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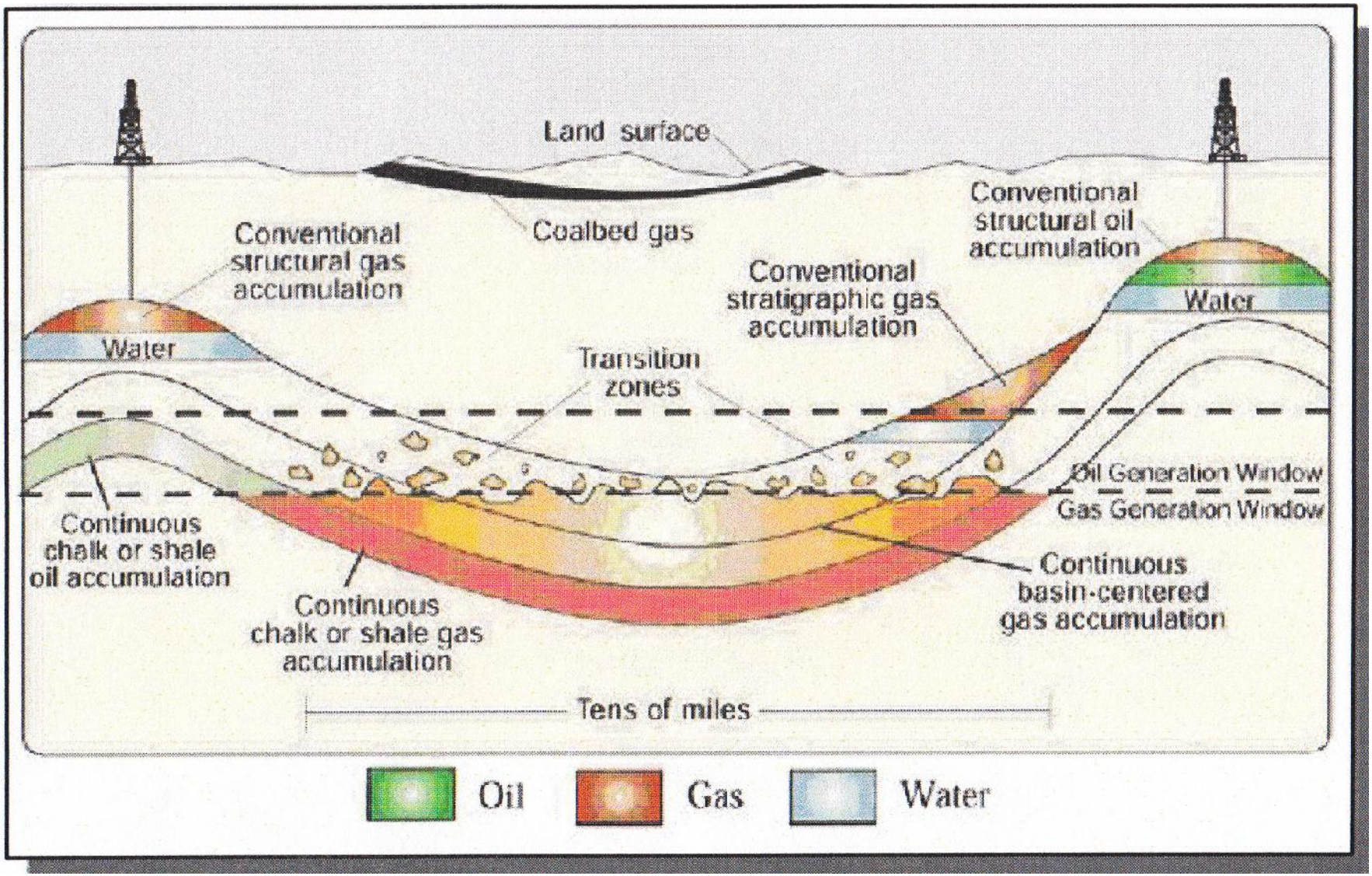
SHALE GAS: COMING SOON TO A COAL MARKET NEAR YOU?

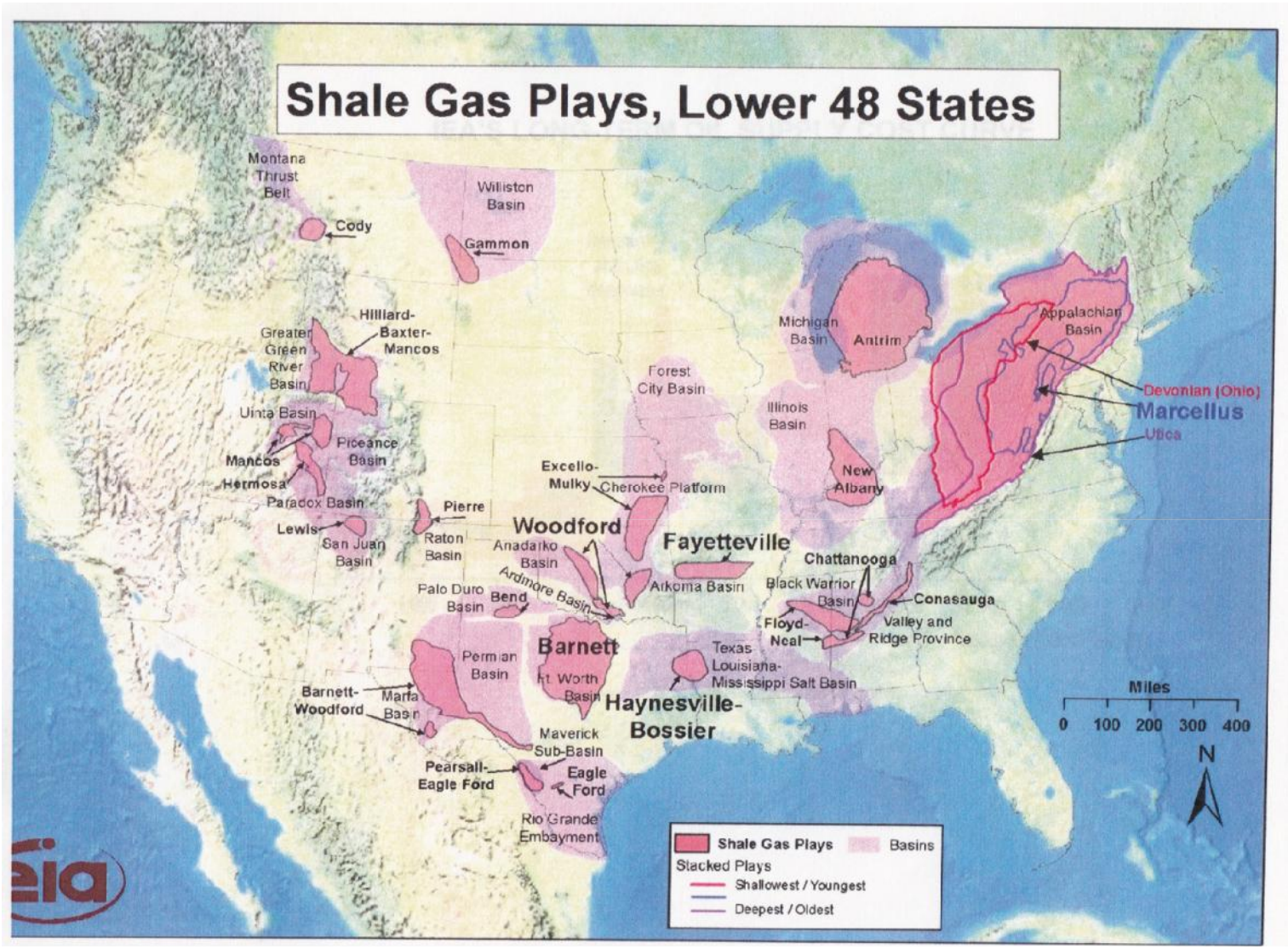
Presentation at:
ICCC Forum
Bangkok, Thailand
November 12, 2012

By: Dr. Manfred G. Raschke
President, ISIS

SAMPLE CONVENTIONAL/UNCONVENTIONAL OIL AND GAS GEOLOGIC SCHEMATIC

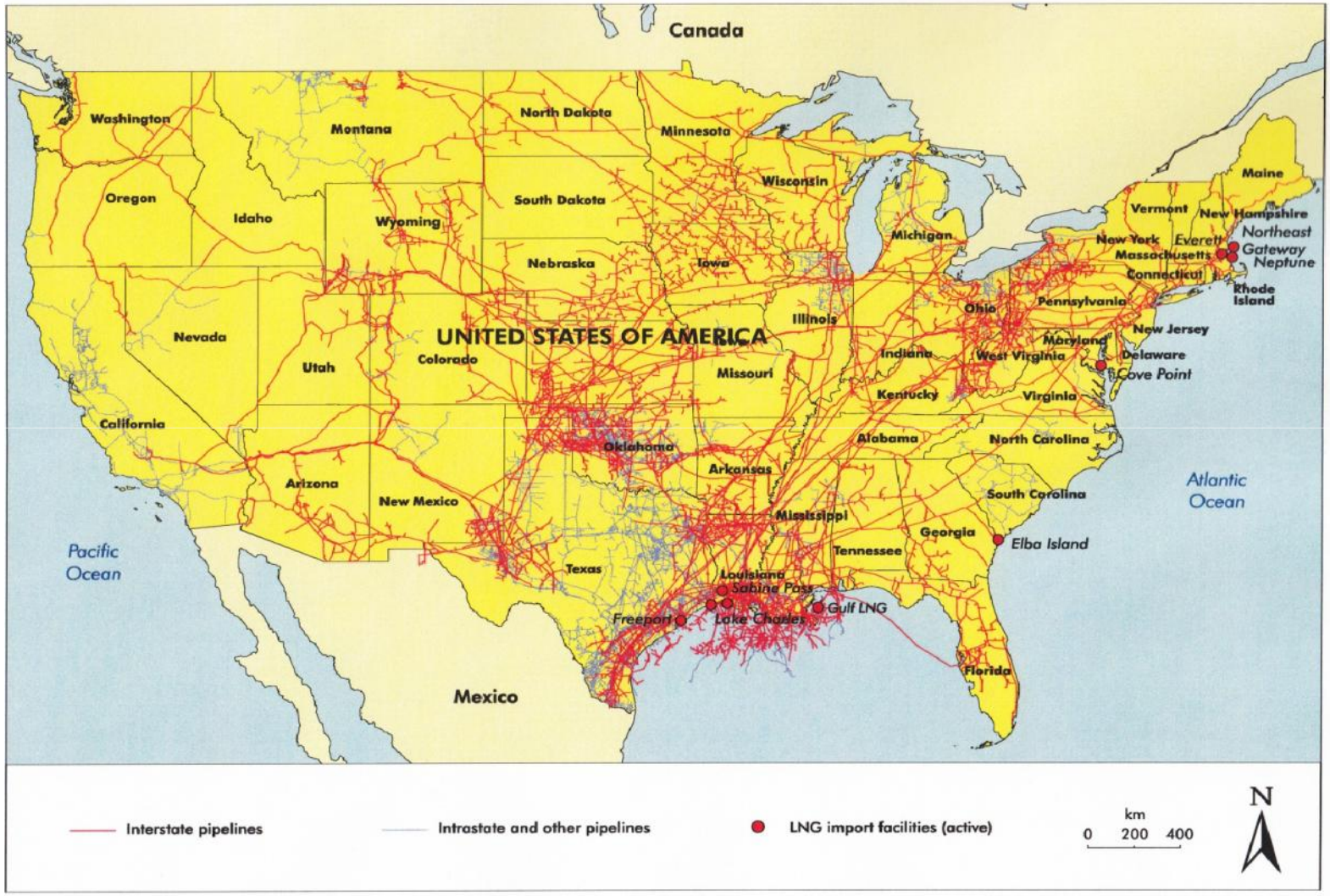


Source: Parks Paton Hoepfl & Brown


Shale Gas Plays, Lower 48 States
Montana Thrust Belt
Williston Basin
Cody
Gammon
Hilliard-Baxter-Mancos
Greater Green River Basin
Uinta Basin
Piceance Basin
Mancos
Hermosa
Paradox Basin
Lewis
San Juan Basin
Pierre
Raton Basin
Forest City Basin
Michigan Basin
Antrim
Appalachian Basin
Devonian (Ohio)
Marcellus
Utica
Illinois Basin
New Albany
Excello-Mulky
Cherokee Platform
Woodford
Anadarko Basin
Ardmore Basin
Arkoma Basin
Fayetteville
Chattanooga
Black Warrior Basin
Conasauga
Floyd-Neal
Valley and Ridge Province
Palo Duro Basin
Bend
Barnett
Permian Basin
Ft Worth Basin
Texas Louisiana-Mississippi Salt Basin
Haynesville-Bossier
Barnett-Woodford
Marfa Basin
Maverick Sub-Basin
Pearsall-Eagle Ford
Eagle Ford
Rio Grande Embayment
Miles
0 100 200 300 400
N
Shale Gas Plays
Basins
Stacked Plays
Shallowest / Youngest
Deepest / Oldest
eia

Source: EIA

UNITED STATES NATURAL GAS PIPELINES



Source: IEA 2012

SHALE GAS UNEXPECTEDLY QUICKLY CHANGED THE LONG-TERM ENERGY PICTURE

- **In 2003, Alan Greenspan, then chairman of the Federal Reserve, testified to Congress that North America was facing a potential shortage of Natural Gas. (June 10, 2003)**

