



# Ethylene – Good Today, Better Tomorrow – A Year Later

Goldman Sachs Chemical Intensity Day

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March 27, 2012

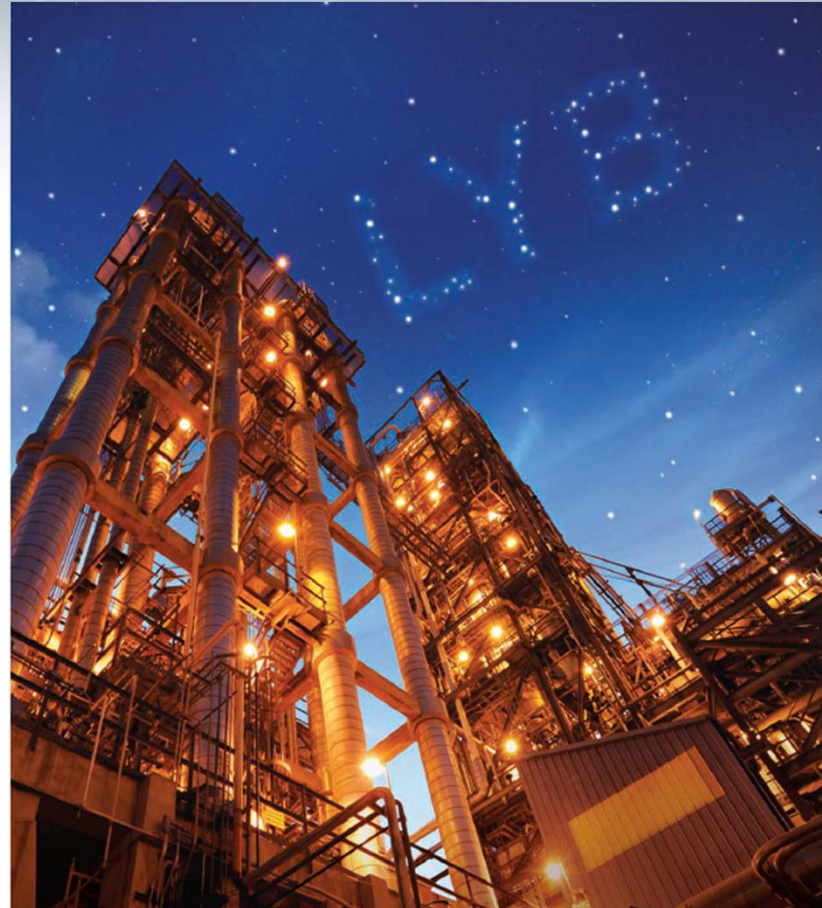
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# Last Year We Said: The Stars are Aligning for a Bright Tomorrow

- **Positive macro factors**
  - Global GDP
  - Asian development
- **Supply trends**
  - Limited construction
  - Limited Middle East gas avails
  - Existing asset reliability
- **U.S. natural gas**
  - A Middle East analog
  - Fractionator construction
  - Elevated crude oil price

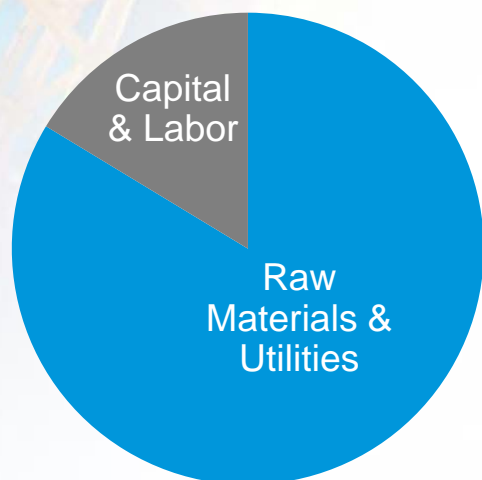


These trends plus two key factors continue to define industry and regional profitability:

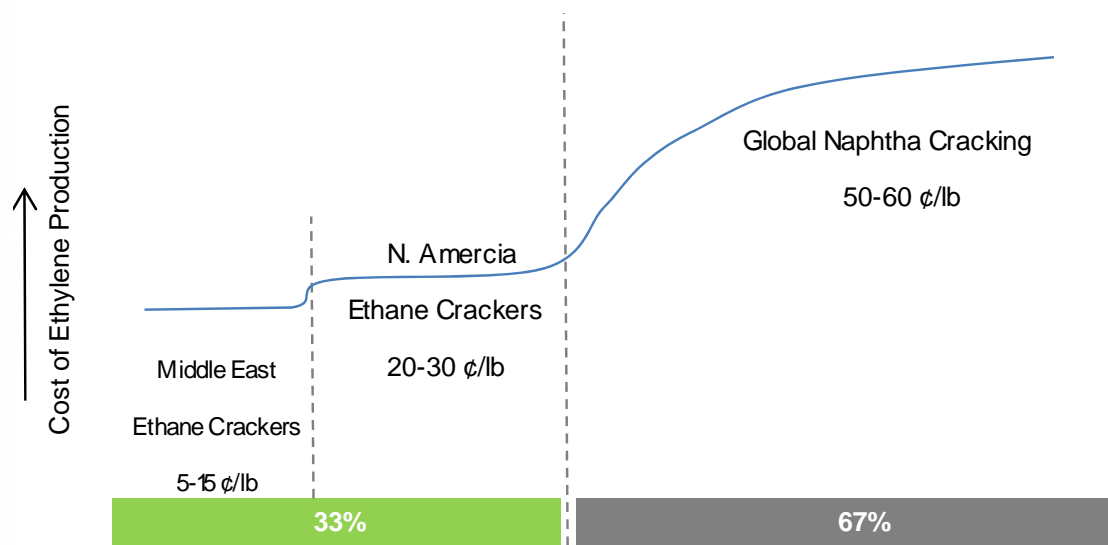
- **Regional Raw Material Costs**
- **Global Supply / Demand**

# With Supply/Demand Still Recovering, Natural Gas versus Crude is Currently the Dominant Factor

## Integrated Polyethylene Production Cost



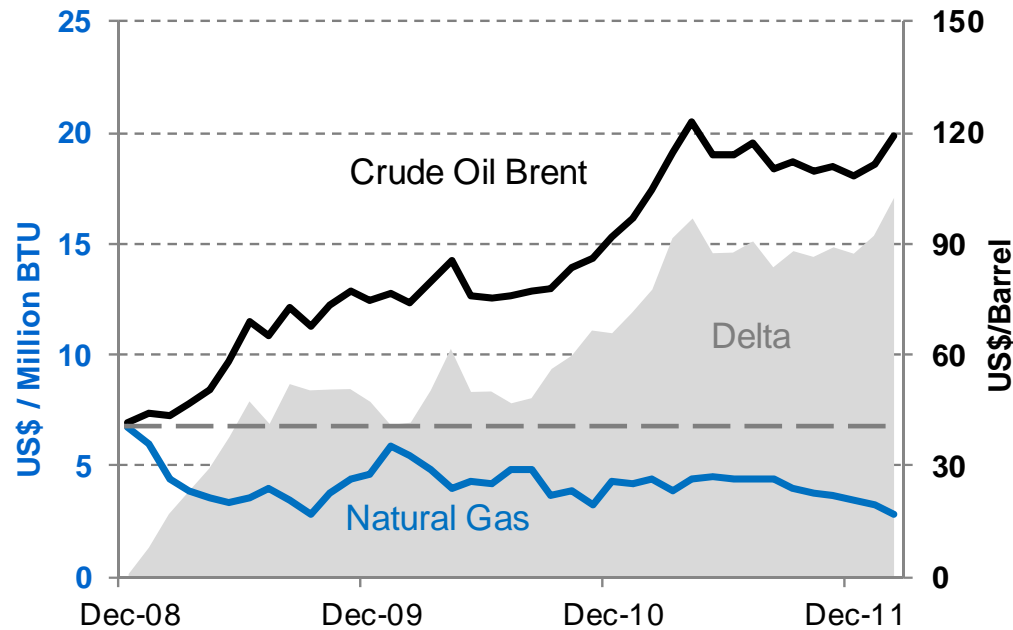
## Global Capacity Cost Curve



Raw material factors define regional competitiveness

Source: CMAI

# Both Natural Gas and Crude Prices have Contributed to Differential Performance in the US Ethylene Industry



**Cost of Ethylene Production**  
(¢/lbs)

	1H'09	Q1'12	Delta
Ethane-based (US)	20	23	3
Naphtha-based (US)	35	54	19
Ethylene price (NEA)	34	61	27

