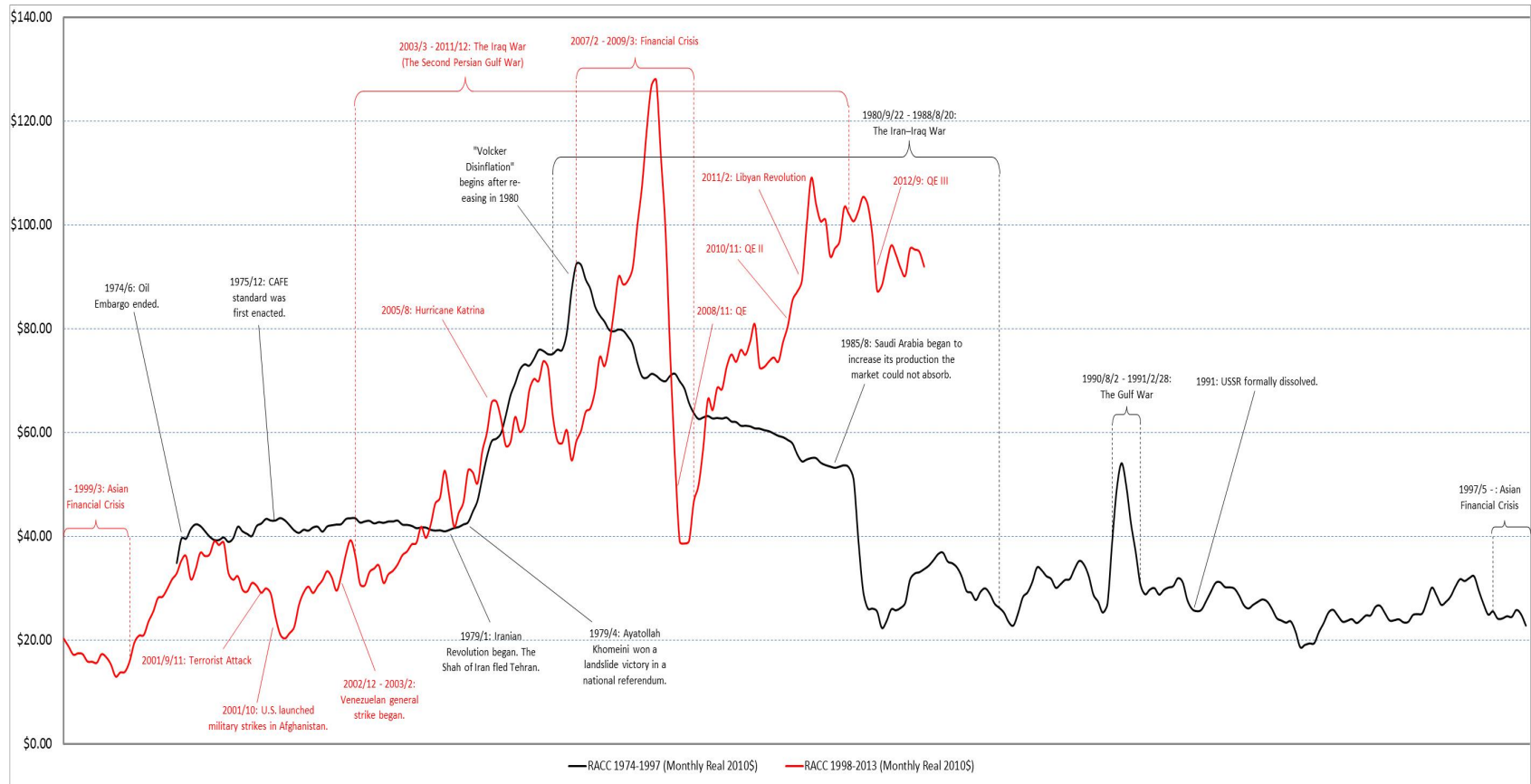


# Energy Security

Presentation to Economics for  
Energy  
Madrid  
January 19, 2015

Amy Myers Jaffe  
Executive Director  
Energy and Sustainability

# OPEC in Disarray : Repeating Boom and Bust Cycles Characterize Oil.



Source: Medlock, K.B., Amy Jaffe, "The price of crude oil: deja vu all over again?" (2013), EIA

- High oil prices usher in demand destruction through conservation, efficiency gains, and substitution
- High oil prices stimulate drilling innovations, which over time can lead to supply bubbles.

