

# The US Tight Oil Revolution: What Kind of a Revolution?

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# The US Tight Oil Revolution: The Hype

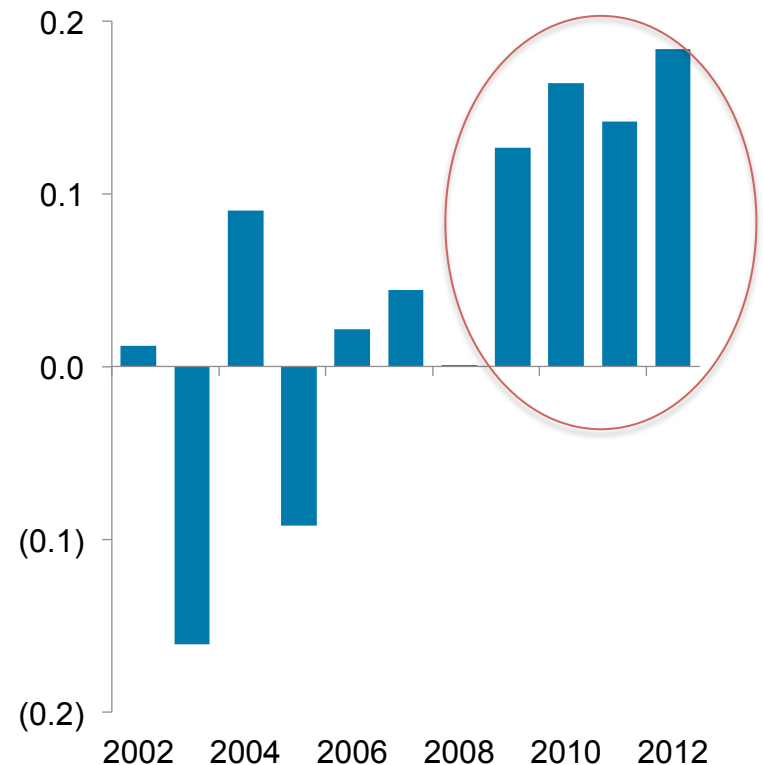
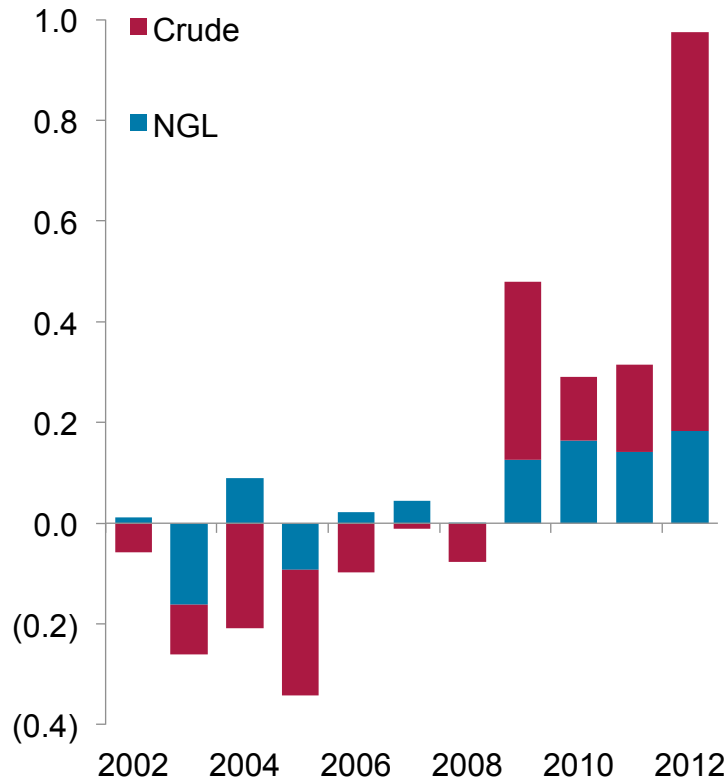
- Robin West (PFC Energy): ‘the energy equivalent of the Berlin Wall coming down. Just as the trauma of the Cold War ended in Berlin, so the trauma of the 1973 oil embargo is ending now’.
- Ed Morse (Citigroup): ‘the growing continental surplus of hydrocarbons points to North America effectively becoming the new Middle East by the next decade’
- Ed Morse (Citigroup): ‘Some producer countries ....those suffering most acutely from the resource curse may see their leadership come under heightened pressure for economic and political reform, as revenues gradually diminish, raising the risk of creating new failed states in the process’.
- IEA: ‘The supply shock created by a surge in North American oil production will be as transformative to the market over the next five years as was the rise of Chinese demand over the last 15’ (note: between 1997 and 2012, Chinese oil consumption increased from less than 4 million b/d to more than 10 million b/d)
- Philip Verleger: ‘the low price of natural gas is going to drive oil from the market. Oil in the US is going to have a ‘Kodak Moment’.’

# Structure of Presentation

- The Record so Far
- US Tight Oil in the Global Context
- Uncertainty Remains the Name of the Game
- Beyond the Supply Shock
- Conclusions

The Record So Far: The Things We Know

# US Liquid Production Growth Been Impressive

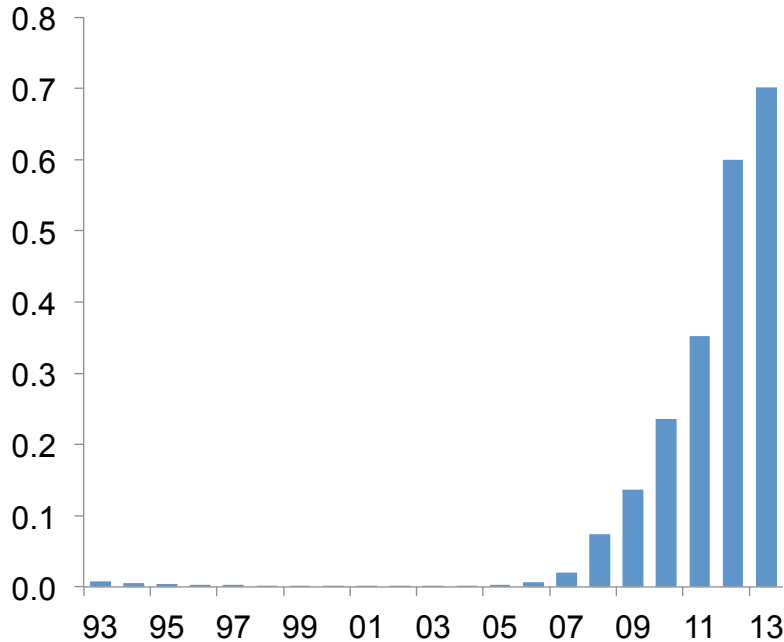


*Source: Energy Aspects*

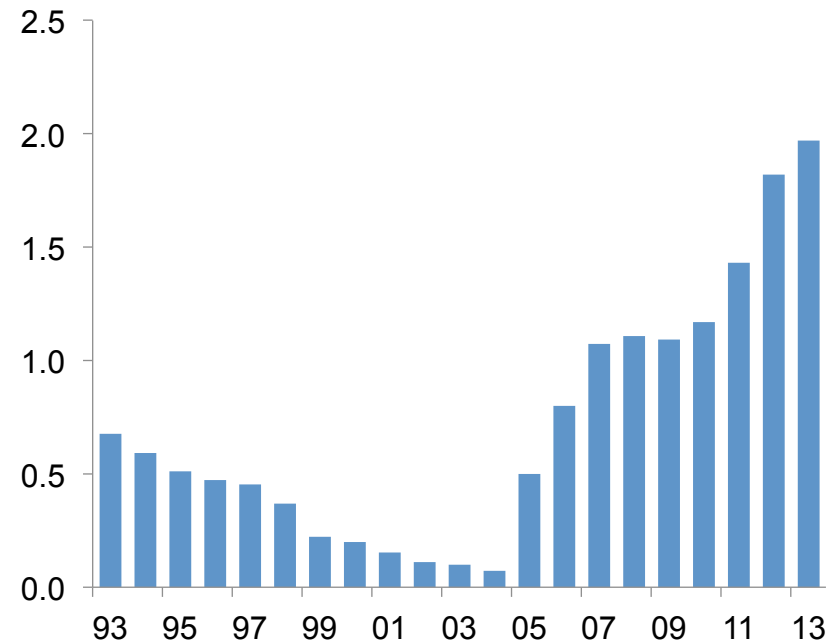
- From a negative annual growth in 2008, US added around 1 million b/d in liquid production in 2012 and similar growth expected for 2013
- US revolution not only about crude production, but also NGLs (annual average growth of 150,000 b/d between 2009 and 2012)

# Growth Thanks to Two Major Shale Plays

**Bakken oil production, mb/d**



**Eagle Ford oil production, mb/d**

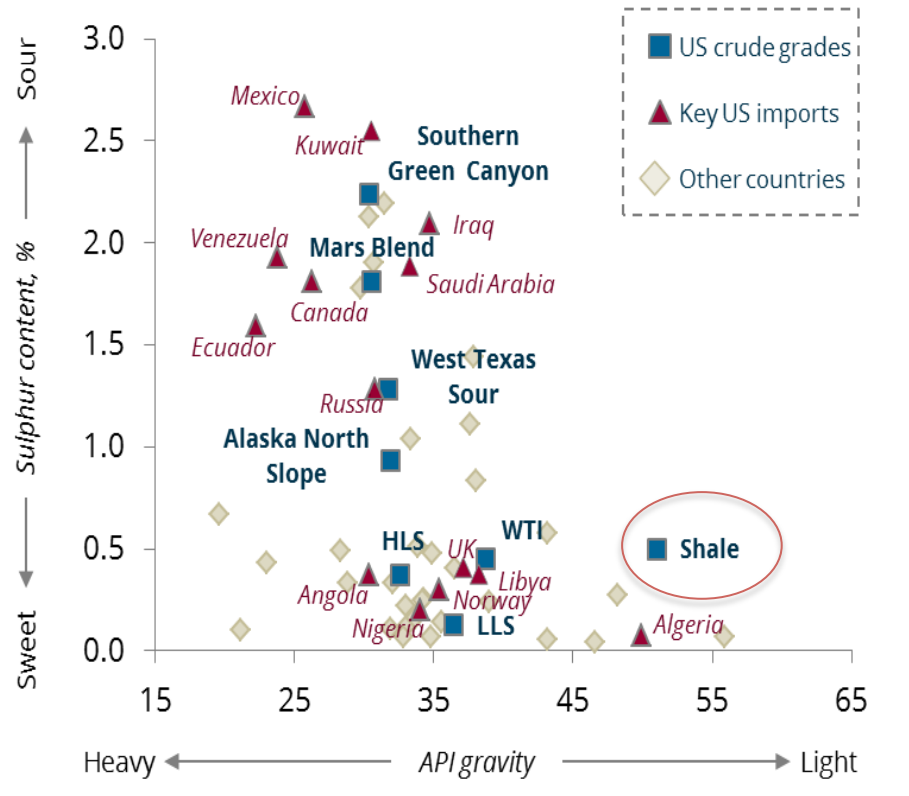


*Source: Energy Aspects*

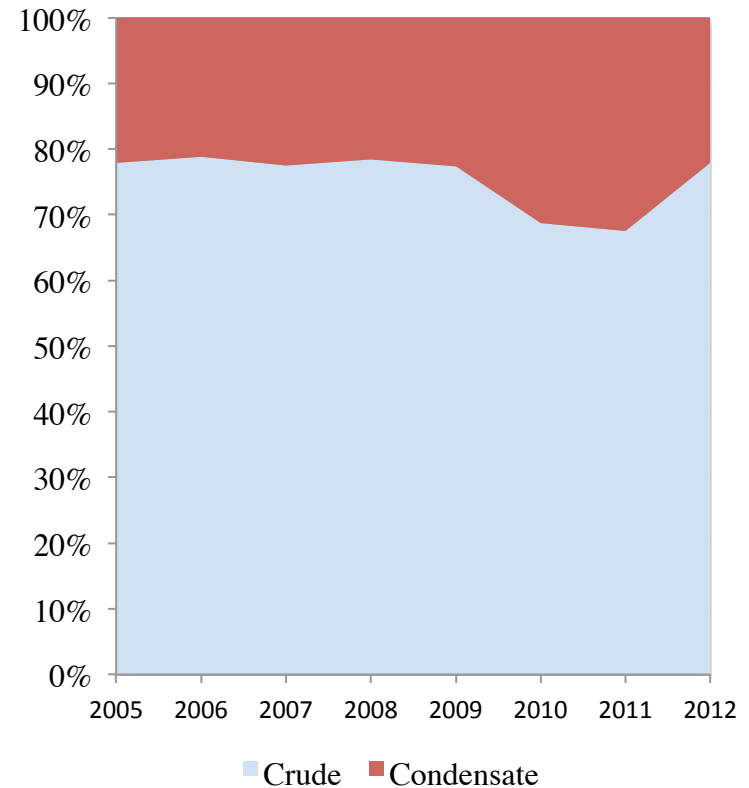
- Share of tight oil out of total **crude** production increased from 2.5% in 2003 to over 40% in 2012

# Much of Crude is Super Light

## Crude oils by quality characteristics



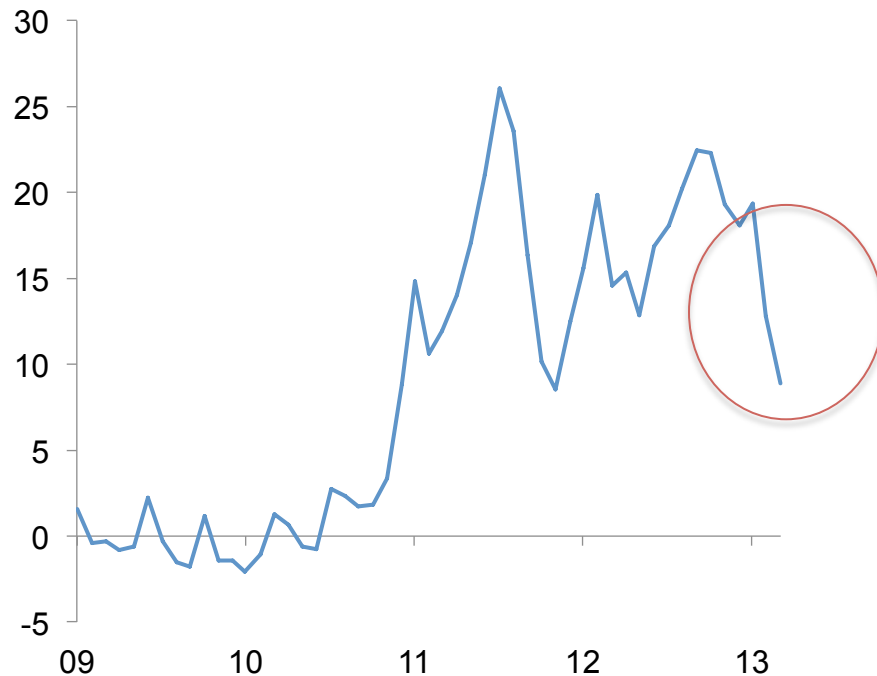
## Share of Condensate in Total Output of Eagle Ford



