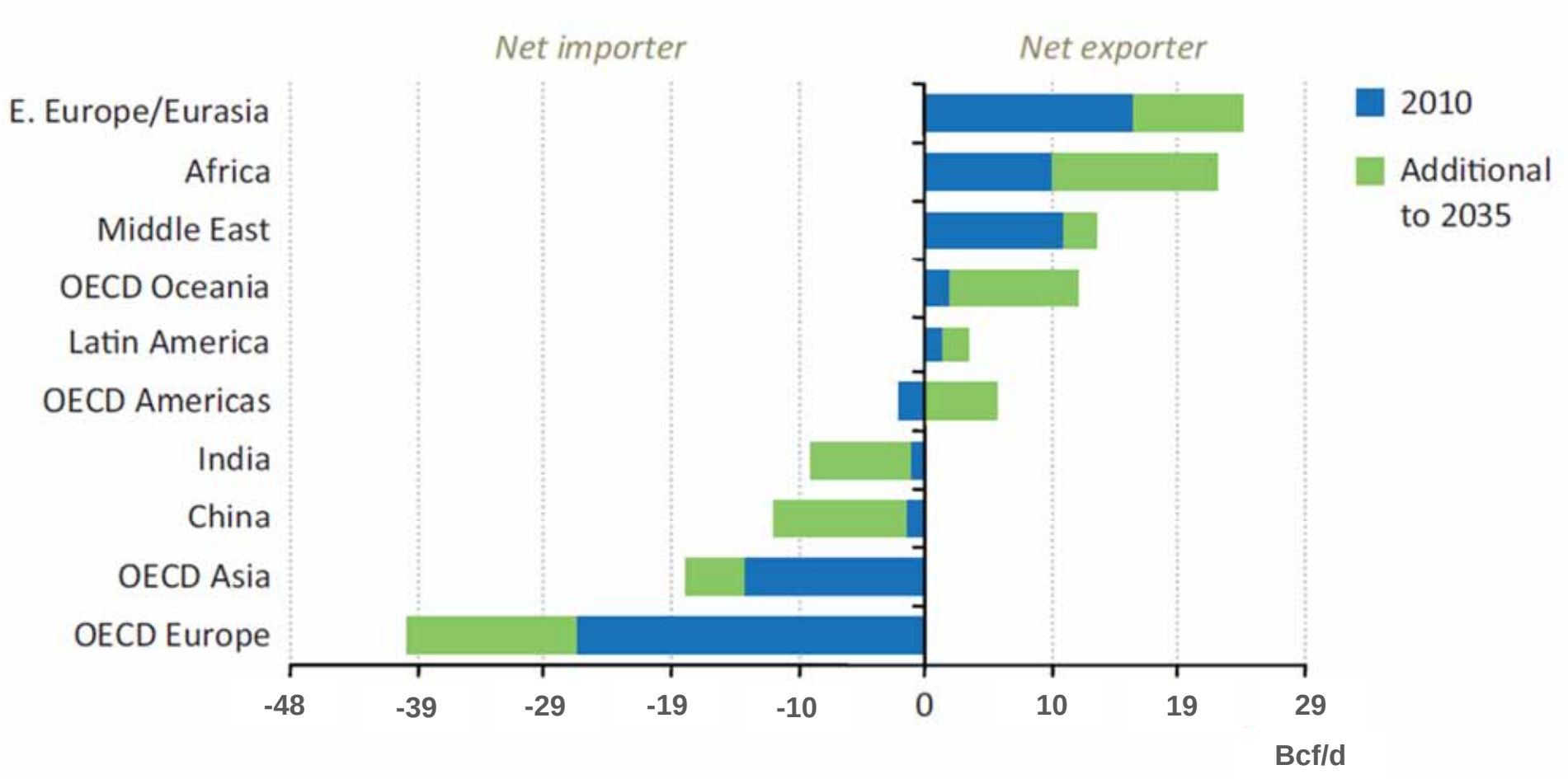
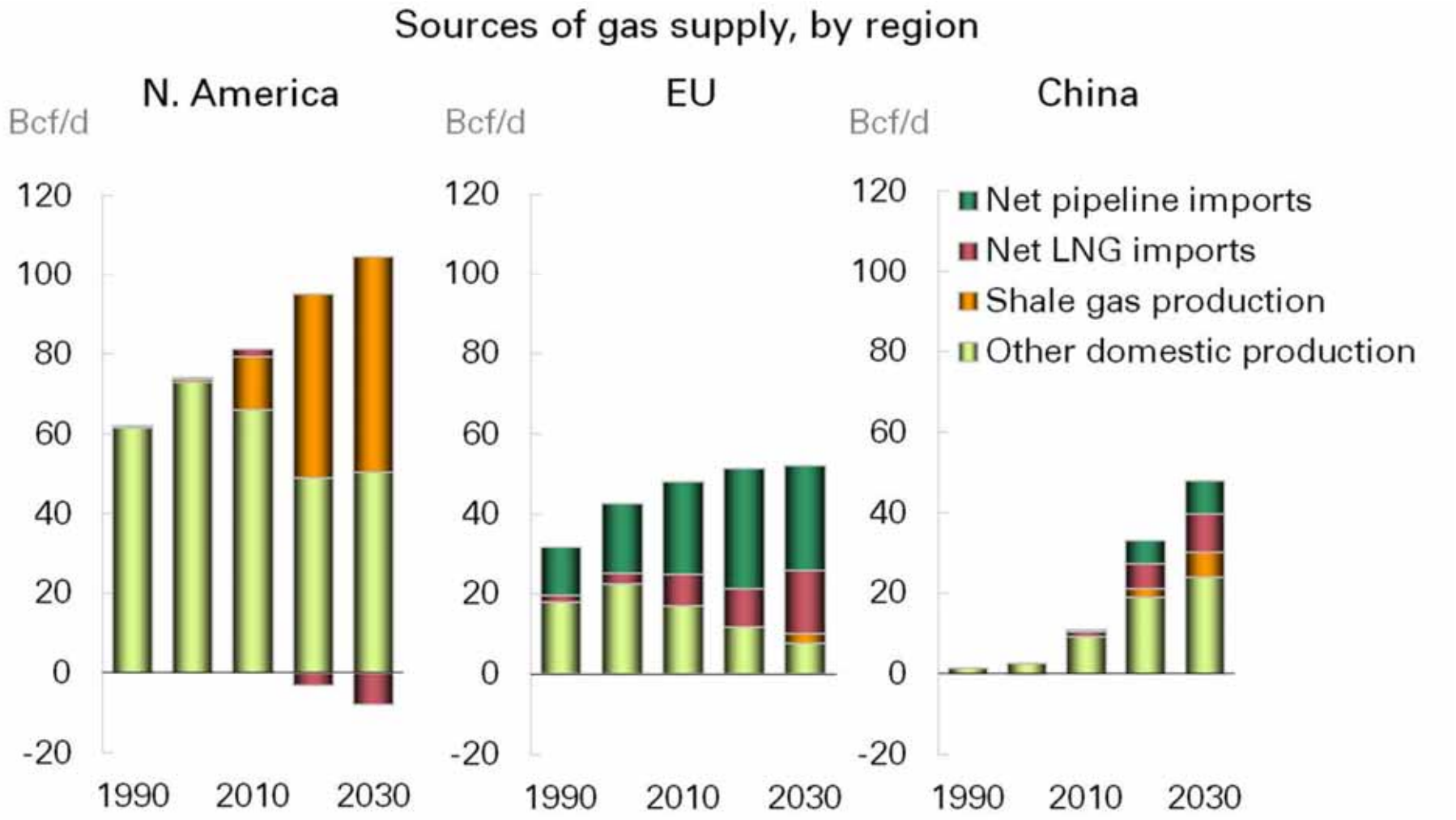
Natural Gas Net Trade by Major Regions
Golden Rules Case