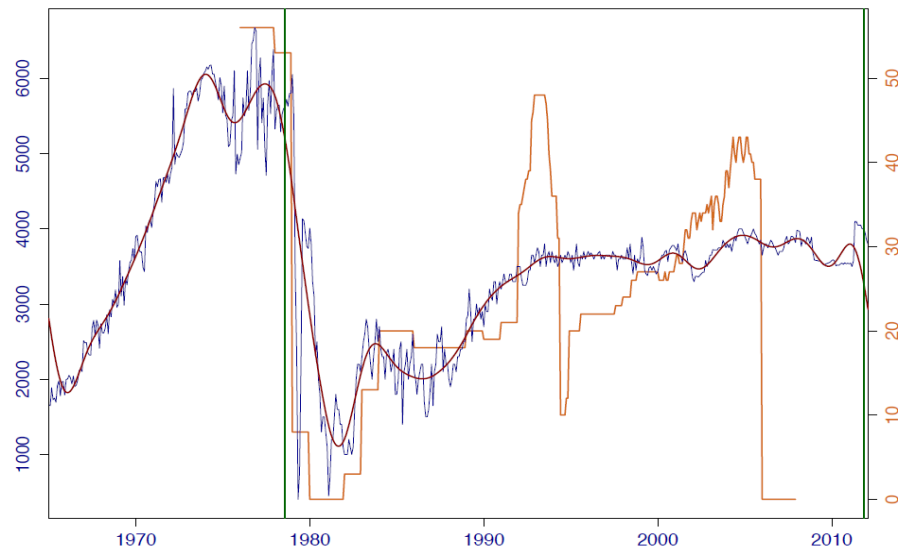
# Research Finding: Wavelet analysis reveals key variables that create prolonged oil price discontinuities and interrupt cycle:

1. War
2. Drilling Technology breakthrough
3. Demand destruction
4. Saudi price war

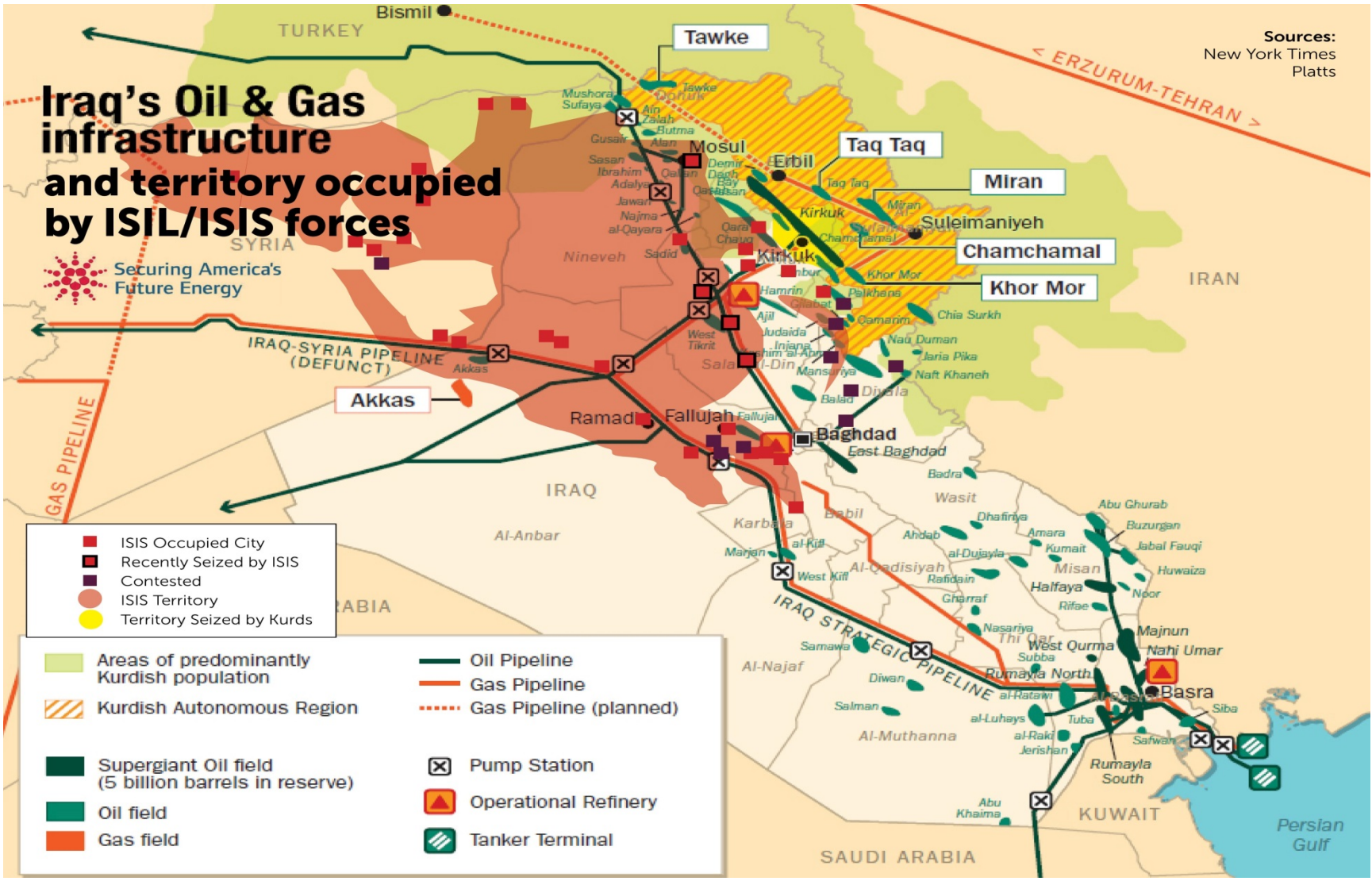
World Demand and Supply  
Other Supply Responses

