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Energy Security
(An Assessment of Chinese and U.S. Interests)

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August 27, 2010
Shanghai

What Do Policy Makers Believe?

Petroleum import dependence is a good measure of vulnerability

Petroleum likely to be in short supply – need directed and crash program to transition to the fuels of the future (peak oil)

Resource competition is inevitable – will lead to strategic tensions.

Consensus on this view leads to policy strategies that are costly and likely not very robust in addressing real world uncertainties –

THIS IS YOUR TAKE AWAY!!!!!!!!!!!!

Conventional Wisdom -- Just 5 Short Years Ago

World to Face Large Scale Shortages in Refining Capacity

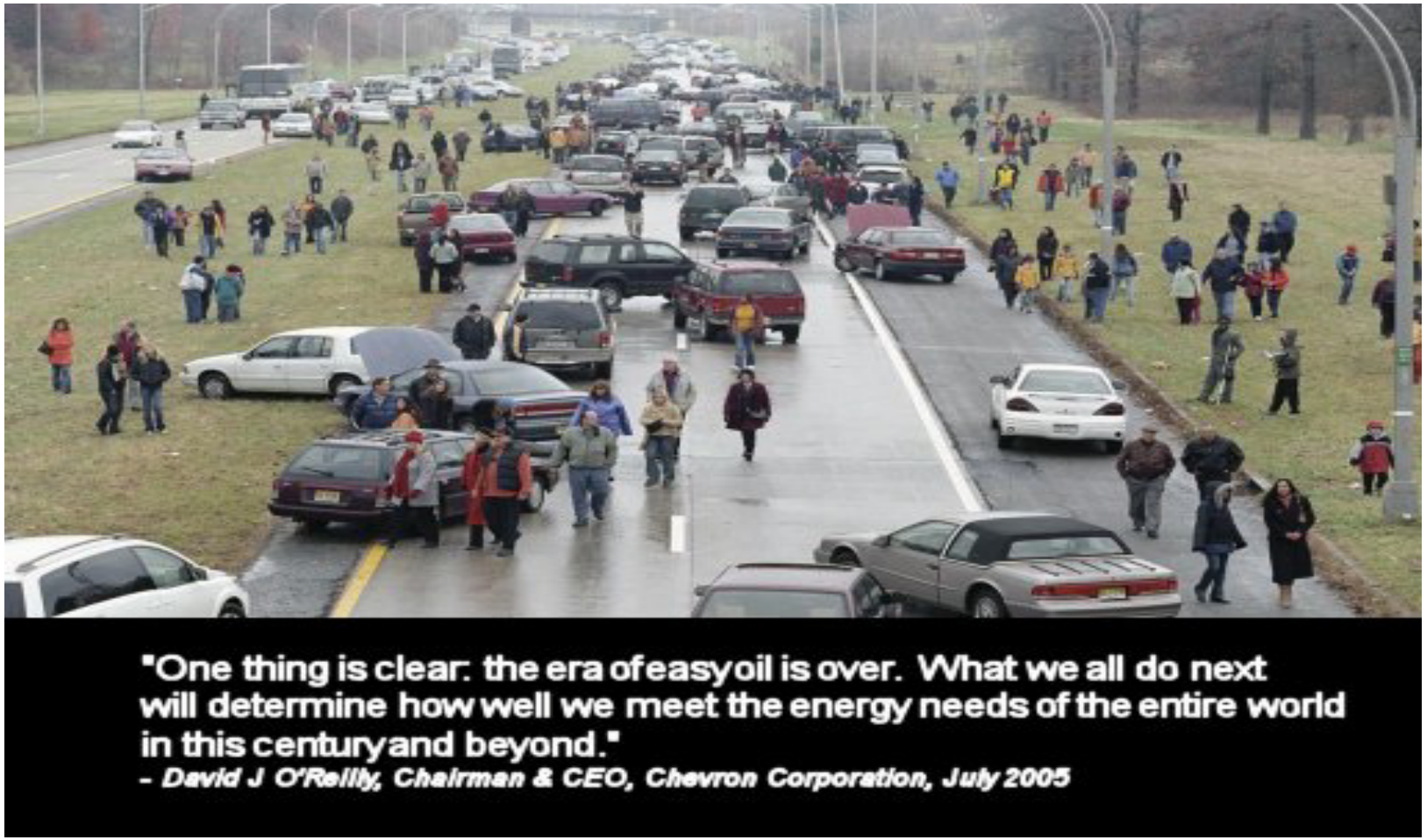
U.S. to Face Natural Gas Shortages – Massive Commitment to LNG Receiving Facilities

Developing World (particularly China, India) – Liquids Demand to Double in 10 years

No Major Large Scale Editions in Petroleum Reserves (peak oil)

Latin America has been Fully Explored

The Peak Oil Problem: How Serious?



San Joaquin Valley

Testing Hubbard-Method Predictions for Reserves and Production (Billions of Barrels)

	1964	1982	2000
Cumulative Discoveries	7.7	11.8	16.1
Percent Attributable to 1915	49%	69%	76%
Cumulative production as of	8.0-9.5	11.9-12.1	16.1-16.2
Year 2000 production projected in: (mb/d)	44-112	189	597(actual)

Source: EPRINC, October 2006. *Does the Hubbard Method Provide a Reliable Means for Predicting Future Oil Production*, Richard Nehring, October 2006,