Crude price increases have been as much a factor as have US natural gas price declines

Source: CMAI

# Are Crude Oil Prices likely to Remain Elevated?

Brent Crude Oil Forecast

Year	<u>2011</u>	<u>2012E</u>	<u>2013E</u>	<u>2014E</u>	<u>2015E</u>	<u>2016E</u>
\$/bbl	111	117	103	102	104	108

## Factors influencing continued strong price

- Global economic growth and crude consumption
- Global vehicle sales
- Rising production costs
  - Marginal crude sources
  - Middle east social cost pressures
- Political instability in producing nations

## Factors influencing to the downside

- US production resurgence
- Vehicle fuel efficiency
- Regulations diversifying fuel mix

Most experts forecast continued elevated crude oil

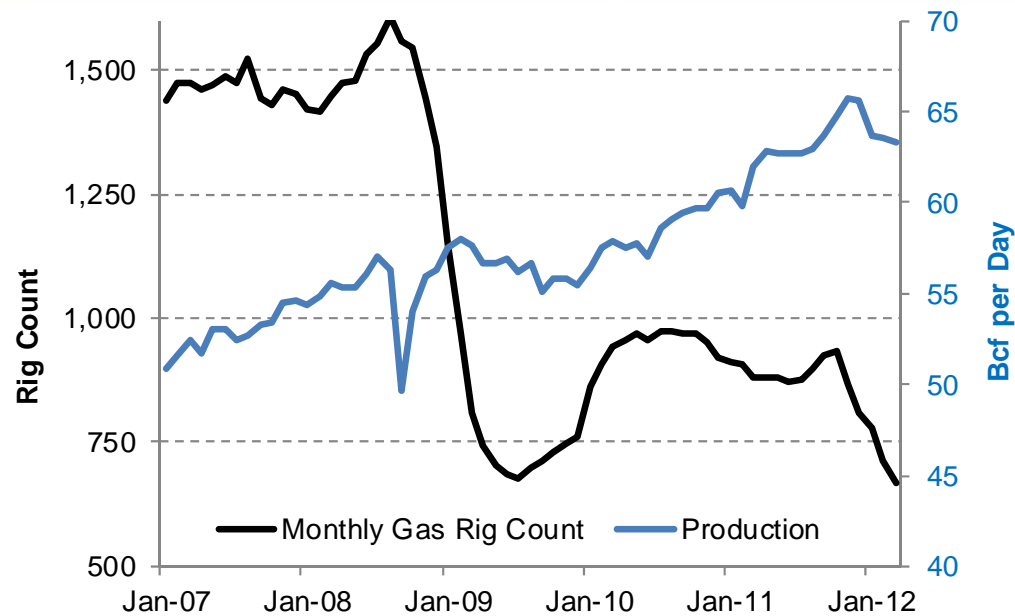
Source: CMAI

# Will Natural Gas Prices Remain Low?

Henry Hub Price Forecast

Year	<u>2011</u>	<u>2012E</u>	<u>2013E</u>	<u>2014E</u>	<u>2015E</u>	<u>2016E</u>
\$/mbtu	4.0	2.8	3.7	4.3	4.6	4.9

Source: Global Insight

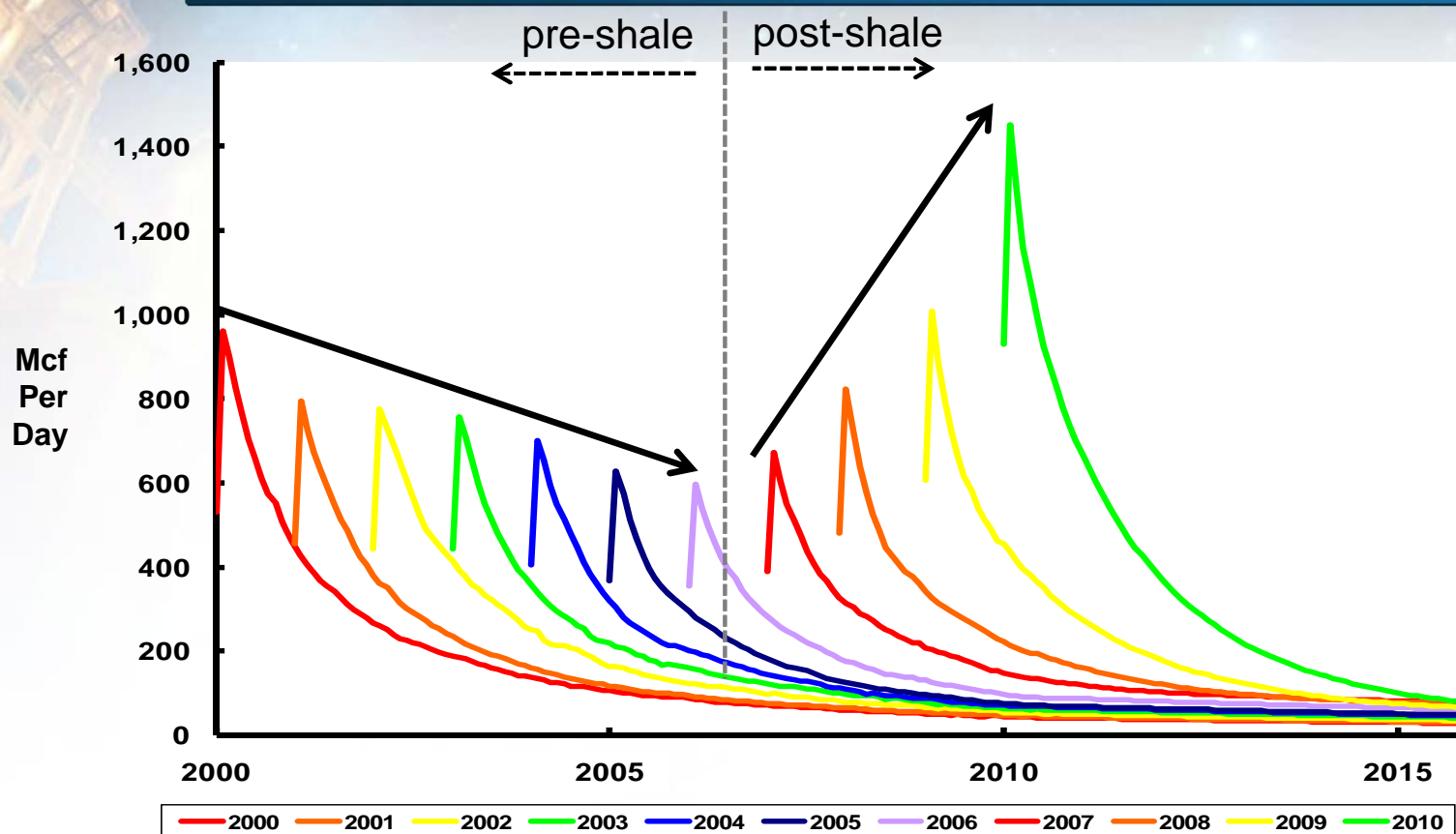


Source: EIA, Bentek

- Production has remained strong despite reduced rig count
- Estimate that rig count must fall below 700 to stabilize inventory levels

# Drilling Technology is Driving the Success

Well productivity has increased dramatically



Source: IHS CERA. May not be used for any purpose without the express written consent of IHS CERA