- **Over 40 New LNG import terminals were announced for the U.S. and border locations in Canada and Mexico.**
  - **Nine new terminals were built bringing the current total to 13 (plus one more each in Canada and Mexico).**

- **Even as Greenspan spoke, the gas production industry (almost all mid-size to small companies) was making the breakthroughs in combining directional drilling with hydraulic fracturing.**

THE SHALE GAS HYPE IS EVERYWHERE

- **At Davos in January 2010 Tony Hayward, then still CEO of BP, described the impact of shale gas: "Unconventional gas will transform the entire energy production landscape in the United States… and alters the U.S. energy outlook for probably a hundred years."**

- **Dan Yergin, IHS/CERA chairman, wrote in the *Wall Street Journal* that "a shale gale" which only became evident in 2007 "is already changing the national energy dialogue and overall energy outlook in the U.S. – and could change the global natural gas balance" (November 3, 2009).**

- **By 2012 the International Energy Agency hailed a "New Golden age of Gas".**

THE US POTENTIAL GAS COMMITTEE'S NATURAL GAS RESOURCE ASSESSMENT AS OF DECEMBER 31, 2008

Resources Category	2008	2006
	(mean values, tcf)	
Traditional Gas Resources		
Probable resources (current fields)	441.4	270.1
Possible Resources (new fields)	736.9	426.4
Specular resources (frontier)	500.7	460.7
Subtotal traditional resources	1,673.4	1,154.8
Coalbed Natural Gas		
Probable resources	14.2	15.5
Possible resources	49.8	50.5
Speculative resources	98.9	98.9
Subtotal coalbed gas resources	163.0	166.1
Total Potential Resources	**1,836.4**	**1,320.9**
Proved reserves (DOE,EIA)	237.7	211.1
US Future Supply	**2,074.1**	**1,532.0**

Source: Potential Gas Committee, June 18, 2009

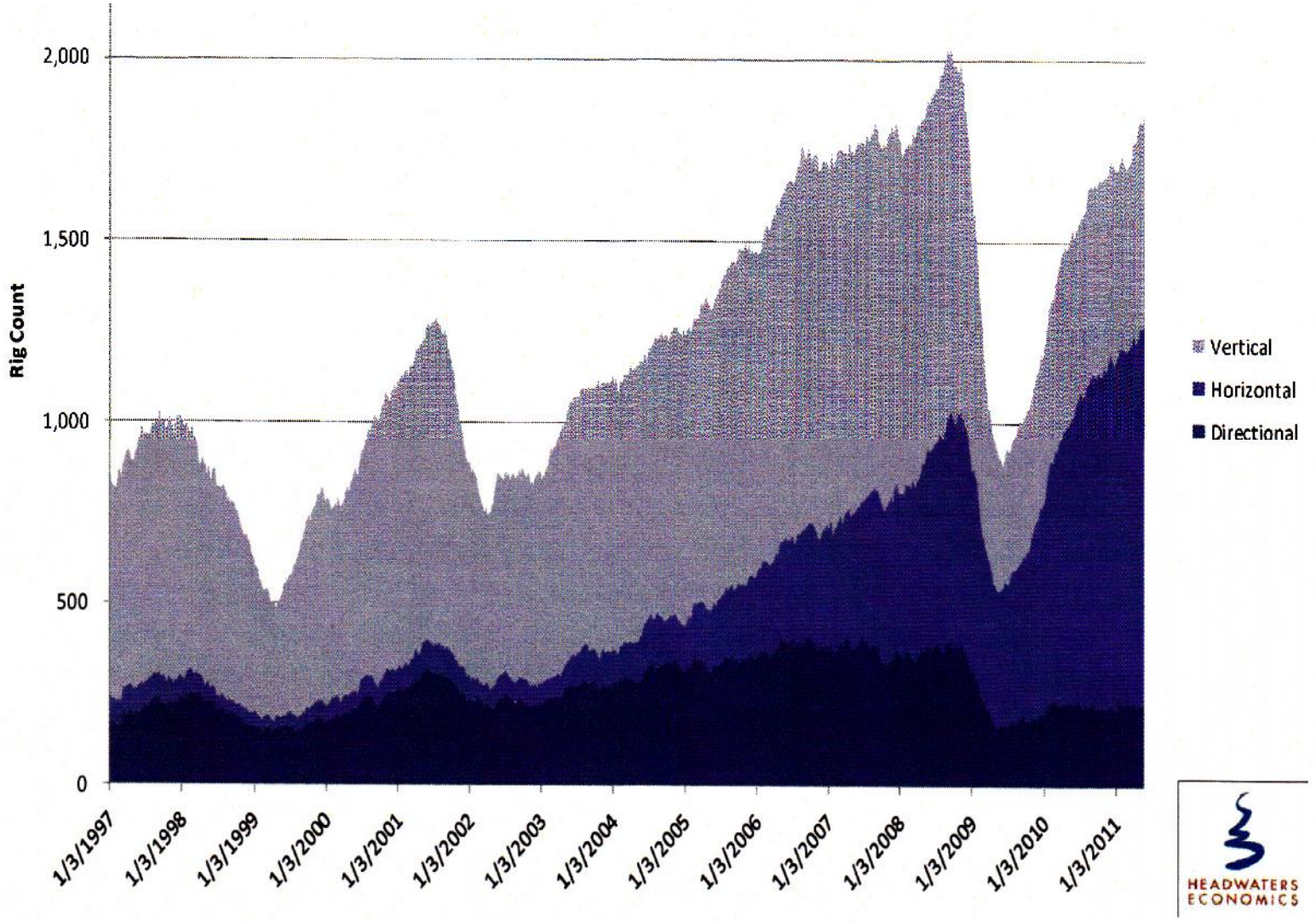
NORTH AMERICAN NATURAL GAS ESTIMATES, 1990-2011 (BILLION M³)

Cedigaz						
	End 1990	**End 2007**	**End 2008**	**End 2009**	**End 2010**	**End 2011**
Canada	2,179	1,658	1,700	1,685	1,744	1,720
Mexico	2,009	373	359	339	349	348
USA	4,650	6,730	7,468	7,712	8,368	8,490

Oil and Gas Journal						
Canada	2,762	1,647	1,639	1,753	1,753	1,726
Mexico	2,059	392	372	359	339	490
USA	4,704	5,974	6,728	6,924	6,924	7,712

Source: Cedigaz; *Oil and Gas Journal*

US RIG COUNT BY DRILLING TYPE, 1997-2011



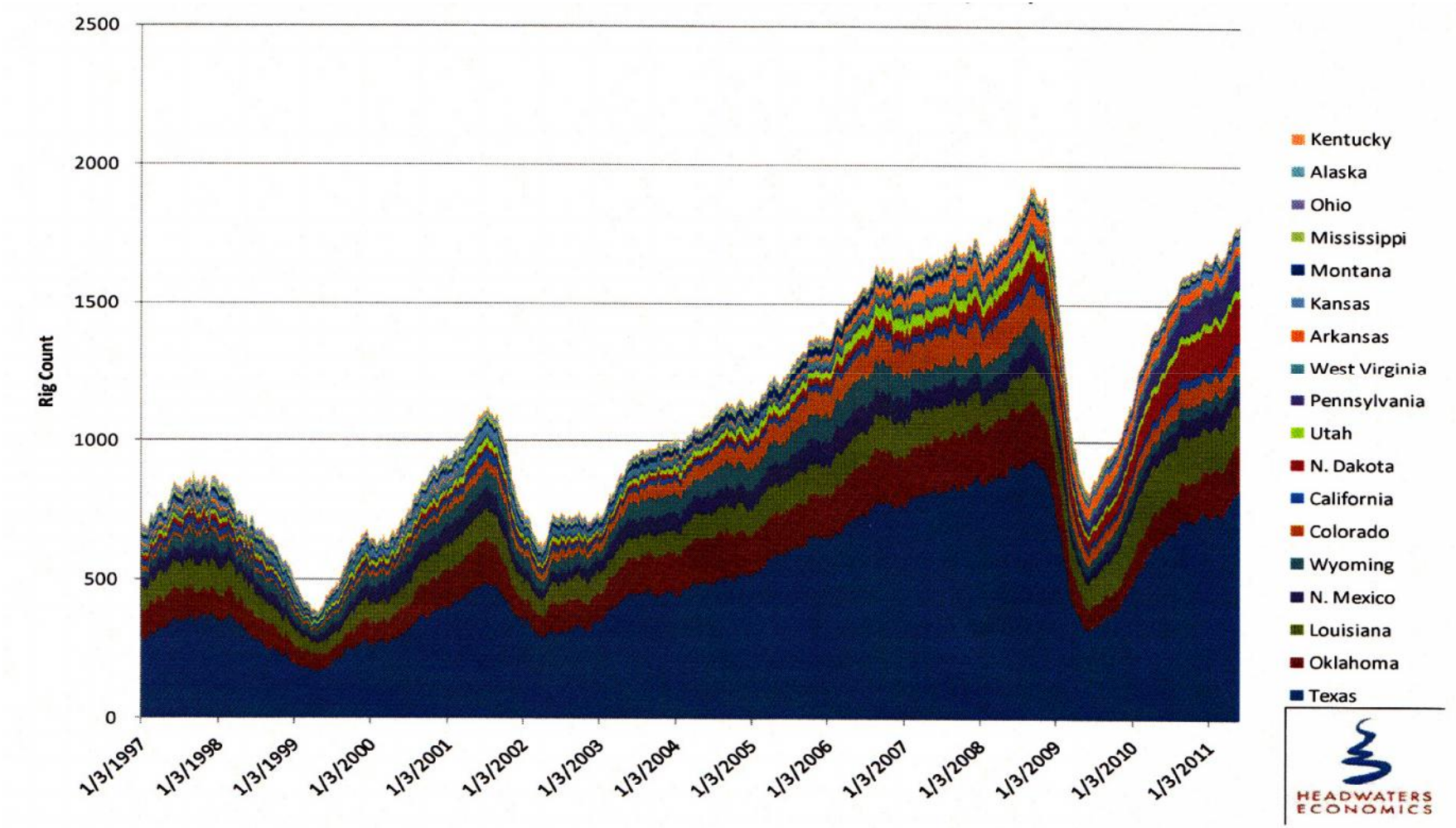
Source: Baker Hughes; Headwaters Economics

NORTH AMERICAN ROTARY RIG COUNT

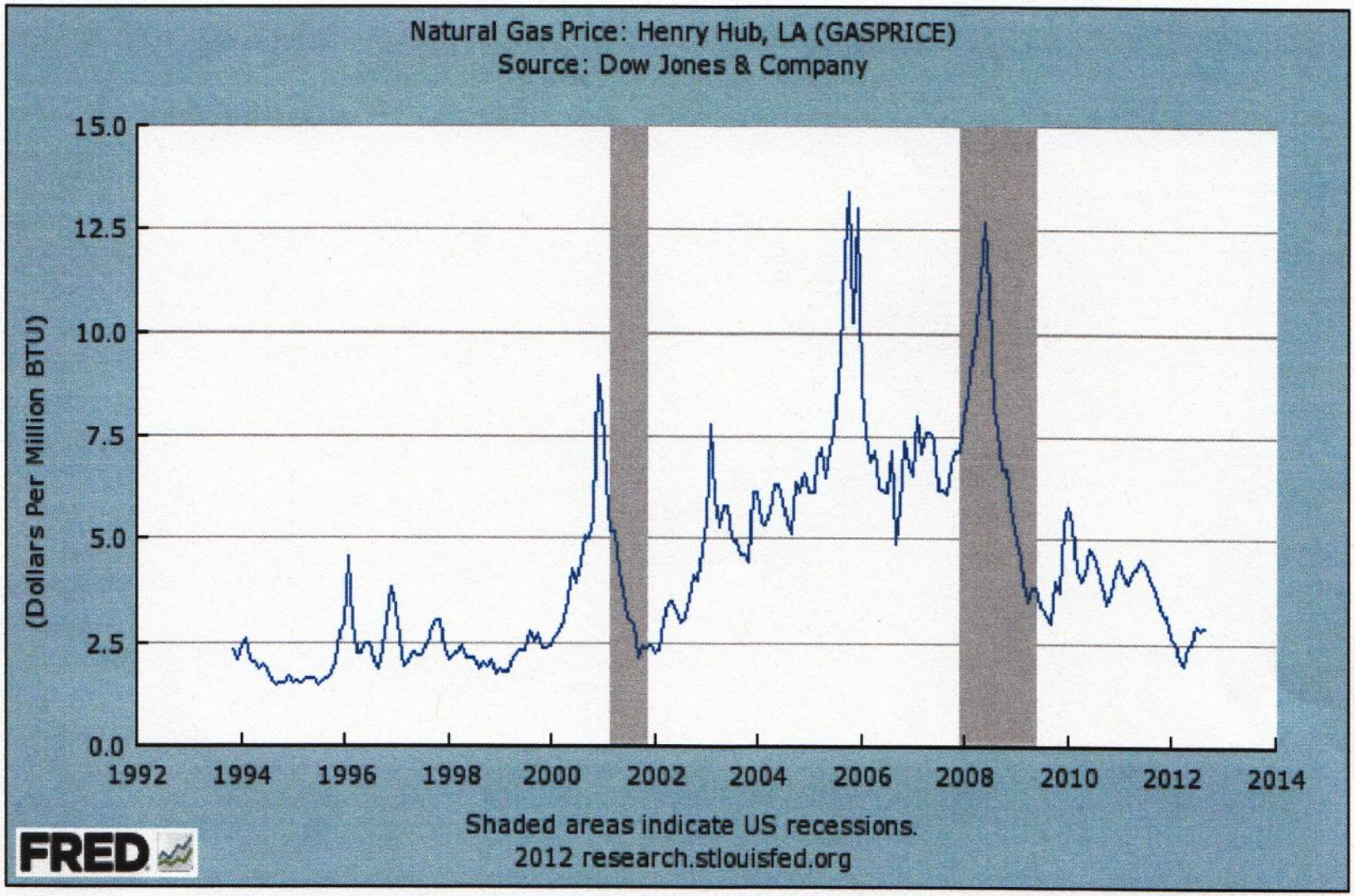
	Oct. 26, 2012	Oct. 19, 2012	Oct. 28, 2011
Total U.S.:	1,826	1,839	2,021
Offshore	52	49	35
Land	1,774	1,790	1,986
Inland Waters	15	16	18
Oil	1,408	1,410	1,078
Percent	*77.1%*	*76.7%*	*53.3%*
Gas	416	427	934
Percent	*22.8%*	*23.2%*	*46.2%*
Total Canada:	370	355	497
Oil	281	268	332
Percent	*75.9%*	*75.5%*	*66.8%*
Gas	88	86	165
Percent	*23.8%*	*24.2%*	*33.2%*
Total North America:	2,196	2,194	2,518