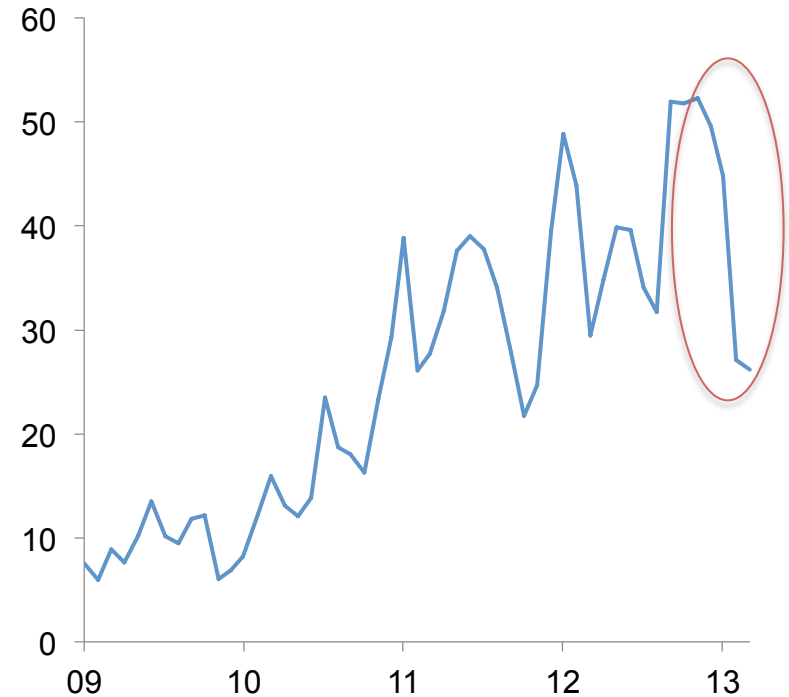
Source: Energy Aspects

# Dislocated Benchmarks

**Brent-WTI, \$/barrel**



**Brent-WCS, \$/barrel**



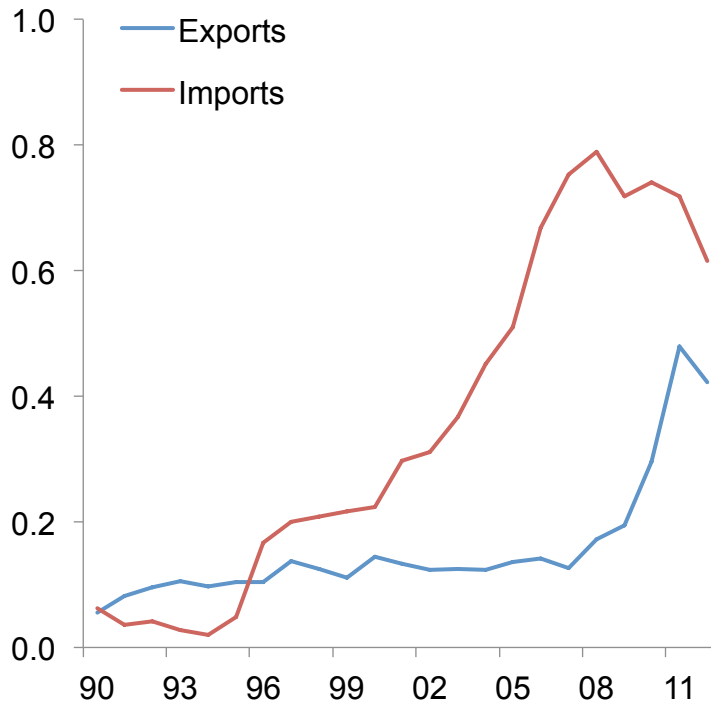
*Source: Energy Aspects*

- Due to infrastructure constraints US and Canadian crudes became disconnected from global benchmarks resulting in availability of highly discounted crudes
- Infrastructure constraints mostly overcome through investment in new pipelines, railways, barges, and reversal of key pipelines

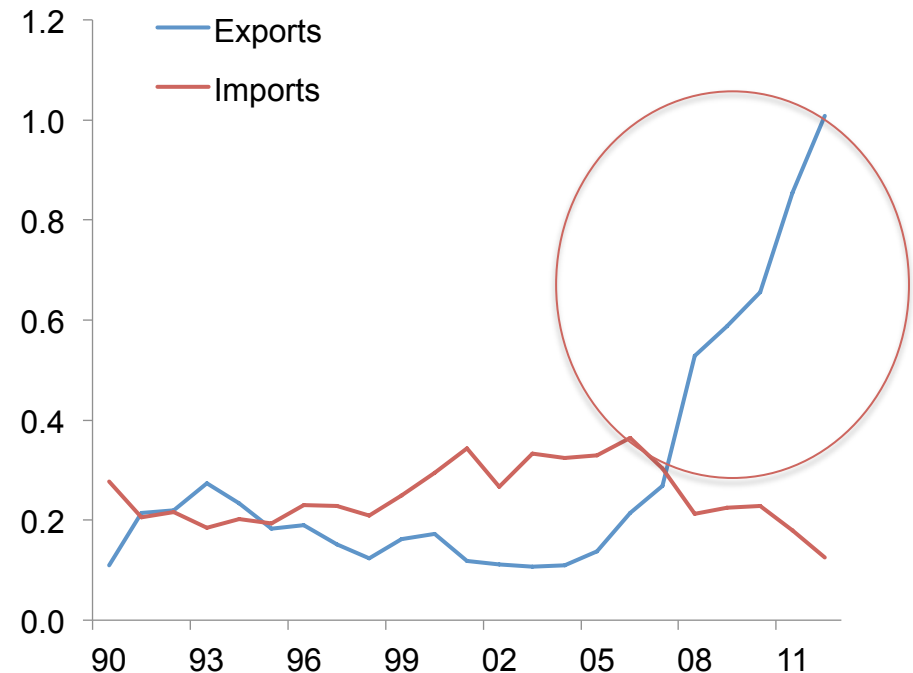


# Export of Petroleum Products

## US Gasoline Balance, mb/d



## US Diesel Balance, mb/d

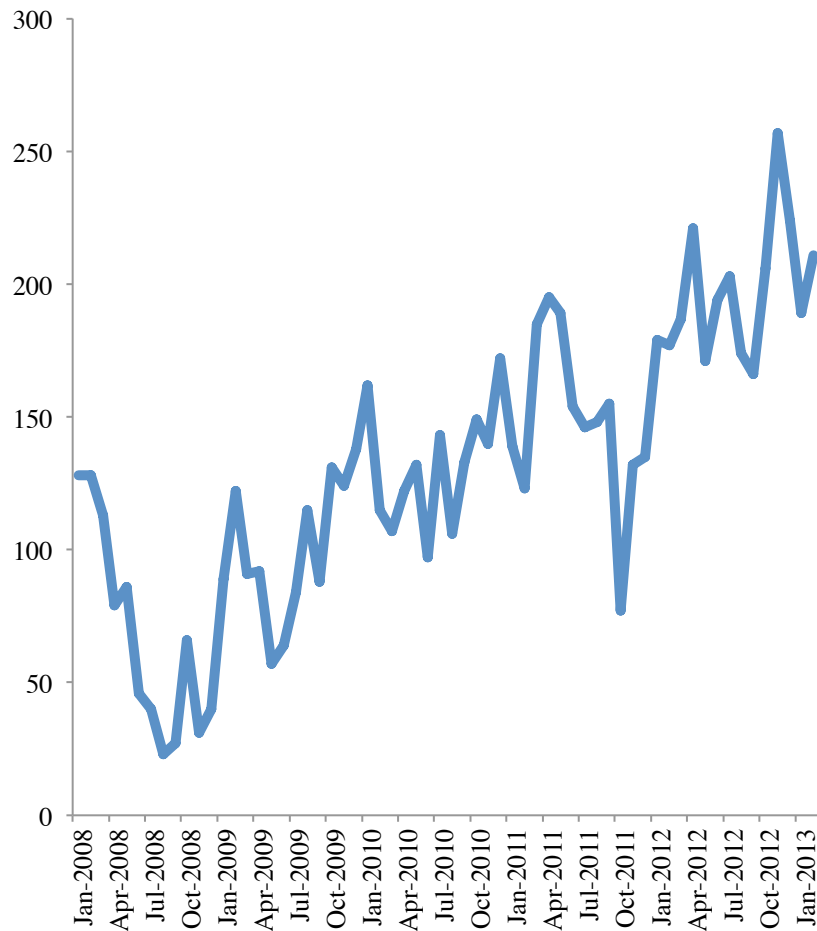


*Source: Energy Aspects*

- Net imports of gasoline has fallen to low levels while US has become a big net exporter of diesel

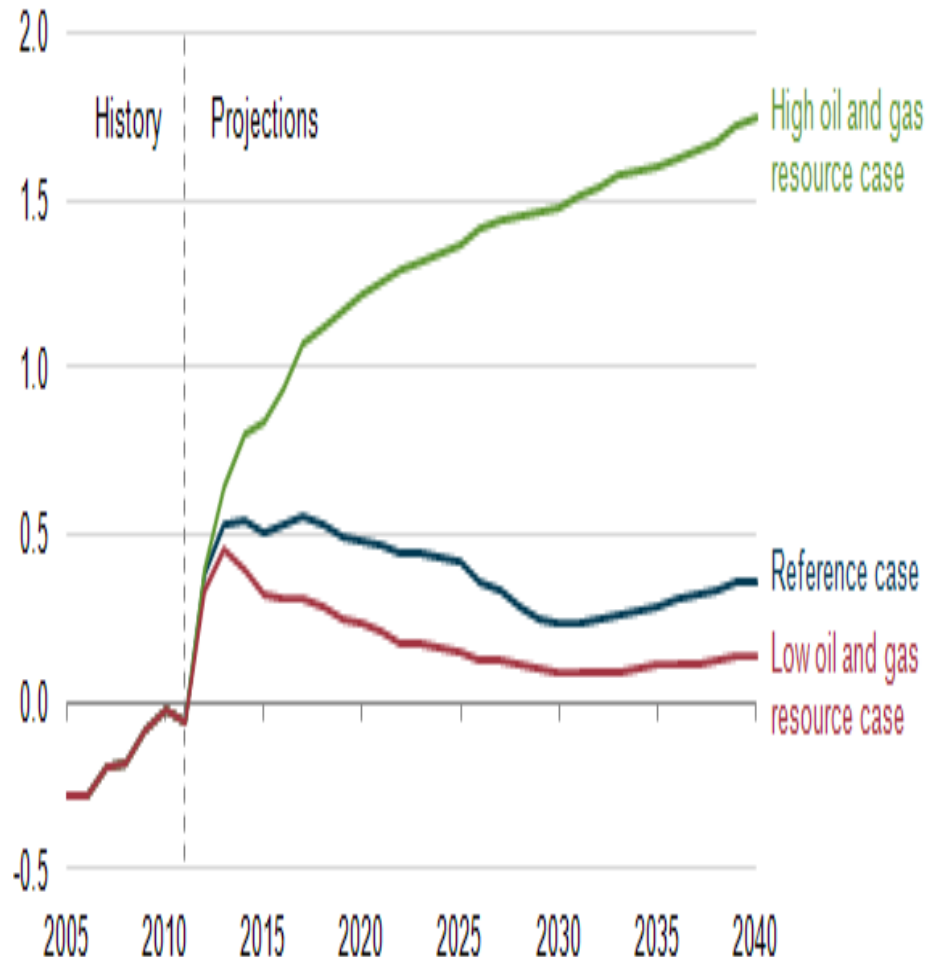
# US Turned into Net Exporter of LPG in 2012