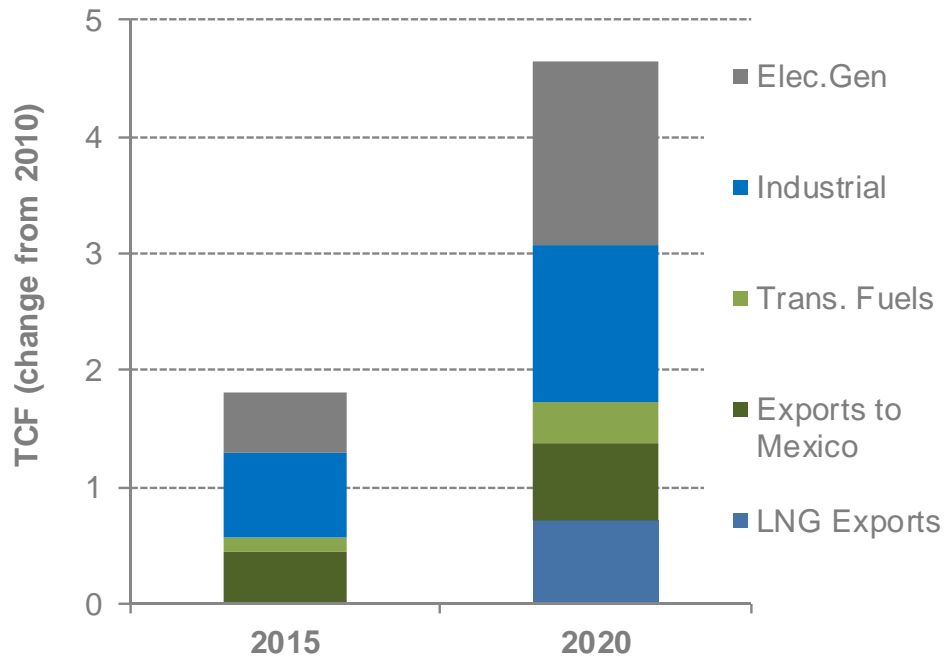
Note: Mcf = thousand cubic feet.

Potential for further improvements as experience develops and majors become more significant participants



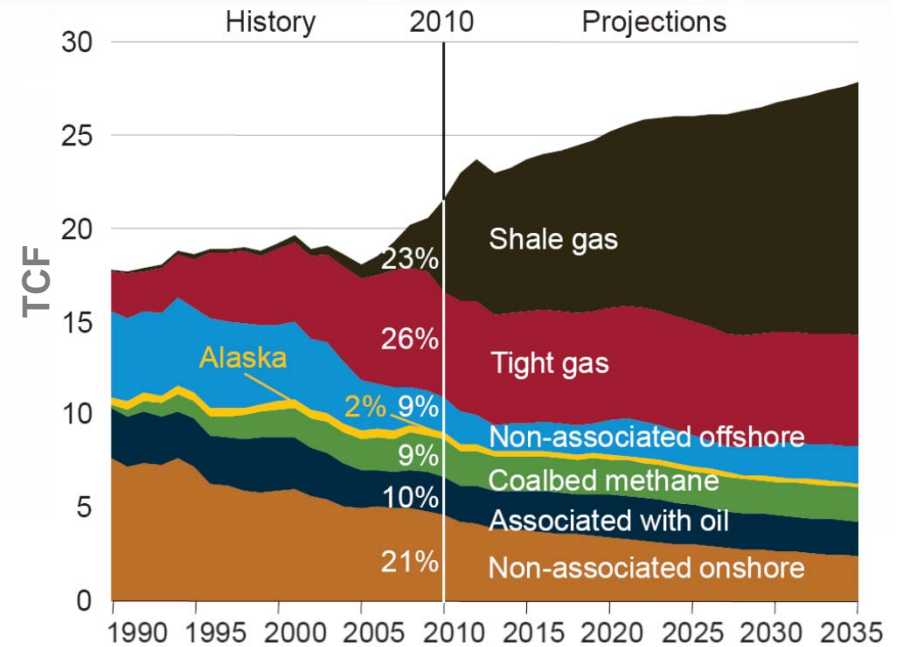
# Low Prices and Abundant Supply are Forecast to Drive Strong Natural Gas Demand Growth

## Gas Demand Growth



Source: PIRA

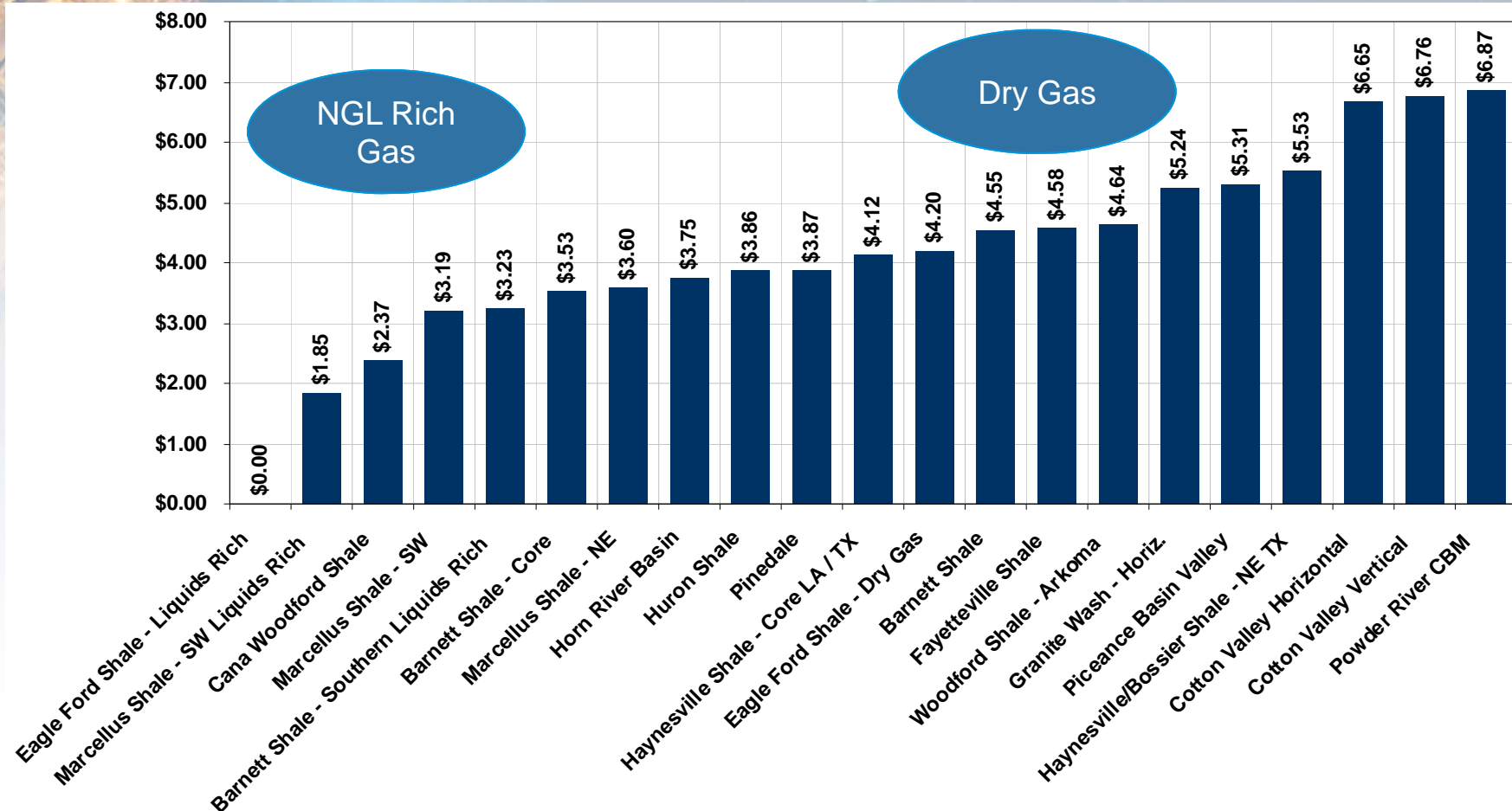
## NG Supply Sources



Source: EIA

Natural gas end use increase leading to increased ethane production in a well supplied natural gas environment

