Production and Export Projects in the New Global Gas Markets

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The New U.S. Role in Global Fossil Fuel Markets
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Overview

- The drivers for natural gas production and export projects
- The new regional global gas markets
- Trends in gas production—reasons, and limits, for the US lead on unconventionals
- Trends in gas export—the prospects for US liquefaction projects, given the possible increase in production overseas
- Identifying and incentivizing the successful projects in uncertain and changing conditions

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Regional Markets and Project Drivers

- That's gas market**s**, with an "s"!
  - There is a global oil market
  - There is *not* a global gas market in the same sense
  - Instead, there are inter-related regional gas markets—defined by geography, but also by economics and politics
- How a developer evaluates projects
  - Look first at production and consumption within a regional market
  - Then at the possibility of movements among regional markets
  - Production and export projects start with consideration of return on investment and price differentials
  - But the analysis doesn't end there—look at other economic and political drivers

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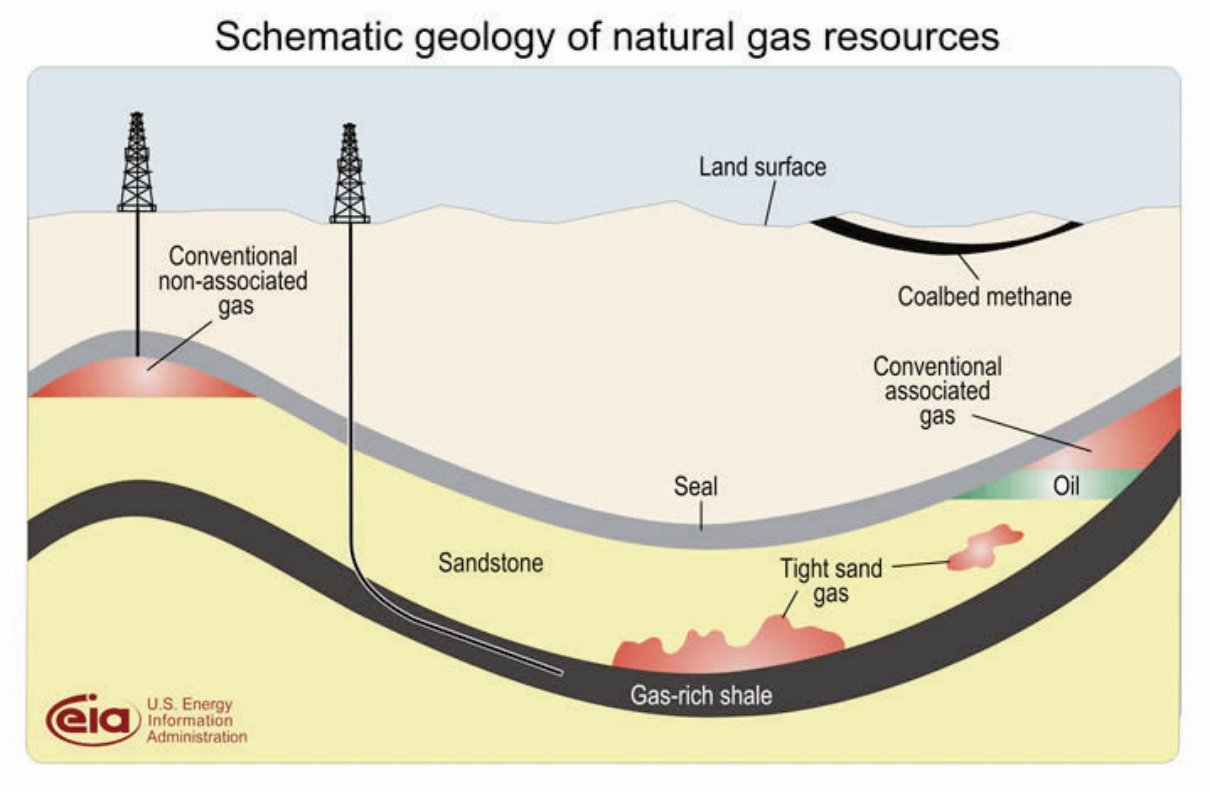
Gas Markets
Supply: The Unconventional Shift I

- Conventional sources: non-associated gas, associated gas
- Unconventional sources: "tight" gas, coalbed methane, and especially shale gas



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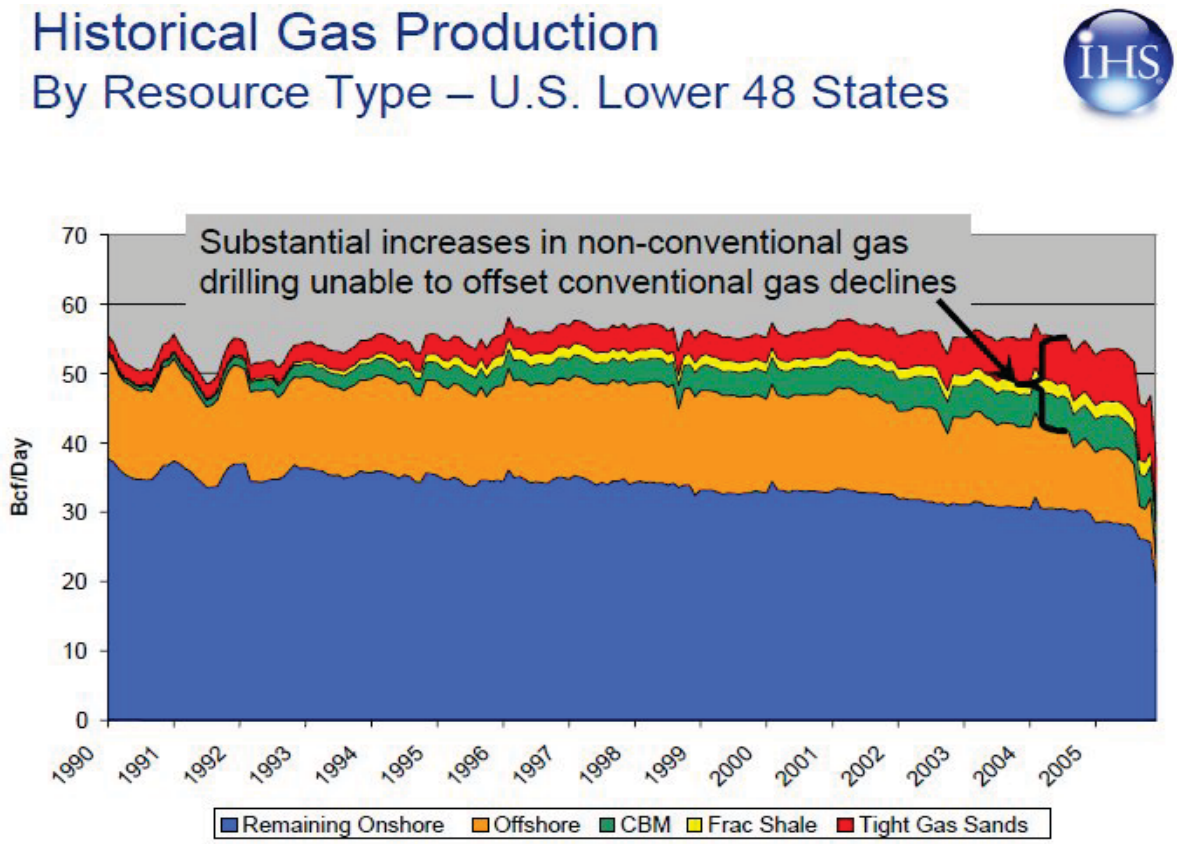
Gas Markets
Supply: The Unconventional Shift 2