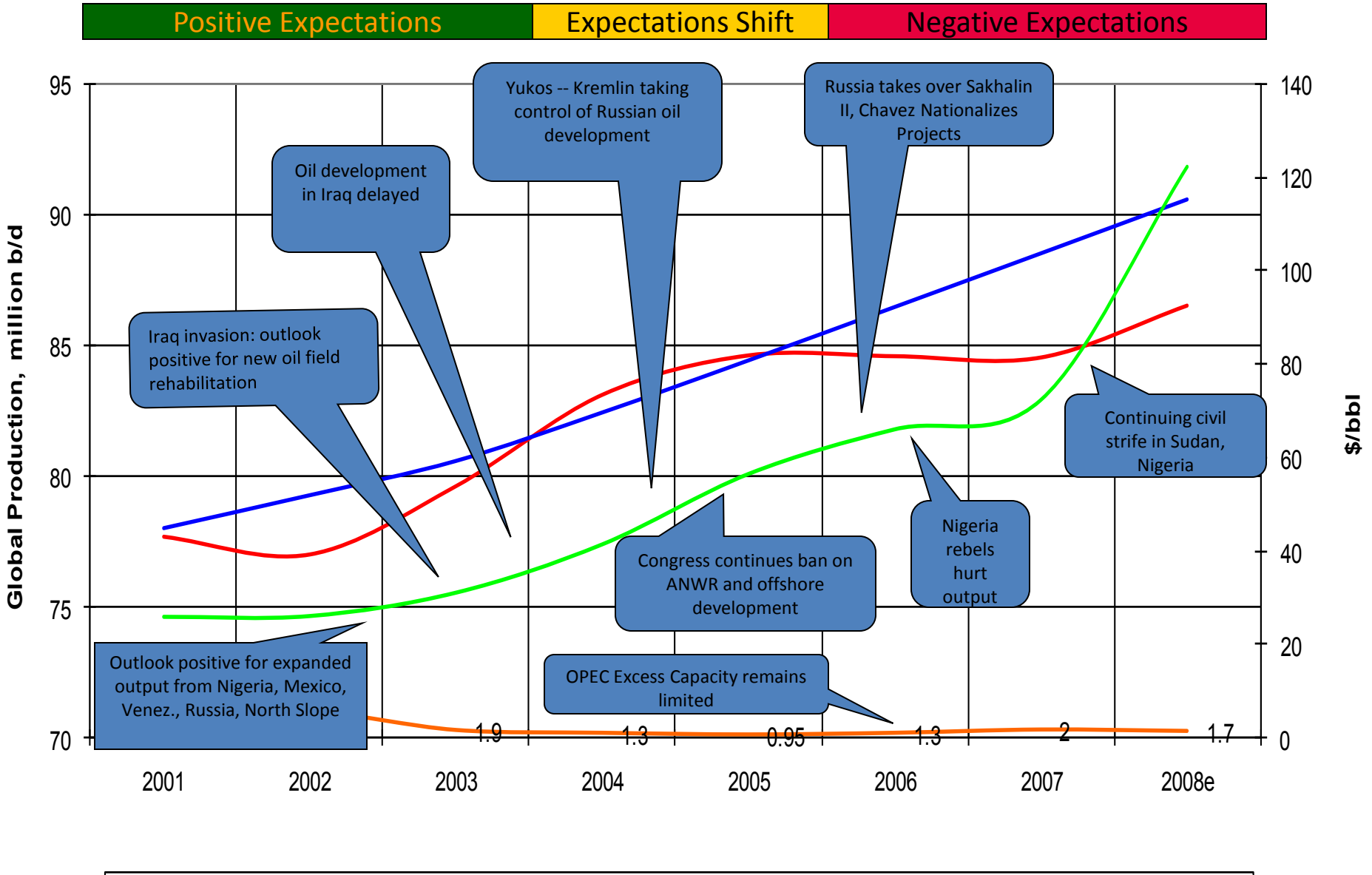
Permian Basin

Testing Hubbard-Method Predictions for Reserves and Production (Billions of Barrels)

	1964	1982	2000
Cumulative Discoveries	17.6	27.9	35.2
Percent Attributable to 1950	85%	86%	84%
Cumulative production as of	19-27.5	28.5-30.5	35.8-37.5
Year 2000 production projected in: (mb/d)	162-479	326-479	910(actual)

Source: EPRINC, October 2006. *Does the Hubbard Method Provide a Reliable Means for Predicting Future Oil Production*, Richard Nehring, October 2006,

A Series of Unfortunate Events Leading to New Expectations



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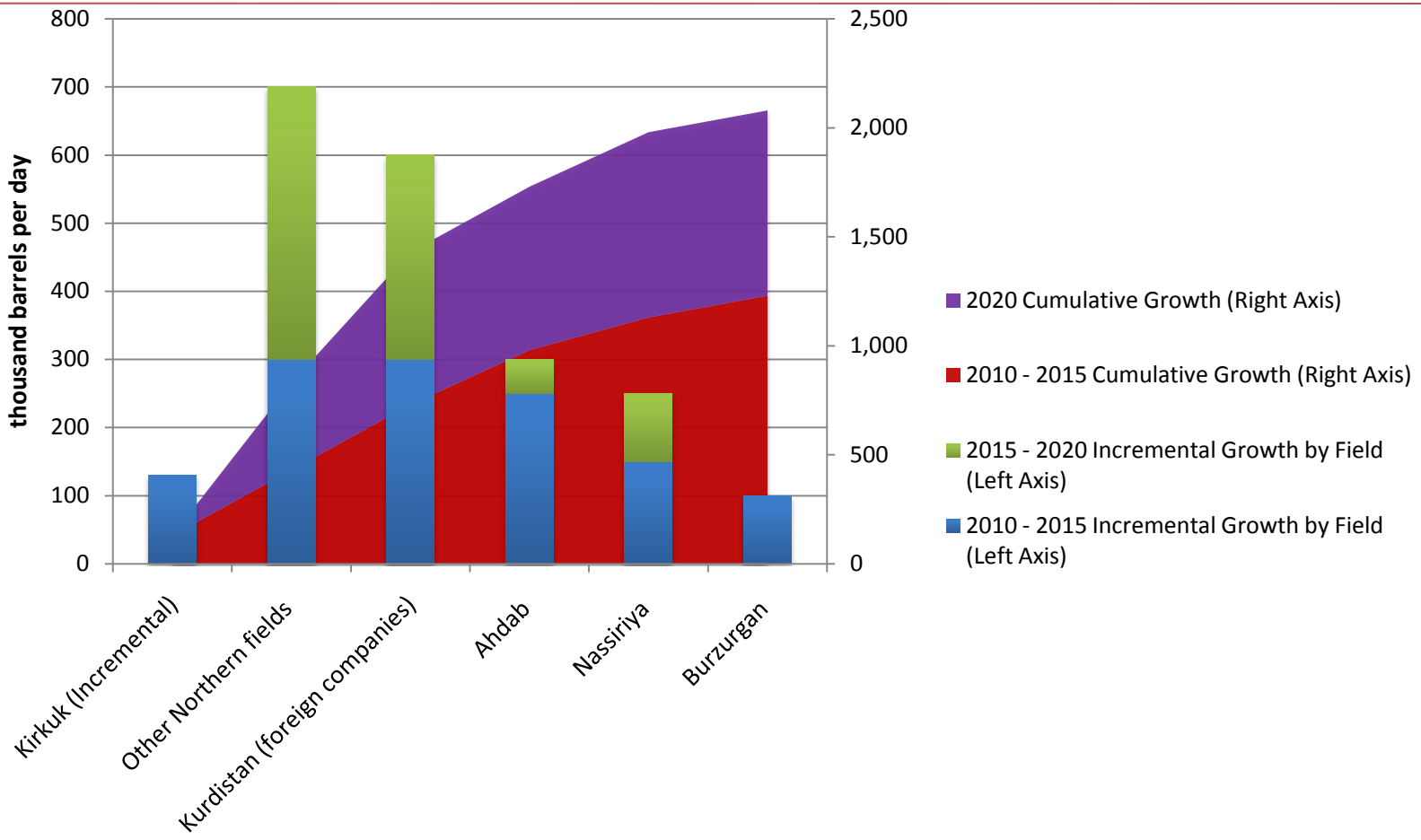
Expected Iraqi Production Growth Excluding Auctioned Projects