# Natural Gas NYMEX Price Breakevens by Play (15% After Tax Rate of Return)

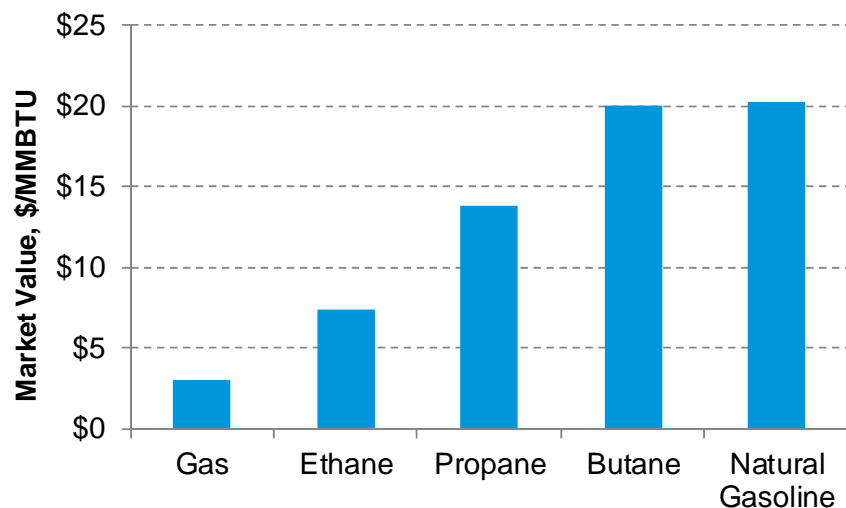


- Most fields yield an acceptable return at \$5-6.00/mmbtu
- Low natural gas prices drive production to NGL rich fields

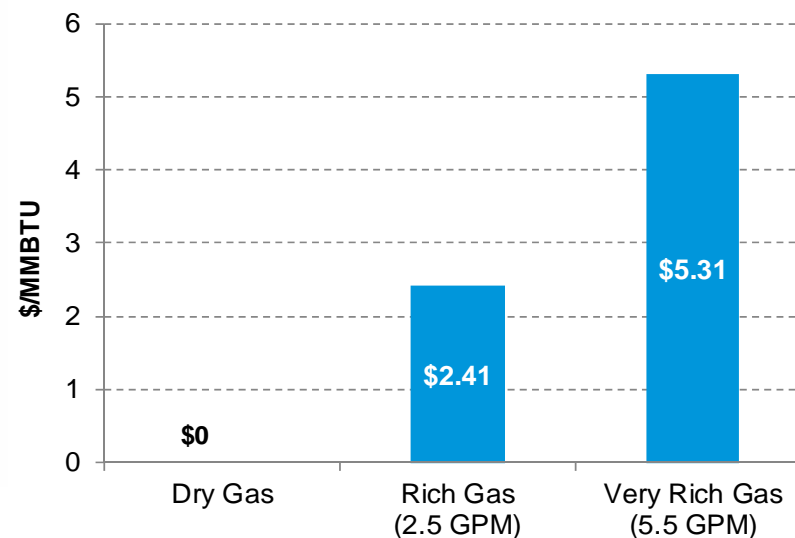
Source: Investment Banks

# The Value of NGLs Drives Production Even at Low Natural Gas Prices

## NGL Component Values vs. Natural Gas



## Dry vs. Rich Gas: NGL Uplift (Margin Over Fuel Value)



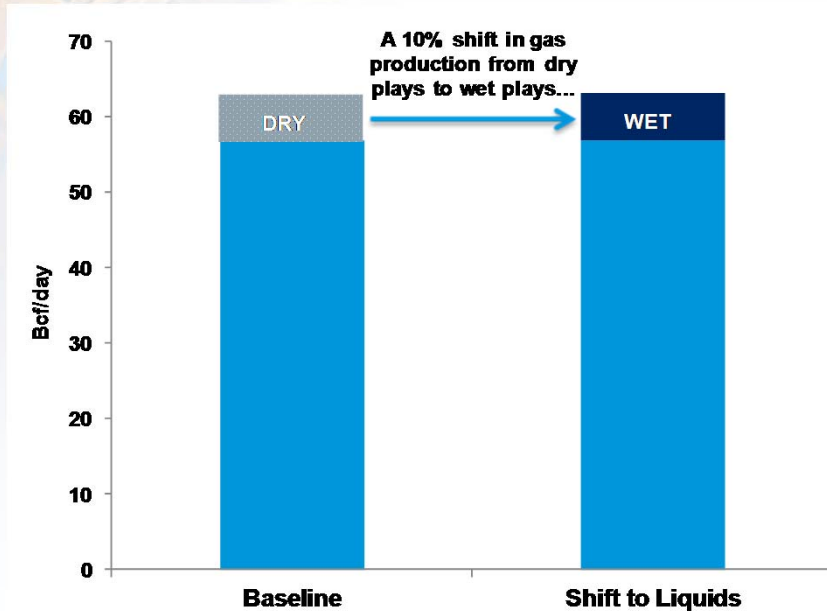
Potential for further improvements as experience develops and majors become more significant participants

Source: CMAI, LYB

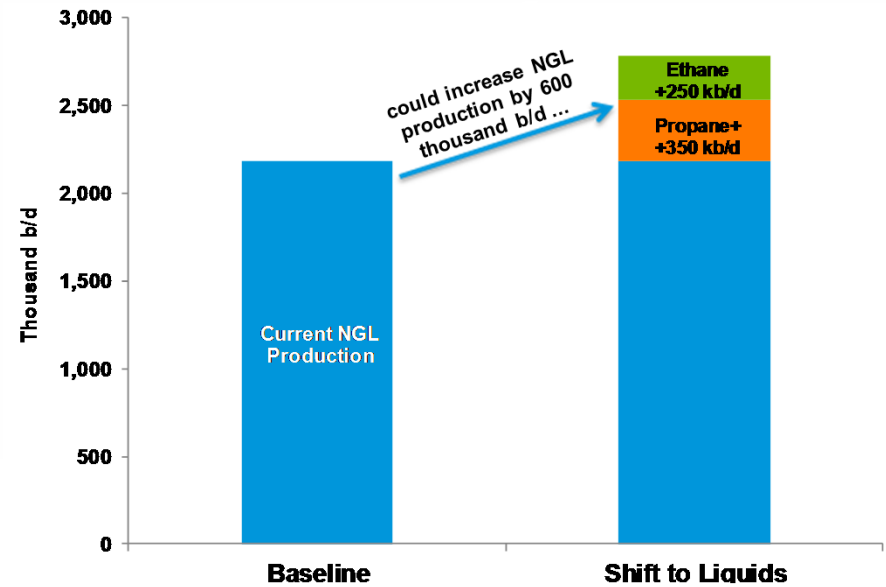
# Trend Toward Wet Wells Benefits US Ethylene Producers

If we assume 10% shift from dry gas to wet gas → NGL production can increase significantly