**US LPG Exports, 1000 b/d**



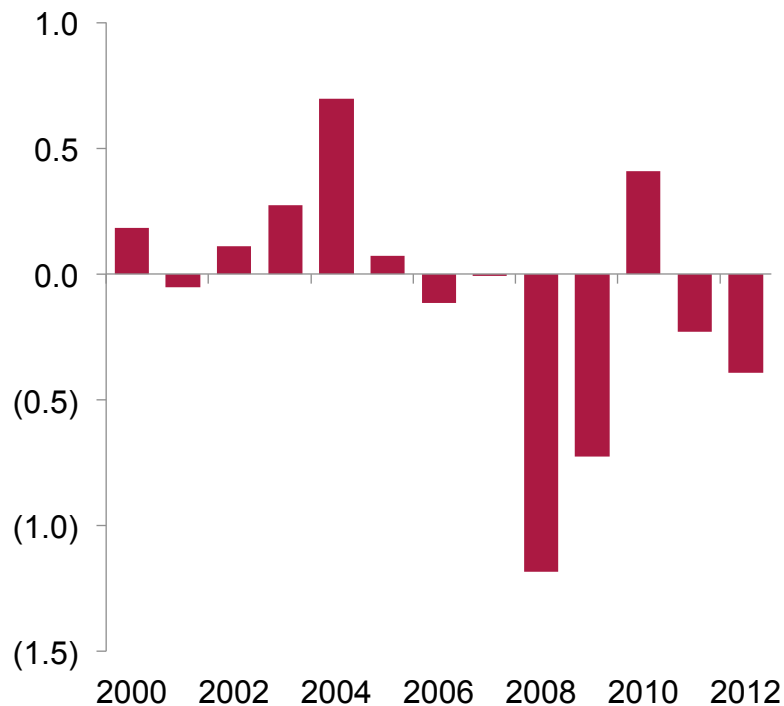
Source: EIA

U.S. net exports of liquefied petroleum gas (2005-40)  
million barrels per day

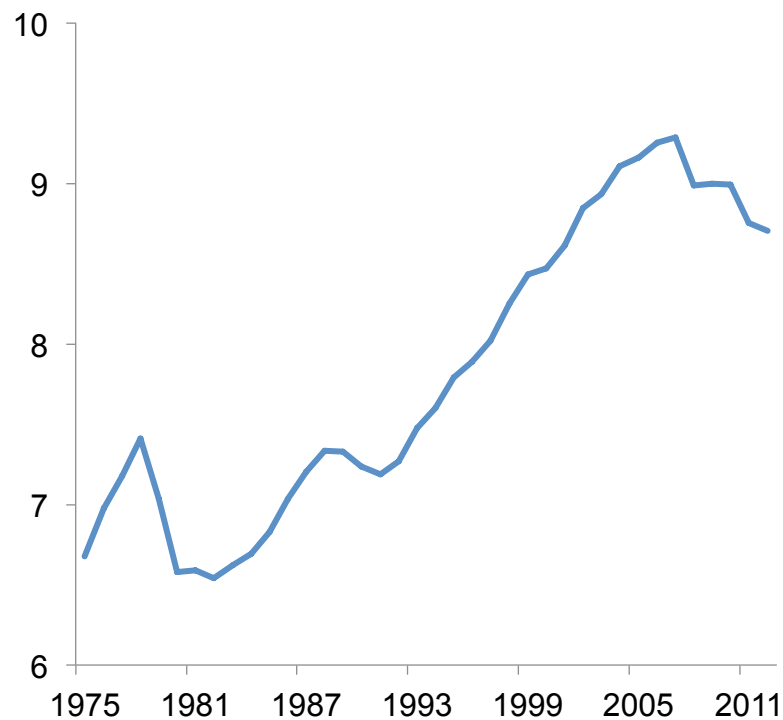


# Supply Improvements Accompanied with Decline in Liquid Consumption

**Year-on-Year Change in Total Oil Demand, mb/d**



**Gasoline Demand, mb/d**

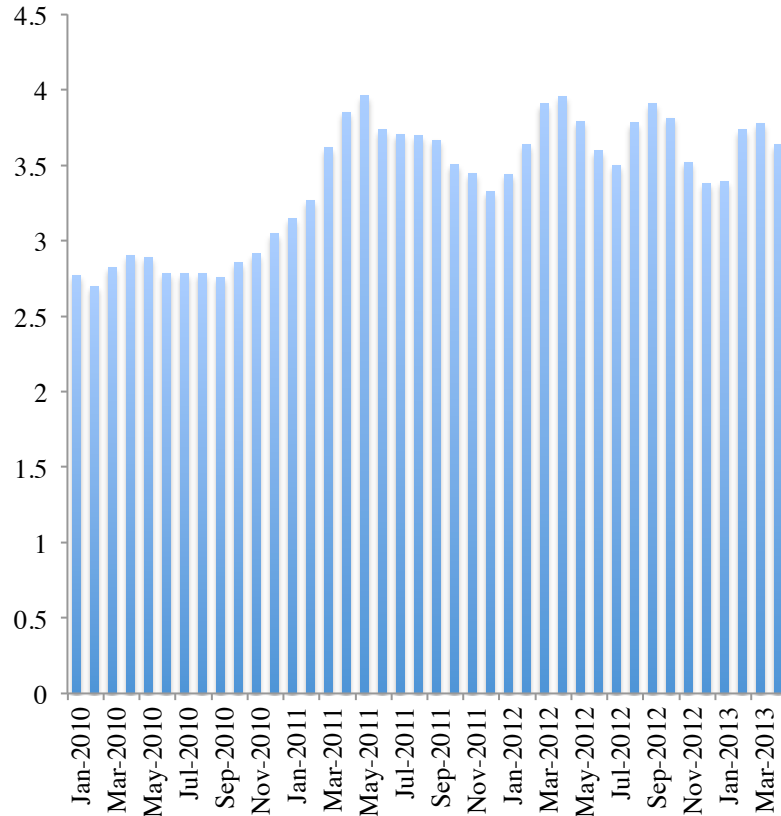


*Source: Energy Aspects*

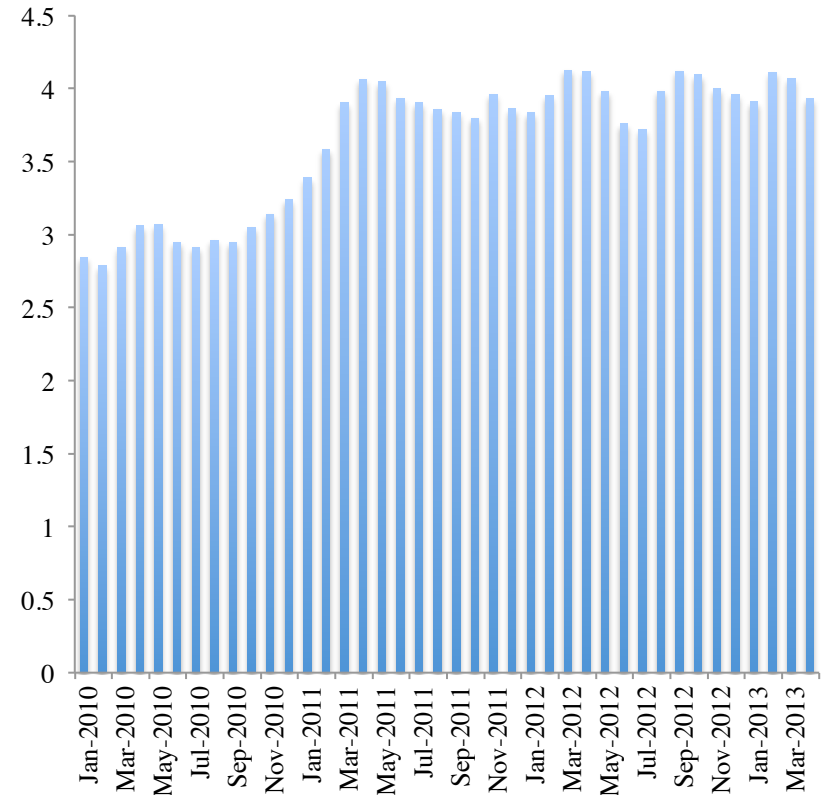
- Year-on-Year change in total oil demand has turned negative (annual average decline of 230,000 b/d between 2009 and 2012)
- Decline is across all products including gasoline which peaked in 2007

# Impact of Revolution Not Felt at the Pump Yet

**U.S. Retail Gasoline Prices (Dollars per Gallon)**



**U.S. No 2 Diesel Prices (Dollars per Gallon)**

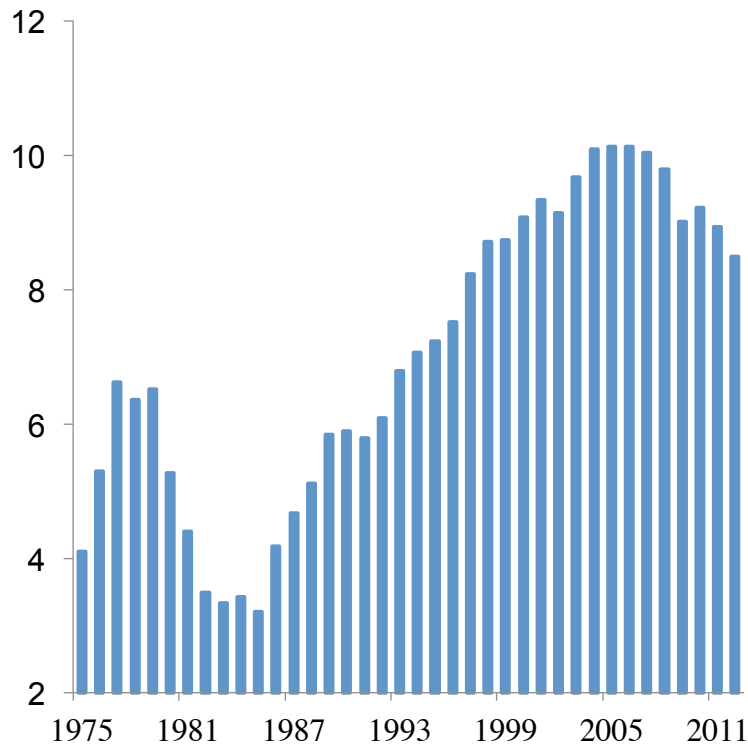


*Source: EIA*

- Discounted crude prices have not been passed to US consumers
- Boost in the profitability of some refineries

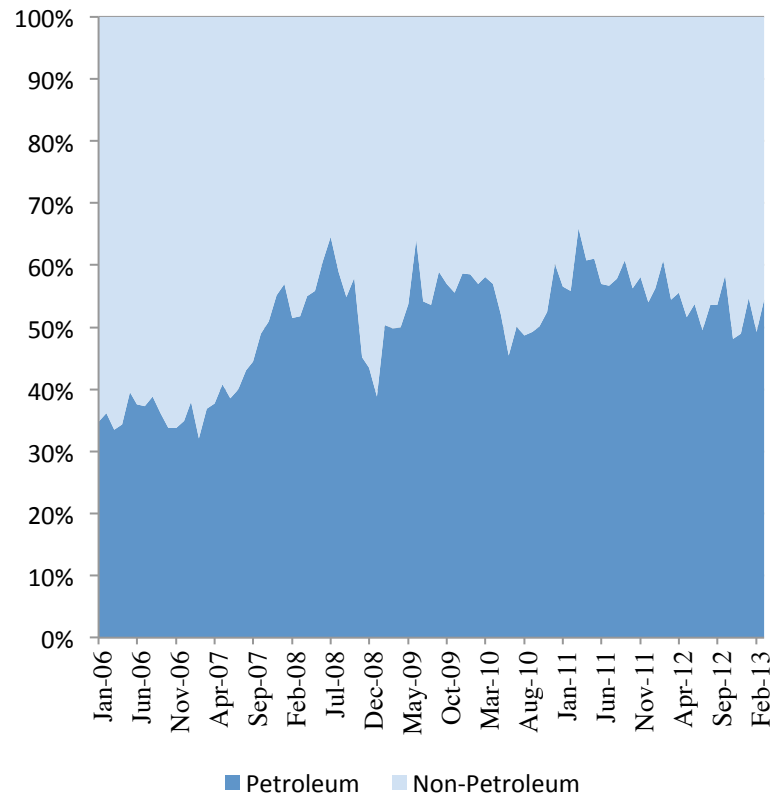
# Reduction in Oil Imports

**Crude Oil Imports, mb/d**



*Source: Energy Aspects*

**Petroleum as a % of Trade Deficit**



*Source: US Bureau of Economic Analysis*

- US crude imports fell from 10.1 to less than 8.5 mb/d between 2005 and 2012
- Petroleum share of trade balance fell marginally but still high

# The Enablers of this Robust Performance

- No shale revolution without high oil price
- Hydraulic fracturing key enabling technology
- But other US specific factors were also important
  - Private ownership of underground resources
  - Strong logistics and oil service providers
  - Well functioning capital markets and cheap cost of credit
  - Liquid futures markets allowing producers to hedge production
  - Heightened political risk in many parts of the world
- Enablers
  - Quality of reserve base
  - Turn activity into sustainable business model
  - Continuous improvement in technology
  - Access to new plays
  - US policy (enabler or disabler)?

## 2013E oil hedging profile for selected US Independents

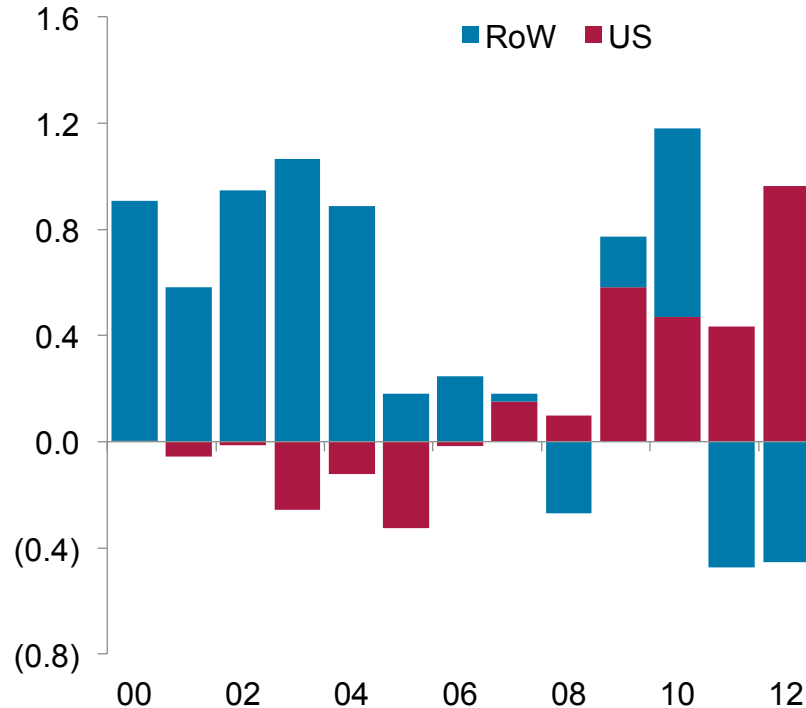
	Total % Hedged	% Swaps	Price \$/bbl
Antero Resources	--	--	--
Berry Petroleum	60%	--	--
Bill Barrett Corp	65%	65%	--
BreitBurn Energy	77%	66%	93.87
Carrizo Oil & Gas	85%	21%	93.55
Chaparral Energy	70%	17%	96.78
Chesapeake Energy	85%	85%	95.45
Cimarex Energy	35%	35%	96.13
Comstock Resources	84%	84%	98.67
Concho Resources	70%	70%	95.67
Continental Resources	64%	64%	96.24
Denbury Resources	79%	--	--
Energy XXI	82%	--	--
EP Energy	89%	60%	103.52
Exco Resources	44%	44%	94.05
Forest Oil Corp	53%	53%	95.53

Source: Energy Aspects

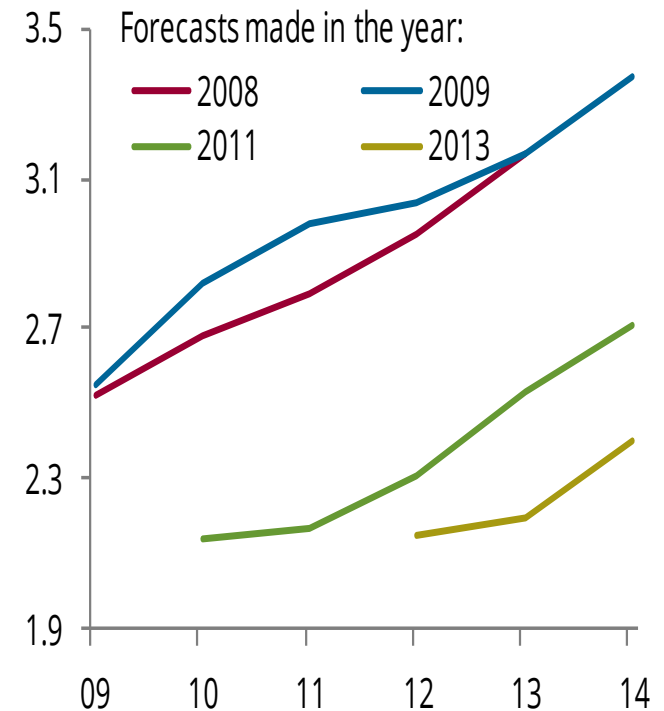
# The US Tight Oil Revolution in Global Context