Incorporating Hotelling  
Wars and Regime Changes

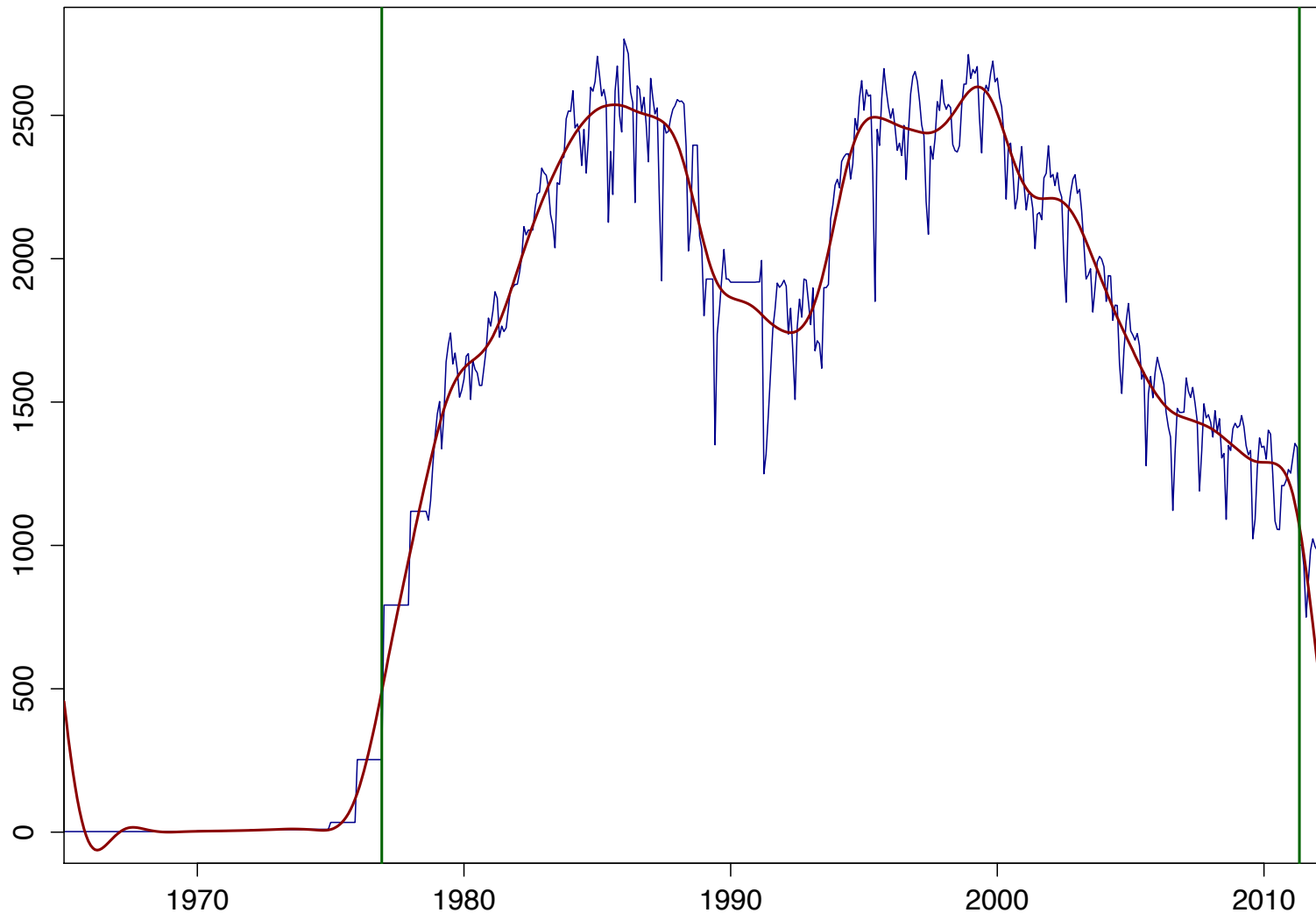
## The Effect of War on Iran



# Insurgencies Target Oil Facilities



# Technology-Driven