The view from 2006, supporting US LNG import terminal proposals:



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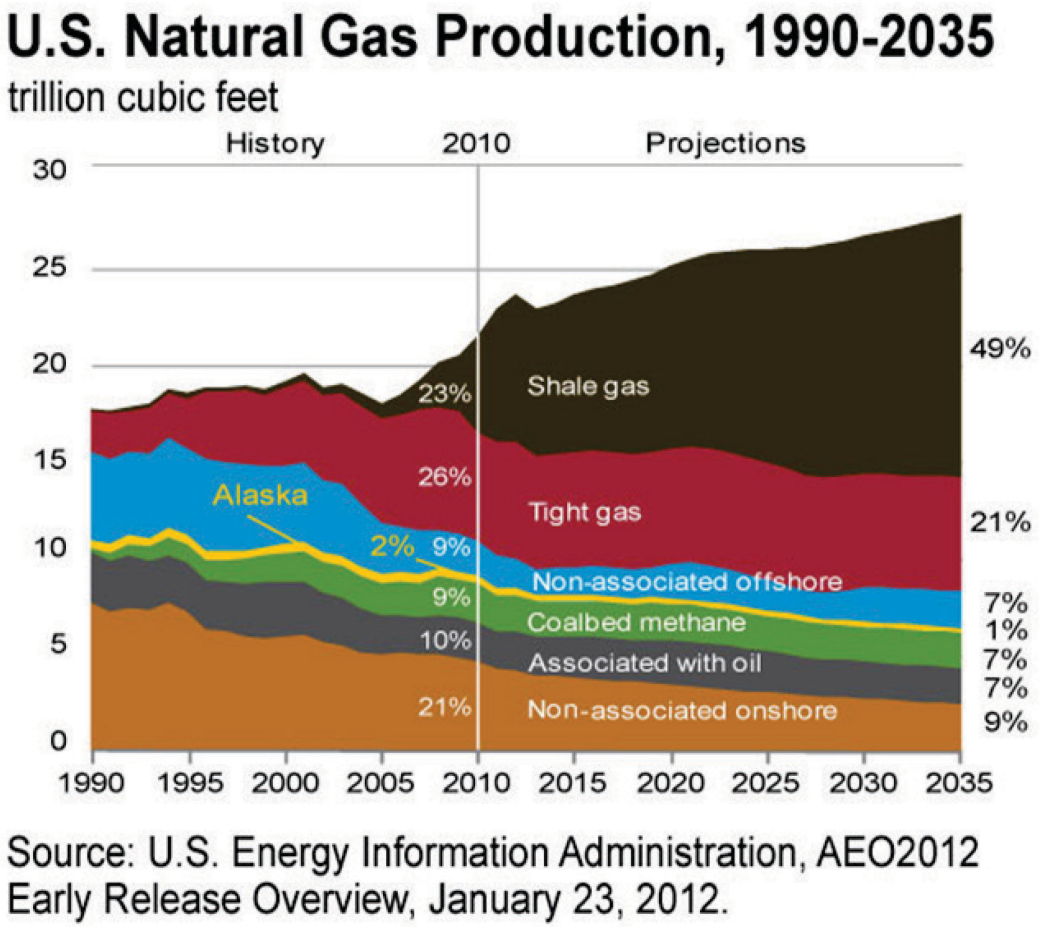
Gas Markets
Supply: The Unconventional Shift 3

- The view from 2012
- Shale gas and tight gas account for 70% of predicted 2035 US production
- IEA predicts that in 2015 the US will surpass Russia to become the world's largest natural gas producer



Source: U.S. Energy Information Administration, AEO2012 Early Release Overview, January 23, 2012.

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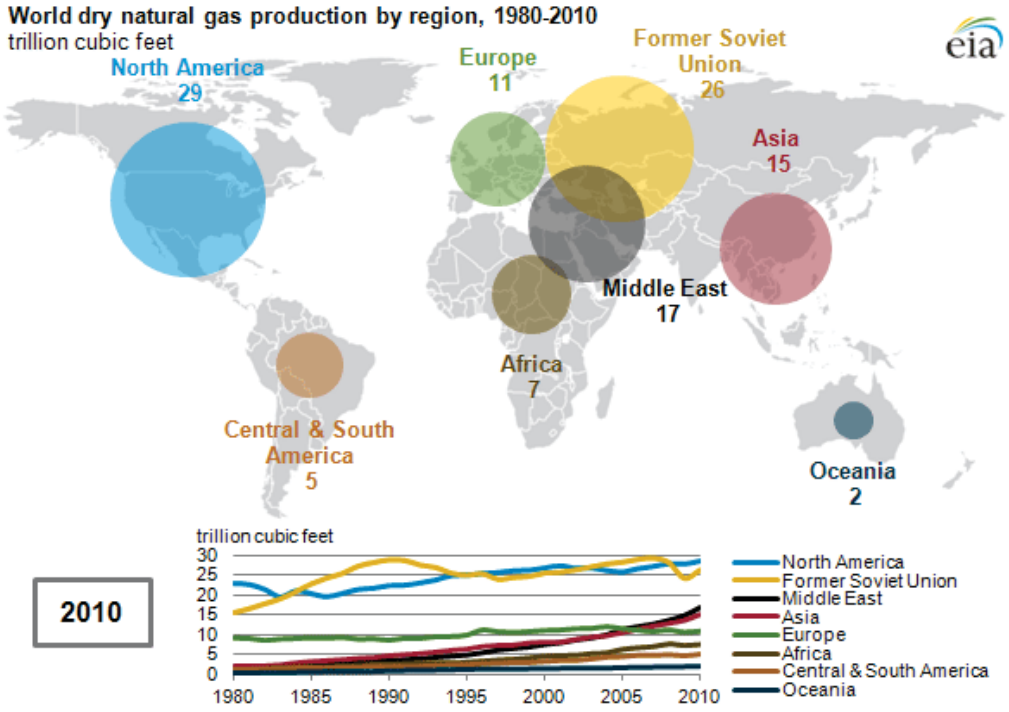
Gas Markets
Supply: The Unconventional Shift 4

- Shift to unconventional production is most pronounced in the US
- Overall growth in last decade driven mostly by conventional sources—in Australia, the Middle East, and Asia