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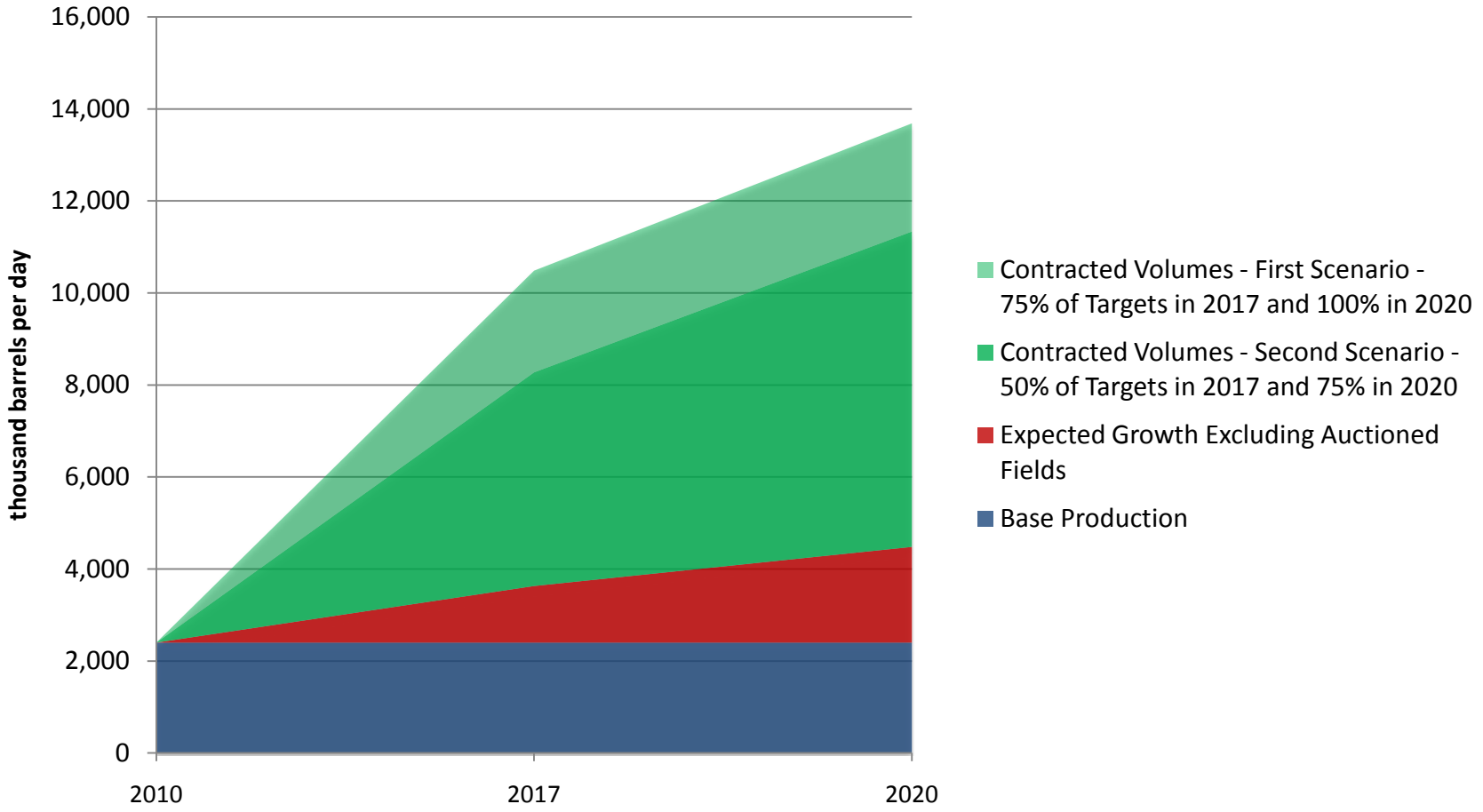
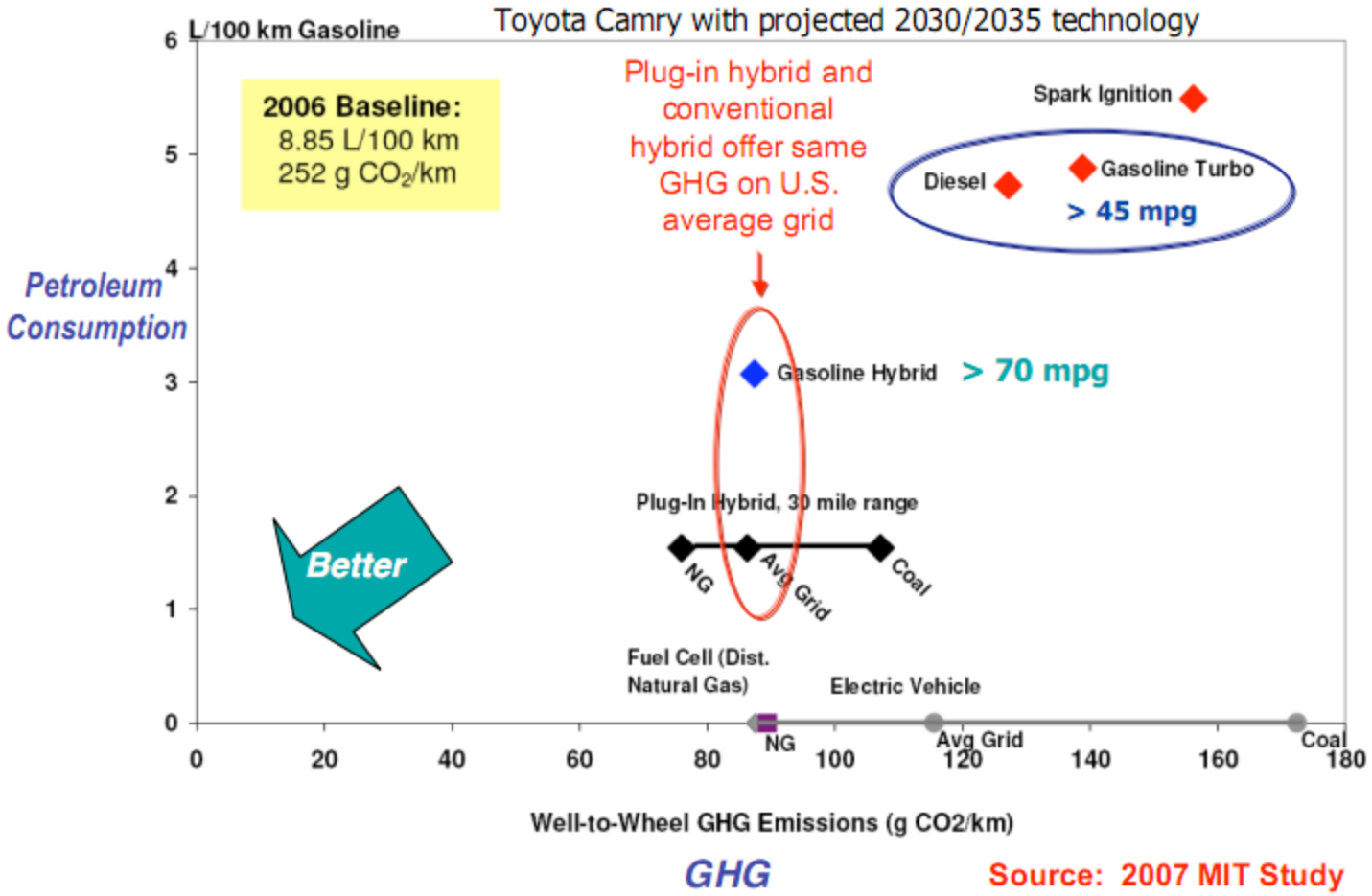
Iraqi Production Growth Under Several Scenarios