Supply Response to Rising Prices: UK

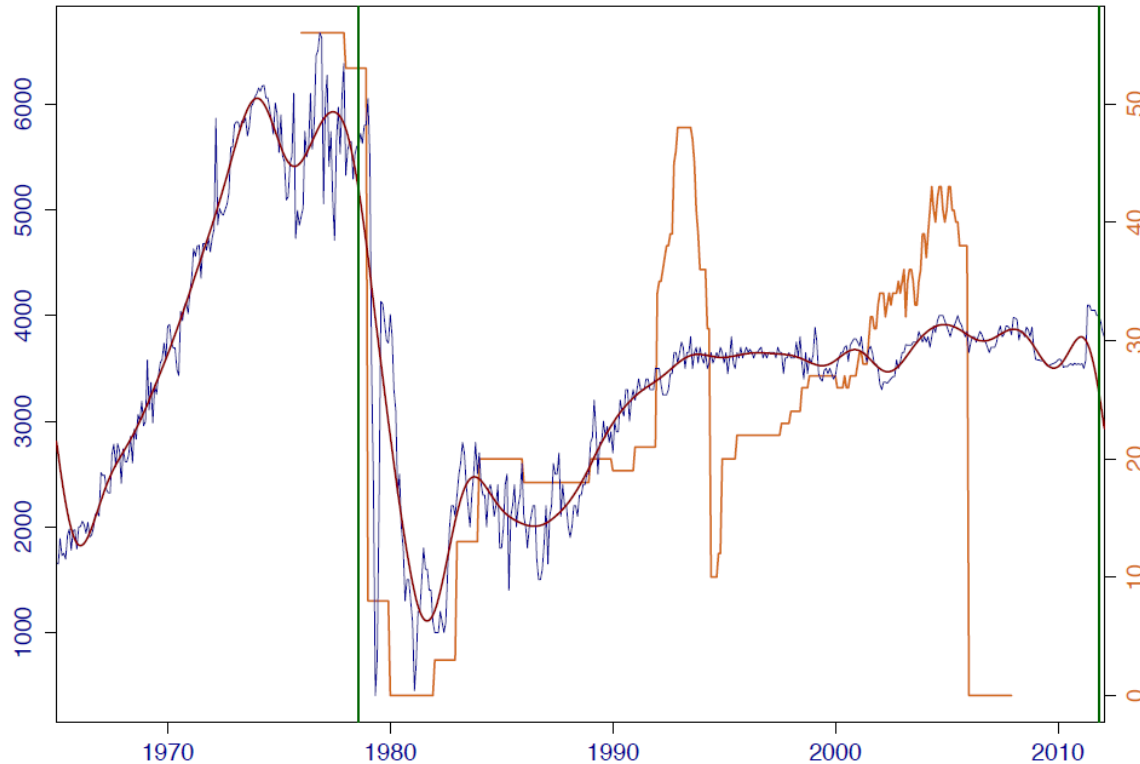


War's impact can be extended as countries struggle to repair facilities damaged during prolonged conflicts.