# US Supply Shock Being Offset

**Year-on-Year Changes in Non-OPEC Supply**



**IEA's estimates of Brazilian output, mb/d**



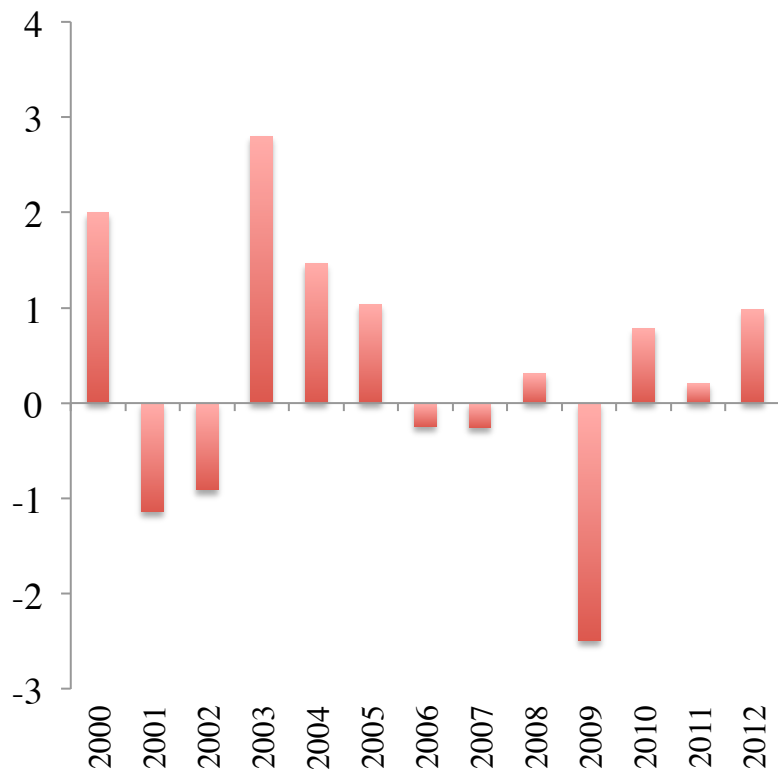
*Source: Energy Aspects*

- Looking at world of oil supplies from prism of US gives impression of 'oil abundance'
- US helped offset decline in non-OPEC somewhere else

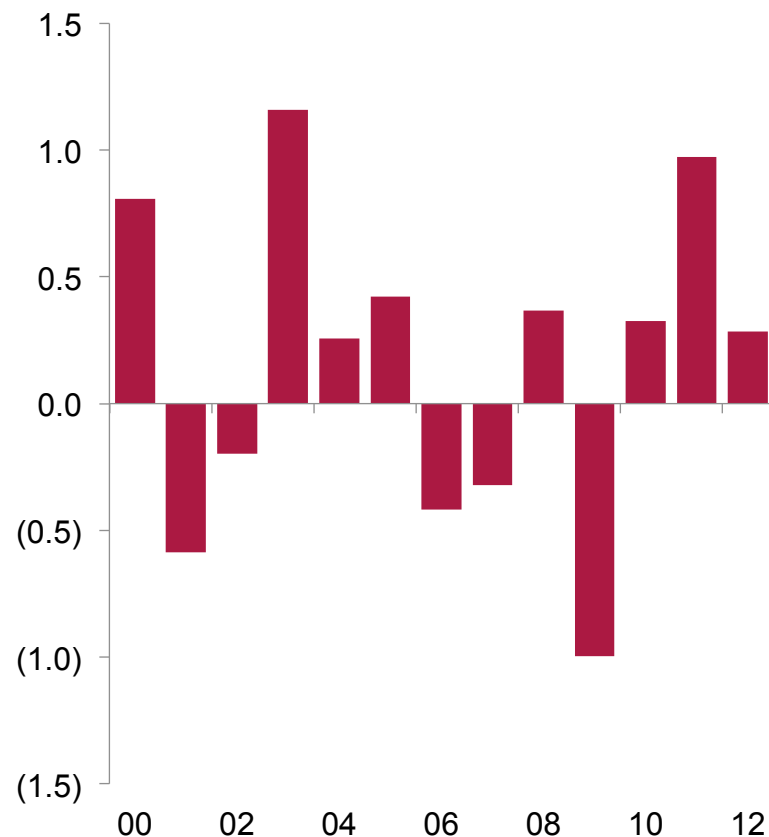


# Adjustment in OPEC Production

**Year-on-Year Changes in OPEC Supply (mb/d)**



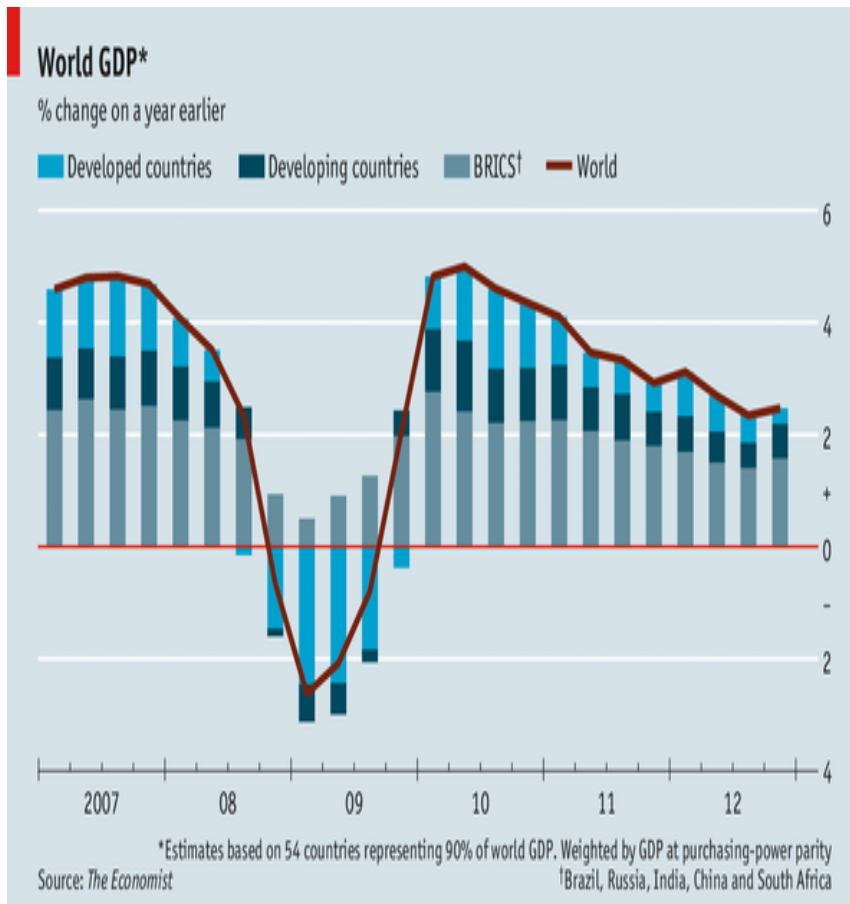
**Year-on-Year Changes in Saudi Arabia Supply**



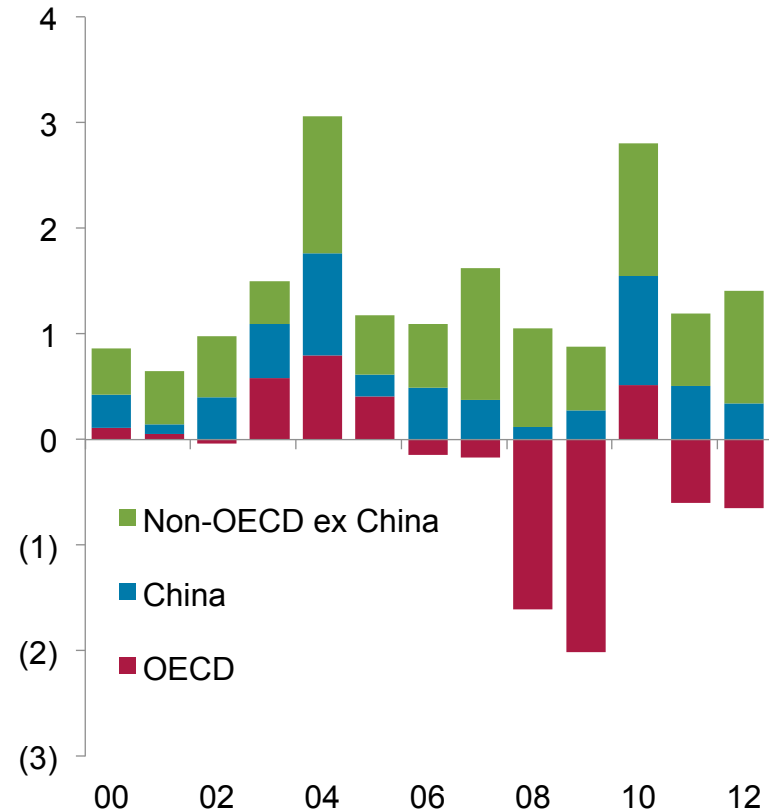
*Source: Energy Aspects*

# In a Context of Non-Inspiring Oil Demand Growth

## Year-on-Year Changes in Global Oil Demand



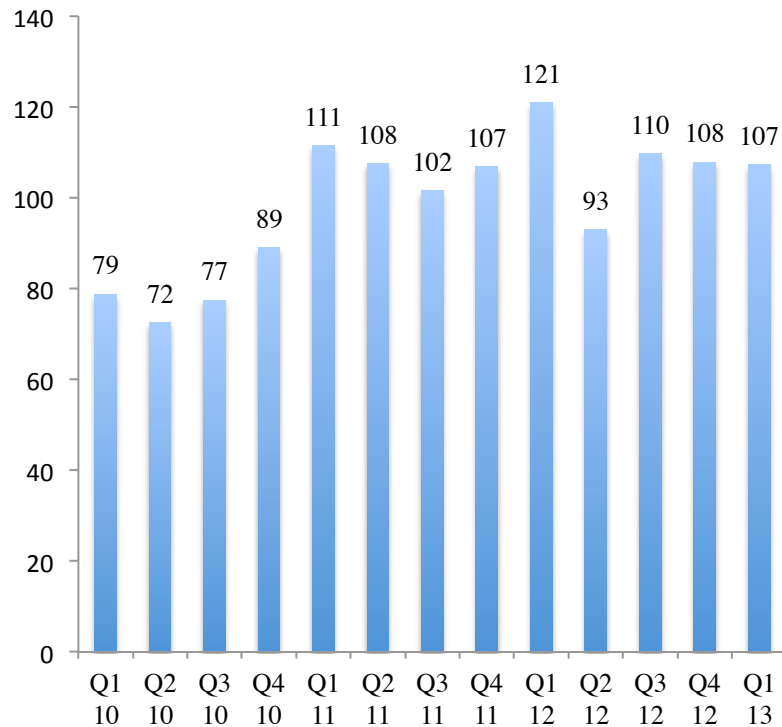
Source: The Economist



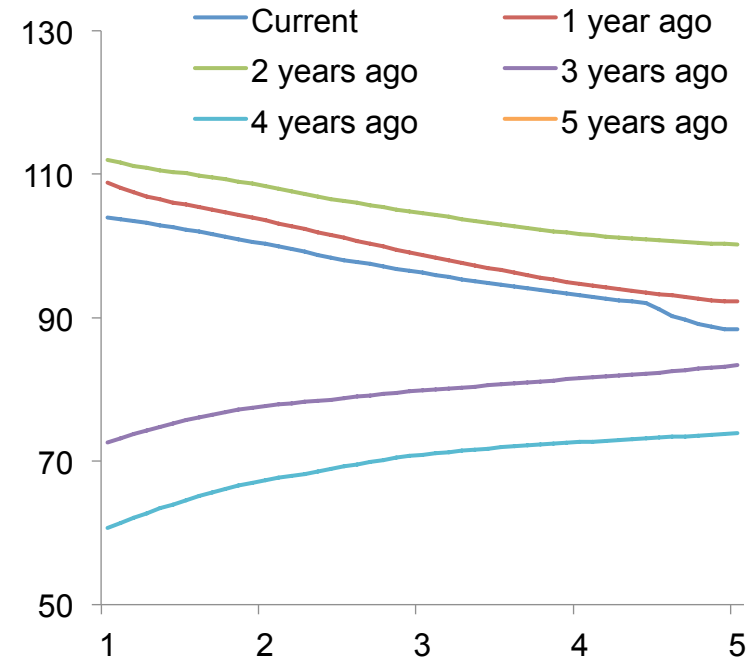
Source: Energy Aspects

# Impact of Revolution Not Felt on Global Oil Price

Quarterly OPEC basket prices, \$/barrel



Brent Forward Curve, \$/barrel



*Source: Energy Aspects*

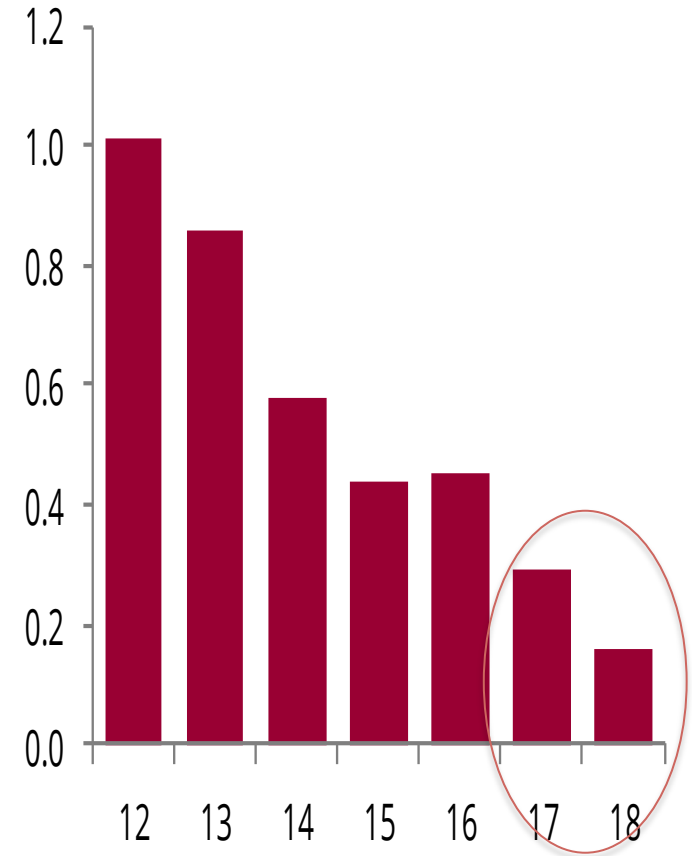
- Question could be posed differently: How high would oil prices have been without the US oil revolution?