2030/2035 Technology Comparison



Source: 2007 MIT Study

January 28, 2010
Davos, Switzerland

*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**

Tony Hayward
Chief Executive Officer
BP plc

In 2009 the United States became the world's largest producer of natural gas

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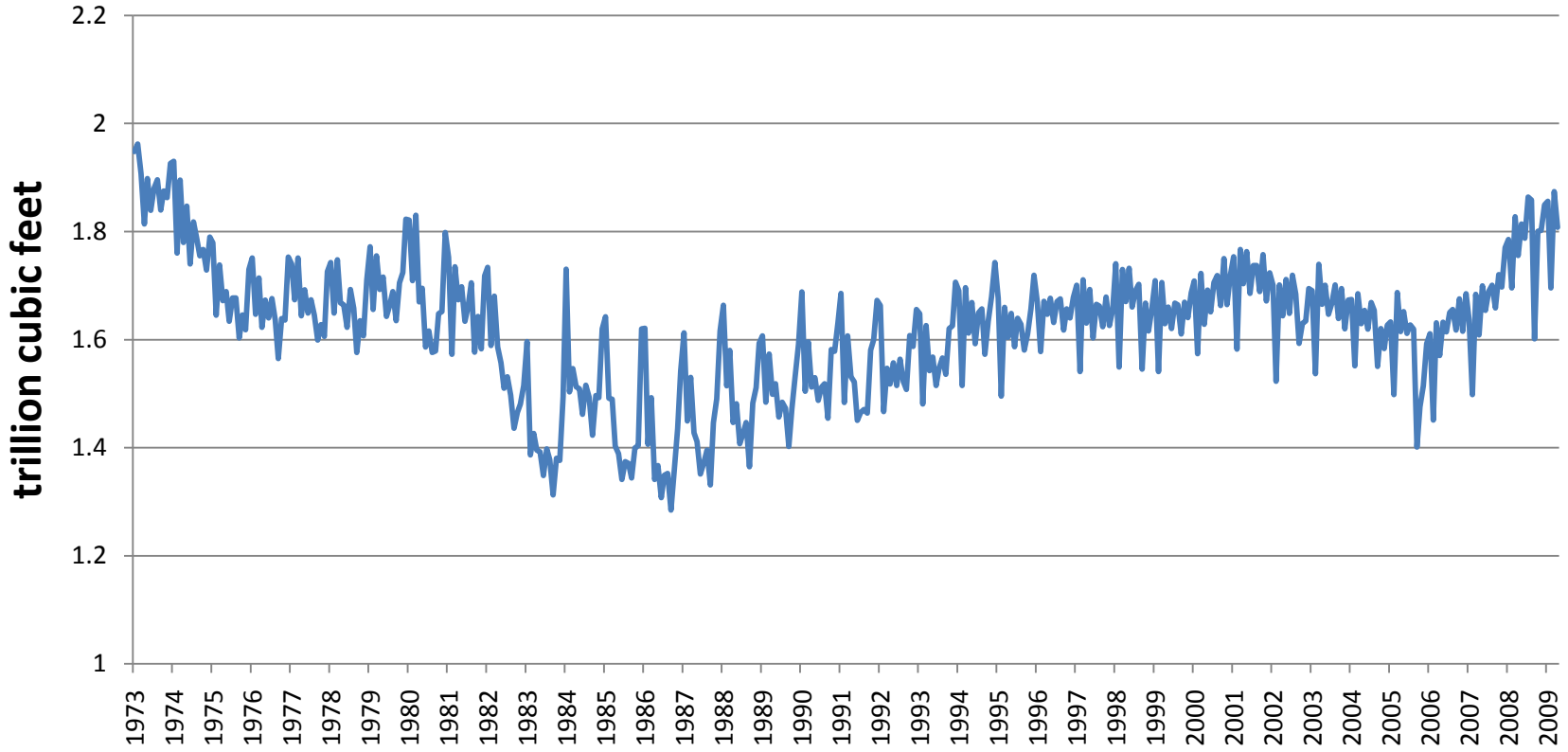
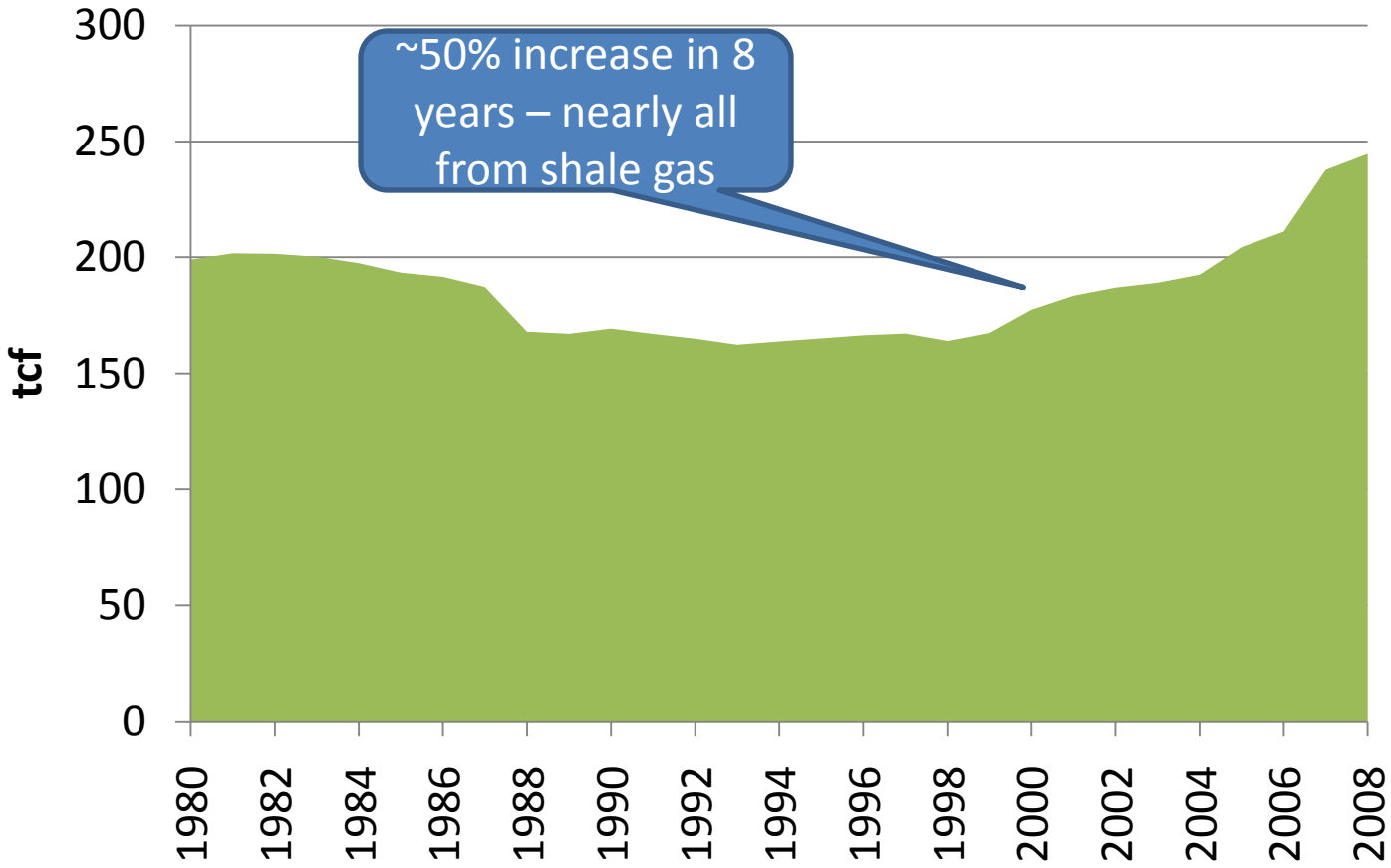
U.S. Monthly Marketed Natural Gas Production 1973 - 2009