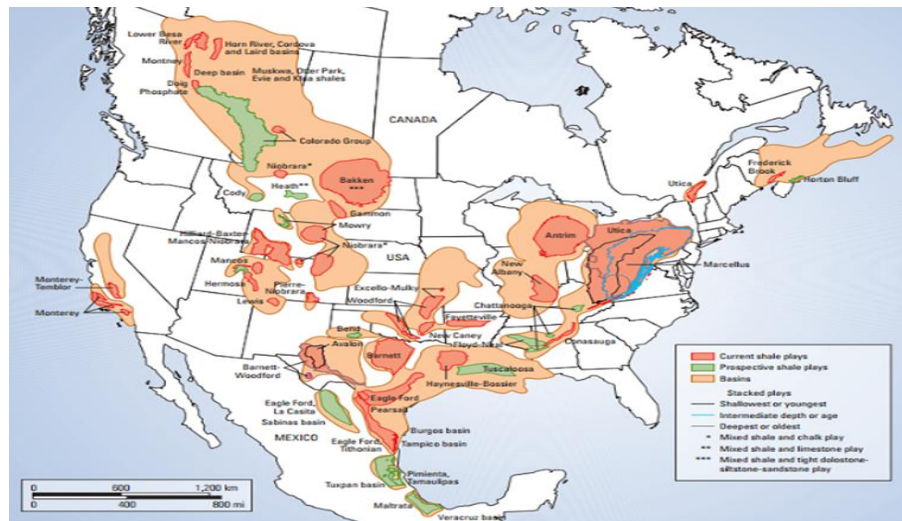
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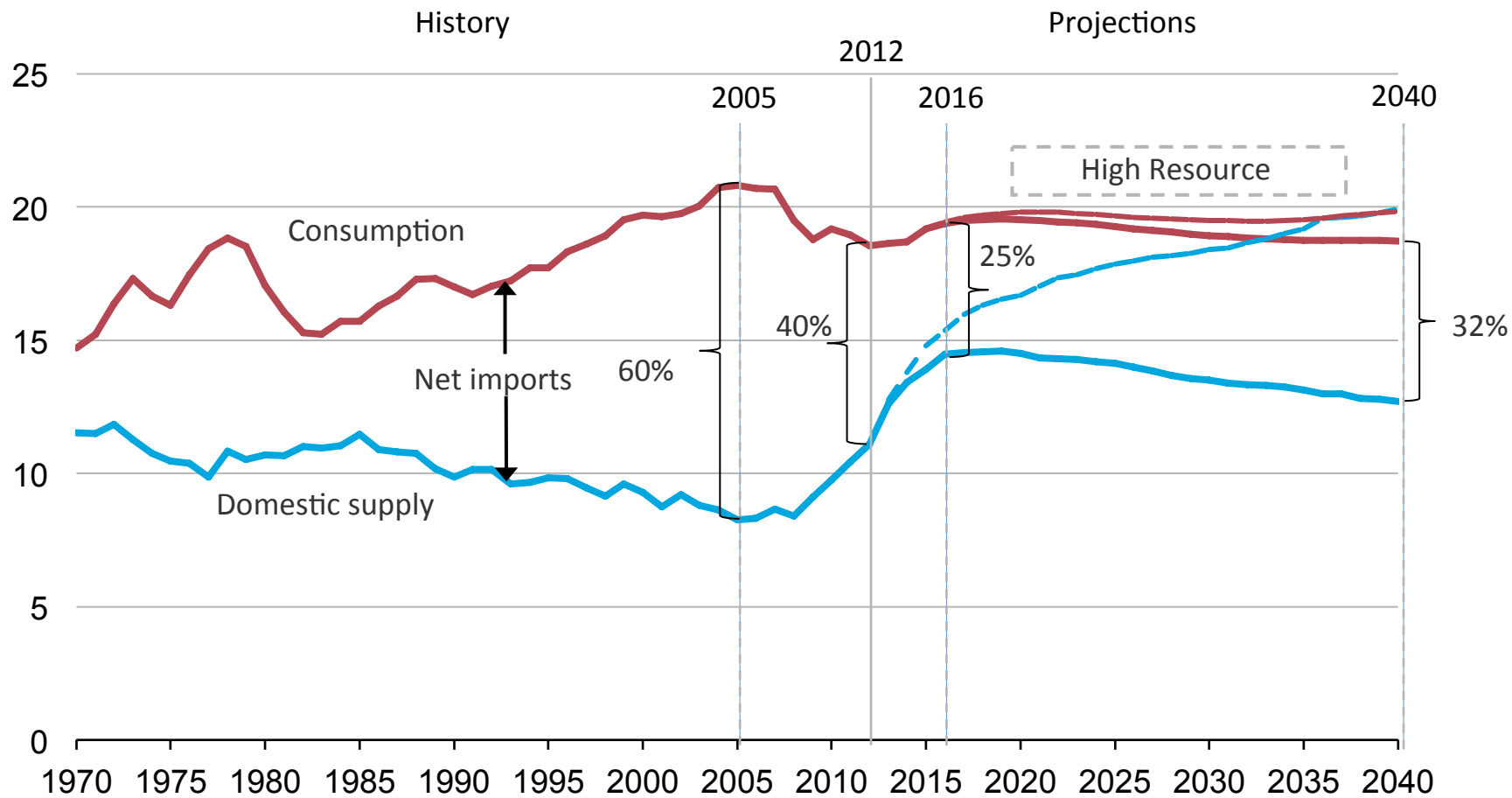


# US Stimulus Hits the Energy Jackpot Twice at Once



# The United States has the opportunity to become a net oil exporting country. Future US climate, vehicle and energy policy and the industrial internet will accelerate this trend.