Source: www.wtrg.com

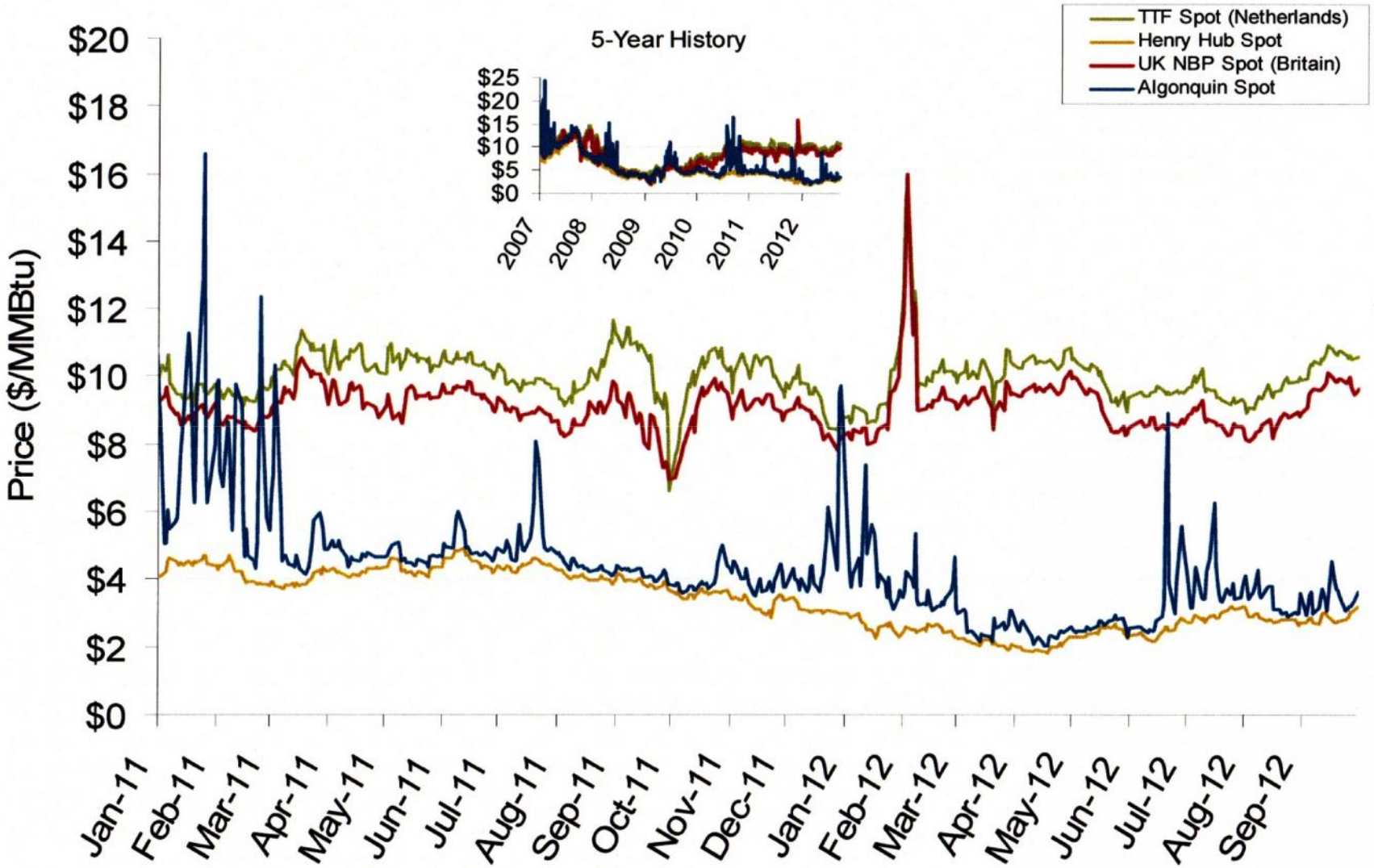
U.S. LAND RIG COUNT FOR MAJOR OIL AND GAS PRODUCING STATES, 1997-2011



Source: Baker Hughes; Head Waters Economics

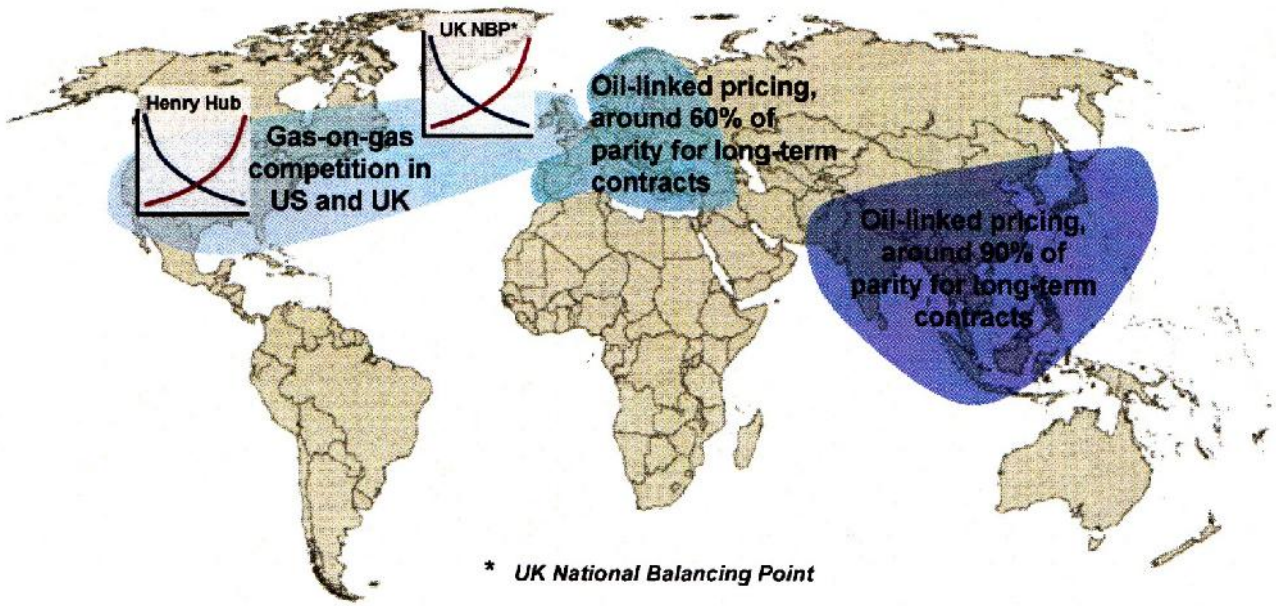

Natural Gas Price: Henry Hub, LA (GASPRICE)
Source: Dow Jones & Company
(Dollars Per Million BTU)
15.0
12.5
10.0
7.5
5.0
2.5
0.0
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
Shaded areas indicate US recessions.
2012 research.stlouisfed.org
FRED

Atlantic Basin European and US Spot Natural Gas Prices



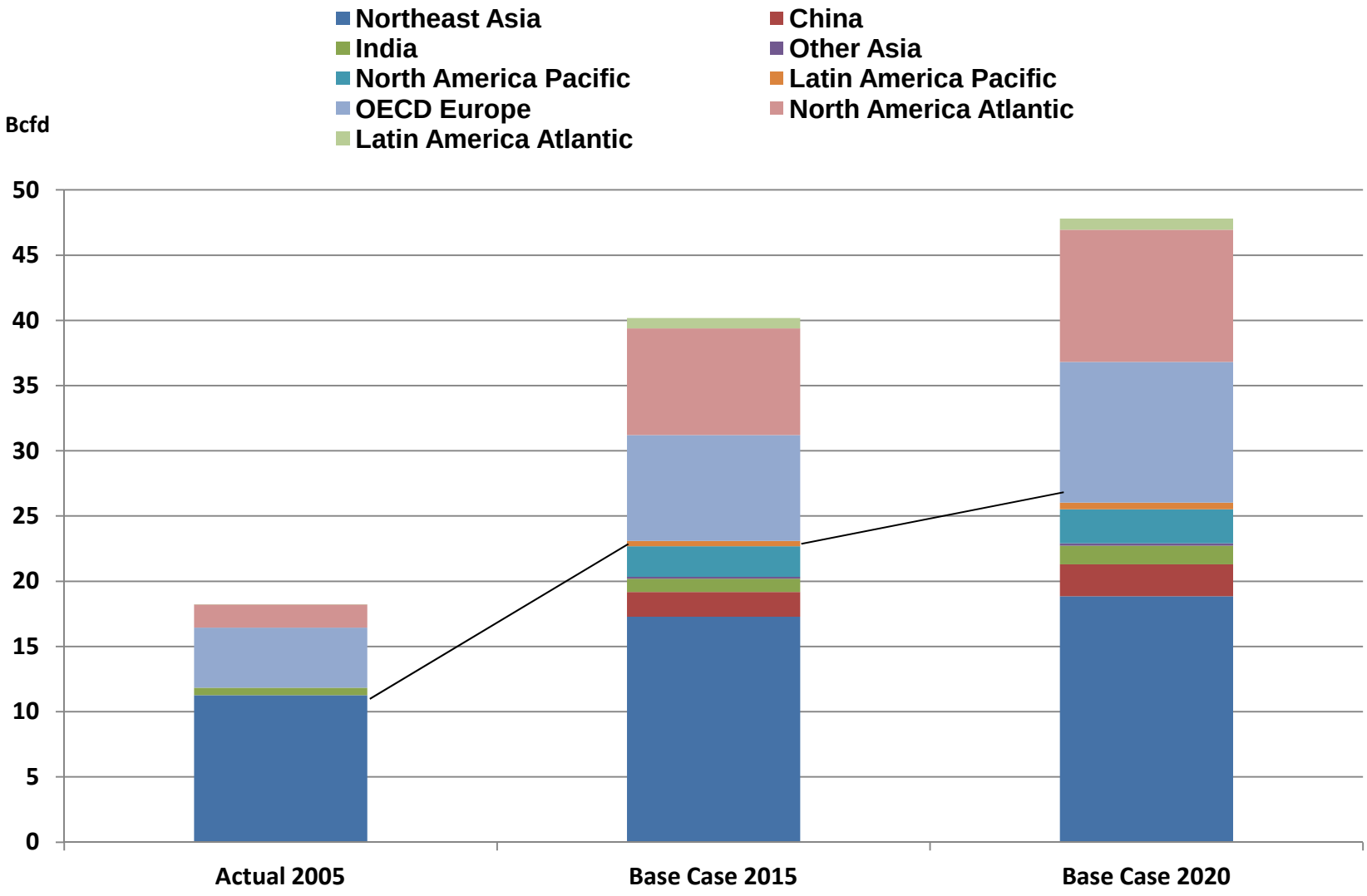
Source: Bloomberg; ICE; current to October 5, 2012