Source: EIA Data

U.S. Proven Gas Reserves Since 1980



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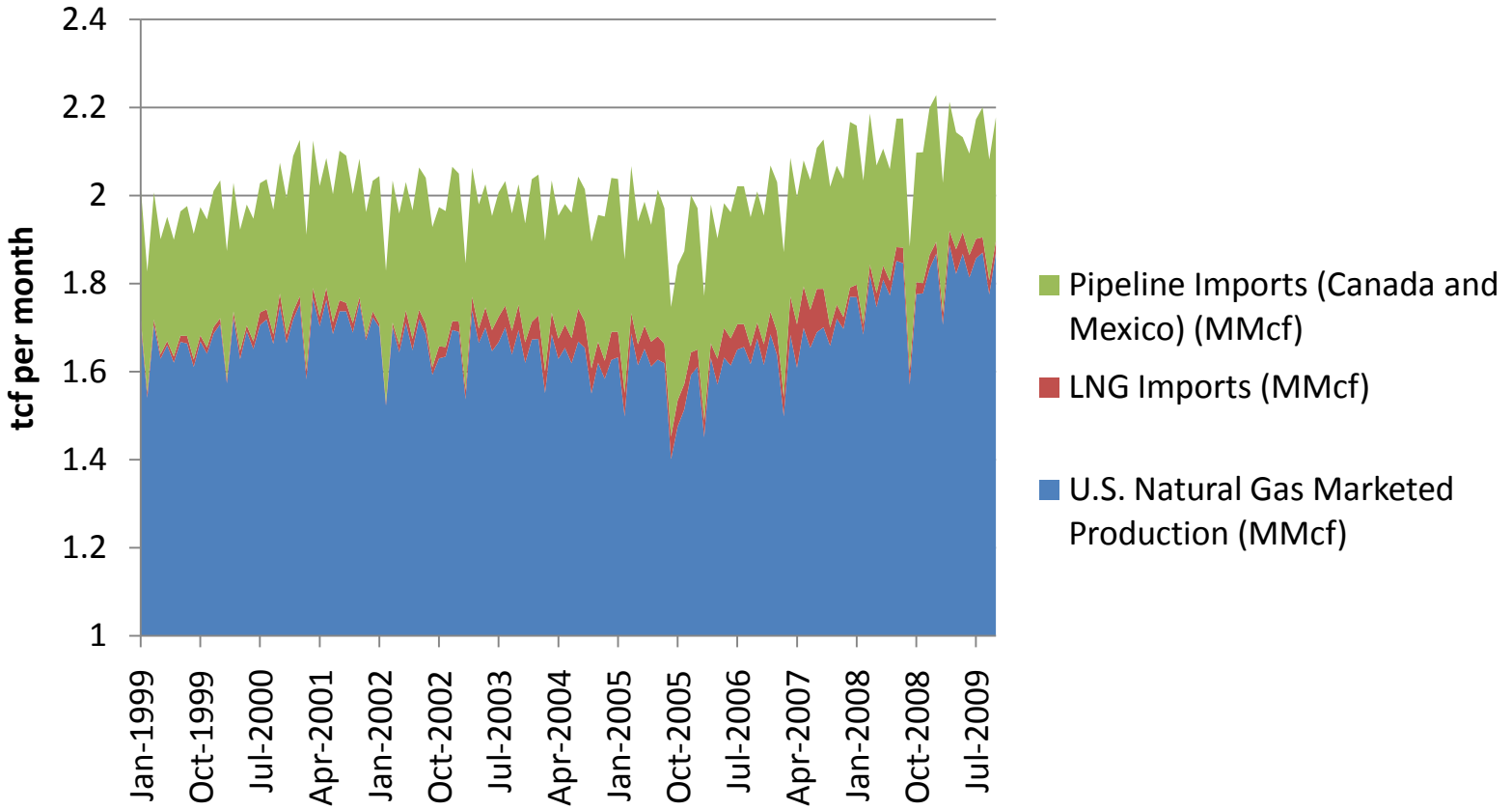
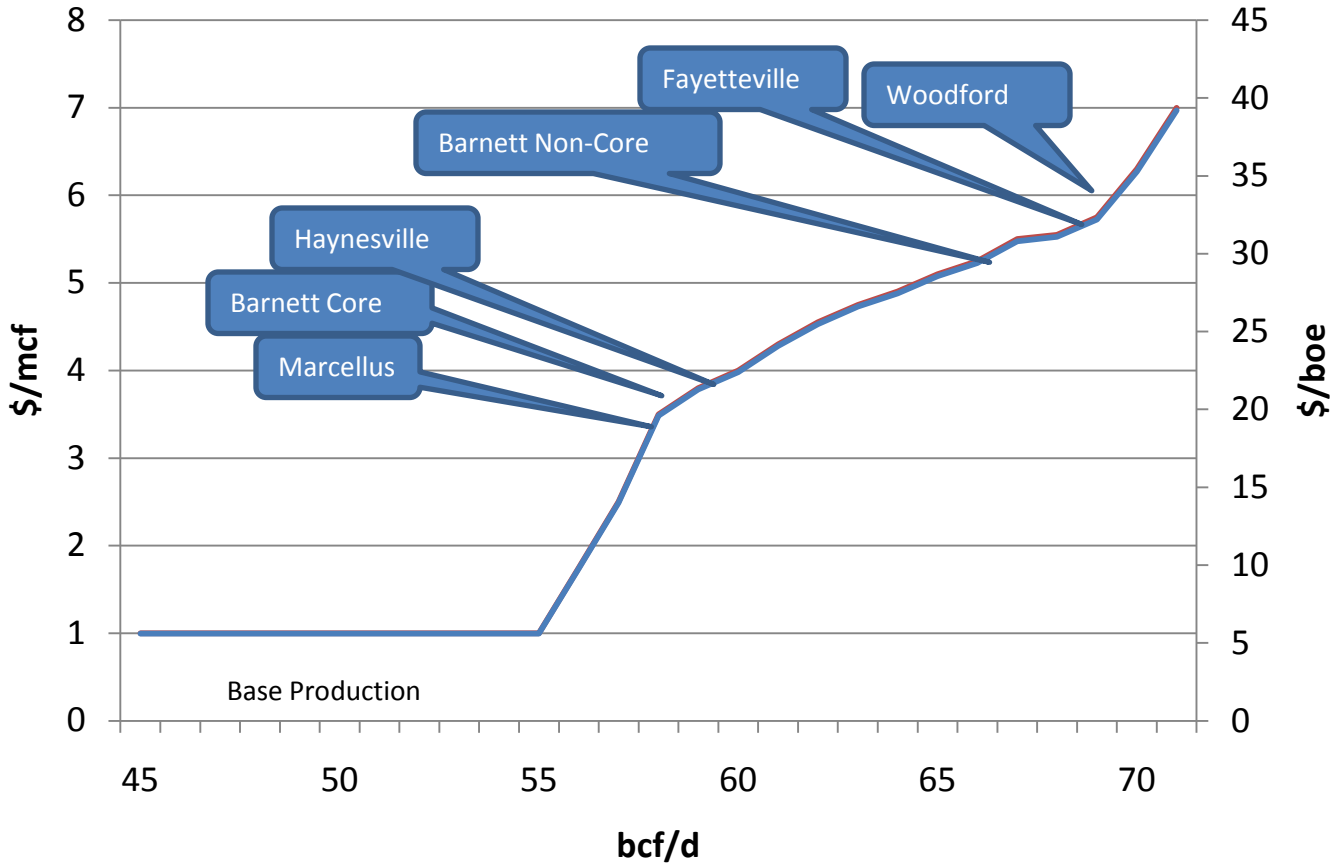
U.S. Nat Gas Production and Imports