U.S. liquid fuel supply  
million barrels per day



Source: EIA, Annual Energy Outlook 2014 Reference case and High Resource

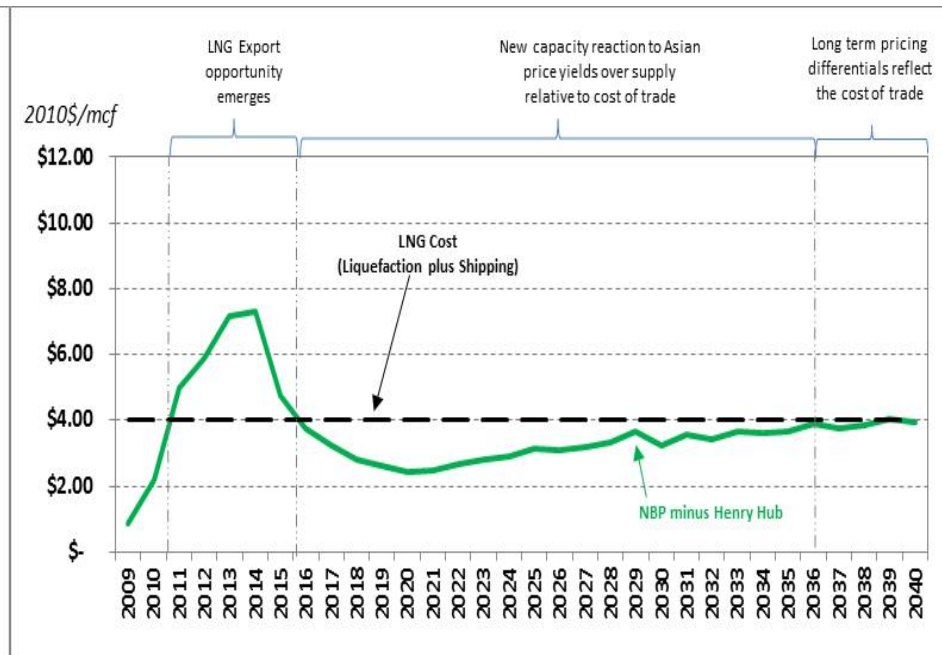
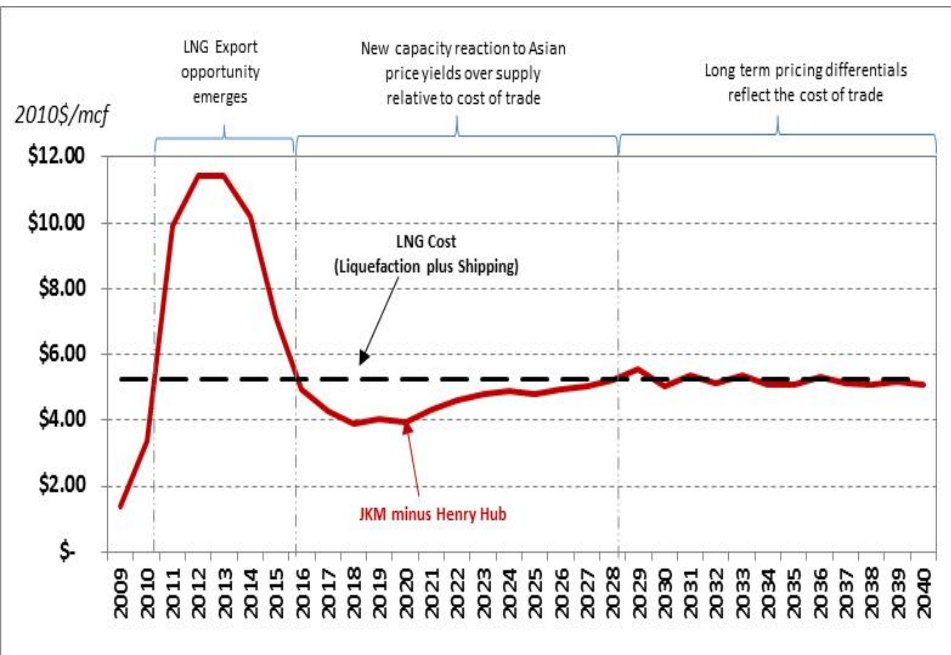
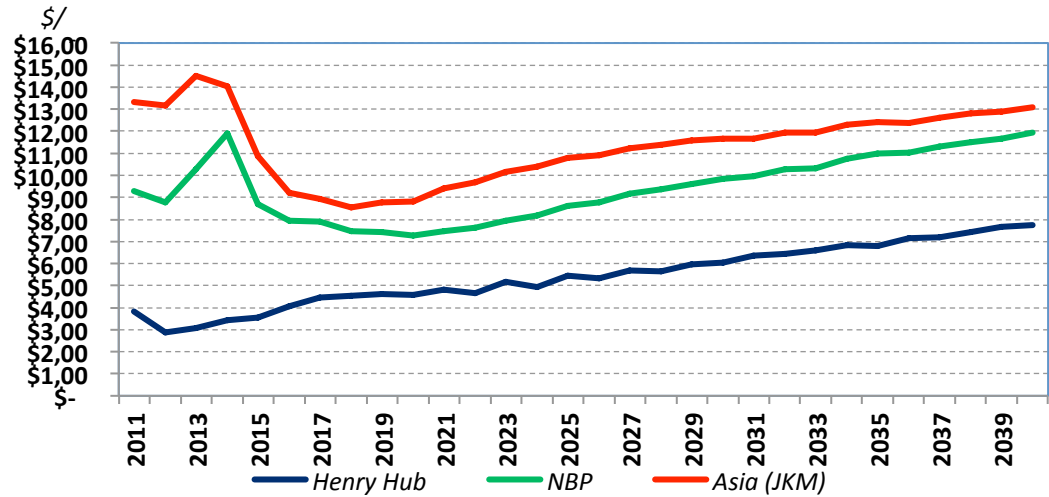