## US Gas Production



## US NGL Production

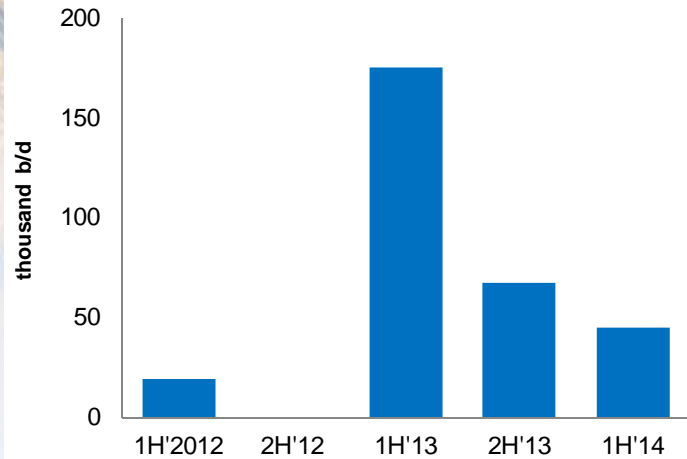


As drilling emphasis shifts, ethane production is not being sacrificed, in fact, it can be increased

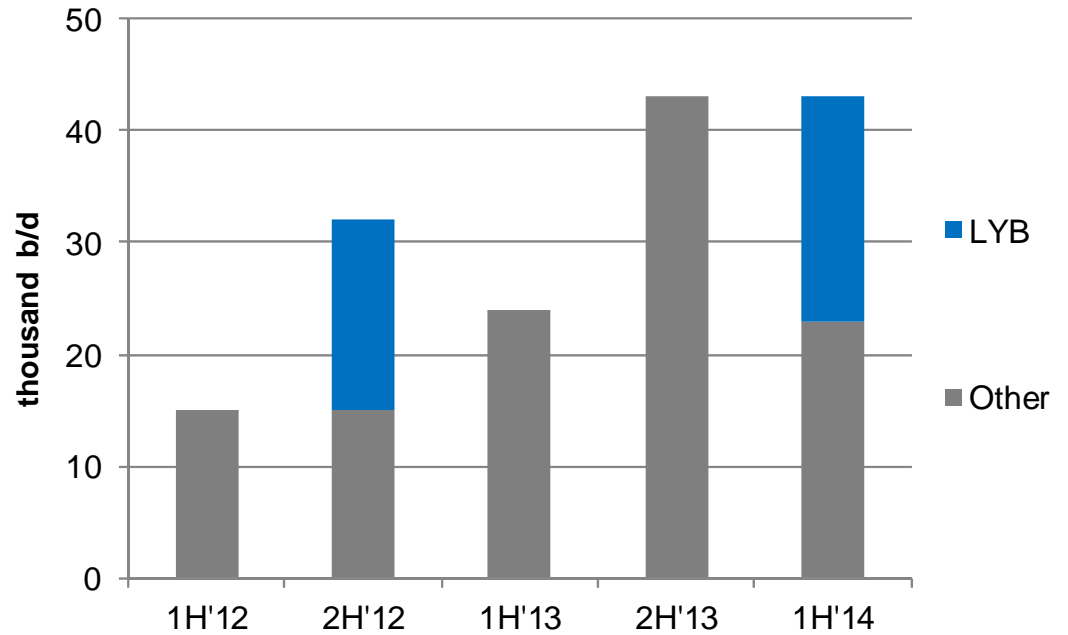
Source: LYB

# Both the Mid-Stream and Ethylene Industries are Responding to this Trend

## Gulf Coast Fractionation Capacity Ethane Additions

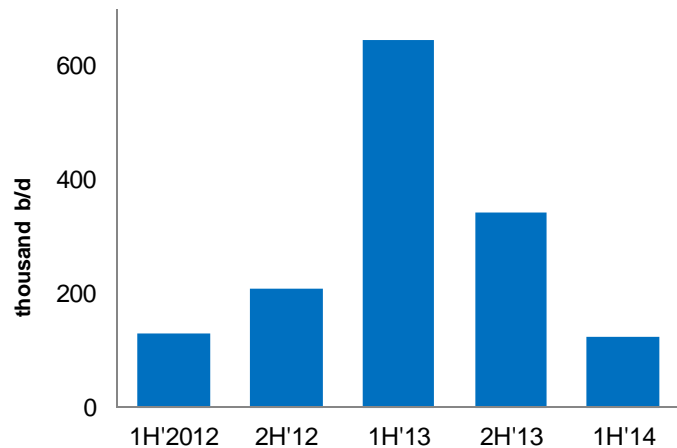


## Ethane Cracking Capacity Growth



Sources: LYB

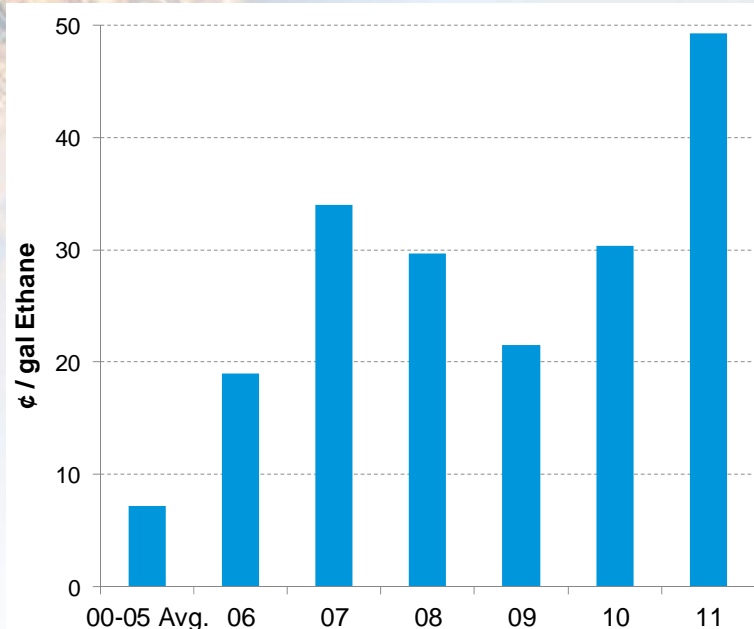
## Pipelines Flowing into Mont Belvieu



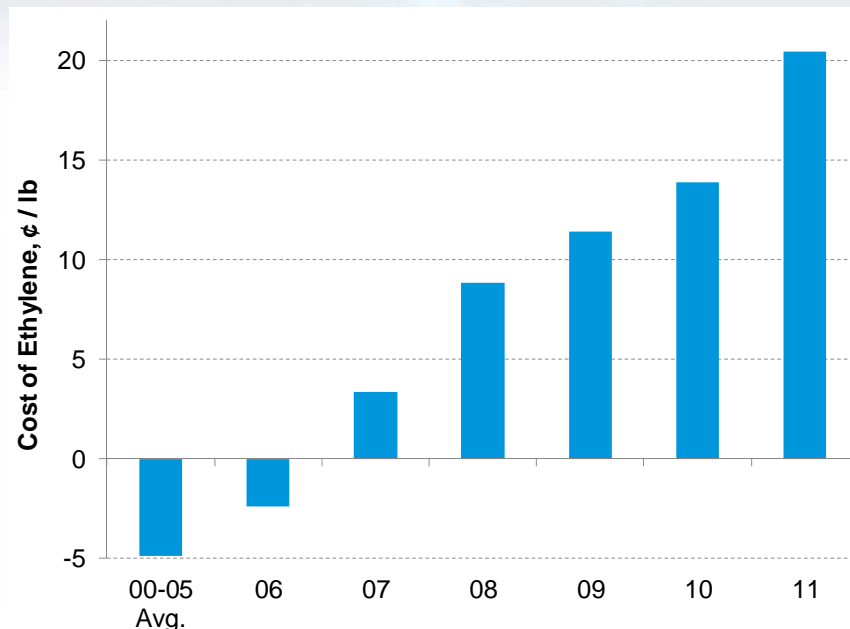
Development has been like a game of leapfrog and the next step is significant fractionation and pipeline infrastructure addition