Source: EIA Data

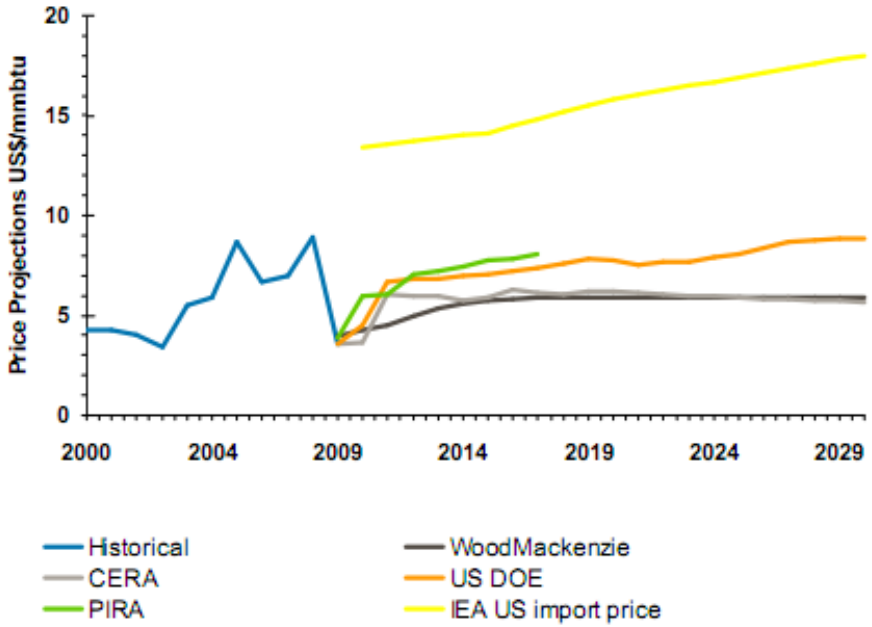
U.S. Shale Supply Cost Curve



Source: Wood Makenzie, EPRINC calculations

Range of U.S. Gas Price Projections

Gas price projections (US)