Source: Golden Rules for a Golden Age of Gas, World Energy Outlook Special Report on Unconventional Gas, IEA, 2012.

Sources of Gas Supply By Region



Source: BP Energy Outlook 2030, January 2013, slide 46.

~37 Bcf/d of Proposed U.S. LNG Export Capacity

Proposed U.S. LNG Export Terminals (As of May, 2013)

Project		Capacity (Bcf/d)	Status FTA	Status non-FTA	Announced Online Date
[1]		[2]	[3]	[4]	[5]
Lower 48:					
Sabine Pass Liquefaction, LLC	[a]	2.2	Approved	Approved	2016/2018
Sabine Pass Liquefaction, LLC	[b]	0.5	Pending Approval	Under DOE Review	
Freeport LNG Expansion, L.P. and FLNG Liquefaction, LLC	[c]	2.8	Approved	Approved	2018
Lake Charles Exports, LLC	[d]	2.0	Approved	Under DOE Review	2016
Carib Energy (USA) LLC	[e]	0.0	Approved	Under DOE Review	
Dominion Cove Point LNG, LP	[f]	1.0	Approved	Under DOE Review	2017
Jordan Cove Energy Project, L.P.	[g]	2.0	Approved	Under DOE Review	2017
Cameron LNG, LLC	[h]	1.7	Approved	Under DOE Review	2016/2017
Gulf Coast LNG Export, LLC	[i]	2.8	Approved	Under DOE Review	
Gulf LNG Liquefaction Company, LLC	[j]	1.5	Approved	Under DOE Review	
LNG Development Company, LLC (d/b/a Oregon LNG)	[k]	1.3	Approved	Under DOE Review	2020
SB Power Solutions Inc	[l]	0.1	Approved	n/a	
Southern LNG Company, L.L.C.	[m]	0.5	Approved	Under DOE Review	
Excelerate Liquefaction Solutions I, LLC	[n]	1.4	Approved	Under DOE Review	2017
Golden Pass Products LLC	[o]	2.6	Approved	Under DOE Review	
Cheniere Marketing, LLC	[p]	2.1	Approved	Under DOE Review	2017
Main Pass Energy Hub, LLC	[q]	3.2	Approved	n/a	2017
CE FLNG	[r]	1.1	Approved	Under DOE Review	2017
Waller LNG Services, LLC	[s]	0.2	Approved	n/a	
Pangea LNG (North America) Holdings, LLC	[t]	1.1	Approved	Under DOE Review	2017
Magnolia LNG, LLC	[u]	0.5	Approved	n/a	
Gasfin Development USA, LLC	[v]	0.2	Approved	n/a	
Freeport-McMoRan Energy LLC	[w]	3.2	Approved	Under DOE Review	
Venture Global LNG, LLC	[x]	0.7	Pending Approval	Under DOE Review	
Subtotal (Lower 48)	[y]	**34.6**			
Alaska	[z]	2.5			2021/2024
Total United States	[aa]	**37.1**			

Sources/Notes:

[a] - [y]: http://www.doe.gov/sites/prod/files/2013/06/f1/summary_lng_applications.pdf (accessed June 17, 2013)

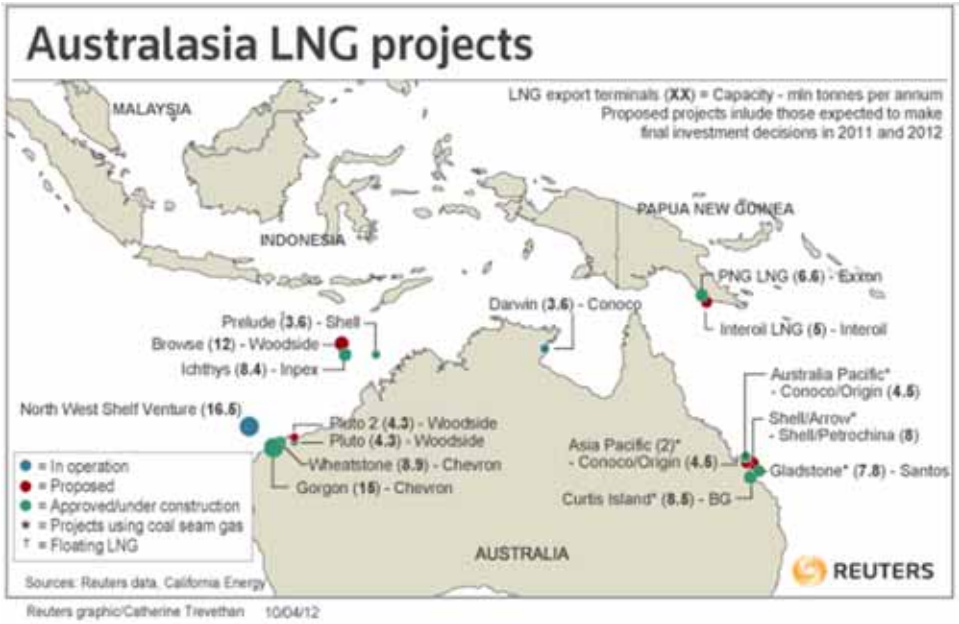
[z]: Alaska Gas Port Authority Application to Export LNG (Docket No. 12-75-LNG) filed on July 12, 2012 before the Dept. of Energy.
The application was dismissed on March 7, 2013 without prejudice to re-filing at a future time if the deficiencies are corrected. Namely, DOE noted that the application was deficient in demonstrating the availability of a pipeline, source of supply, and location of the LNG facilities.