# Russia Cannot Currently Shift Europe's Natural Gas Supply to China



- About 50% of Russia's natural gas exports still transit Ukraine (142 bcm/yr capacity)
- Nordstream design is 55 bcm/yr but currently constrained to 35 bcm/yr by intake limits
- TANAP (Azerbaijan) only adds 10 bcm/yr
- Europe currently has a large surplus in storage, but...
- If Europe's weather were normal and supply remains robust, Europe will have too much gas; If Europe's winter is mild and only half of Russian supply to Europe is disrupted (via Ukraine), inventories will be sufficient; If Europe's winter were cold and there is a Russian supply cutoff, a serious energy shortage would ensue in Europe.
- Residential/commercial sector is 40% of total European natural gas use market.
- Long term prospects for Arctic and other upstream deals may sour over time

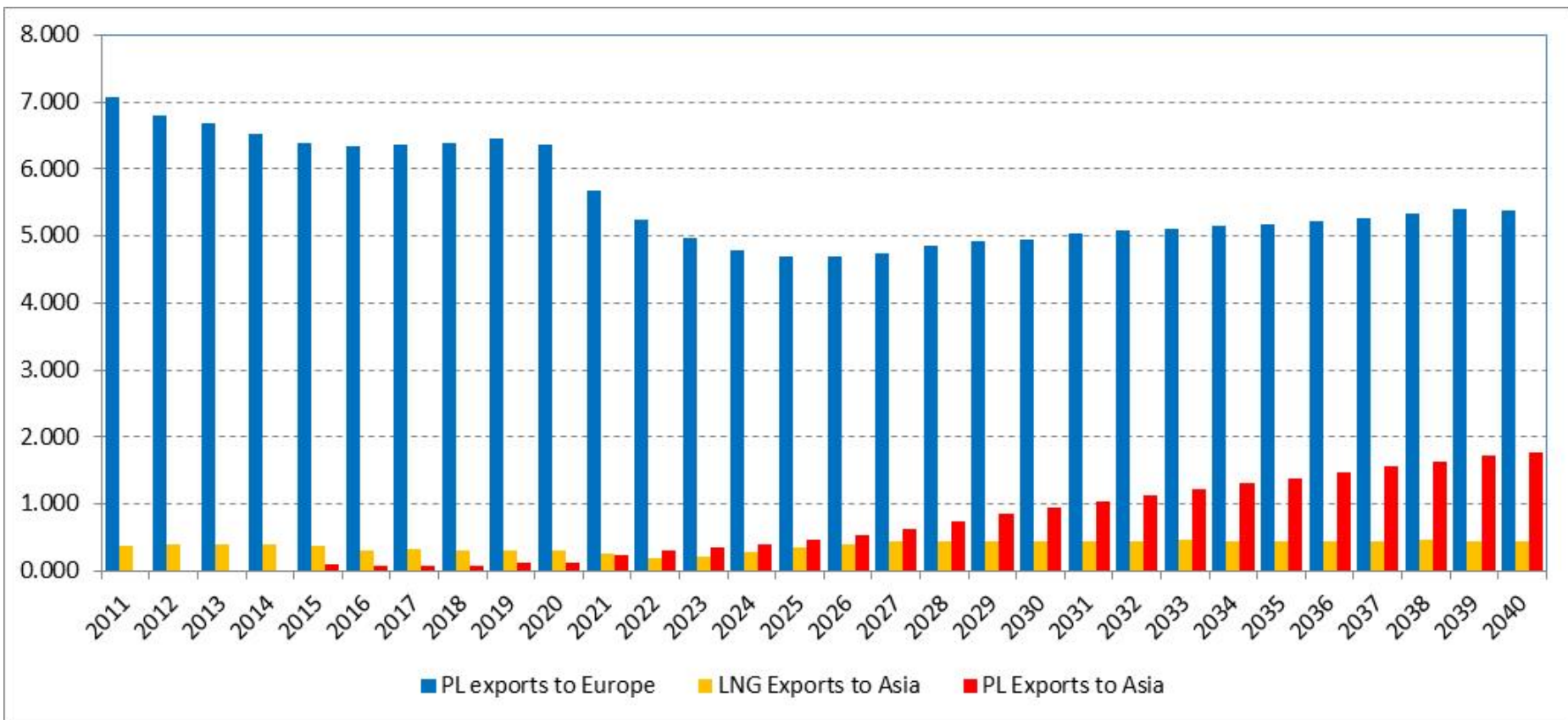
# Liberalization Scenarios: Produces Lower Global Prices and Encourages US LNG Exports