- New consensus view US$4 – 8/mmbtu!
- Driven by marginal cost of supply of unconventional gas (US)
- Impact of climate change, alternative fuels now more unknown

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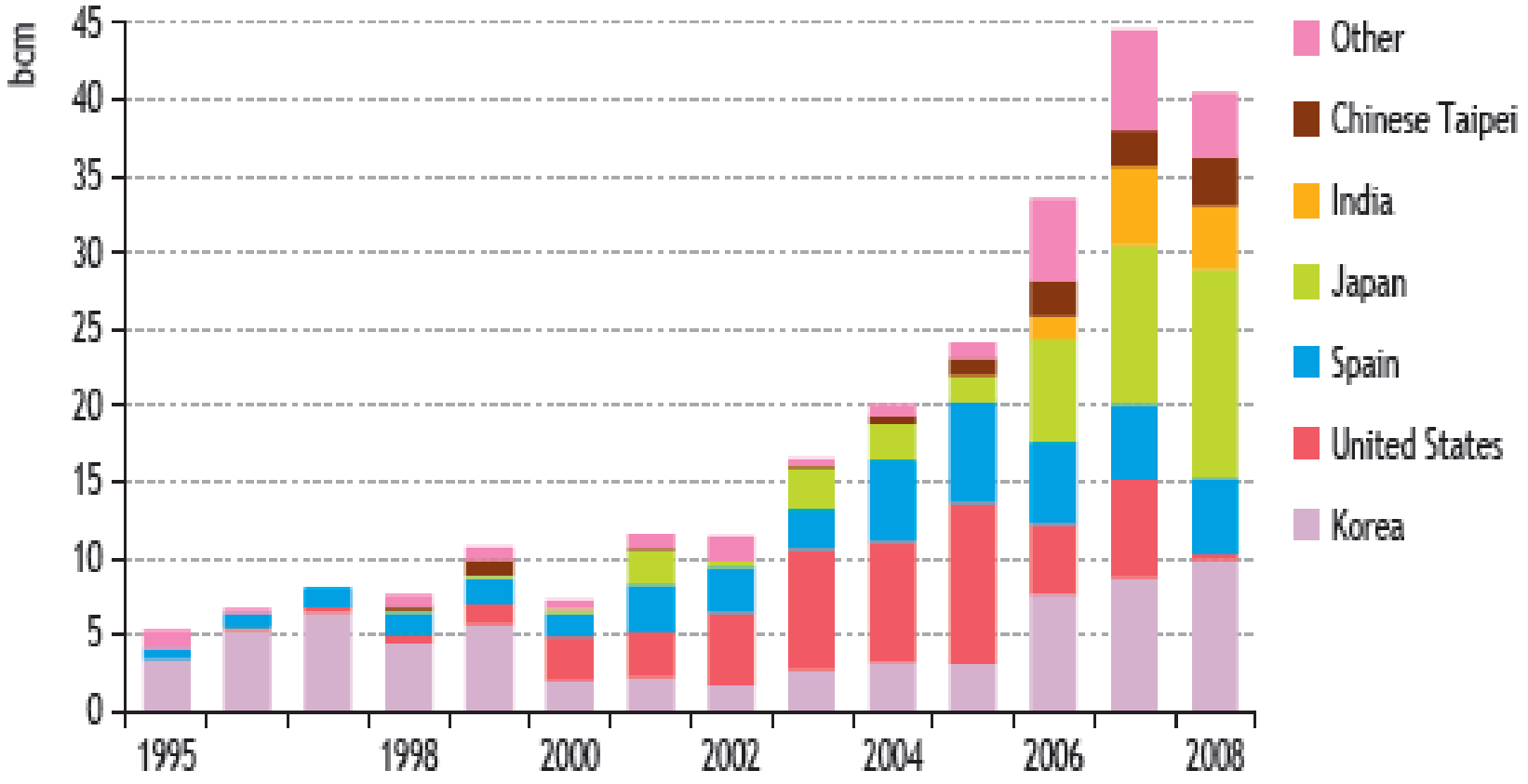
Spot LNG Trade by Country



Source: CIIGNL (2009)

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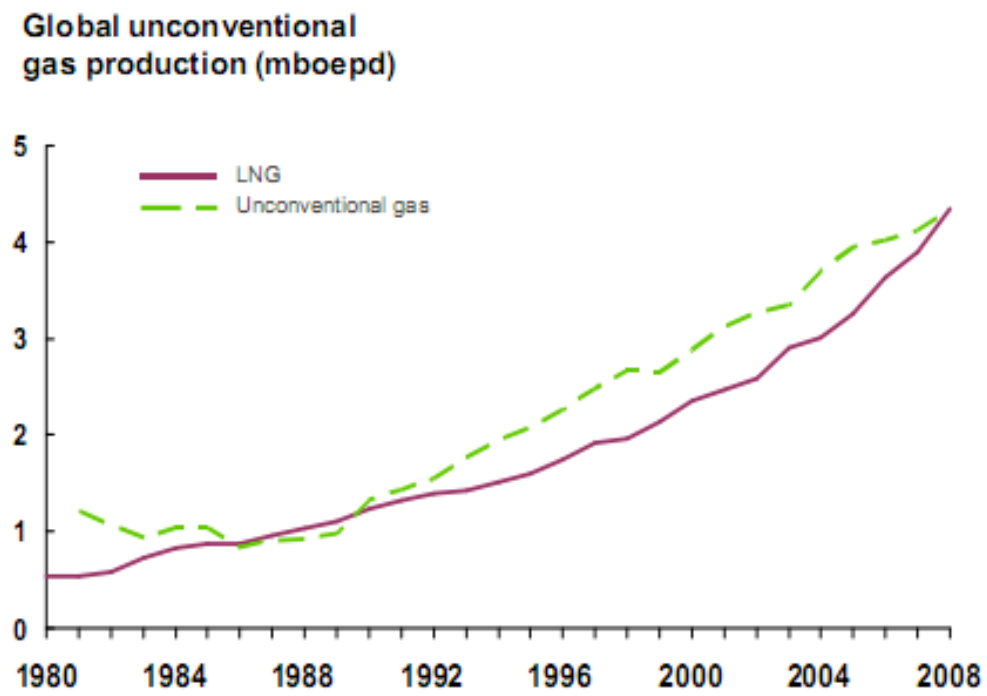
World LNG and Unconventional Gas Production



- 10% of global gas production (most of it in the US)
- 44% of US gas production
- Australia, India, Indonesia, and other places
- Europe now receiving attention