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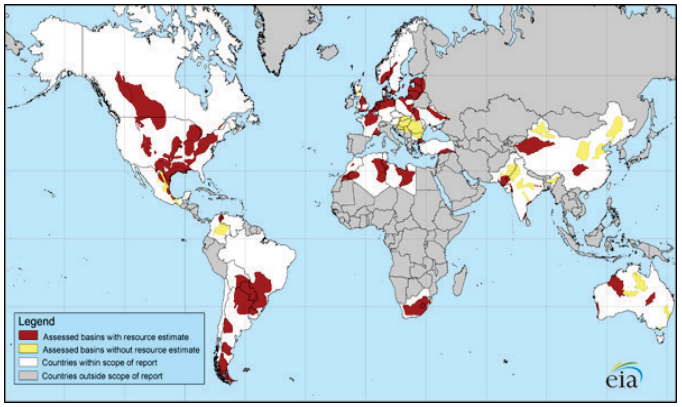
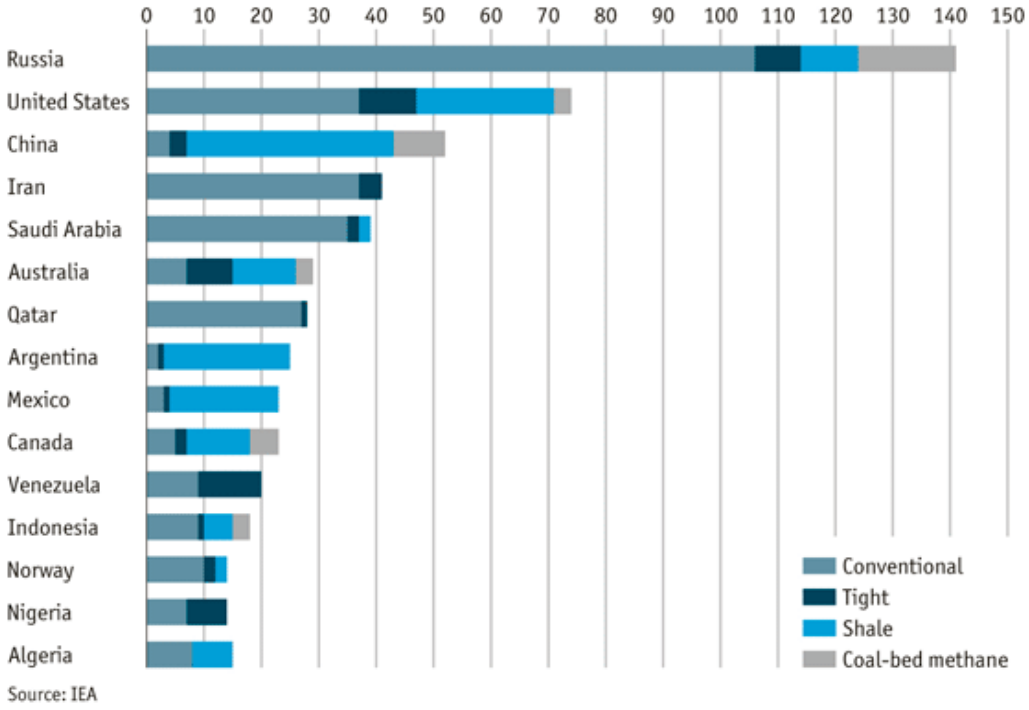
Gas Markets
Supply: The Unconventional Shift 5

- Reserves of unconventional sources are vast—not only in the US but also Canada, China, parts of Latin America, and Europe

Shale Gas Reserves





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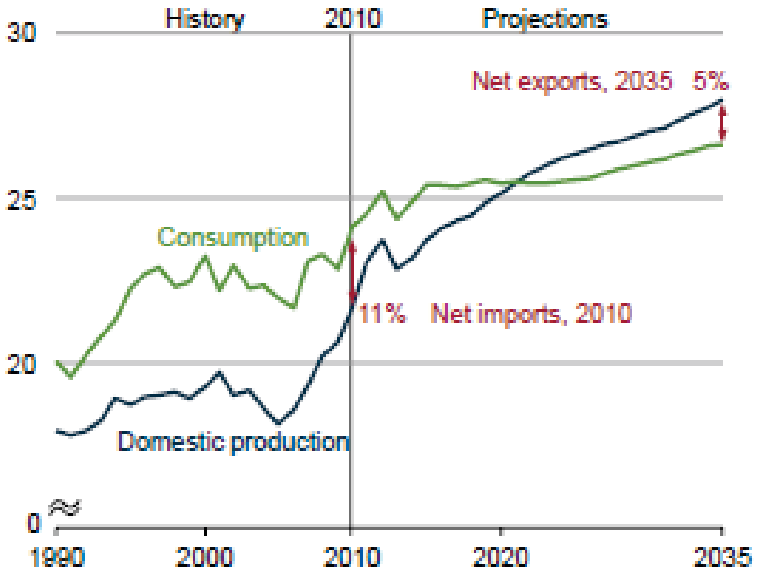
Gas Markets
Demand: Calm Before A Storm I

- US gas consumption has not grown significantly since 2000
- Domestic consumption not keeping up with increasing production, and absent changes by 2020 the US will become a net exporter
- But consumption of gas is growing faster than other fuels, and the IEA predicts that by 2030 gas will overtake oil as the largest fuel in the US energy mix

With rising domestic production, the United States become a net exporter of natural gas

Figure 106. Total U.S. natural gas production, consumption, and net imports, 1990-2035 (trillion cubic feet)



Source: EIA, Annual Energy Outlook 2012

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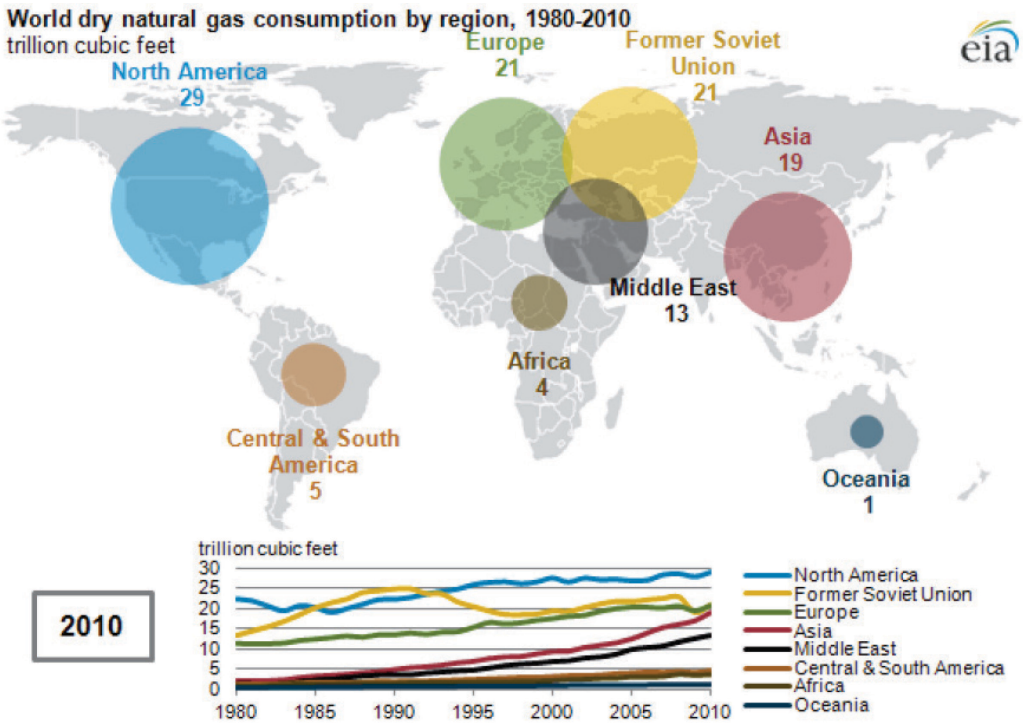
Gas Markets
Demand: Calm Before A Storm 2