# US Developments Alone Can't Have Long-term Transformative Effects on Global Oil Markets

- Other factors needed
  - Demand in US continues to go down due to efficiency and substitution of gas into transport sector
  - Global oil demand to slow down considerably
  - Non-OPEC supply ex-US reverses its downward trend (in part due to the diffusion of technology abroad)
  - OPEC members increase their output capacity
  - Cohesion within OPEC falls

**Contradiction: But under these conditions, will US oil shale continue to grow at current rates?**

**IEA's US crude + NGL annual growth, mb/d**

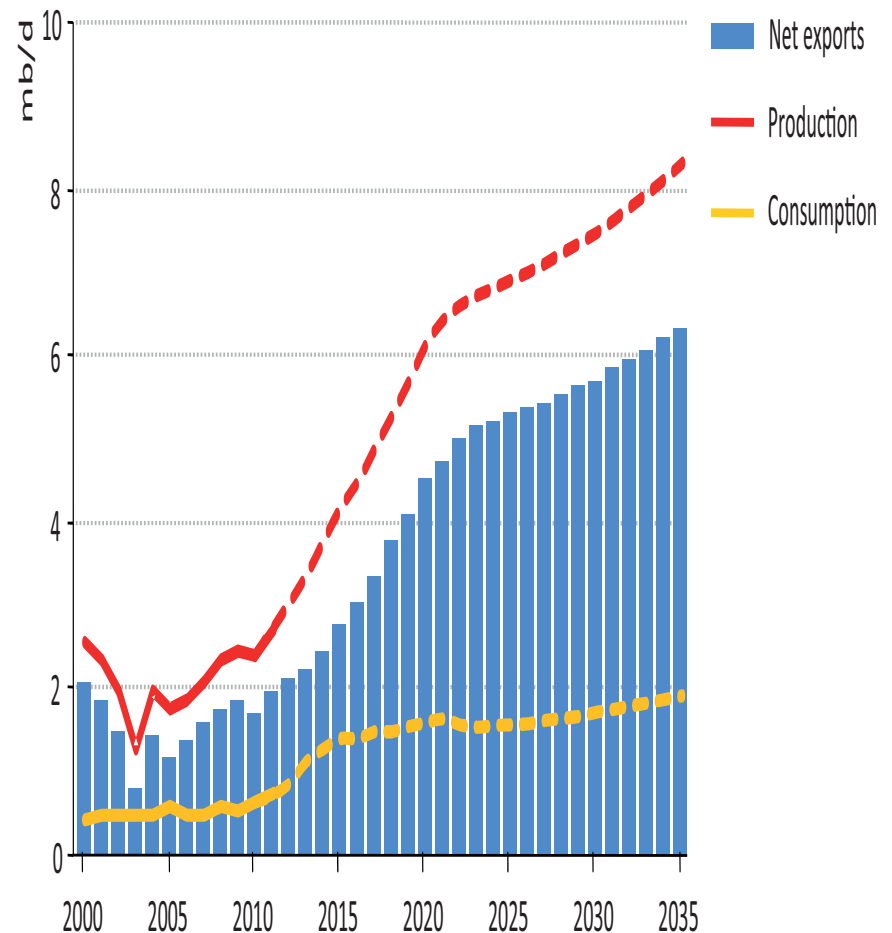


Source: IEA MTOR, Energy Aspects

# The Squeeze on OPEC

- Source of squeeze
  - Demand side
  - US production
  - Non-OPEC production outside US
  - Production within OPEC
- Source of squeeze matters: High cost versus low cost producer
  - US high cost producer but highly elastic supply curve: Supply responsive to upward or downward price movements
- Squeeze from a low cost producer different
  - Less responsive to price movements
  - Generate rents even in relatively low price environment
- Will entry of Iraq at a large scale affect cohesion within OPEC?

## Iraq Oil Balance in Central Scenario



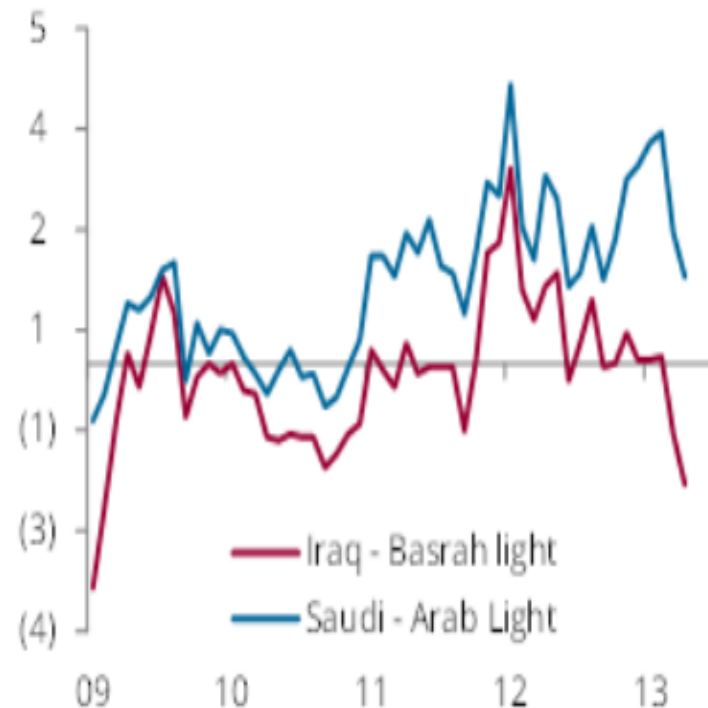
Source: IEA, World Energy Outlook 2012

# Competition through OSPs

**Iraq and Saudi Arabia OSPs to Europe (\$/barrel)**



**Iraq and Saudi Arabia OSPs to Asia**



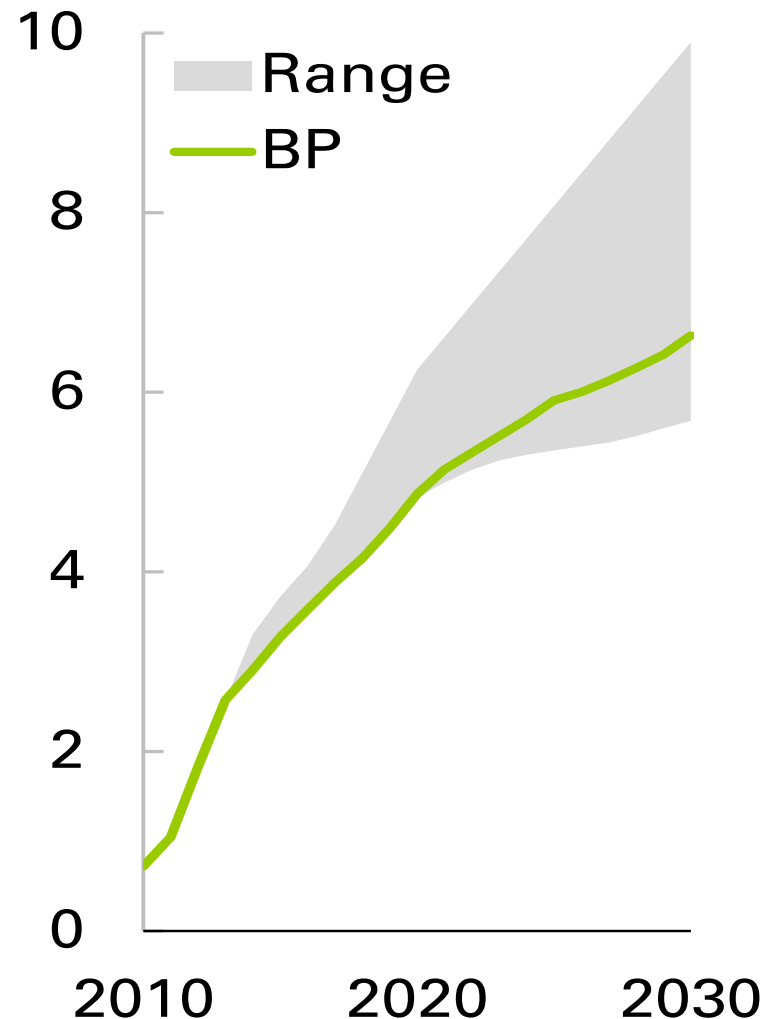
*Source: Energy Aspects*

Uncertainty is the Name of the Game

# Range of Uncertainty High

- ‘The global understanding of tight oil is still evolving and the range of external forecasts reflects the uncertain landscape’
- ‘Different views on the North American resource base – in particular, whether to expect further growth – are the key factor behind the range of external forecasts’
- Projections sensitive to a large number of factors
  - Resource base of new shale plays
  - Well Productivity
  - Decline Rates
  - Number of wells to be drilled
  - Efficiency of drilling
- Modeling tight oil formations as conventional ones not useful

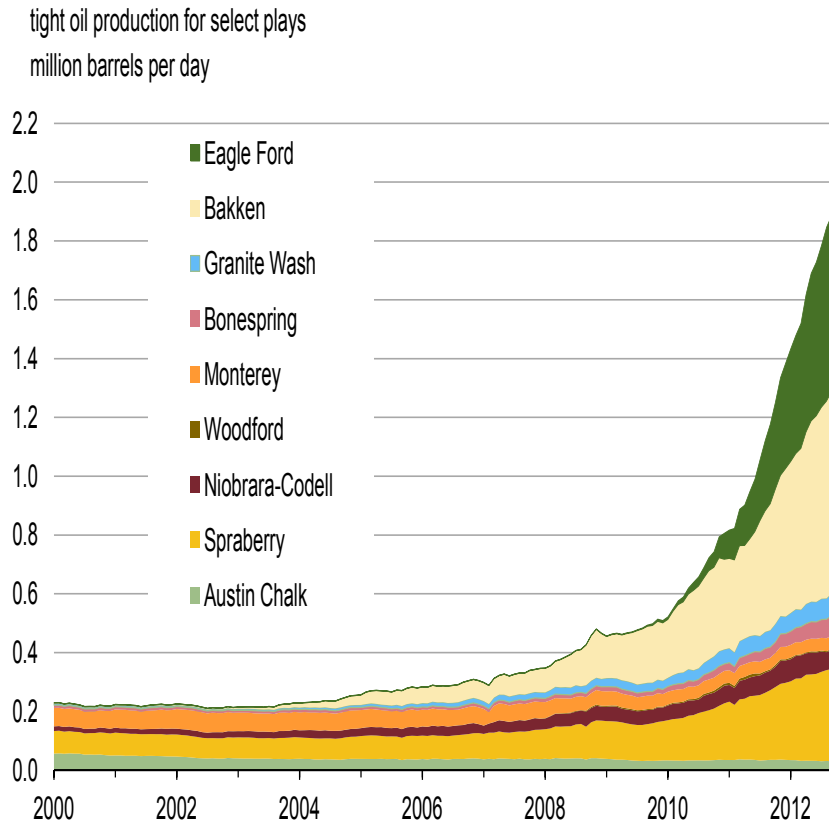
Range of tight oil forecasts (excludes NGLs)



Source: BP Energy Outlook 2030



# Variability in Performance of Shale Plays

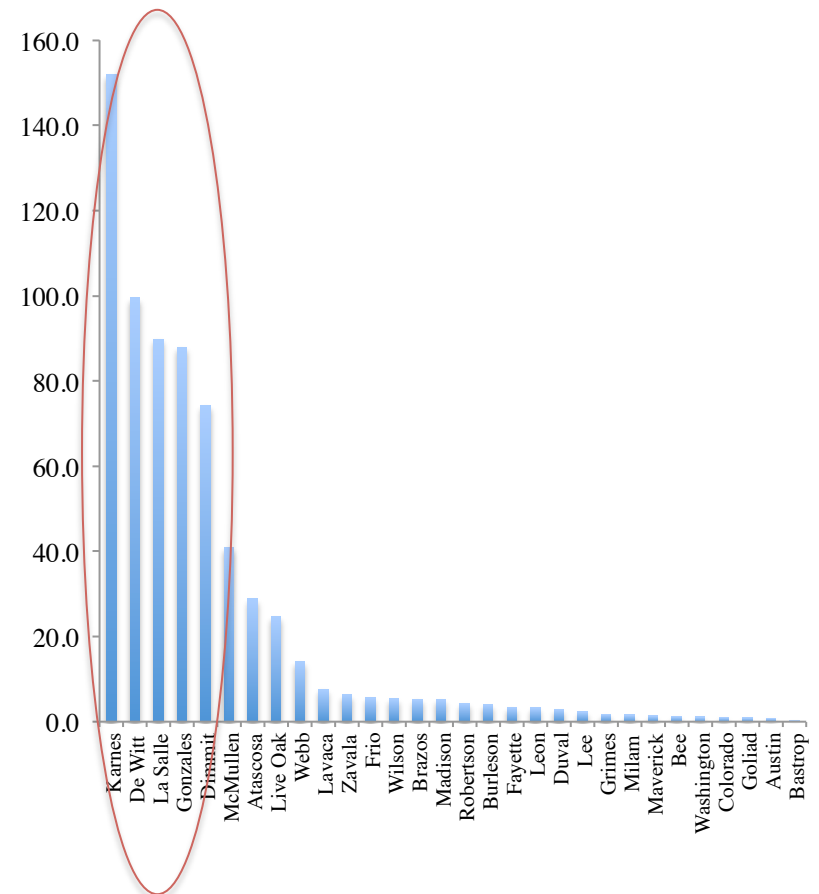


Source: Drilling Info (formerly HPDI), Texas RRC, North Dakota department of mineral resources, and EIA, through October 2012.