Source: SH

Potential for Shale Outside North America

- China and much of Europe possess shale formations similar to those found in the U.S.
  - However, the potential for large-scale gas production remains unknown – significant production is about a decade away

- Exploration in Europe is being carried out largely by joint ventures with companies that have experience in North American Shale
- Exploration in China is at an earlier stage than European exploration
- Successful shale development could have huge implications for historical exporters (Gazprom)

European Shale Exploration Sites

From the Economist

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Potential GTL Operating and Capital Costs

Gas Price - $ per MM btu	Operating ($10/bbl) and Energy Costs (40% energy loss) per barrel of produced product	Capital Costs - $ per barrel of Installed Capacity	Capital Costs ($ per barrel of installed capacity over 20 years)	Total Cost - Operating and Capital
3	**36.88**	$25,000	**3.42**	**40.30**
4	**45.84**	$50,000	**6.85**	**52.69**
5	**54.8**	$75,000	**10.27**	**65.07**
6	**63.76**	$100,000	**13.70**	**77.46**
7	**72.72**	$125,000	**17.12**	**89.84**
8	**81.68**	$150,000	**20.55**	**102.23**
9	**90.64**	$175,000	**23.97**	**114.61**
10	**99.6**	$200,000	**27.40**	**127.00**

*EPRINC preliminary estimates

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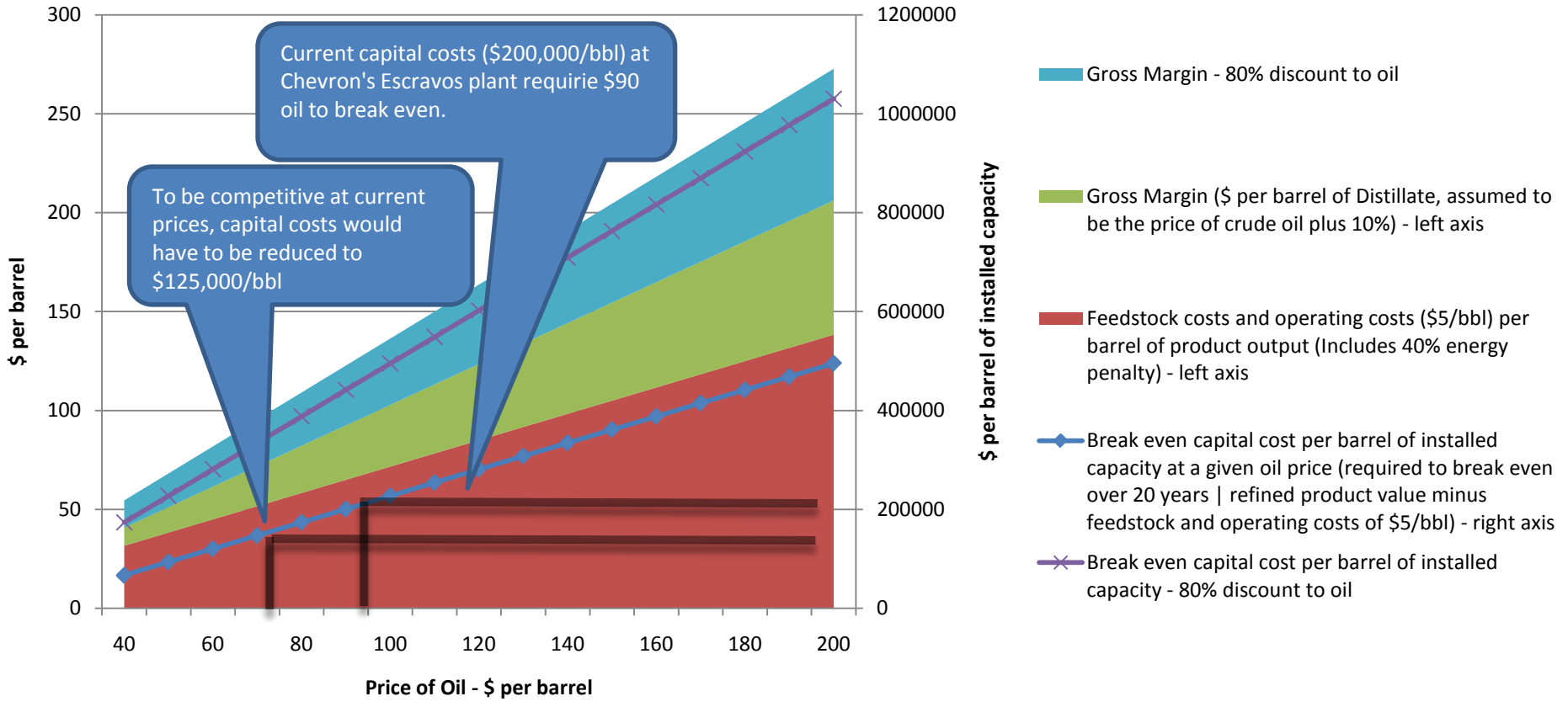
Capital Costs and the Gas Crude Spread*



*EPRINC preliminary estimates

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Gas – Heading to a World Market?

- Natural gas markets undergoing rapid and fundamental shifts in supply, demand, and pricing
- European importers are reducing imports from Gazprom – Russians losing leverage.
- At the same time, supply of liquefied natural gas (LNG) has increased globally.
- Surge in U.S. shale gas production is gaining interest worldwide
- World markets are saturated with natural gas, pressuring prices

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Policy Implications

Energy Security – more closely linked to volatility instead of dependence.

Oil Shortages and Peak Oil—issue is the backstop price for petroleum. Iraq, and abundance of natural gas may drive down backstop price.

Oil is Fungible – Chinese strategies "to lock" up oil resources not necessarily bad for the West and may even be helpful.

Government policies are often inadequate at addressing market uncertainties, e.g., Gazprom unable to change strategy as its leverage and asset value decline, but may be open to more foreign investment

Policy Implications, con'd.

Expensive and state directed strategies (e.g., US commitment to electric cars), without understanding potential for paradigm shifts, failure modes, likely to be very costly.

Shale/Unconventional Gas Technology Migration Will Accelerate –
Reserve Growth Likely to Continue and long term prospects for GTL will continue to improve -Potential to Lower the Backstop price for transportation fuels.

U.S. and China both benefit from increments to world oil and gas supplies, input costs to national economies decline, e.g., $20/bbl price decline over long term worth NPV to U.S. economy of over $1 trillion in import savings alone. High benefits to both countries in greater stability in Middle East (especially Iraq).

World's Largest Oil Spills