- Asia
  - From 10 Tcf in 2000 to 19 Tcf in 2010
  - China alone from 4.6 Tcf in 2011 to 19.2 Tcf in 2035
  - Growth in Japan spiked post-Fukushima, but constrained by high prices and renewable/efficiency policy mandates?
- Europe
  - From 17 Tcf in 2000 to 21 Tcf in 2010
  - Demand lower now, and may not recover 2010 levels for years



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Gas Markets
Competing Fuels and New Uses

- Competing Fuels for Gas
  - Renewables: growing but still policy-dependent and not baseline
  - Nuclear: safety, cost, delay and regulatory hurdles
  - Coal: EPA and economics made new coal-fired power plants unlikely
  - Limited industrial substitutes
- New Uses for Gas
  - Transportation: CNG growing but currently less than 1% of U.S. consumption; vehicles running on electricity made from gas another story?
  - Petrochemicals: rejuvenation of domestic petrochemical industry, but will take time and have limited impact on total consumption
- Outlook—gas is a privileged baseline fuel, abroad and *especially* in the US

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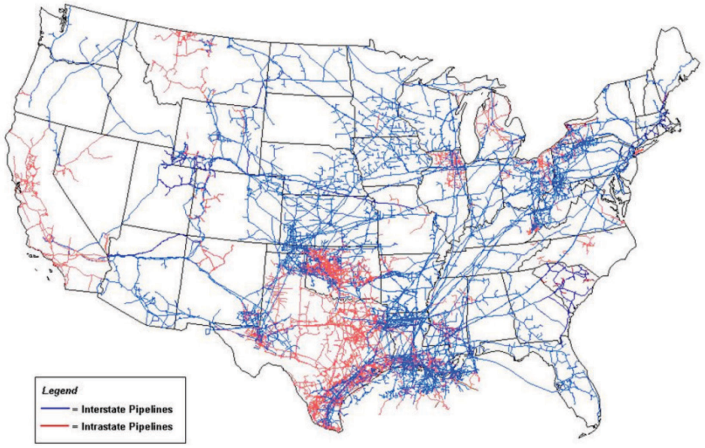
Gas Markets
Infrastructure

- Pipelines
  - US has 300,000 miles of gas pipelines
  - US shale plays close to major markets
  - China has 27,000 miles of pipelines, and "only" plans to double by 2015
  - Chinese and European shale plays often far from markets
- Storage
  - US storage capacity of about 4.2 Tcf
  - Europe has storage capacity of 3.2 Tcf
  - Storage in China?
- Other kinds of infrastructure
  - Ports—thanks in part to import terminals
  - Human and intellectual capital
  - Regulatory, contractor and transactional base



Source: Energy Information Administration, Office of Oil & Gas, Natural Gas Division, Gas Transportation Information System

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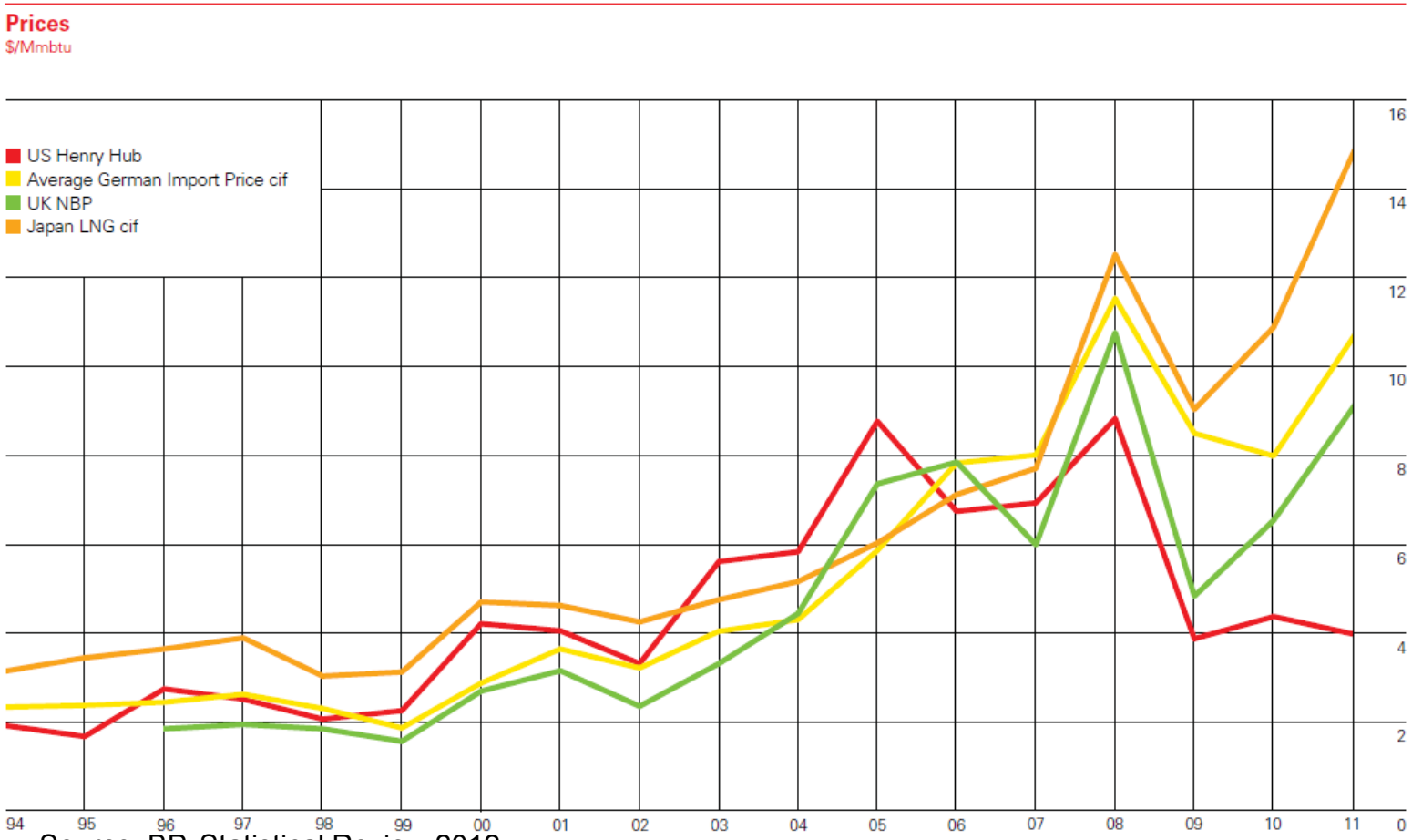
Gas Markets
Price: The American Disconnect



Source: BP, Statistical Review 2012

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Gas Markets
Price: The Cloudy Crystal Ball

- 2020 projection, from IEA World Energy Outlook 2011:
  - U.S. - $6.70/MMBtu
  - Europe - $13.00
  - Japan - $16.20
- Other projections

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Gas Markets
The Prize for New Production and Export