Source: EIA

Eagle Ford, Bakken and Spraberry (Permian) responsible for bulk of shale oil production

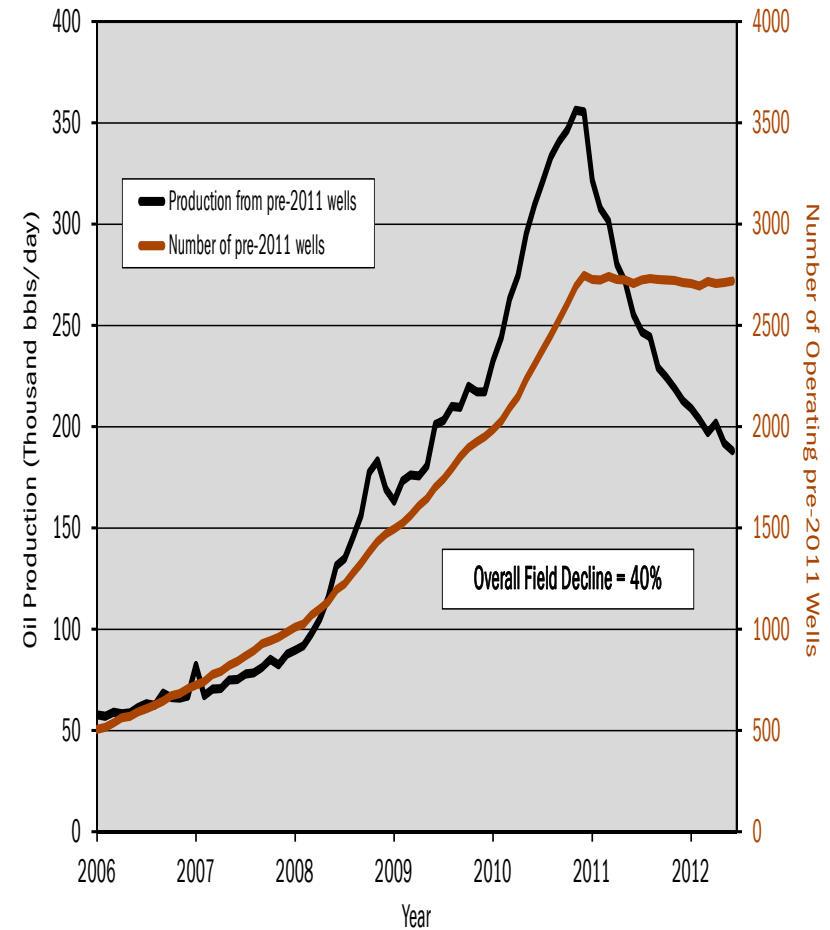
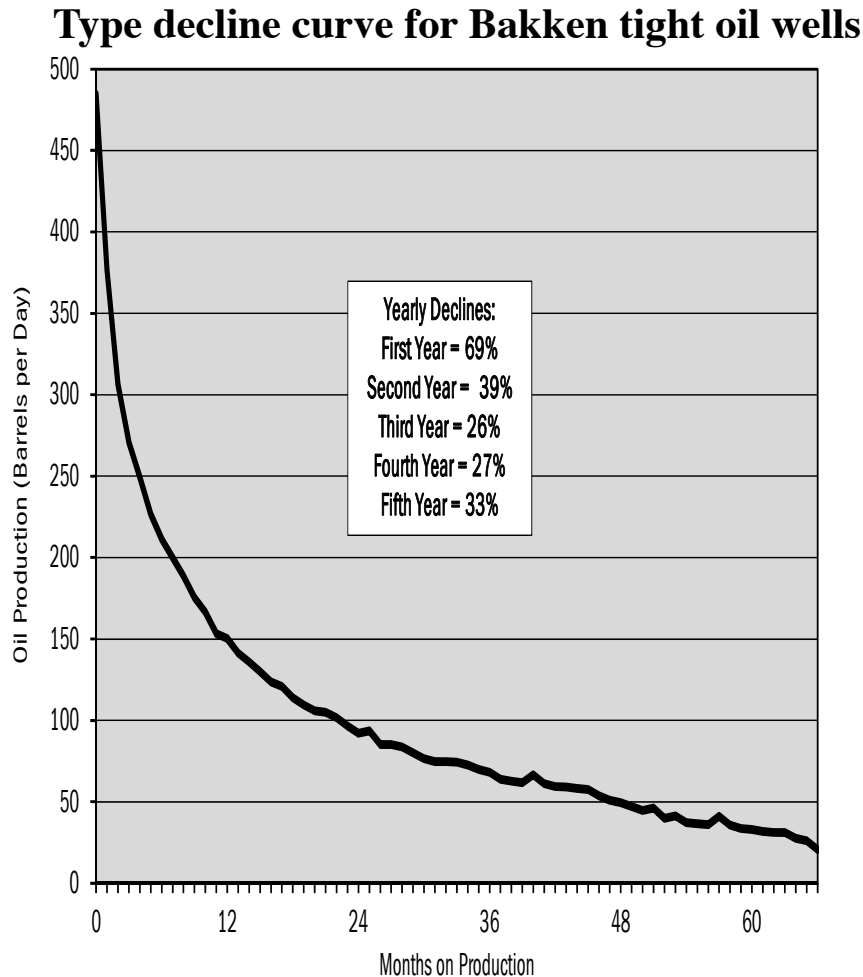
## Production by County, Eagle Ford (1000 b/d)



Source: Energy Aspects

Within each shale play, production is concentrated within few counties (sweet spots)

# High Decline Rates of Shale Oil Fields



*Source: David Hughes, Drill Baby Drill, Feb 2013*

Once output from a typical Bakken well begins to decline within 24 months production flow is down to 1/5 level achieved at its peak

Suppose that no new wells were drilled after 2010, Bakken oil production would have fallen sharply