~7 Bcf/d to 14 Bcf/d of LNG Export Terminals Proposed in British Columbia, Canada

LNG Export Projects Proposed in British Columbia						
Project		Ownership	Start Year	LNG Capacity (mmtpa)	LNG Capacity (Bcf/d)	Status/Notes
[1]		[2]	[3]	[4]	[5]	[6]
LNG Canada	[a]	Shell / KOGAS / Mitsubishi / PetroChina	2019	12.0 - 24.0	1.6 - 3.1	25 year export license approved
Pacific Northwest LNG	[b]	PETRONAS / JAPEX	2018	12.0 - 18.0	1.6 - 2.3	NEB application pending
Kitimat LNG	[c]	Chevron / Apache	2017	5.0 - 10.0	0.6 - 1.3	20 year export license approved
Prince Rupert LNG	[d]	BG Group	2020	14.0 - 21.6	1.8 - 2.8	NEB application pending
Douglas Channel LNG	[e]	LNG Partners / Haisla Nation	2015	0.9 - 1.8	0.1 - 0.2	20-year export license approved (for 1.8 mmtpa)
WCC LNG	[f]	Exxon Mobil Canada / Imperial Oil Resources	2021	10.0 - 30.0	1.3 - 3.9	NEB application pending

Sources & Notes:
Company websites, press releases, public documents.