# Ethane Premiums to Natural Gas have Grown but so has the Advantage Versus Global Naphtha

## Ethane Premium to Fuel Value ("Frac Spread")



## US Ethane Advantage to NE Asia Naphtha



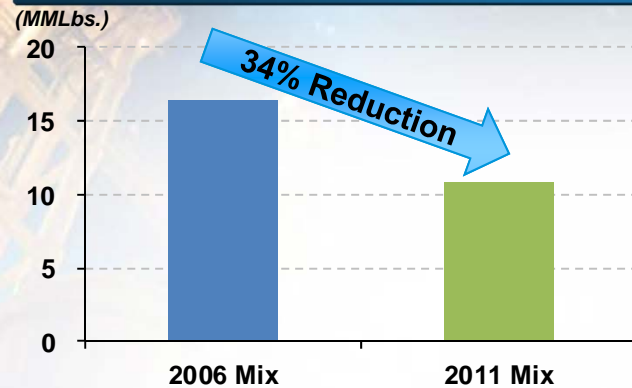
Ethane price at equivalent value to:

- US natural gas energy value: 15-20 c/gal
- Global naphtha economics: 115-150 c/gal

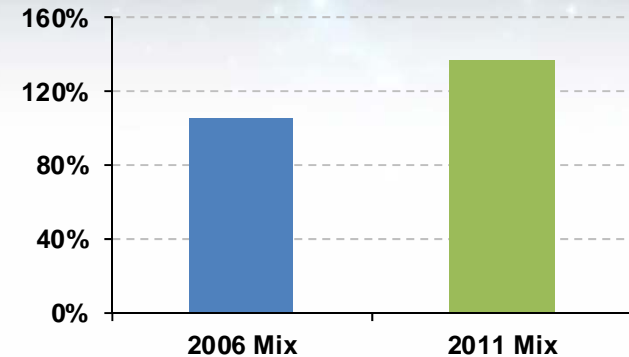
Source: CMAI

# Shift in Feed Mix Has Significantly Impacted Co-Products

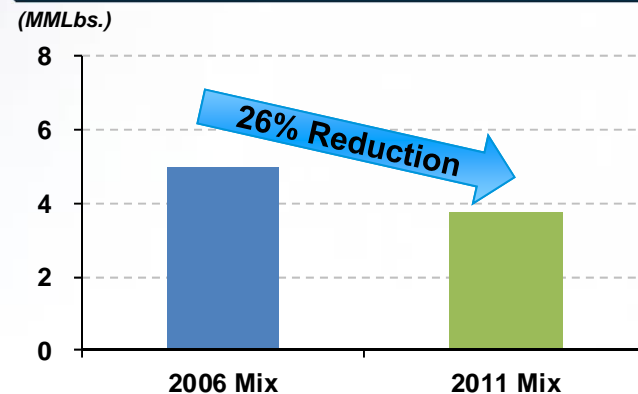
## Estimated Propylene Production (1)



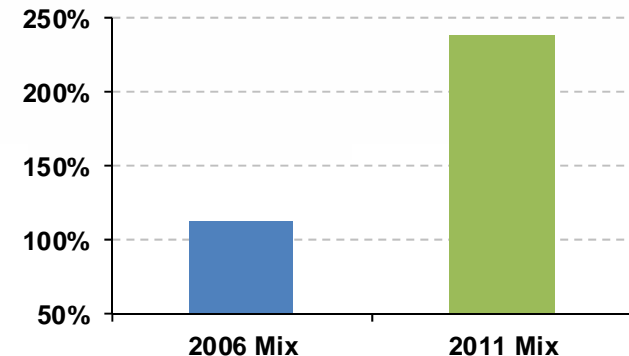
## Propylene Price as a % of Ethylene



## Estimated Butadiene Production (1)



## Butadiene Price as a % of Ethylene



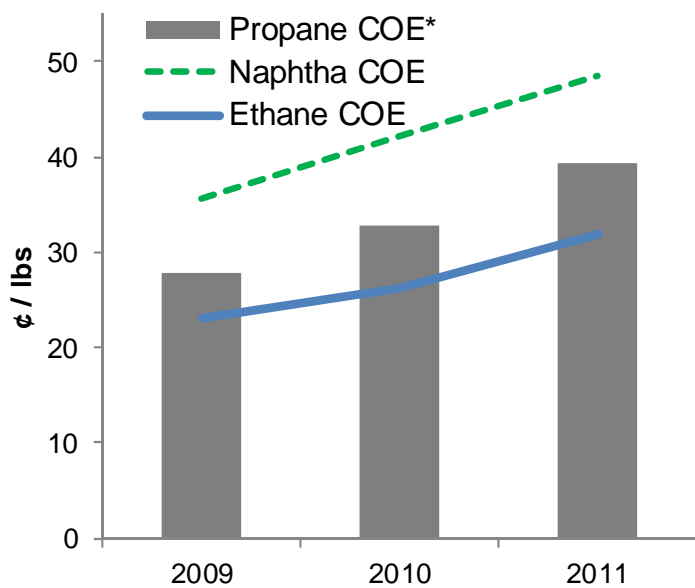
- Co-product capabilities add significant value
- Future growth in durable products could further benefit co-products

Sources: CMAI.

(1) Estimated co-product production based on 2011 ethylene production and 2006 and 2011 feed mixes.

# Ethane is Not the Only Important NGL in the US Market

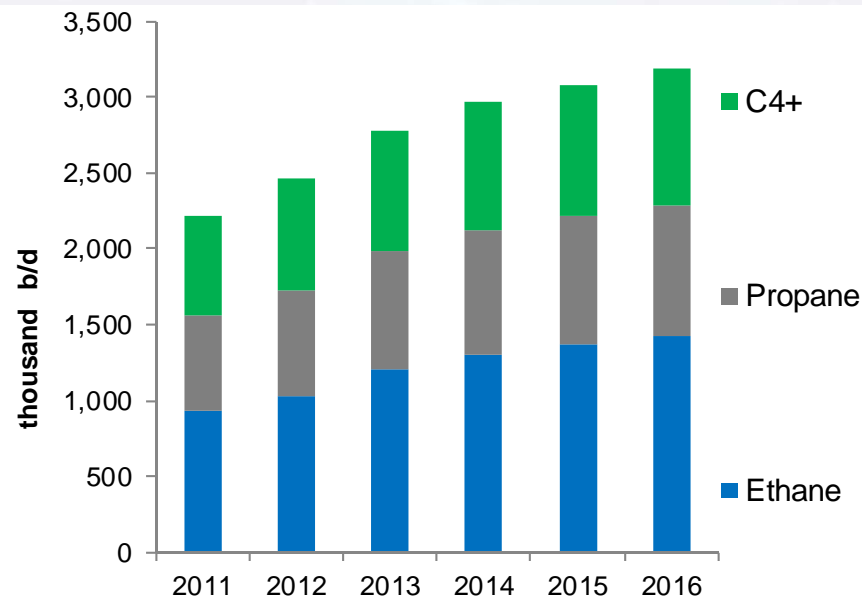
## US Cost of Ethylene Production



Source: CMAI

\* COE – Cost of Ethylene

## US NGL Supply Growth



Source: Bentek

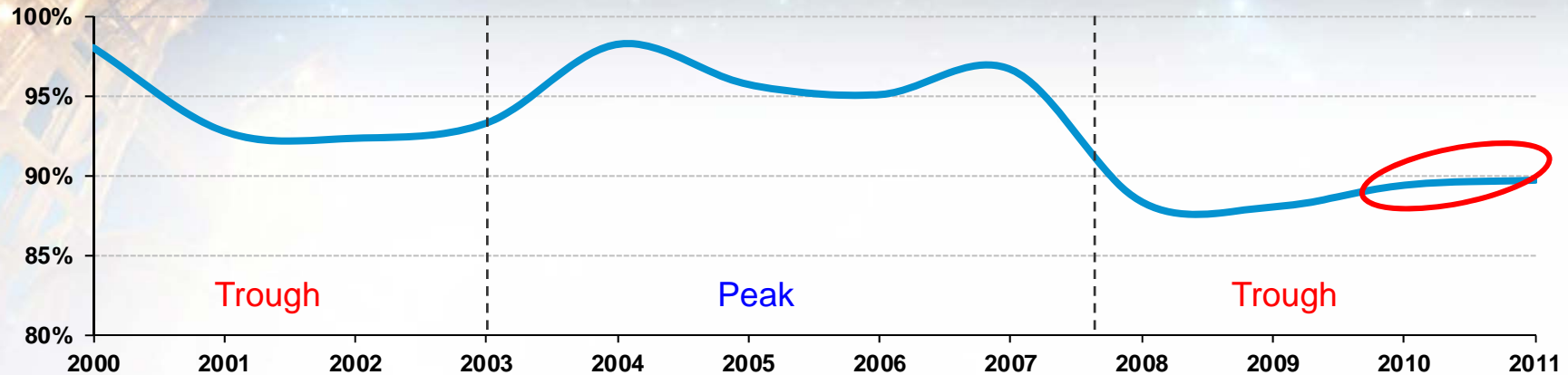
### Propane:

- Can limit ethane pricing
- Greatly expands the cracking pool

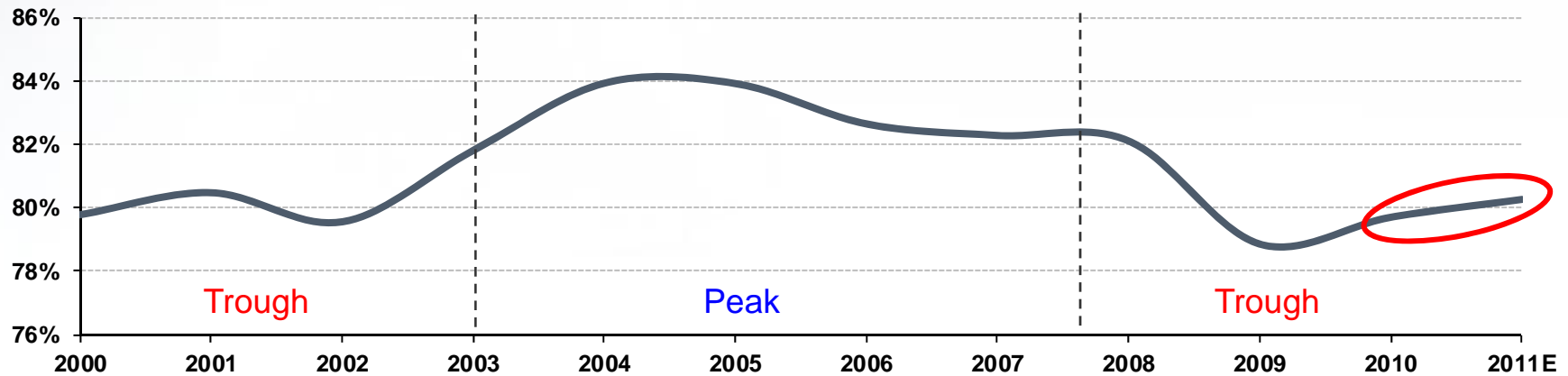


# Strong LYB Results in Global Trough

## Global Ethylene Effective Operating Rates



## Global Refining Operating Rates

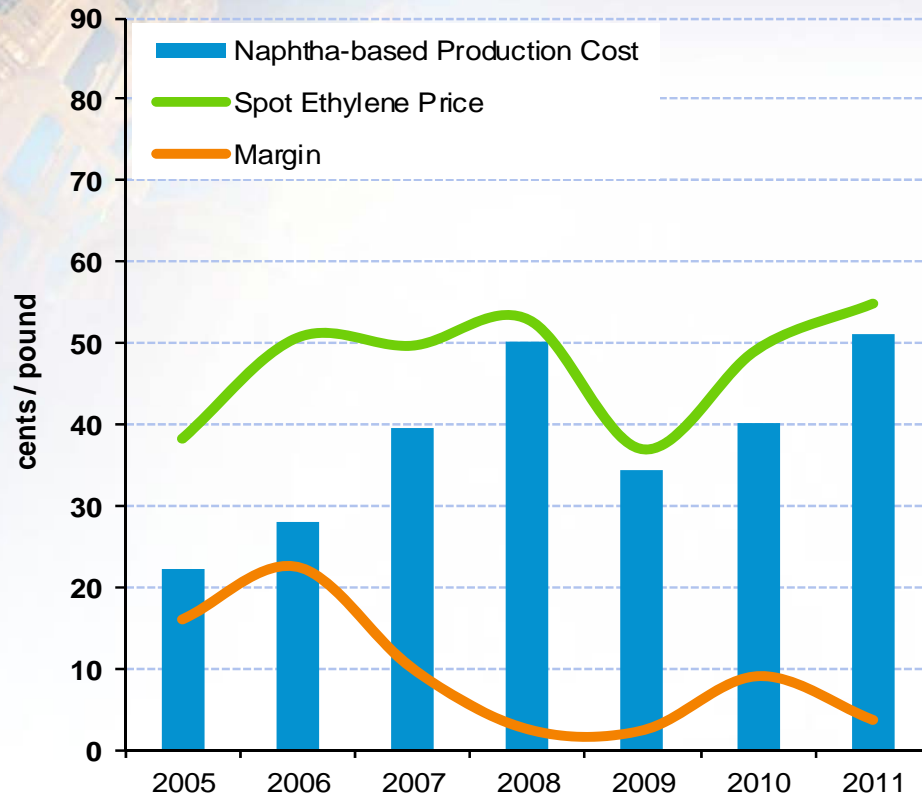


Performance has been driven by actions, geographic position and assets, not cycle

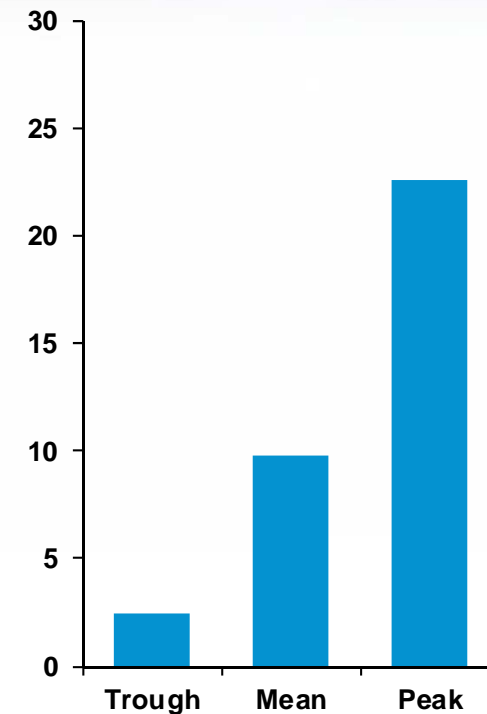
Sources: CMAI, Purvin & Gertz.