- How is the Asian-US price differential impacting projects?
- Is the differential permanent or evanescent?
  - IEA World Energy Outlook 2012:
    "Price relationships between regional gas markets are set to strengthen as LNG trade becomes more flexible and contract terms evolve"
- Who benefits and is burdened by the differential?
  Strange policy bedfellows:
  - Beneficiaries: US gas users, and overseas alternative fuel suppliers and users (coal, nuclear, renewables)
  - Adversely affected: US alternative fuel suppliers and users, and overseas gas users

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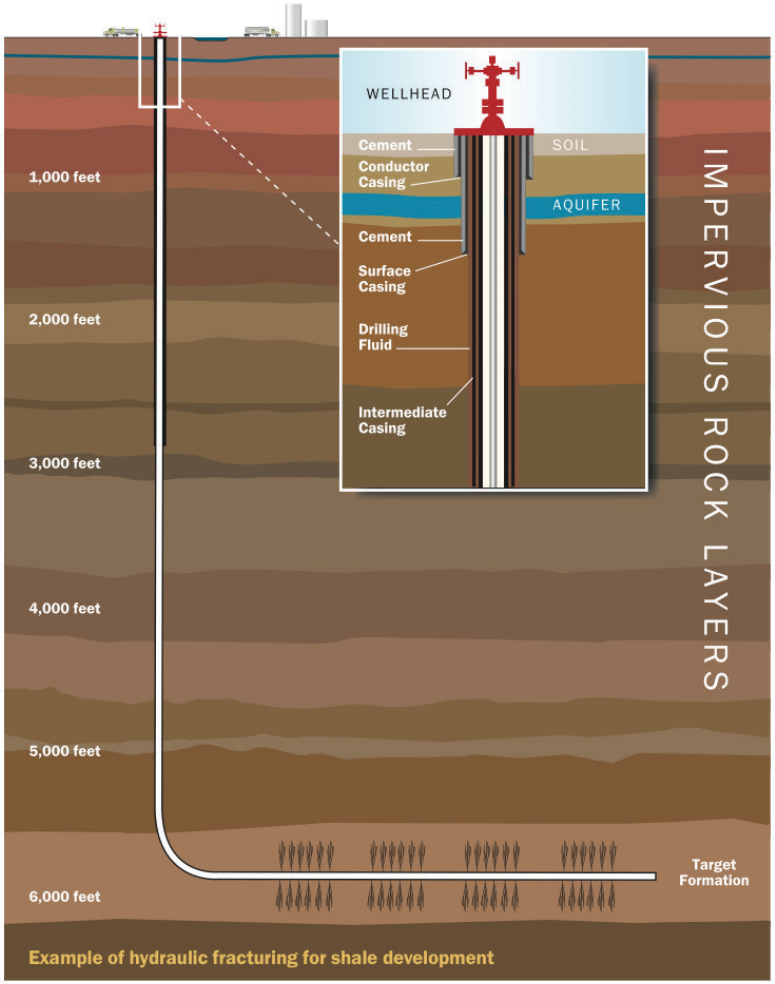
Gas Production
The Unconventional Gas Revolution



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Gas Production
Shale Plays—Why Now, and Why Here? I

- **Background**
- Overnight success for a suite of technologies and processes most of which date back decades
- Roles of US government policy and financial support (National Laboratories, DOE predecessors, DOE itself)
- Not a case of proprietary fundamental technology, though patents and trade secret protection for chemical agents are on the rise
- Long history of US gas exploration and production
- Favorable geology—and favorable geography, given infrastructure and markets

Gas Production
Shale Plays—Why Now, and Why Here? 2

- **Industrial Organization and Regulation**
- Entrepreneurial gas developers—for better and otherwise
- Infrastructure of all kinds—transportation, storage, regulation, contract models, human capital, contractor and vendor base, access to water and chemicals
- Dispersed private ownership of gas resources
- Primary oversight by state resources agencies
- Common carrier regulation and eminent domain for pipelines and storage

- **Which of these are uniquely American, and which can be readily replicated in China and Europe?**

Gas Production
Business Constraints on Shale Development

- Water
  - Hydraulic fracturing of a well requires between 1 and 5 million gallons of water
  - If water is not available on-site, could require 150 to 700 truckloads of water
  - Wastewater treatment and disposal also expensive
  - Looming issue as development extends to arid regions
- Transport
  - Pipeline access and capacity constraints due to changing geography of production
  - Transportation issues have constrained production of Bakken and Marcellus formations

Gas Production
Political Constraints on Shale Development

- Well integrity and methane release
- Water use and water disposal
- Chemical additives
- Seismicity
- Surface land use
- Impact on domestic prices

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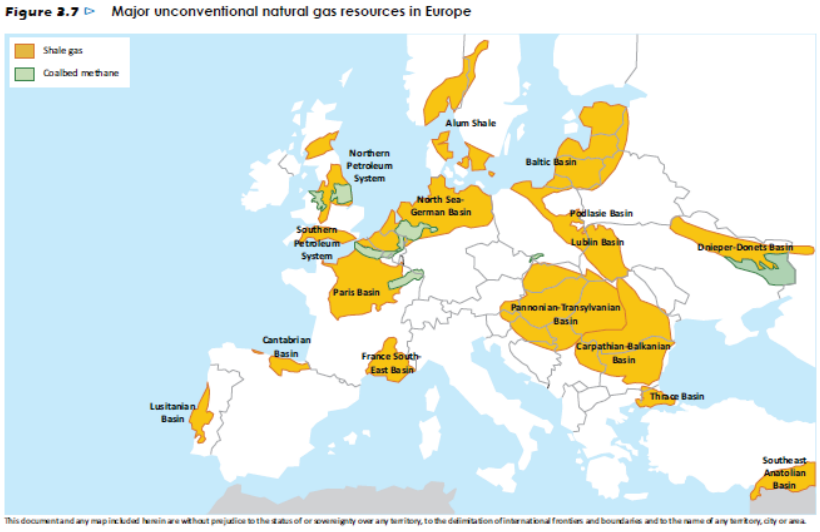
Gas Production
Shale Plays in Europe

- Unconventional reserves are significant but pale with production
- Range of political and economic reactions
- Impediments
  - High population density
  - No center of advocacy
  - New EU Commission regulations and local moratoria hang over current development



Source: IEA, Golden Rules Report, May 2012

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Gas Production
Shale Plays in China

- Coalbed methane production (0.3 Tcf in 2010), but only 20 shale gas wells drilled by early 2012
- Drivers
  - Government support
  - Partnerships with North American companies
- Impediments
  - Shale gas resources may be more difficult and expensive to access than in the U.S.
  - Limited infrastructure
  - Limited water availability

Figure 3.5 ▷ Major unconventional natural gas resources in China

This document and any map included herein are without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