Australia Ahead of the Pack with ~8 Bcf/d Under Construction



Australian LNG Projects

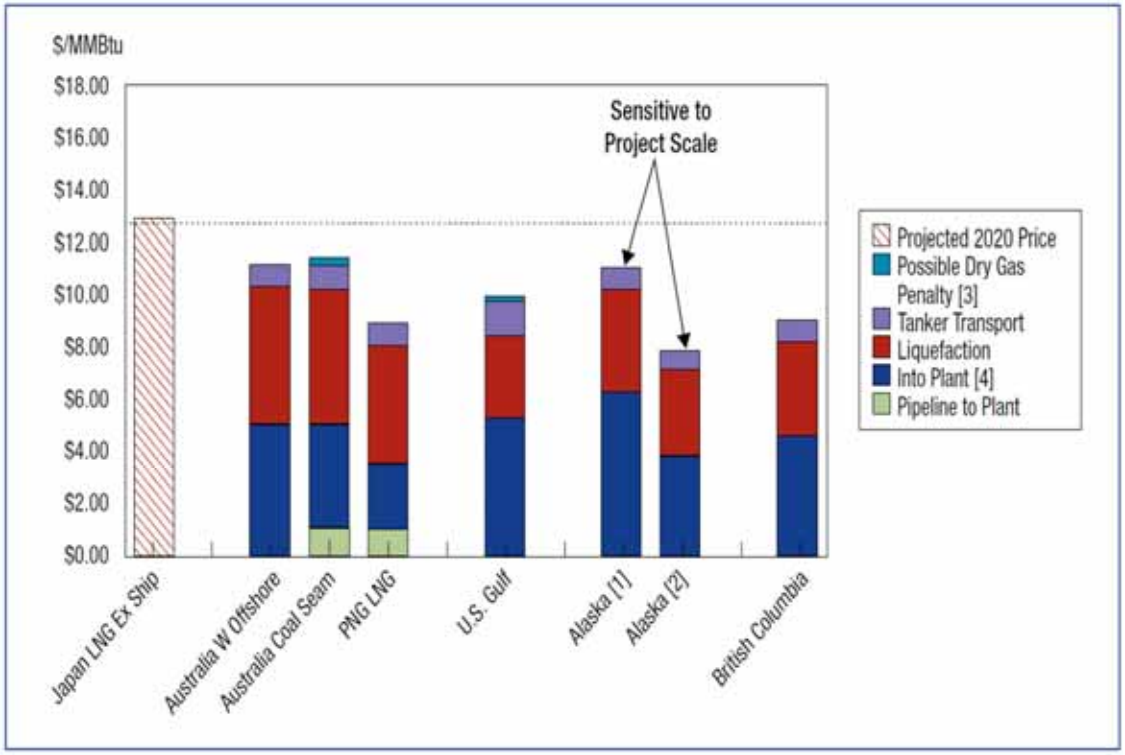
Project		Status	Owner	Capacity (Bcf/day)	Cost	Online
[1]		[2]	[3]	[4]	[5]	[6]
North West Shelf Venture	[a]	Operational		2.20		1989
Darwin	[b]	Operational	Conoco	0.48		Early 2006
Pluto	[c]	Operational	Woodside	0.57	$15 Billion	2013
Subtotal	[d]			**3.26**		
Gorgon	[e]	Approved/Under Construction	Chevron	2.00	$57 Billion	2014
Wheatstone	[f]	Approved/Under Construction	Chevron	1.19	$35 Billion	2016
Curtis Island	[g]	Approved/Under Construction	BG	1.13	$34 Billion	2014
Ichthys	[h]	Approved/Under Construction	Inpex	1.12	$43 Billion	Q4 2016
Gladstone	[i]	Approved/Under Construction	Santos	1.04	$30 Billion	2015
PNG LNG	[j]	Approved/Under Construction	Exxon	0.88		2014
Australia Pacific	[k]	Approved/Under Construction	Conoco/Origin	0.60	$37 Billion	2015
Prelude	[l]	Approved/Under Construction	Shell	0.48		
Subtotal	[m]			**8.45**		
Browse	[n]	Proposed	Woodside	1.60		
Shell/Arrow	[o]	Proposed	Shell/Petrochina	1.07		
Interoil LNG	[p]	Proposed	Interoil	0.67		2015
Asia Pacific	[q]	Proposed	Conoco/Origin	0.60		
Pluto 2	[r]	Proposed	Woodside	0.57		
Subtotal	[s]			**4.51**		
Grand Total	[t]			**16.21**		

Sources:
Reuters, CNN Money, Bloomberg.

- Australian LNG projects facing substantial cost overruns and competitive pressures
- Korea Gas has reportedly walked away from a non-binding agreement to purchase 1.5 mmtpa (~200 MMcf/d) from Gorgon LNG
- Only 65% of Chevron's share of Gorgon LNG is committed under long-term contracts

Competition to serve LNG demand

Competition to Serve Asian LNG Markets



Note: Gulf exports to Asia assume tankers travel through an expanded Panama Canal
[1]: Assumes 1 bcf/day from Valdez, Alaska
[2]: Assumes 3.1 bcf/day from Valdez, Alaska
[3]: Dry gas penalty is assumed at 2 percent
[4]: For Alaska and British Columbia, "Into Plant" refers to the opportunity cost relative to projections of Henry Hub price
Source: From a client presentation by James Jensen, Jensen Associates

Source: "Liquid Markets: Assessing the Case for U.S. Exports of Liquefied Natural Gas," Brookings Energy Security Initiative, May 2012

- Competition between Lower 48, British Columbia, Alaska and Australia
- Infrastructure challenges for Alaska and BC relative to Gulf Coast (government policies may come into play)
- Brookings & Wood Mackenzie: Alaskan LNG competitive with other LNG suppliers
- But, significant uncertainty in project costs and timing
  - Wood Mackenzie 2011 estimate ~$45 - $50 Billion project costs (21 million ton capacity) or $8.50/MMBtu
  - But, updated costs ~$45 - $65+ Billion (15-18 million ton capacity)
  - Hence, delivered price might be higher than $8.50/MMBtu due to updated project cost and scope

The Future(s) – 2013-2020 and post-2020?