# At These Low Operating Rates Global Margins Have Been Near Trough Levels

## Northeast Asian Ethylene Margins



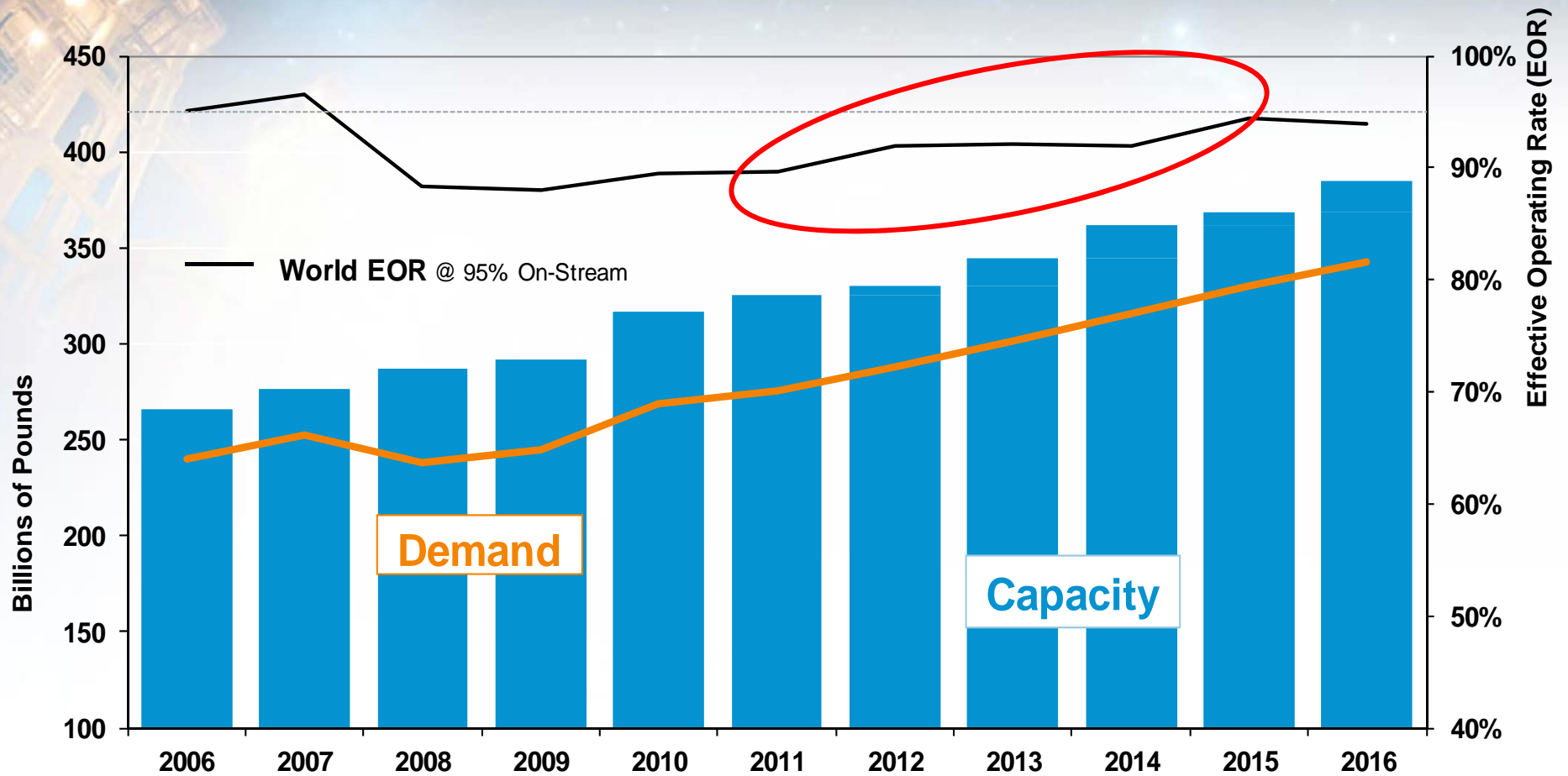
## Typical NE Asian Cycle Margins



Asian margins have been weak, Asian prices set the global price

Source: CMAI

# Cyclical Upside is a Second Chapter in a Positive Story

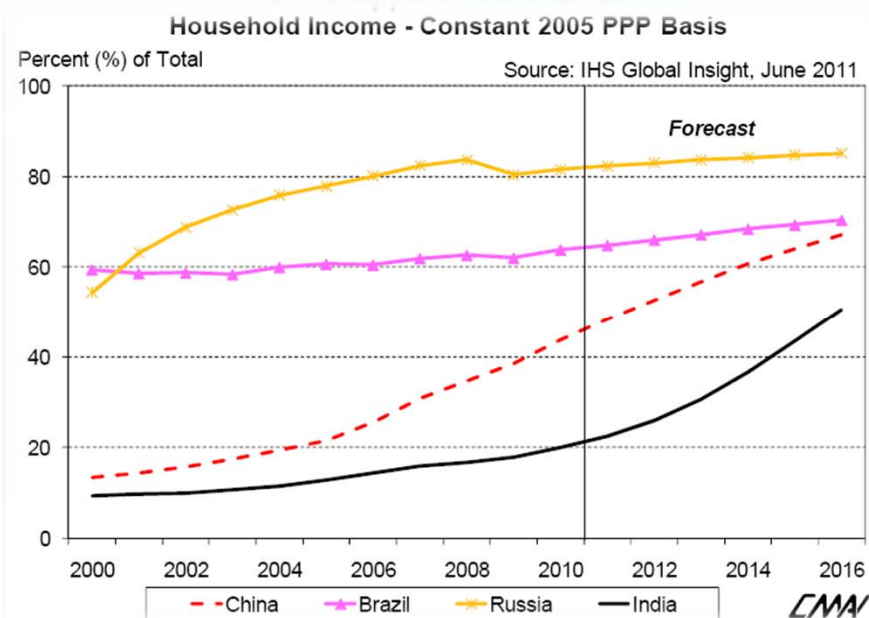
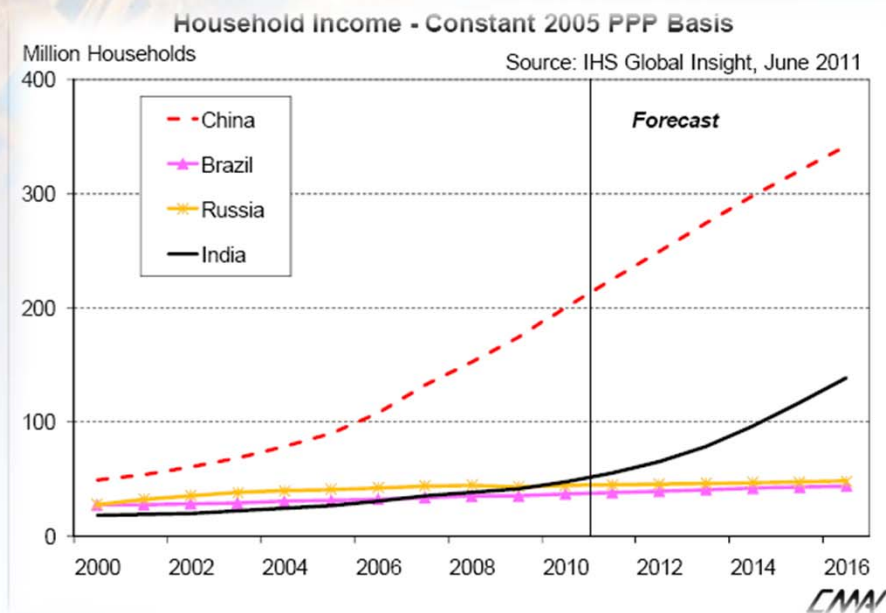


Balance begins to shift in favor of producers in 2012 / 2013

Source: LYB,CMAI

# Economic Progress and Increased Consumption are a Focus in Developing Economies

## Expanding Number of Upper/Middle Class Households In Asia



Economic forecasts anticipate a significant increase in the Asian middle class - this typically drives ethylene demand

# The Path from Concept to Full Production is Long

ID	Task Name	Year 1				Year 2				Year 3				Year 4				Year 5				Year 6		
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3
1	Technology Supplier Selection	Feasibility																						
2	Basic Engineering and Estimate																							
3	EPC Bidding and Award																							
4	FEED Package	Engineering and Permitting																						
5	Permitting																							
6	Detailed Engineering																							
7	Major Equipment Procurement	Construction and Start-up																						
8	Site Prep and Construction																							
9	Commissioning and Start-up																							

A major ethylene project can require 5+ years to move from concept to production

# The Stars Are Aligning For A Bright Tomorrow

- **View from a US ethylene producer perspective**
  - Geography, geology, technology are positively aligned
  - Economics of crude oil and natural gas support U.S. producers
  - Infrastructure investments are bringing NGL's to the market
  - Supply / demand positioned for a cyclical upside
  - New U.S. plants are not forecast to start-up until 2016+



We continue to believe:

- **Good today and better tomorrow**
- **The stars are aligning**