GENERAL OUTLINE OF LNG PRICING REGIMES



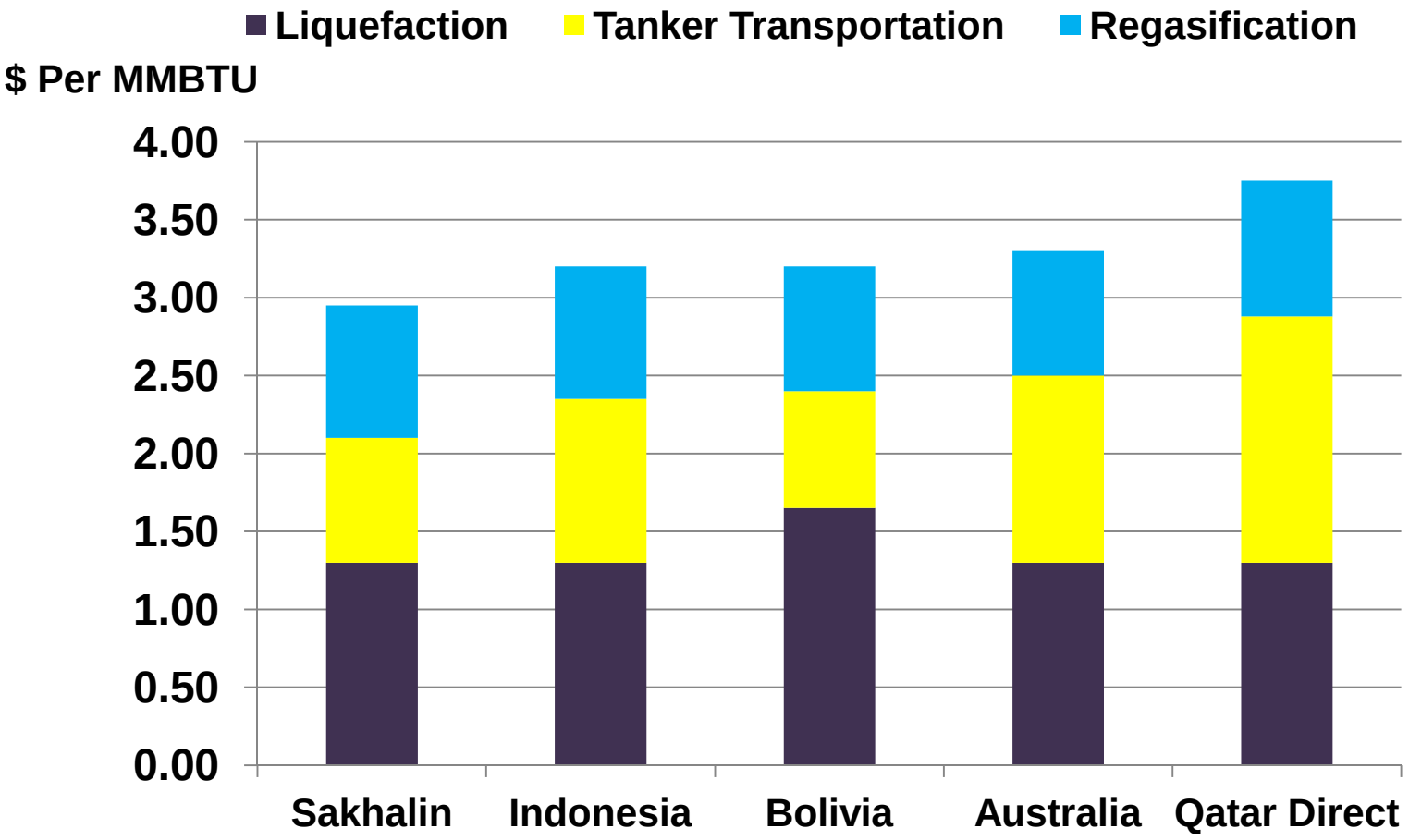
Source: Poten & Partners, *2015-2035 LNG Market Assessment, Outlook for the Kitimat LNG Terminal*

SUMMARY OF 2007 BASE CASE DEMAND ESTIMATES



Source: Jensen Associates, for California Energy Commission, August 2007

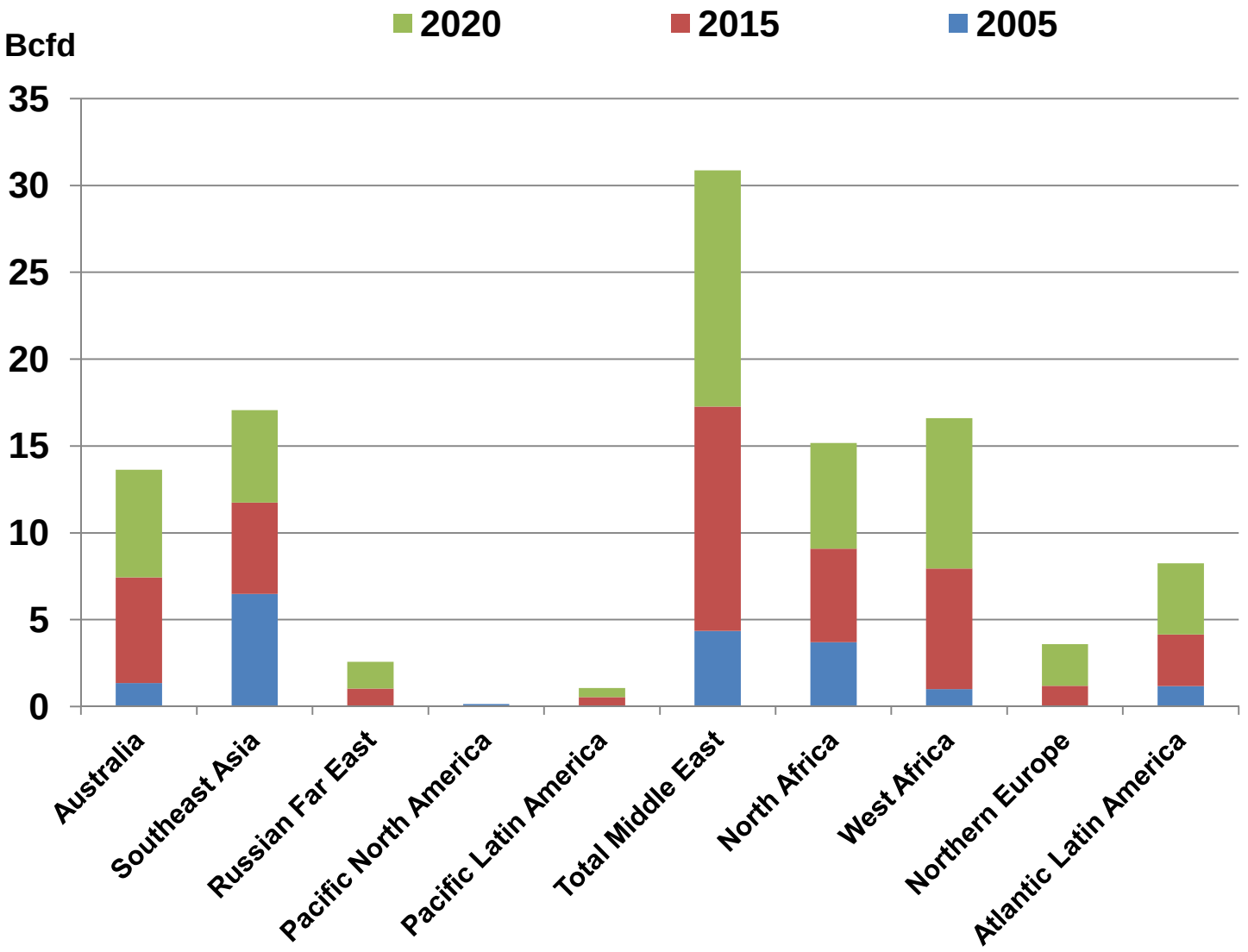
ILLUSTRATIVE COSTS OF SERVING NORTH AMERICAN PACIFIC MARKETS FROM VARIOUS SUPPLY SOURCES: ONE 4.8 MILLION TON EXPANSION TRAIN; STANDARD SIZED TANKERS



Notes:
Does Not Include Feedstock Cost;
Greenfield Plant in Bolivia;
Using Larger "Q Flex" Tankers from Qatar

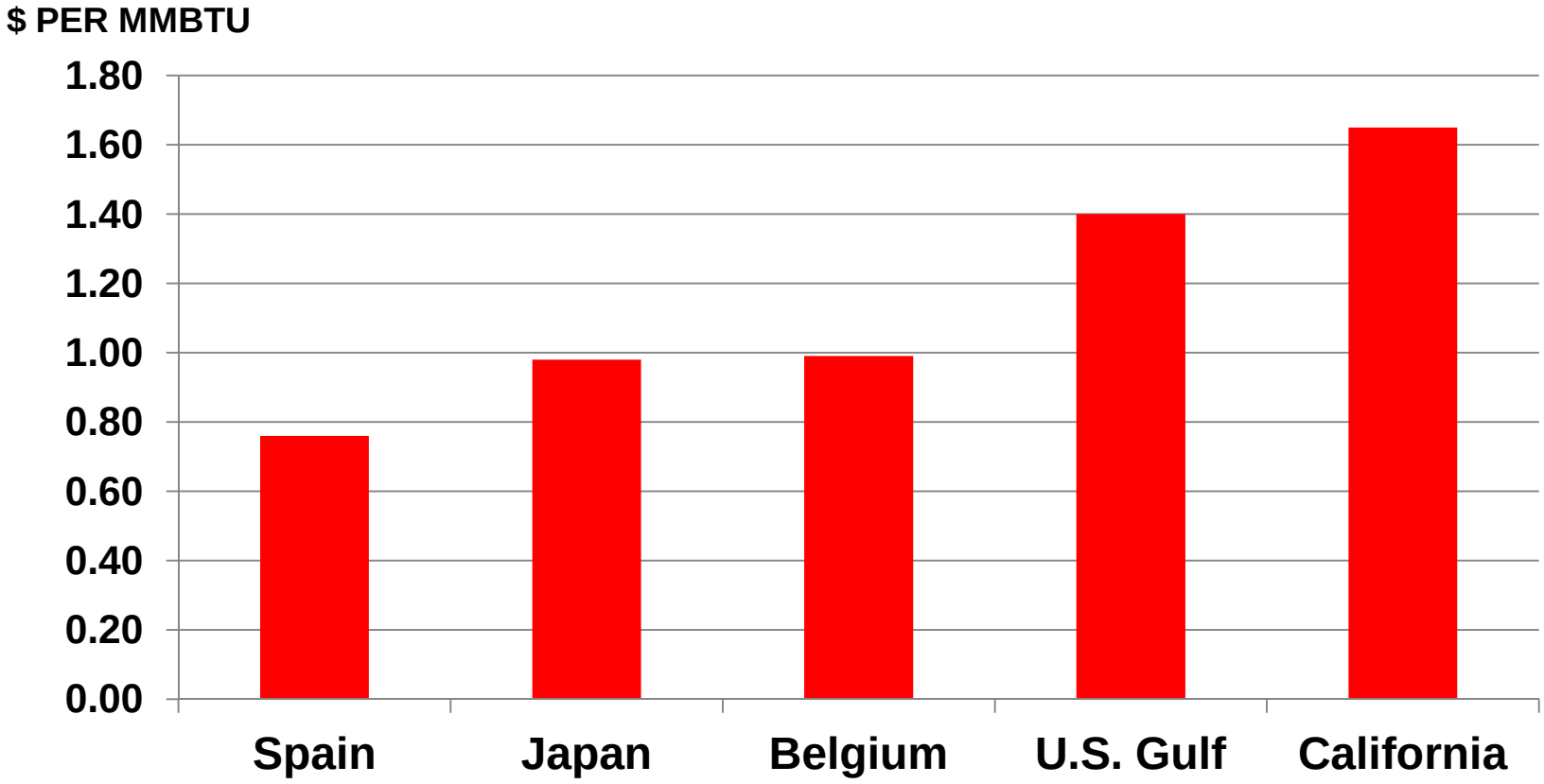
Source: Jensen Associates, for California Energy Commission, August, 2007

SUMMARY OF BASE CASE SUPPLY ESTIMATES



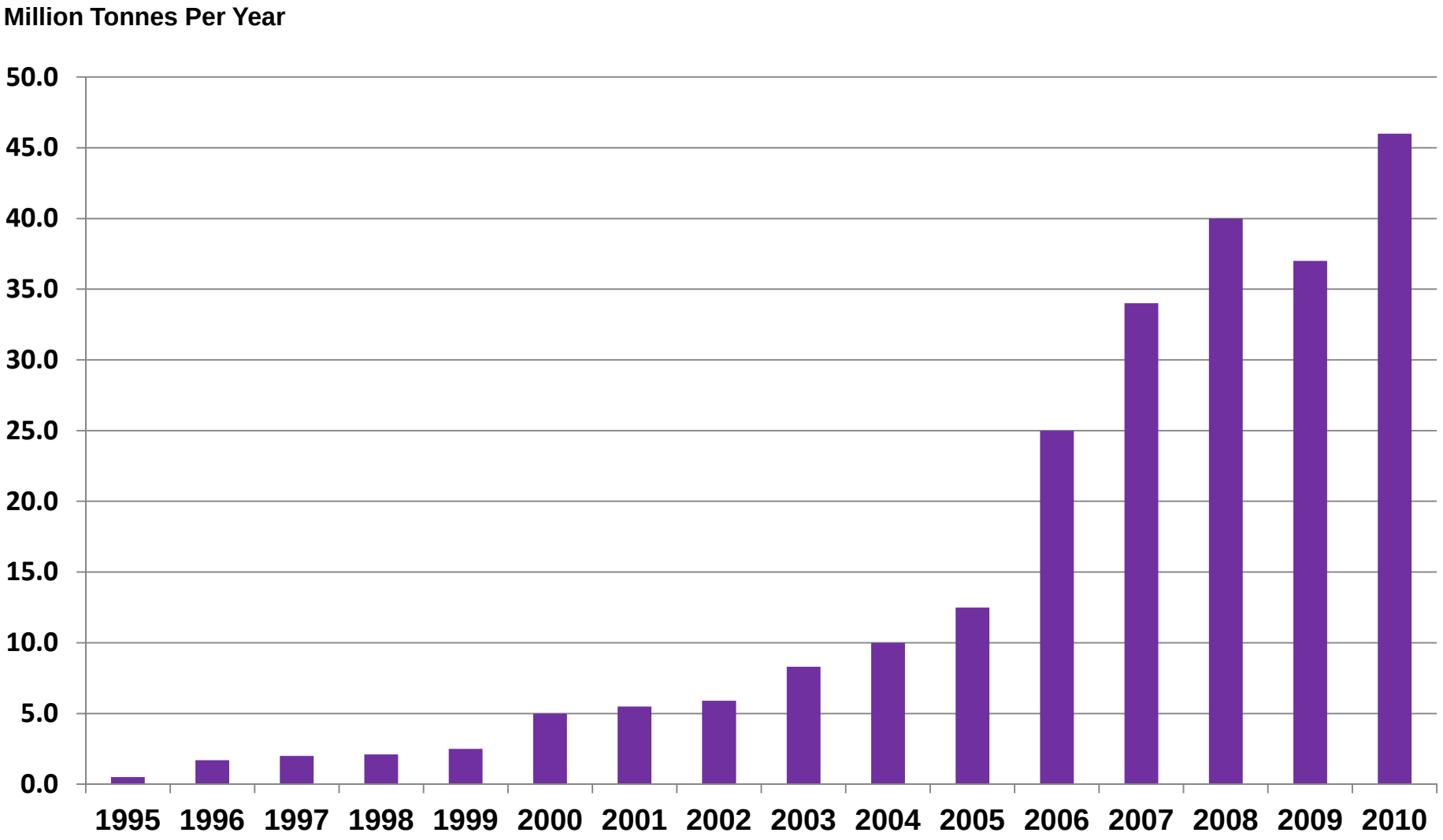
Source: Jensen Associates, for California Energy Commission, August 2007