These two time periods present very different possible futures, as significant new liquefaction capacity will come on line in the first period, at the same time as unconventional (shale) gas technology may spread worldwide in time for the second period (if not before)

What makes the evaluation of these markets (and consequently LNG and infrastructure projects) very difficult is that these two future periods could look very different, and the payoffs and probabilities are very hard to assess. But the long capital recovery period for these projects necessitates that we do so.

LNG and associated infrastructure projects some of the riskiest investments in the world today

- Pre-2020 projects with contracts – the risks involve project cost pressures and pressure on contract pricing arrangements
- Post-2020 projects face significant development, market and competitive risks (significant supply/demand balance uncertainties, LNG imports vs. indigenous production vs. pipeline imports, demand growth uncertainty in China and India)

US LNG Export Policy

DOE's approval of Freeport LNG for export to non–FTA countries addressed some of the questions regarding U.S. LNG exports. DOE found:

- Opponents of Freeport failed to demonstrate that approval would be inconsistent with the public interest
- Freeport LNG exports will yield net economic benefits, are unlikely to adversely affect the availability of domestic gas supplies or result in gas price increases that would negate benefits
- Relied on two commissioned studies by EIA and NERA

DOE to assess cumulative impacts of each succeeding request for export authorization on the public interest and monitor developments that could undermine the public interest

Key areas of debate

- Quantifying the benefits of free trade, sectoral impacts
- Magnitude of domestic price impacts (shape of U.S. gas supply curves)
- Amount of U.S. LNG exports that can be absorbed by world markets (demand and competition)
- Impact of exports on global prices and particularly on oil-linked LNG markets in Asia (will oil-linked prices come under pressure?)
- Can U.S gas resource base serve both LNG exports and energy intensive industries in U.S.?
- How significant will the effects of increased LNG exports and higher domestic prices be on energy intensive industries?

Prospects for global price convergence?

Prospective competition for buyers in post-2020 projects creates some price convergence pressures even now

- Asian buyers now looking for gas price linkage in contracts
  - Possibly Henry Hub-linked, or other Asian market index
  - "Linkage", of course, does not necessarily mean parity
- Price convergence pressures seen recently in Europe as LNG supplies have pressured oil-linked supply contracts

But some North American project developers want (and may require) continuation of oil-linked contracts

- Even Gulf Coast projects might require premium to Henry Hub
- Link to Henry Hub creates price volatility risk

Pricing uncertainty is creating project uncertainty since contractual support is key to project success

Summary of Uncertainties Facing LNG Export Projects

Demand Uncertainty

- Need for LNG post-2020 is very uncertain (*e.g.*, China's needs will depend upon its natural gas demand growth as well as growth in its indigenous production)

Competition Uncertainty

- Competition between Australia, British Columbia, Gulf Coast, Alaska and other LNG projects
- Competition from indigenous production and pipeline import options

Pricing/ Project Economics Uncertainty

- Oil-linked or gas-linked
- Panama Canal toll uncertainty
- Project cost uncertainty (*e.g.*, Australian cost overruns)

Upstream Infrastructure Development Uncertainty

- Infrastructure challenges seen for British Columbia and Alaskan LNG exports since contingent upon large pipeline build-out
- Possible siting advantage in U.S. Gulf Coast due to existing infrastructure

Level of Government Support

- Large "stranded gas" advantage in British Columbia and Alaska, but pipeline infrastructure disadvantage
- Uncertainty in U.S. export permit process

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- Climate Change Policy and Planning
- Cost of Capital
- Energy Asset Valuation
- Fuel and Power Procurement
- Regulatory Strategy and Litigation Support
- Renewables
- Risk Management
- Market Design and Competitive Analysis

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