# Sharp Rise in Number of Wells Drilled

**No of wells producing in North Dakota**



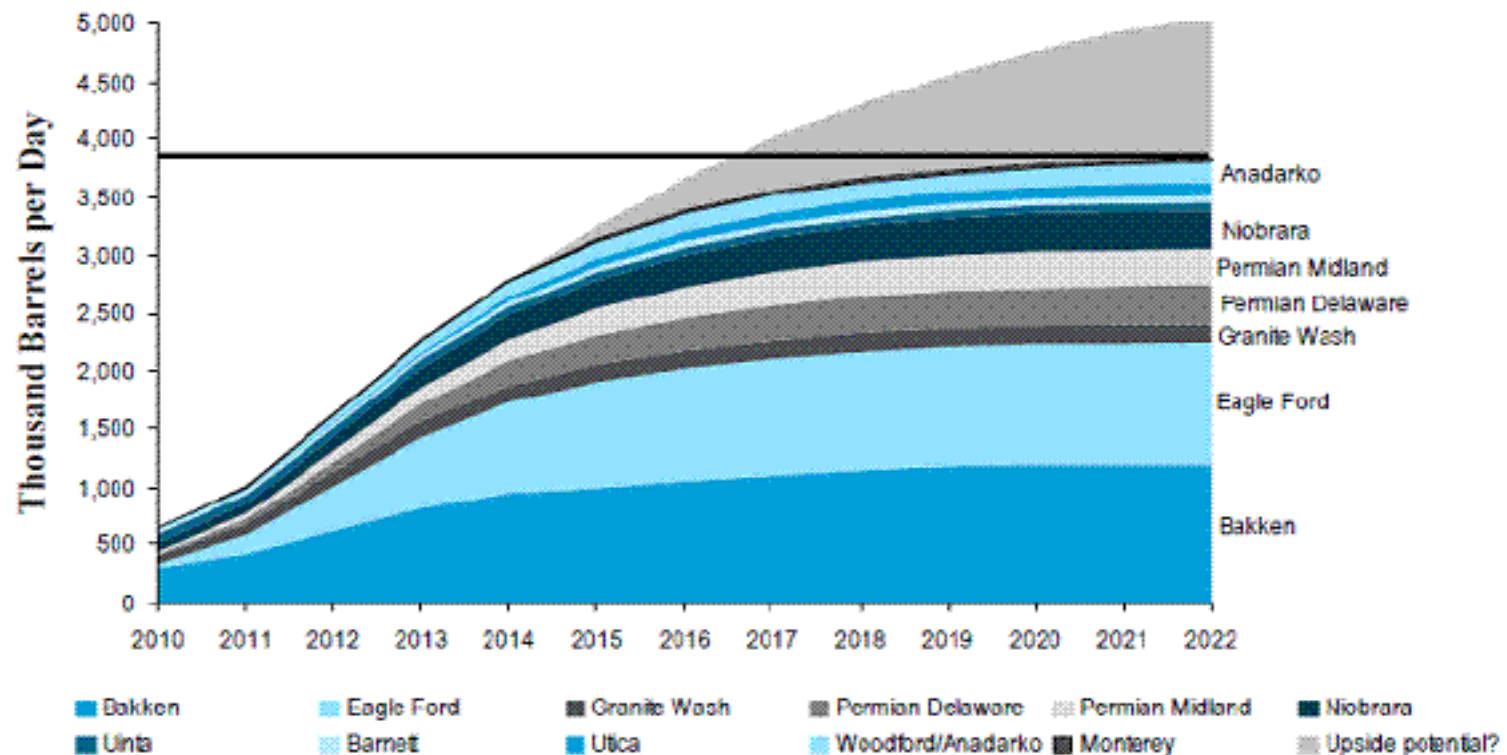
**Oil output per well, b/d**



*Source: Energy Aspects*

# Underlying Assumptions Not Clear

## Citigroup 2012 Projection of U.S. Shale Oil, 2010-2022 (limitless well locations and no declines)

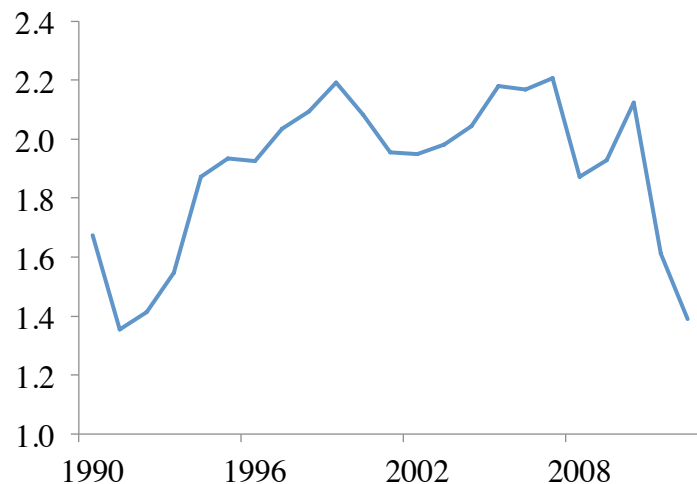


Source: Citi Investment Research and Analysis

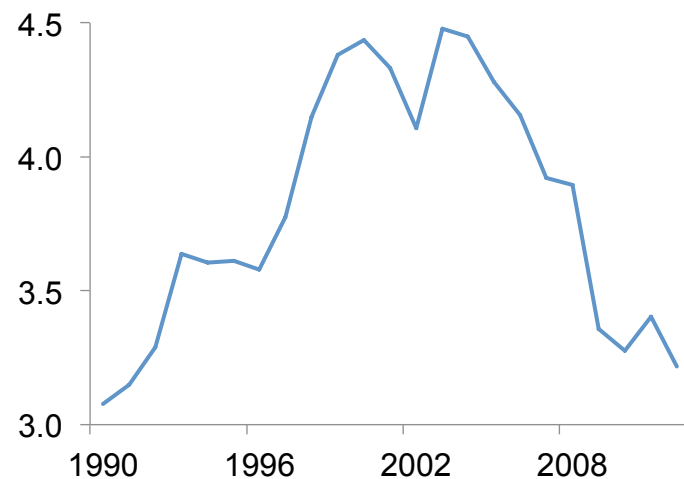
# Beyond the US Supply Shock

# Change in Crude Oil Trade Flows

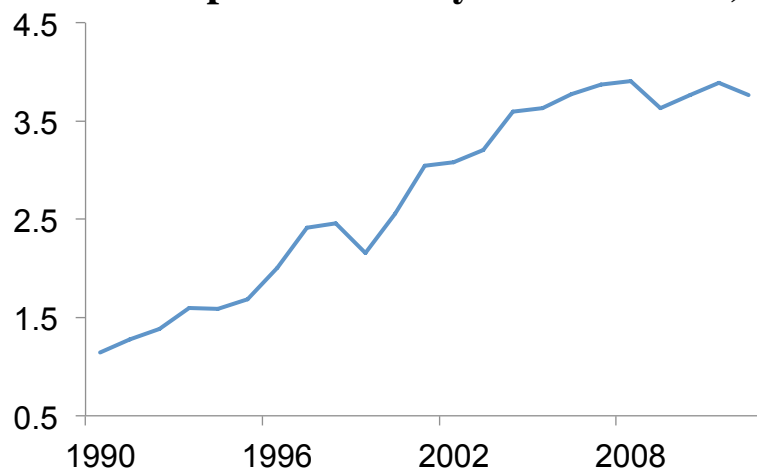
**US Imports of Light Crude, mb/d**



**US Imports of Medium Crude, mb/d**

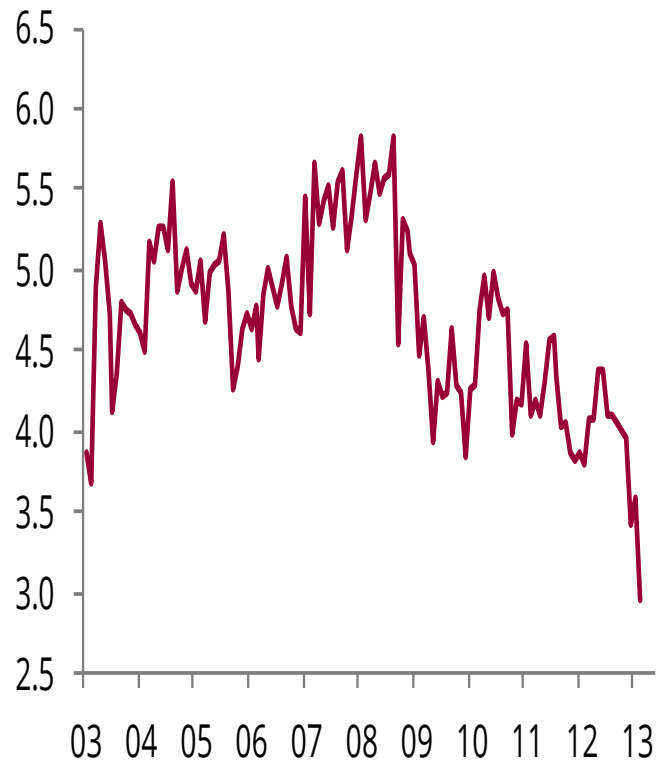


**US Imports of Heavy Crude, mb/d**

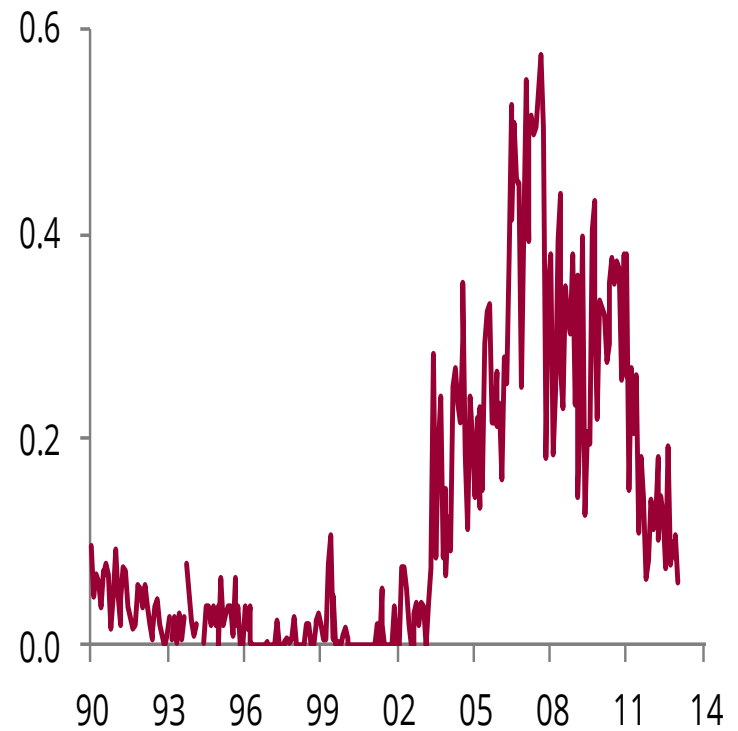


# OPEC Exports to US Decline

**US Crude Imports from OPEC (mb/d)**

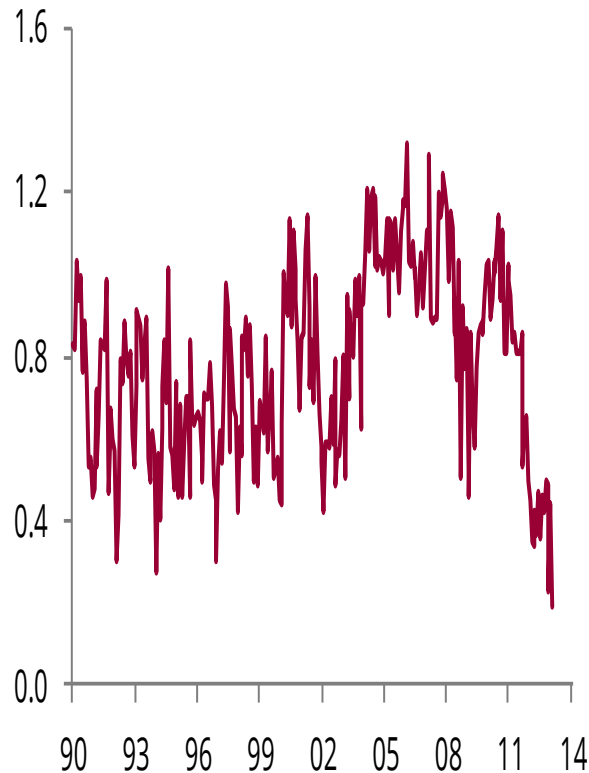


**US Crude Imports from Algeria (mb/d)**



# Middle East Producers Facing More Competition in Asia

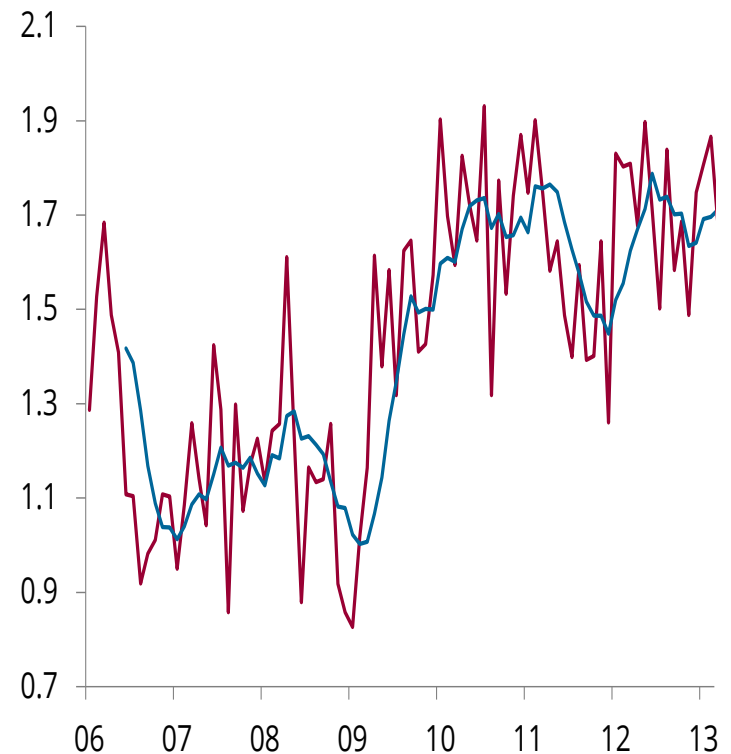
**Nigerian US Crude Imports from the US  
(mb/d)**



*Source: Energy Aspects*

Backing out of light sweet crude imports impacted WAF most, impacting Atlantic basin

**WAF exports to Asia  
mb/d**

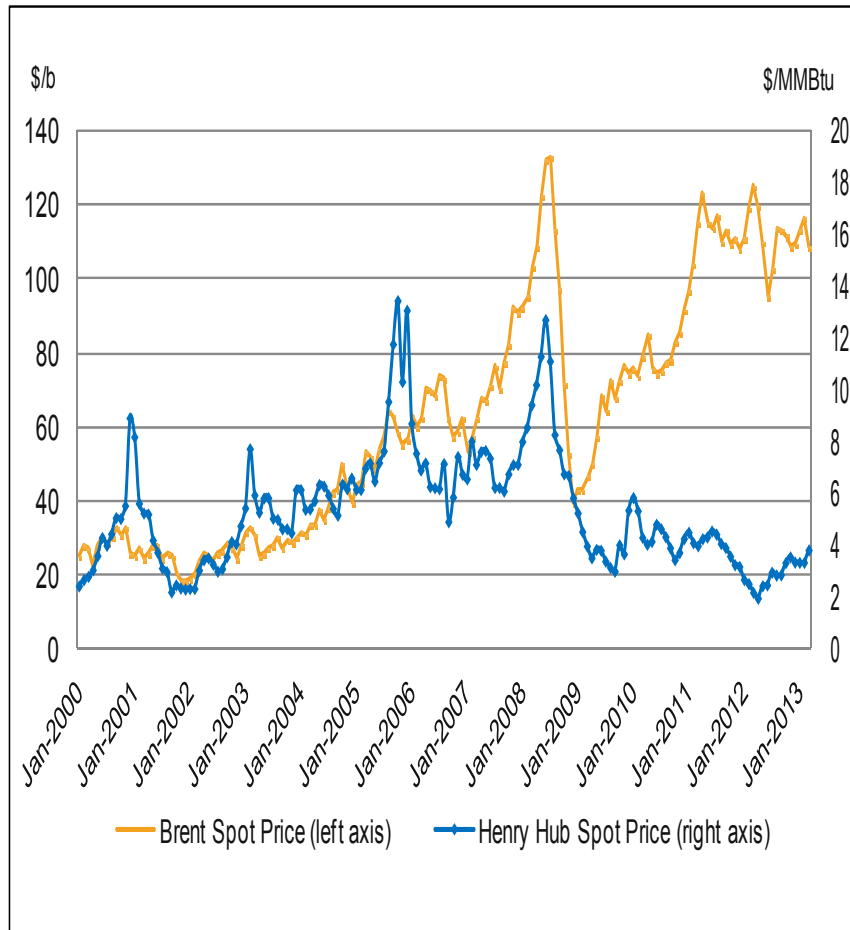


West African barrels are increasingly swinging into Asia, weighing on Dubai and supporting Brent-Dubai differentials

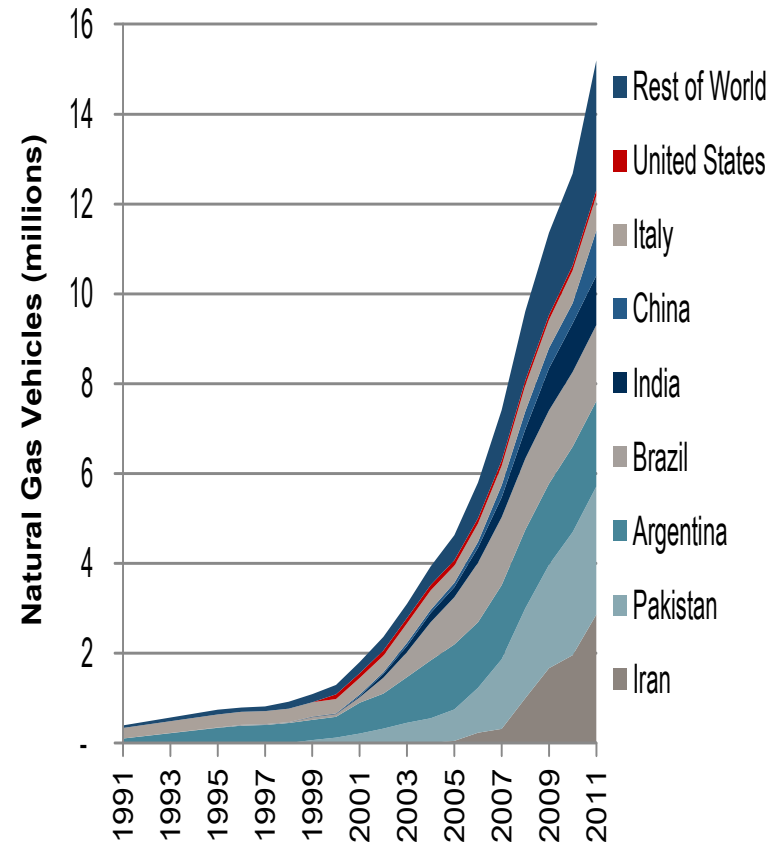


# Relative Prices Matter... in the Long Run?

Brent crude spot price vs. Henry Hub spot price (2000–13)



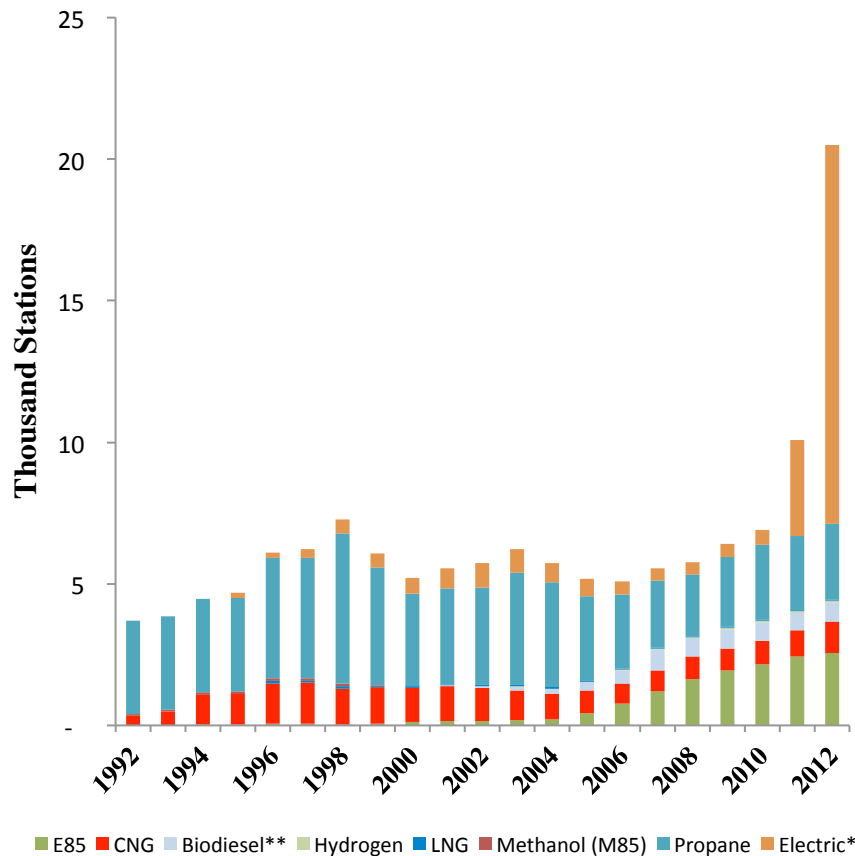
Source: Brown (2013)



Source: NGV Global, Credit Suisse estimates.