ILLUSTRATIVE TRANSPORTATION COSTS OF SERVING SELECTED MARKETS FROM QATAR: "Q-FLEX" SIZED TANKERS



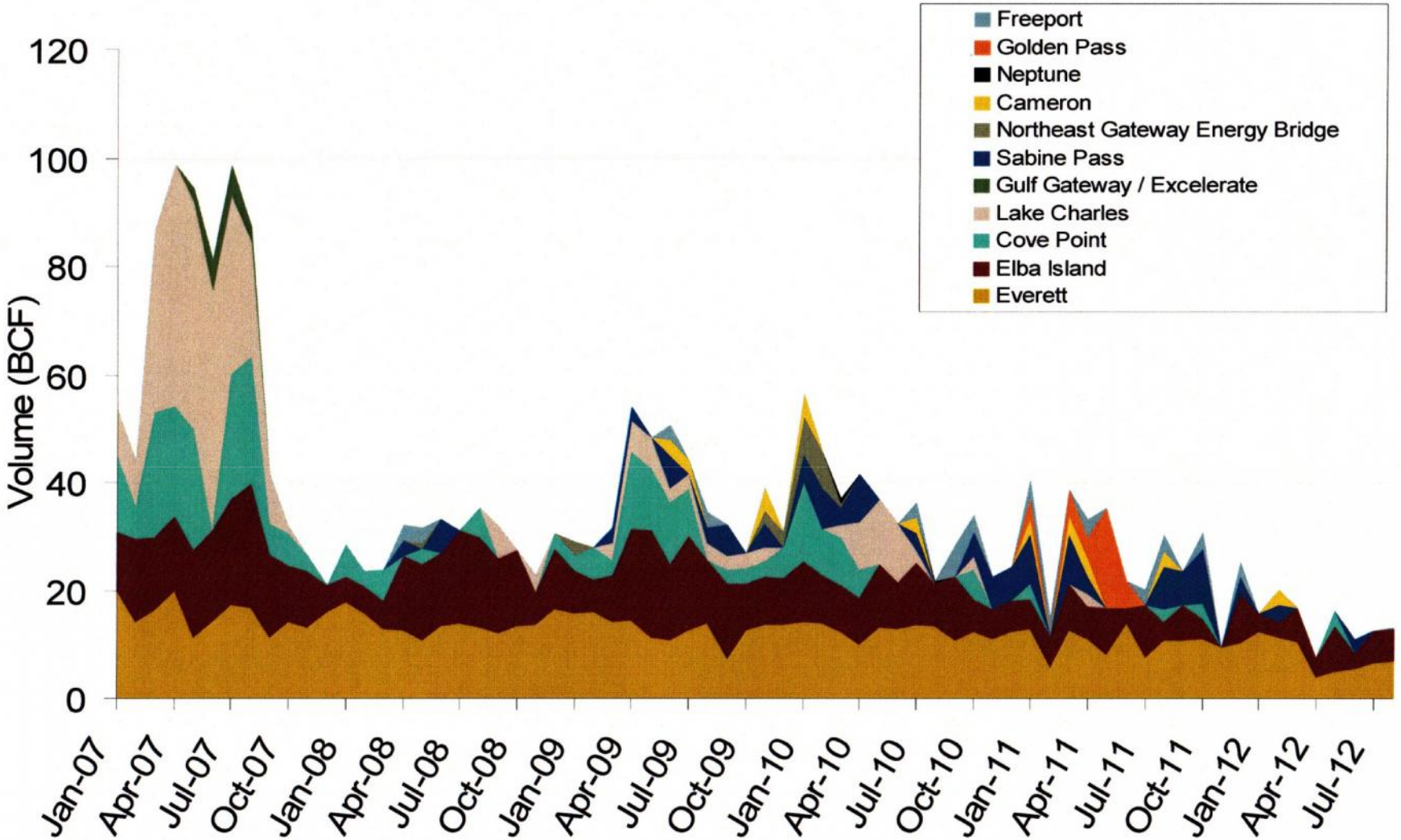
Source: Jensen Associates, for California Energy Commission, August, 2007

RISE IN THE SPOT LNG TRADE: 1995-2010



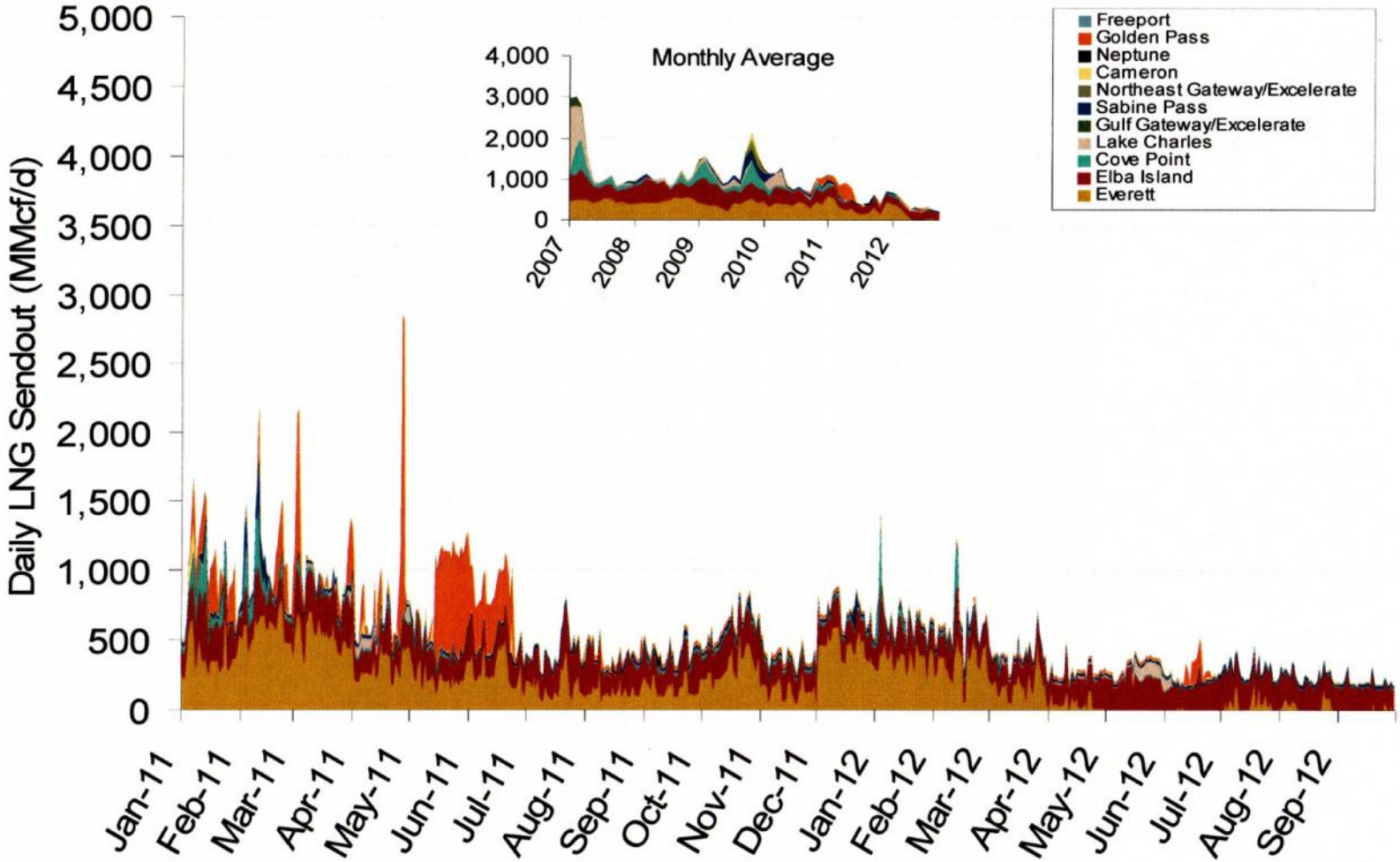
Source: Cedigaz

Monthly Gas Imports at Existing U.S. LNG Facilities



Source: Derived from *DOE Office of Fossil Energy* data
Updated: October 09, 2012

Daily Gas Sendout from Existing U.S. LNG Facilities



Notes: Everett data includes flows onto the AGT and TGP interstate lines, plus estimates of flows to the Mystic 7 power plant, Keyspan Boston Gas, and LNG trucked out of the terminal. Excludes flows to the Freeport LNG which flows via intrastate pipelines and flows to the Mystic 8 and 9 power plants.

Source: Derived from *Bentek Energy* data

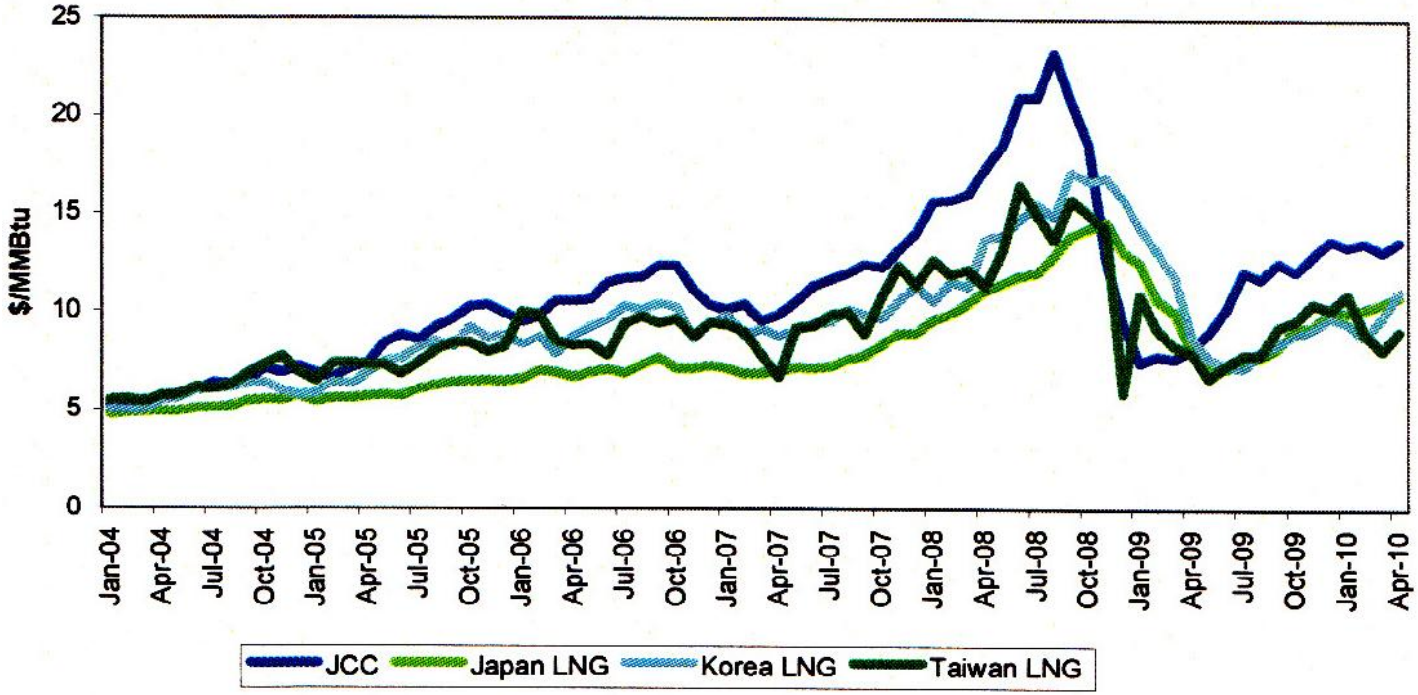
Updated: October 02, 2012

3007

World LNG Estimated November 2012 Landed Prices

Source: Waterborne Energy, Inc. Data in $US/MMBtu
Updated: October 4,2012

ASIAN LNG PRICES GENERALLY TRACK CRUDE OIL PRICES



Source: Poten & Partners, *2015-2035 LNG Market Assessment, Outlook for the Kitimat LNG Terminal*