Source: IEA, Golden Rules Report, May 2012

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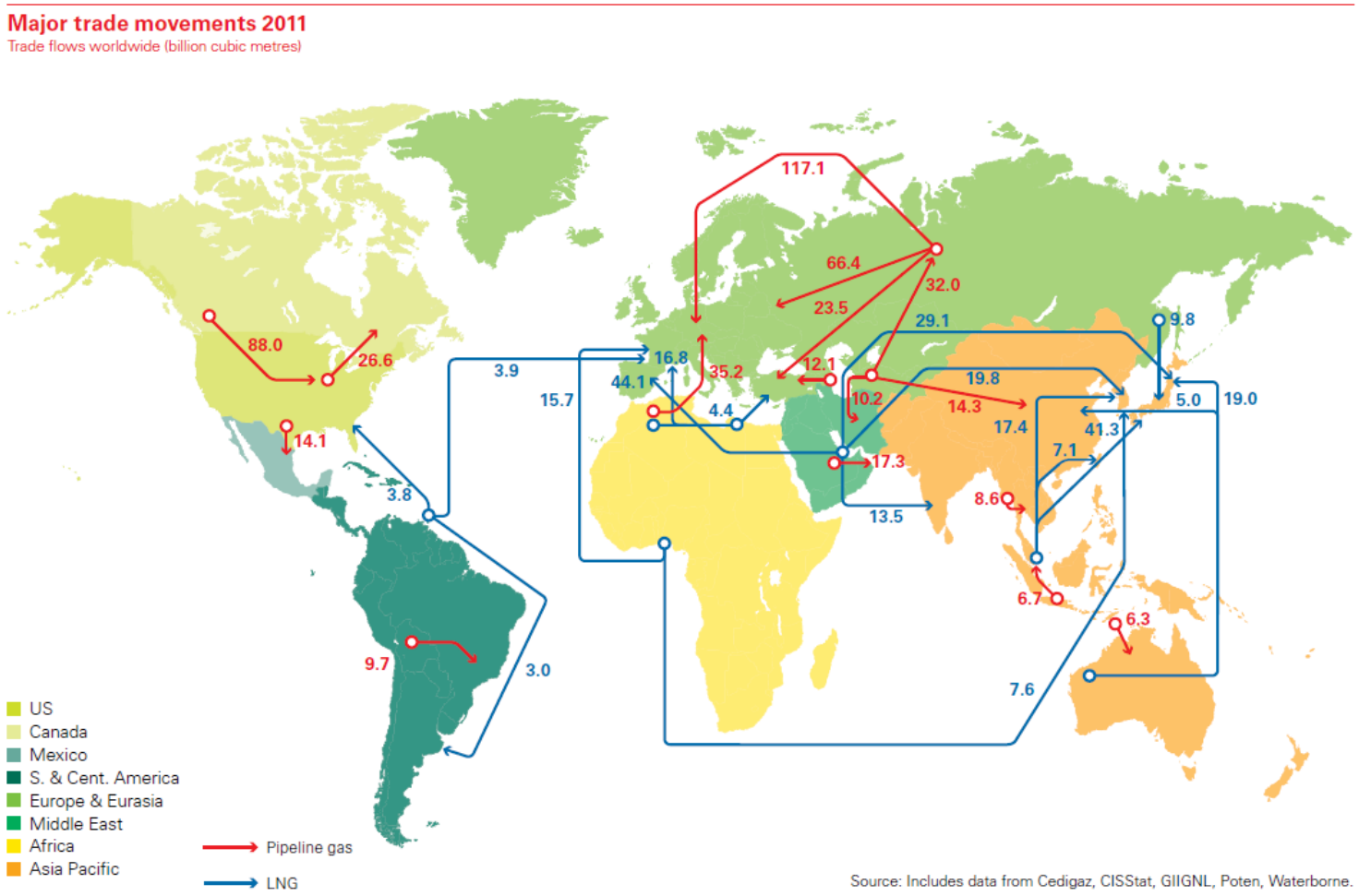
Gas Export
Inter-market Movements



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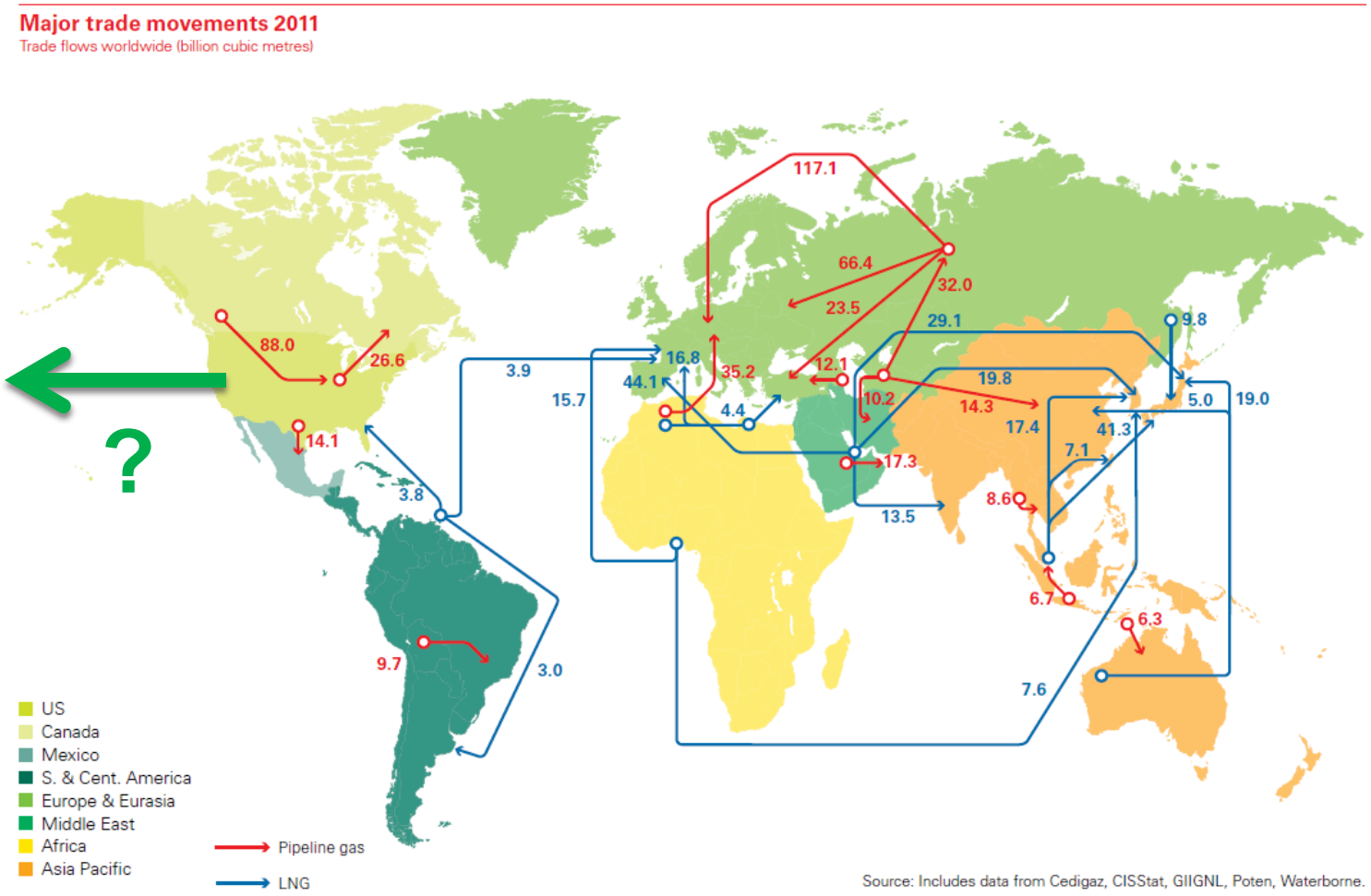
Gas Export
Inter-market Movements