# Low Penetration of Gas in Transport Sector & GTL

## U.S. Alternative Fueling Station Count



Source: Alternative Fuels Data Center

## Firm proposed large-scale GTL capacity outlook

Plant name	Country	Operator	Proposed completion	Nameplate Capacity (bpd)
Escravos	Nigeria	Chevron/MNPC	2013	34,000
Oltin Yo'l GTL	Uzbekistan	Sasol/UNG/Petronas	2017	38,000
Sasol Louisiana	USA	Sasol	2018–19	96,000
Firm Proposed GTL Capacity*				168,000
Existing capacity at end-2012				232,100
Potential global capacity 2020				400,100

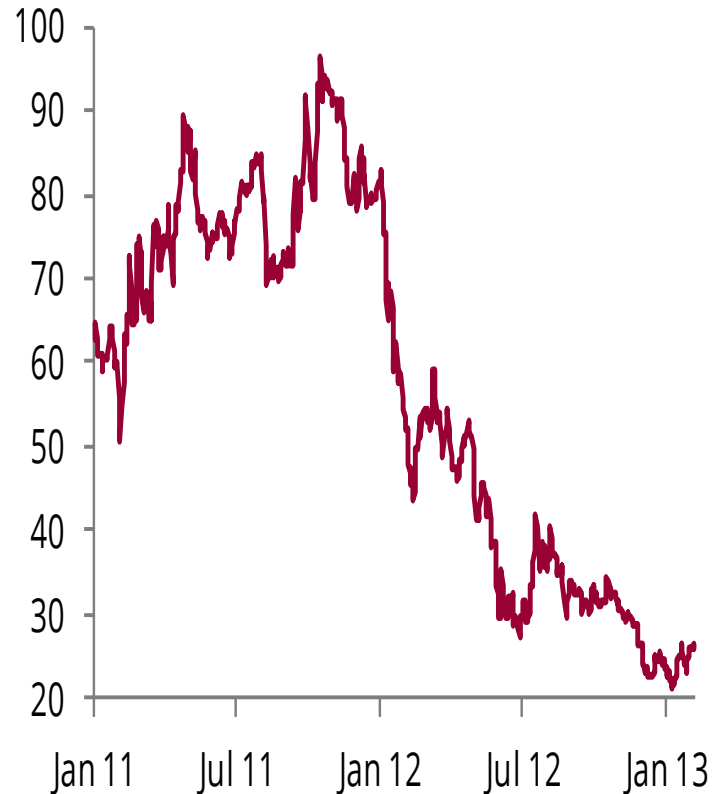
\*Projects past the feasibility study and in FEED process

Note: Capacity outlook excludes modular GTL developments, pilot and demo units

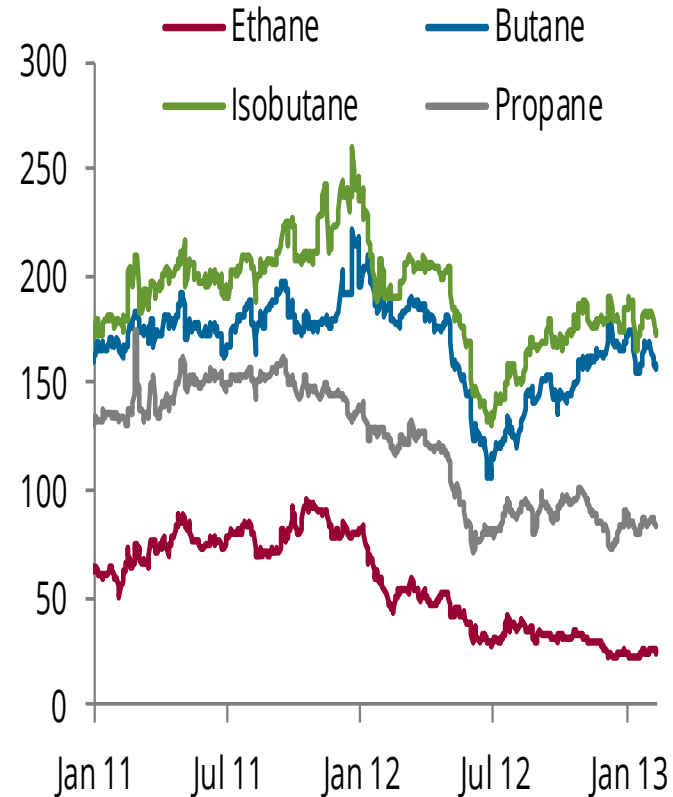
Source: Brown (2013)

# NGL Prices Going Down

**Ethane Prices, cents/gal<sup>2</sup>**



**Purity grade NGL prices, cents/gal**



*Source: Energy Aspects*

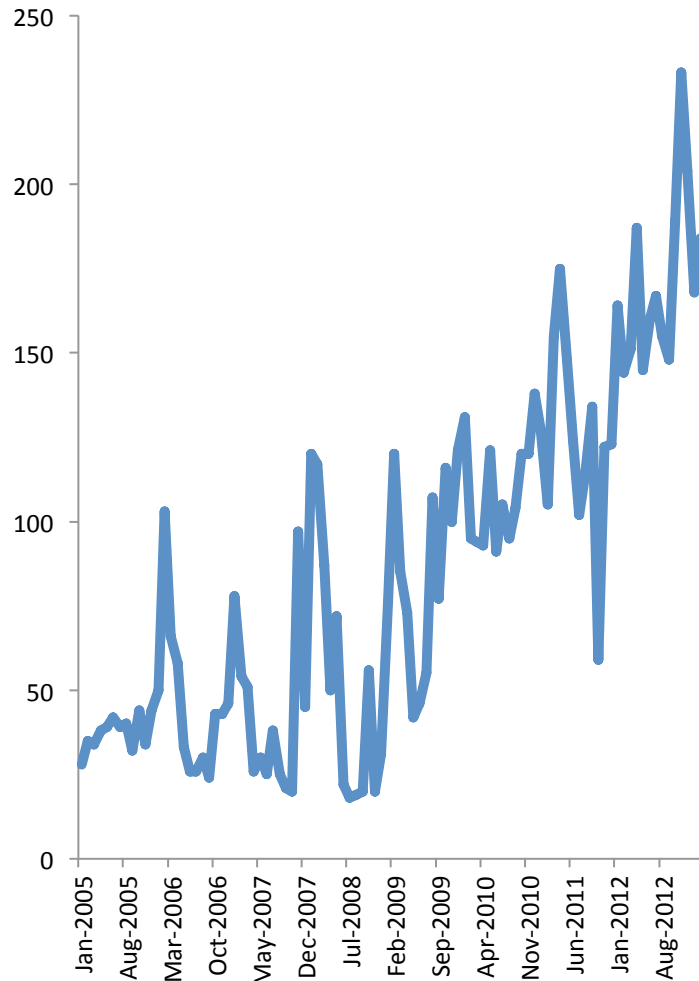
# The Petrochemical Renaissance?

Company	Location	Type	Cost (\$ Mn)	Additional capacity (thousand t/y)					
				2012	2013	2014	2015	2016	2017
Dow Chemical	Hahnville, LA	Restart	n/a	390	-	-	-	-	-
LyondellBasell	Channelview, TX	Expansion	25	227	-	-	-	-	-
Williams	Geismar, LA	Expansion	350	-	270	-	-	-	-
Ineos	Chocolate Bayou, TX	Expansion	n/a	-	115	-	-	-	-
Westlake Chemical	Lake Charles, LA	Expansion	n/a	-	105	-	105	-	-
LyondellBasell	La Porte, TX	Expansion	n/a	-	-	386	-	-	-
Westlake Chemical	Calvert City, KY	Expansion	220	-	-	286	-	-	-
BASF Fina Petrochem.	Port Arthur, TX	Expansion	n/a	-	-	115	-	-	-
ExxonMobil Chemical	Baytown, TX	Expansion	n/a	-	-	-	-	1,500	-
Formosa	Point Comfort, TX	Construction	1,700	-	-	-	-	800	-
Mexichem / Oxychem	Ingleside, TX	Construction	1,000	-	-	-	-	544	-
Dow Chemical	Freeport, TX	Construction	1,700	-	-	-	-	-	1,500
ChevronPhillips Chem.	Baytown, TX	Construction	5,000	-	-	-	-	-	1,500
Shell	Monaca, PA	Construction	4,000	-	-	-	-	-	1,500
Sasol	Lake Charles, LA	Construction	4,500	-	-	-	-	-	1,200
<b>Total</b>			<b>18,495</b>	<b>617</b>	<b>490</b>	<b>787</b>	<b>105</b>	<b>2,844</b>	<b>5,700</b>

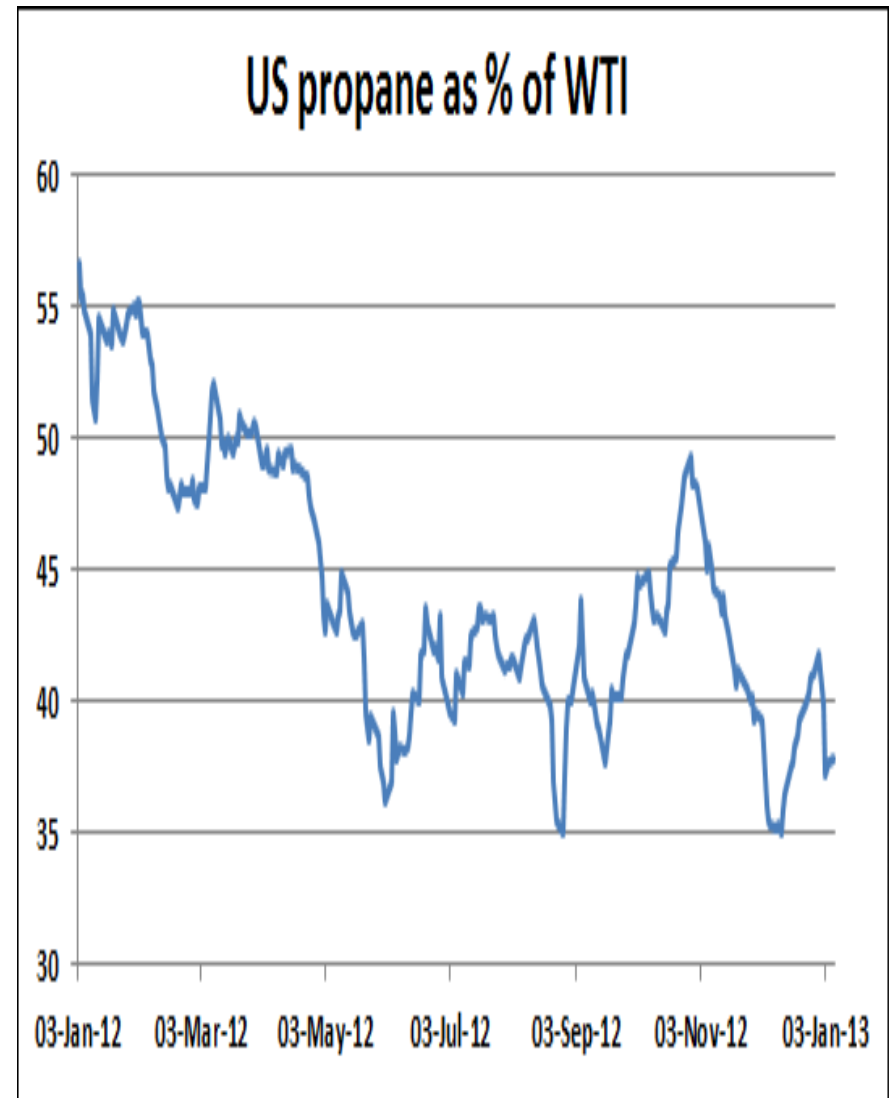
*Source: Energy Aspects*

# US Propane Exports Increased Sharply

**U.S. Exports of Propane and Propylene  
(1000 b/d)**



Source: EIA

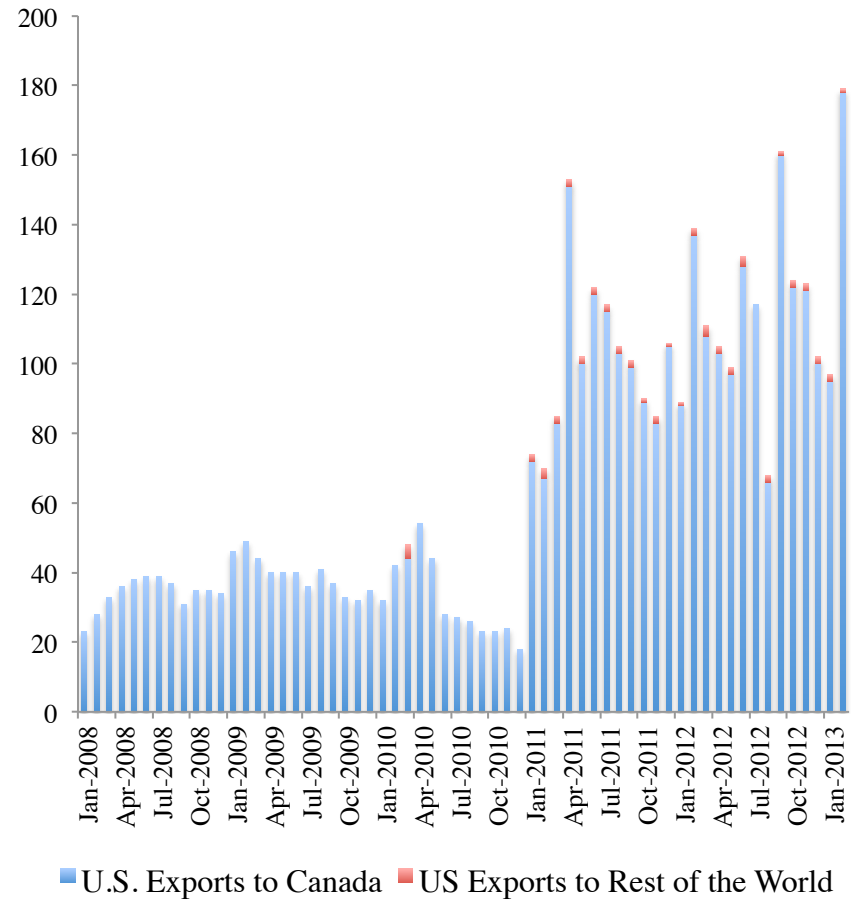


Source: Platts

# US Exporter of Natural Gasoline (Naphtha)?

- Canada takes US naphtha to dilute western oil sands
  - Sharp Increase in recent months
- But there are limits on Canadian demand especially as production growth slows down
- Some potential demand from Latin America
  - Mexico, Colombia and Venezuela
- But US cargoes will inevitably go to Asia

**U.S. Exports of Pentanes Plus (1000 b/d)**



Source: EIA

# Conclusions

# What Type of Revolution?

- For the US certainly
  - Reduce import dependency
  - Improve balance of payments and trade balance
  - Create employment in an environment of below full employment
  - Promote industrial growth
  - Change in relative prices of fuel
- For the rest of the world
  - Positive supply shock
  - Shift in perceptions from scarcity to abundance
  - Potential diffusion of technology to rest of world
  - Change in crude oil and petroleum product trade flows
  - Shift in NGLs supply flows
  - US energy policy now matters (export policy)
  - Change in the US view of the world (and the world of US)
- Transformative supply shock highly uncertain
  - Price and technology



# Be Careful of UniDimensional Analysis

- Some of story lines don't make sense once they are inter-linked
- The natural gas story
  - Increase in demand from power sector
  - Increase in demand from transport sector
  - Increase in demand from industry
  - Export to other parts of the world
  - But the gas price remains low (The US can't have it all!!!)
- The ethane story
  - Supply creates its own demand
  - But if all projects come through, ethane price will rise
  - Uncertainty in price; option to wait becomes valuable
  - Will all projects materialize?
- The US supply shock offset by a number of counter-shocks
  - Developments in oil market can't be looked from prism of US alone
  - Non-OPEC supply, OPEC policy, oil demand, geopolitical shocks, investment decision, strategic behavior