RISKED GAS IN-PLACE AND TECHNICALLY RECOVERABLE SHALE GAS RESOURCES: SIX CONTINENTS

Continent	Risked Gas In-Place (Tcf)	Risked Technically Recoverable (Tcf)
North America	3,856	1,069
South America	4,569	1,225
Europe	2,587	624
Africa	3,962	1,042
Asia	5,661	1,404
Australia	1,381	396
Total	**22,016**	**5,760**

Source: US Energy Information Administration

ESTIMATED SHALE GAS TECHNICALLY RECOVERABLE RESOURCES FOR SELECT BASINS IN 32 COUNTRIES, COMPARED TO EXISTING REPORTED RESERVES, PRODUCTION AND CONSUMPTION DURING 2009

	2009 NATURAL GAS MARKET [a] (trillion cubic feet, dry basis		PROVED NATURAL GAS RESERVES [b] (trillion cubic feet)	TECHNICALLY RECOVERABLE SHALE GAS RESOURCES (trillion cubic feet)
	PRODUCTION	CONSUMPTION		
Europe				
France	0.03	1.73	0.2	180
Germany	0.51	3.27	6.2	8
Netherlands	2.79	1.72	49.0	17
Norway	3.65	0.16	72.0	83
U.K.	2.09	3.11	9.0	20
Denmark	0.30	0.16	2.1	23
Sweden	----	0.04		41
Poland	0.21	0.58	5.8	187
Turkey	0.03	1.24	0.2	15
Ukraine	0.72	1.56	39.0	42
Lithuania	----	0.10		4
Others [c]	0.48	0.95	2.7	19
North America				
United States [d]	20.60	22.80	272.5	862
Canada	5.63	3.01	62.0	388
Mexico	1.77	2.15	12.0	681
Asia				
China	2.93	3.08	107.0	1,275
India	1.43	1.87	37.9	63
Pakistan	1.36	1.36	29.7	51

(continued)

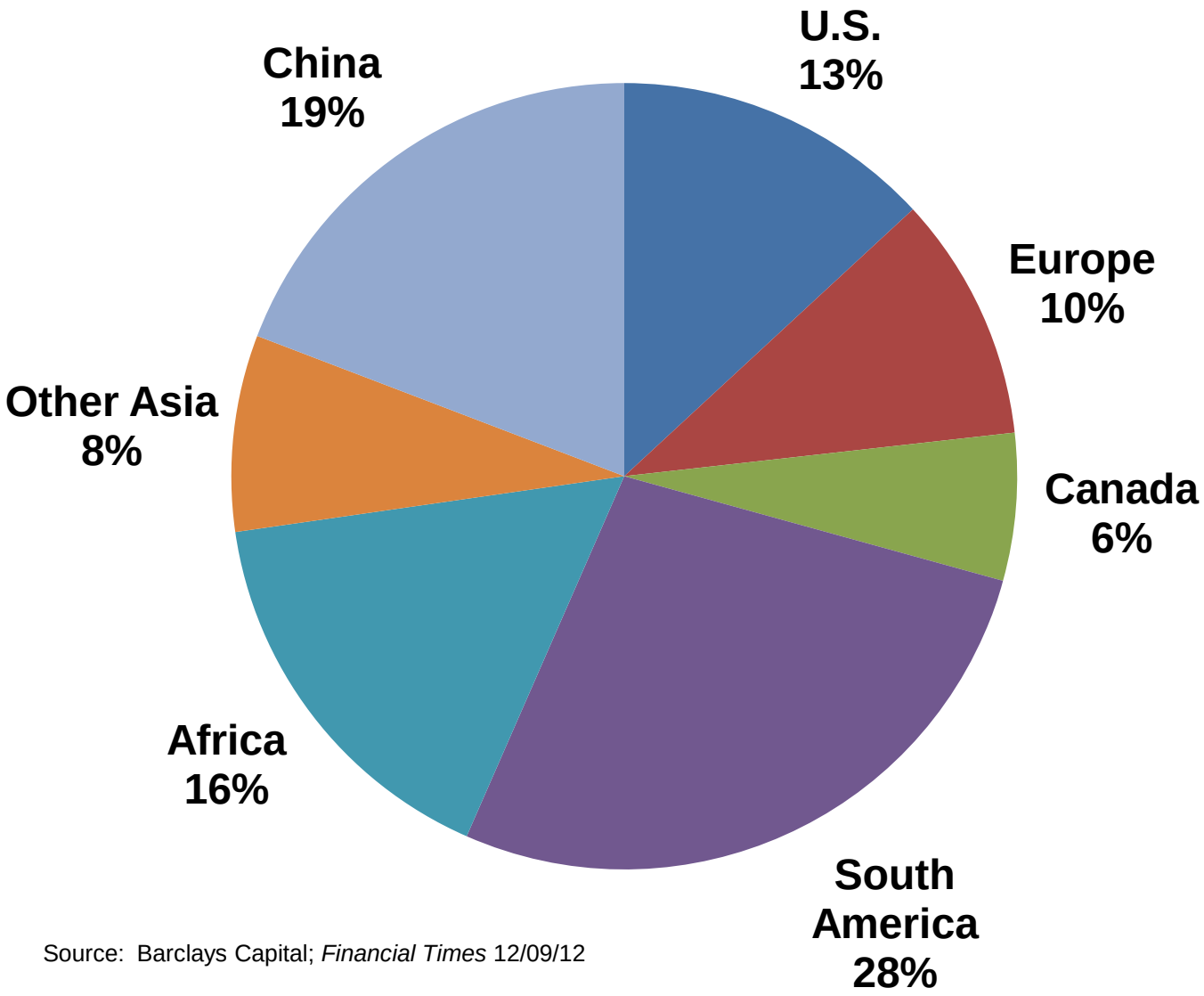
Australia	1.67	1.09	110.0	396
Africa				
South Africa	0.07	0.19	----	485
Libya	0.56	0.21	54.7	290
Tunisia	0.13	0.17	2.3	18
Algeria	2.88	1.02	159.0	231
Morocco	0.00	0.02	0.1	11
Western Sahara	----	----	----	7
Mauritania	----	----	1.0	0
South America				
Venezuela	0.65	0.71	178.9	11
Colombia	0.37	0.31	4.0	19
Argentina	1.46	1.52	13.4	774
Brazil	0.36	0.66	12.9	226
Chile	0.05	0.10	3.5	64
Uruguay	----	0.00		21
Paraguay	----	----		62
Bolivia	0.45	0.10	26.5	48
Total of above areas	53.1	55.0	1,001	6,622
Total World	106.5	106.7	6,609	

Notes:

a. Dry production and consumption: EIA, International Energy Statistics, as of March 8, 2011
b. Proved gas reserves: Oil and Gas Journal, Dec. 6, 2010, P. 46-49
c. Romania, Hungary, Bulgaria
d. U.S. data are from various EIA sources

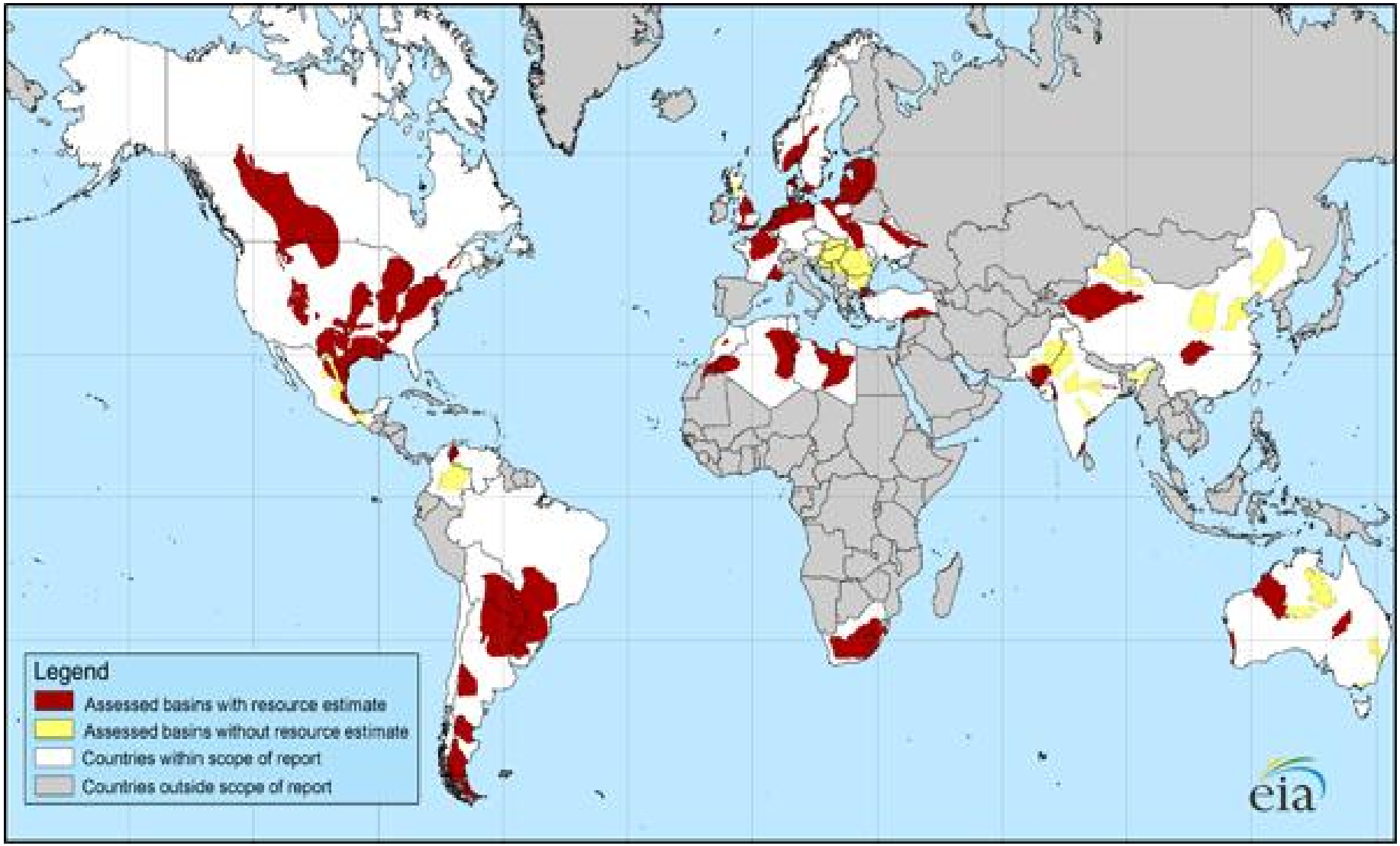
Source: U.S. Energy Information Administration

ONE VIEW OF SHARES OF GLOBAL SHALE GAS RESERVES



Source: Barclays Capital; *Financial Times* 12/09/12

MAP OF 48 MAJOR SHALE BASINS IN 32 COUNTRIES

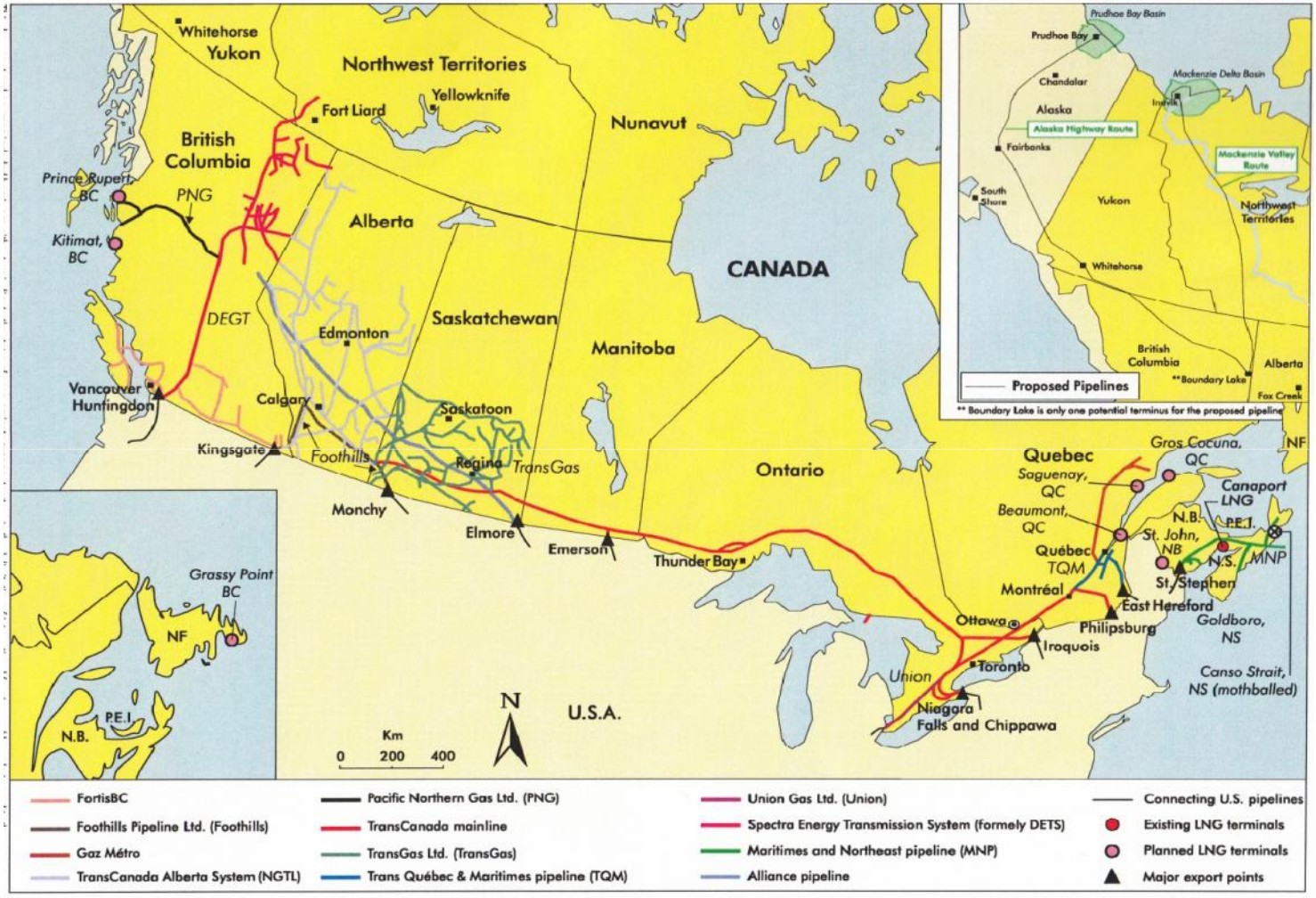


Source: Advanced Resources International, Inc.