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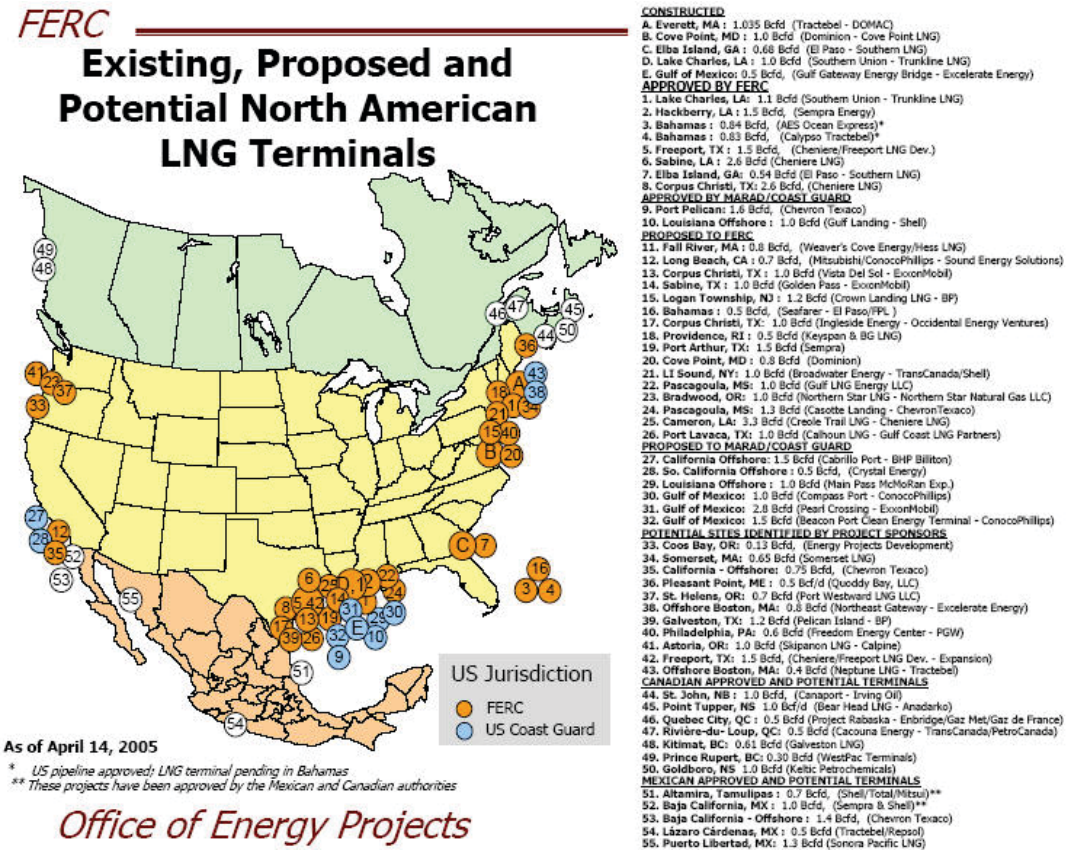
Gas Import
The US Import Terminal Experience I

- Henry Hub price averaged about $9/MMBtu in 2005
- Over 50 proposed import terminals circa 2005



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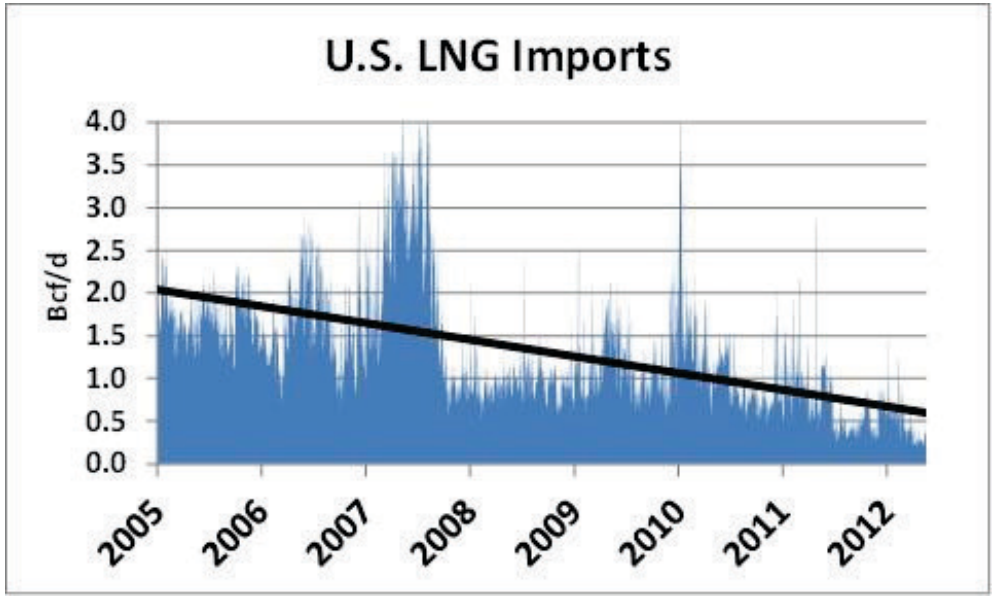
Gas Import
The US Import Terminal Experience 2

- Cratered projects the lucky ones
- Only 7 new LNG import terminals completed since 2005
- Lessons learned



Source: RBN Energy LLC

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Gas Import
The Cheniere Experience

- Cheniere's History
  - Bet in early 2000s on sustainably high US gas prices
  - Tolling model—secured long-term terminal use agreements from producers and buyers
  - Completed three of four of proposed import projects
- An un-hedged bet on the direction of gas prices is risky for terminal users as well as terminal owners