WHAT IT TAKES TO BE A SUCCESSFUL SHALE GAS PRODUCING NATION

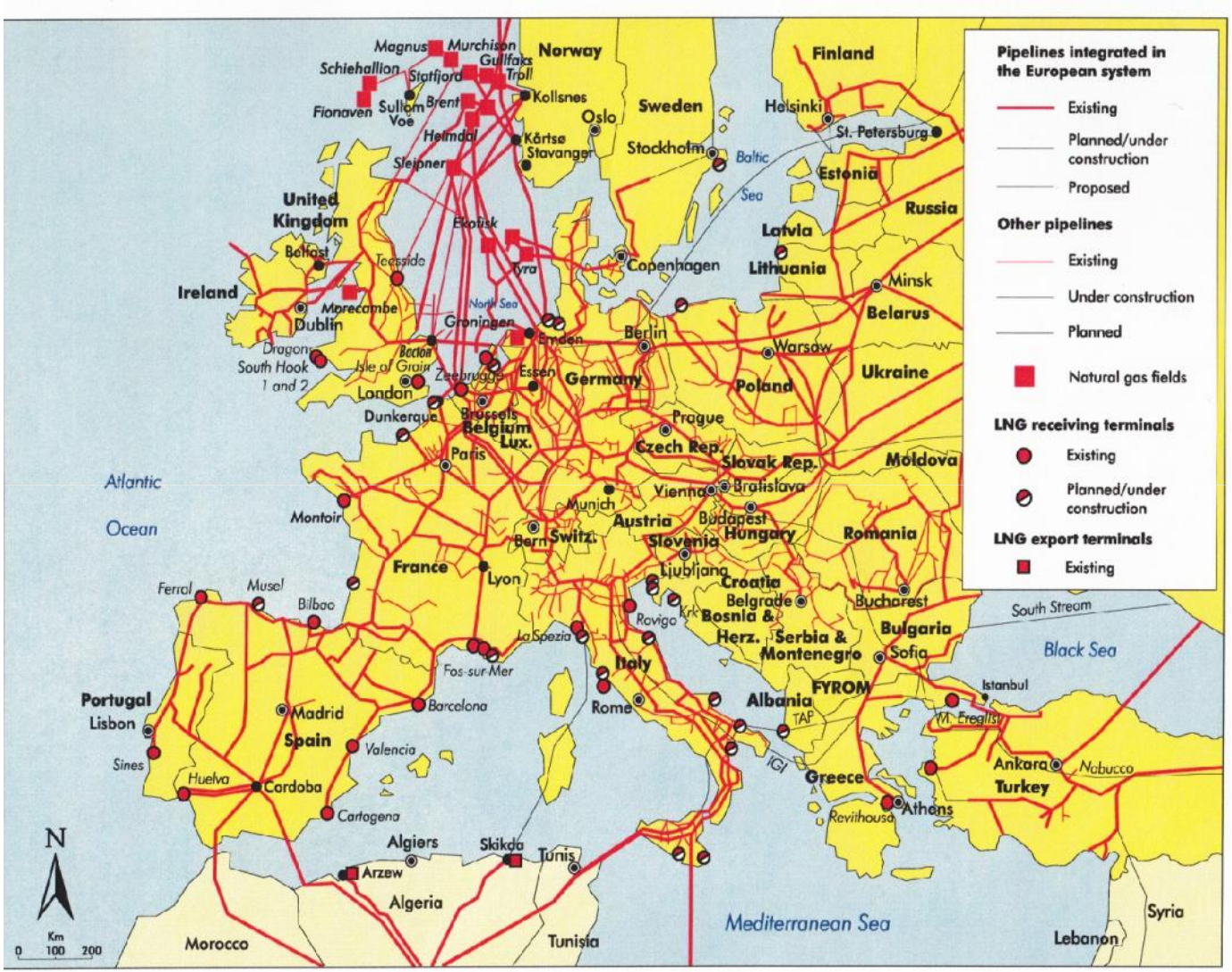
- **Relatively shallow reserves; the presence of NGL's is also helpful.**
- **A large technically sophisticated and entrepreneurially driven gas production and service industry.**
- **A large experienced blue collar and technical labour pool.**
- **Control of mineral rights in the hands of surface owners.**
- **Generally friendly and experienced regulatory agencies.**
- **A dense network of pipelines.**
- **Strong, diverse source of demand: heating, electric generation, chemical industry, transportation (?), LNG exports (?).**

CANADIAN NATURAL GAS PIPELINES



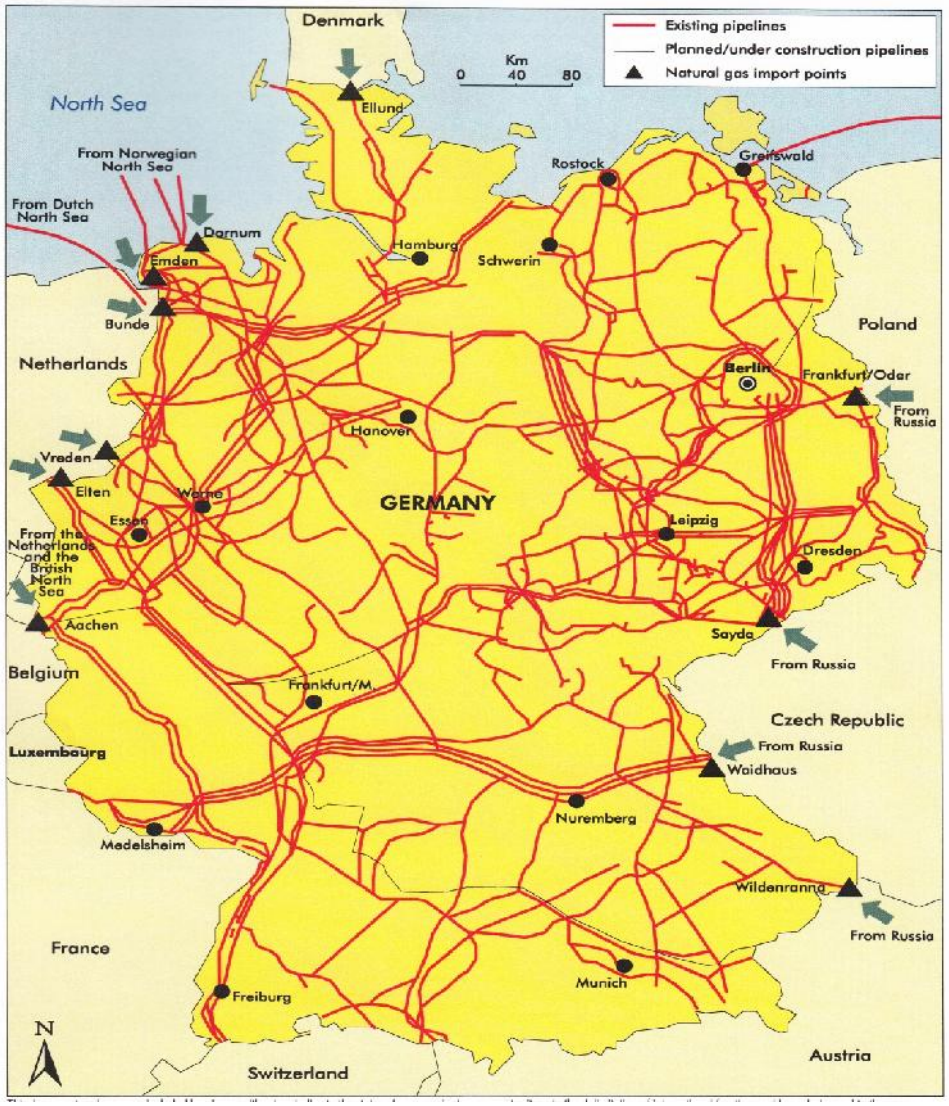
Source: IEA 2012

EUROPEAN NATURAL GAS PIPELINES



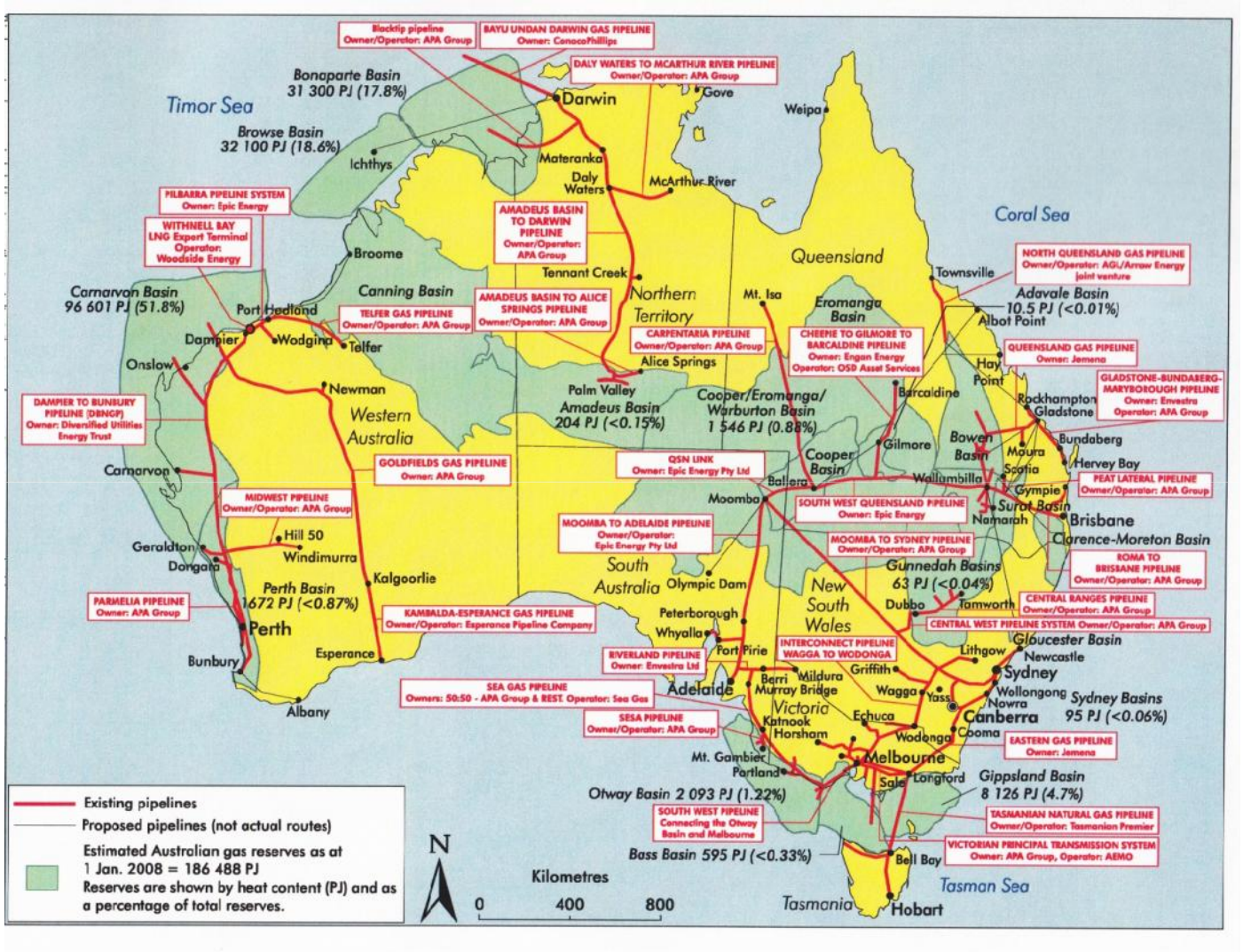
Source: IEA 2012

CENTRAL EUROPEAN NATURAL GAS PIPELINES



Source: IEA 2012

AUSTRALIAN NATURAL GAS PIPELINES



Source: IEA 2012

SOUTHEAST ASIAN NATURAL GAS PIPELINES

Source: IEA 2012

WORLDWIDE ROTARY RIG COUNT

	Sept. 2012	August 2012	Sept. 2011
Latin America	411	417	432
Europe	124	118	120
Africa	108	111	78
Middle East	381	388	292
Far East	230	227	252
International	1,254	1,261	1,174
Canada	355	316	510
United States	1,859	1,913	1,978
World	3,468	3,490	3,662

Source: www.wtrg.com

HOW MUCH DOES SHALE GAS COST?