Cheniere (ticker: LNG) Stock Price: 2000-2012

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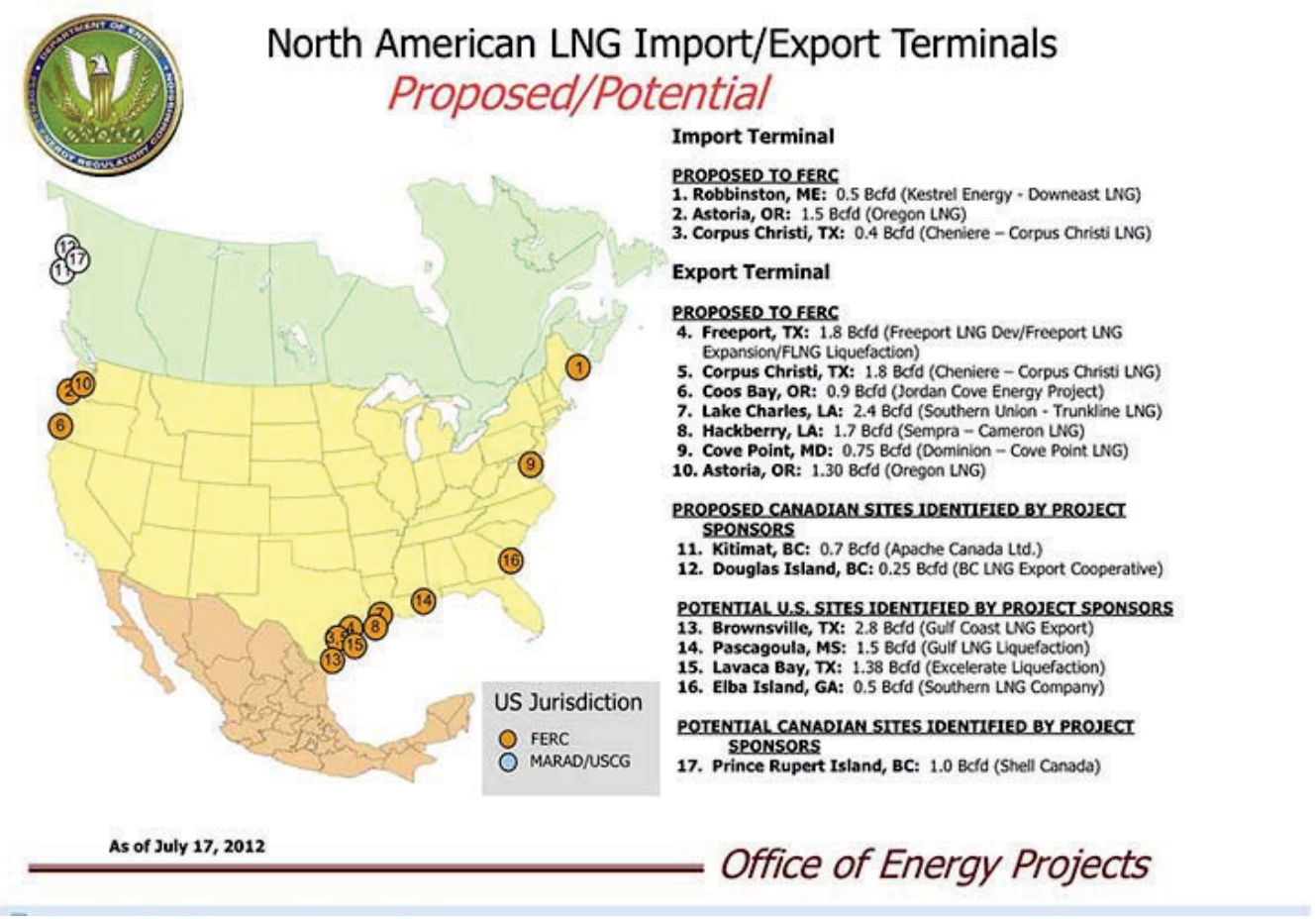
Gas Export
The New Wave of US Export Proposals



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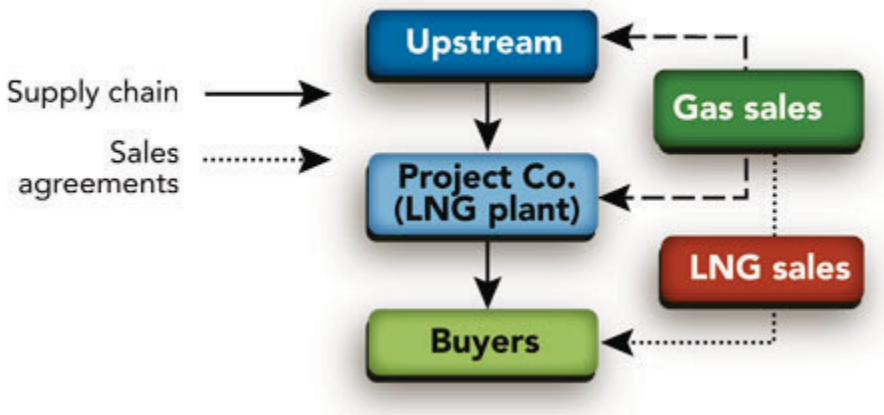
Gas Export
Export Terminal Development

- Dual use (import/export) or dedicated use
- Cost
  - $5 billion estimate for expansion and use reconfiguration of Cheniere's Sabine Pass facility
  - Standalone project costs even higher
- Timetable
  - Cheniere's Sabine Pass is only export terminal with FERC and DOE approval
  - Full permitting of additional export terminals not likely until late 2013 or 2014
  - Construction began on Cheniere's Sabine Pass in August; late 2015 completion date

Gas Export
Commercial Models for Export Terminals

Fig. 2: Project company (merchant) structure



Source: *Oil & Gas Financial Journal,* Mar. 1, 2012

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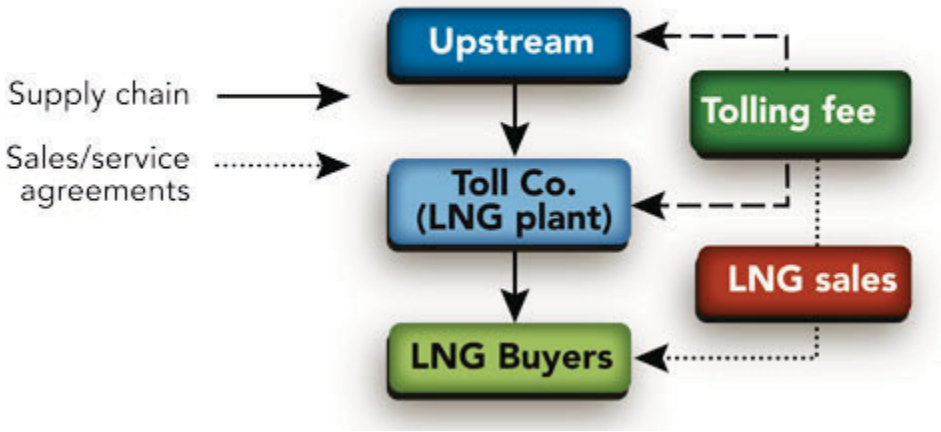
Gas Export
Commercial Models for Export Terminals

Fig. 3: Trolling structure



"Trolling" may be a Freudian slip!

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Gas Export
Political Aspects of Export Projects

- DOE for exports
  - Destinations: FTA vs non-FTA (especially Japan)
  - Statute vests revocation authority in DOE
  - Not DOE's present intent to use revocation as price maintenance scheme
- FERC for terminal siting
- CFIUS—concerns with foreign ownership of key US infrastructure
- State Agencies—resources and environmental agendas
- Local Agencies—regulatory and commercial roles
- Public Utilities—pipelines, storage, power
- Opponents—grass roots, nongovernmental organizations, domestic gas users

Gas Exports
The Prize Revisited

- Is the price differential at risk?
  - Asia/European supply
  - Asia/European demand
  - US supply
  - US demand
- Is the price differential the ***only*** prize?
  Other reasons to invest in US export capability
  - Connection of value chains
  - Integration of economies
  - Diversification of fuel supplies
  - Diversification of future outcomes

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Production and Export Projects in the New Global Gas Markets

- Policyholders and stakeholders do take, and must take, the long view
- A blend of investments may outperform a single bet
- The incentives are there for the entrepreneur with a model that works when either prices or differentials are low, not just when they are both high

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