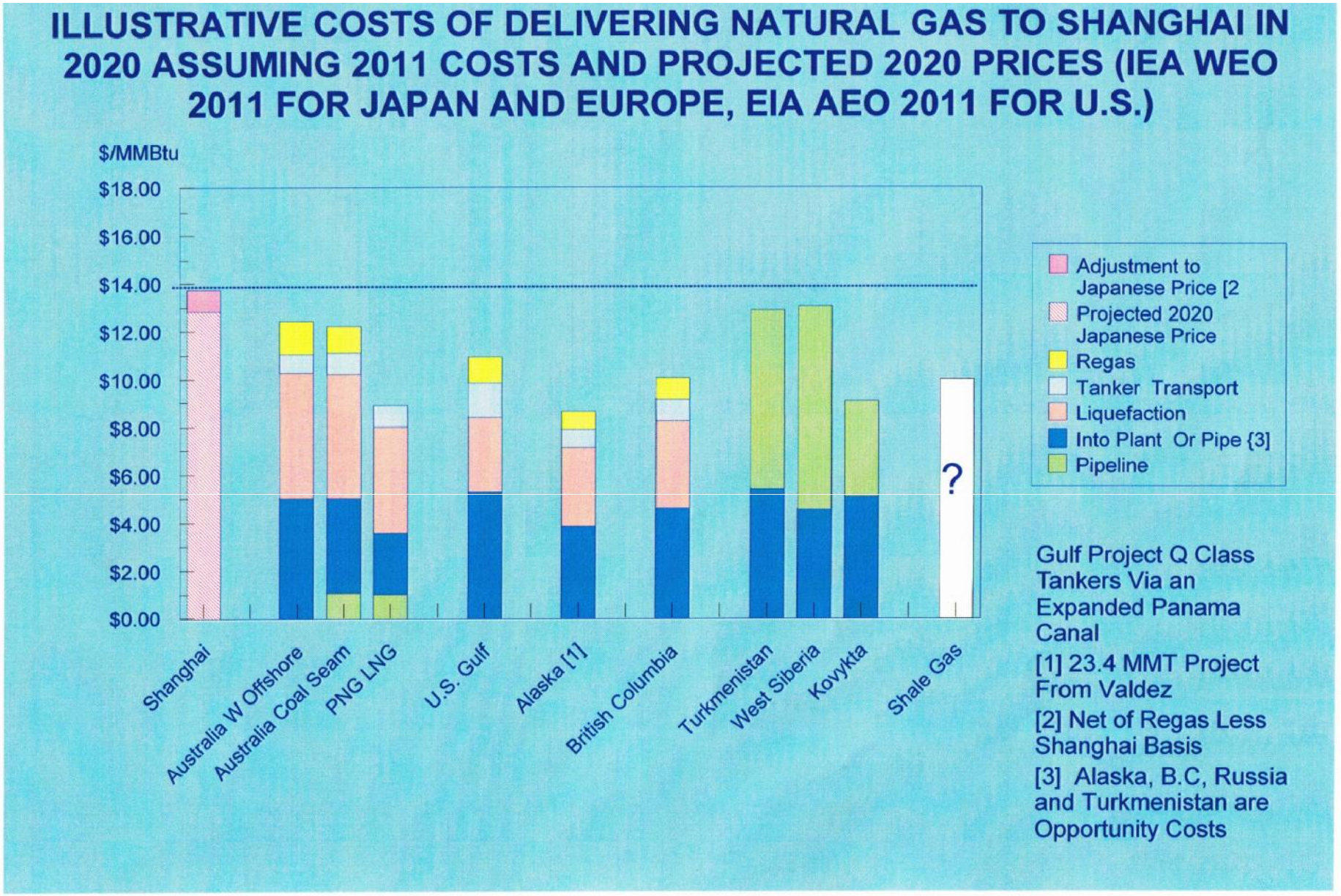
- Current gas prices make the industry unsustainable except for liquid rich plays.

- This assumes no further increase in costs due to new well completion or frac water disposal regulations arising out of the EPA's current review of hydraulic fracturing.

- For production costs numbers are all over the place, but all are much above 2012 market prices.

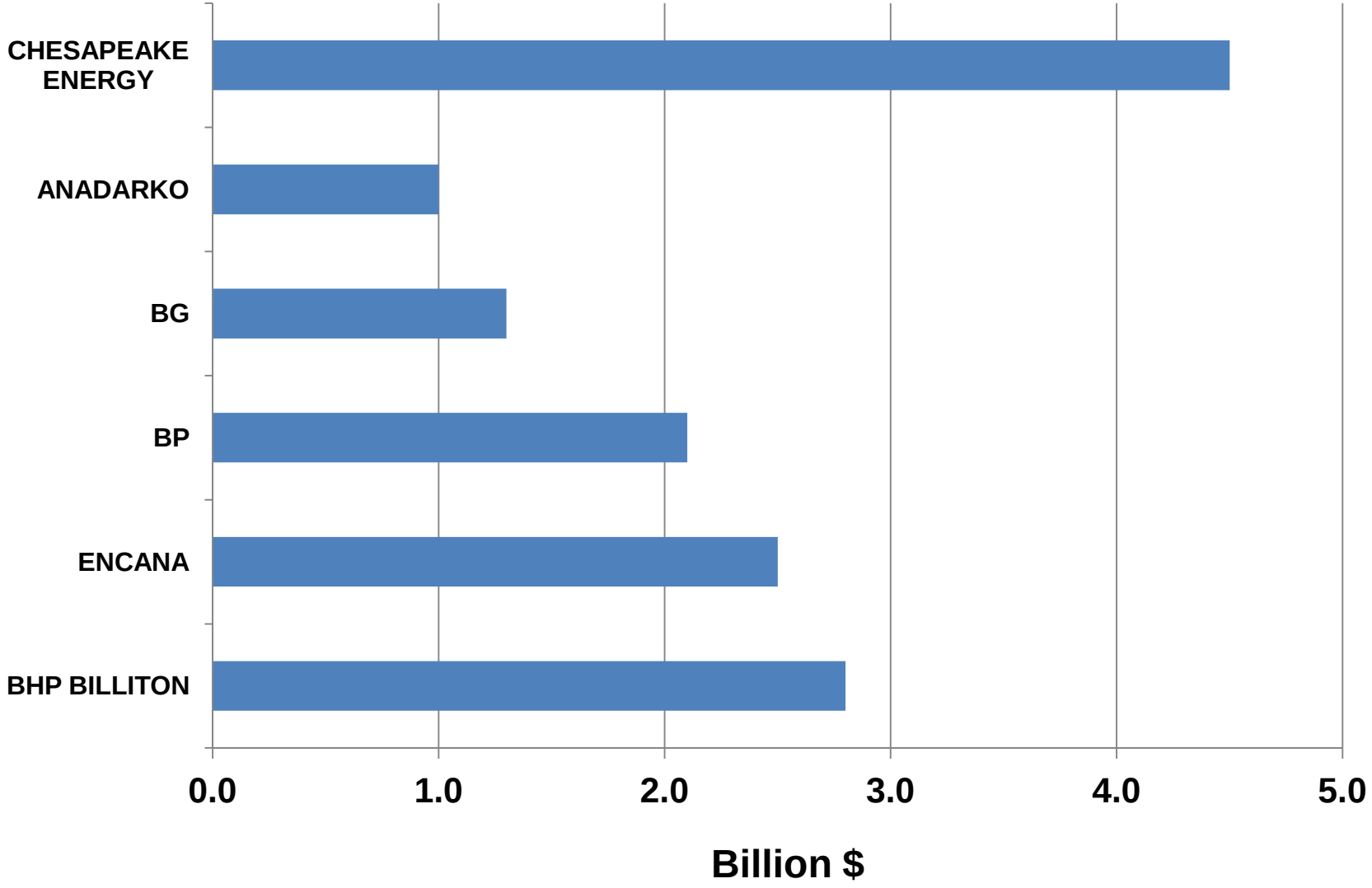
- Some sample estimates:
  - Aubrey McClendon, CEO of Chesapeake Energy (number 2 producer): industry unsustainable at $5.00/mcf.
  - Bernstein Research: cost of finding, developing and operating requires Henry Hub price of $7.50-8.00/mcf.
  - Wood McKenzie and EPRINC have developed supply curves for each play; Marcellus, Haynesville and core areas of Barnett are below $4.00/mcf; non-core areas of the Barnett and Fayetteville are in a range of $5.00-6.00/mcf.

- Ziff Energy has looked at British Columbia and Alberta shales;
  "full cycle" supply costs of C$ 5.00-5.50/mcf with a range of C$ 4.00-7.50+
- Berman and Pittinger examined well-by-well data for the Barnett, Fayetteville and Haynesville plays: $8.00-9.00/mcf to break even on full cycle costs and $ 5.00-6.00 on "point-forward" costs



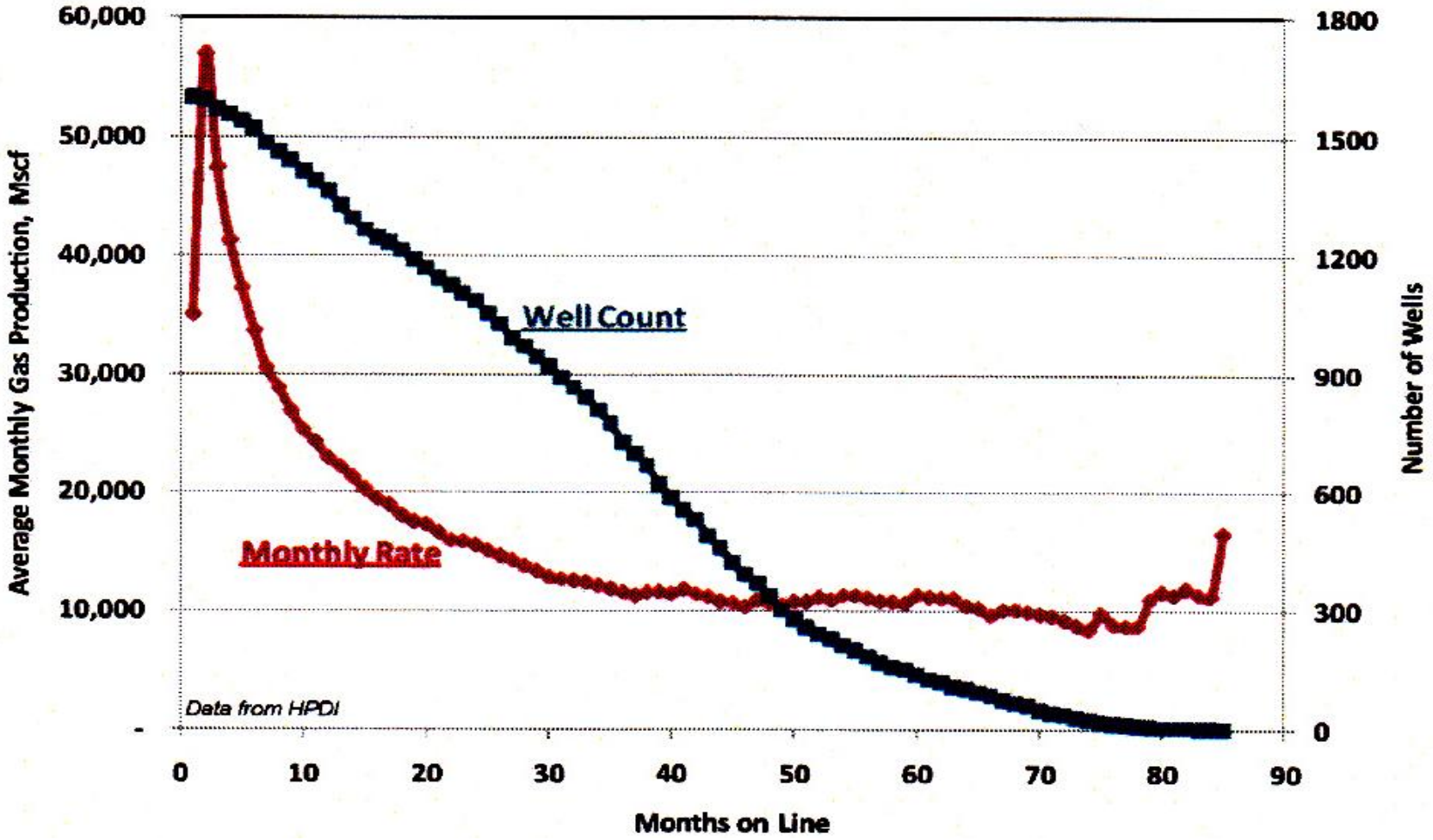
Source: J.J. Jensen, "LNG Exports from North America- How Competitive are they Likely to be?" Presentation at the Paris Energy Club, May 4, 2012

SAMPLE GAS IMPAIRMENT CHARGES DUE TO LOW PRICES (2ND QUARTER, 2012)



Source: Companies; *Financial Times* 1/09/12

COMPOSITE NORMALIZED PRODUCTION PROFILE FOR 1,601 XTO BARNETT WELLS



Source: A.E. Berman and L.F. Pittinger' "U.S. Shale Gas: Less Abundance, Higher cost" *The Oil Drum* Aug 5, 2011