Source: Baker Institute RWGTM February 2014

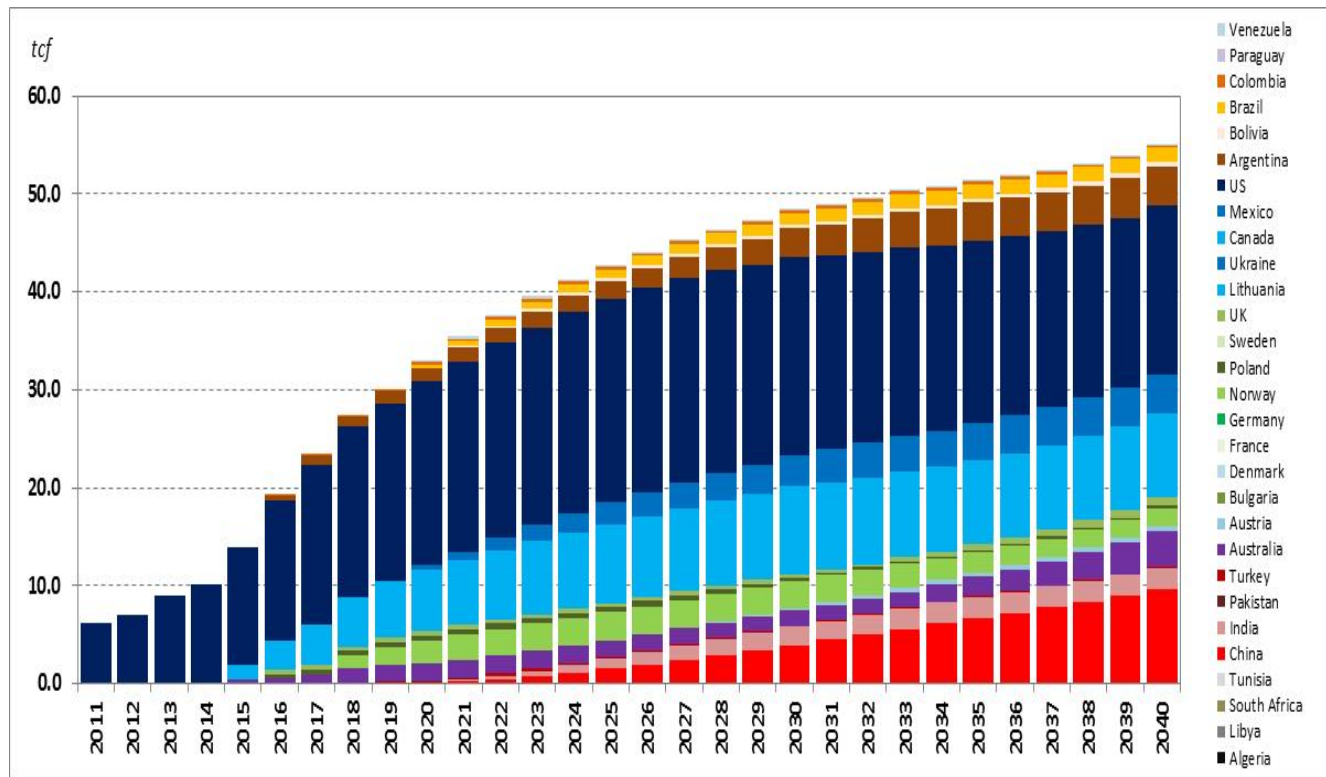
# Europe Would Become Less Reliant on Russian Exports Over Time, But Hard to Do Quickly

- Under a liberalization scenario, Russian export volumes are negatively impacted, with European market share falling. Under Russia/EU “cutoff” scenarios, additional LNG receiving capacity added in Germany, Italy. More North Sea supplies come on line.



# Shale gas production will eventually proliferate globally, bringing down international LNG prices.

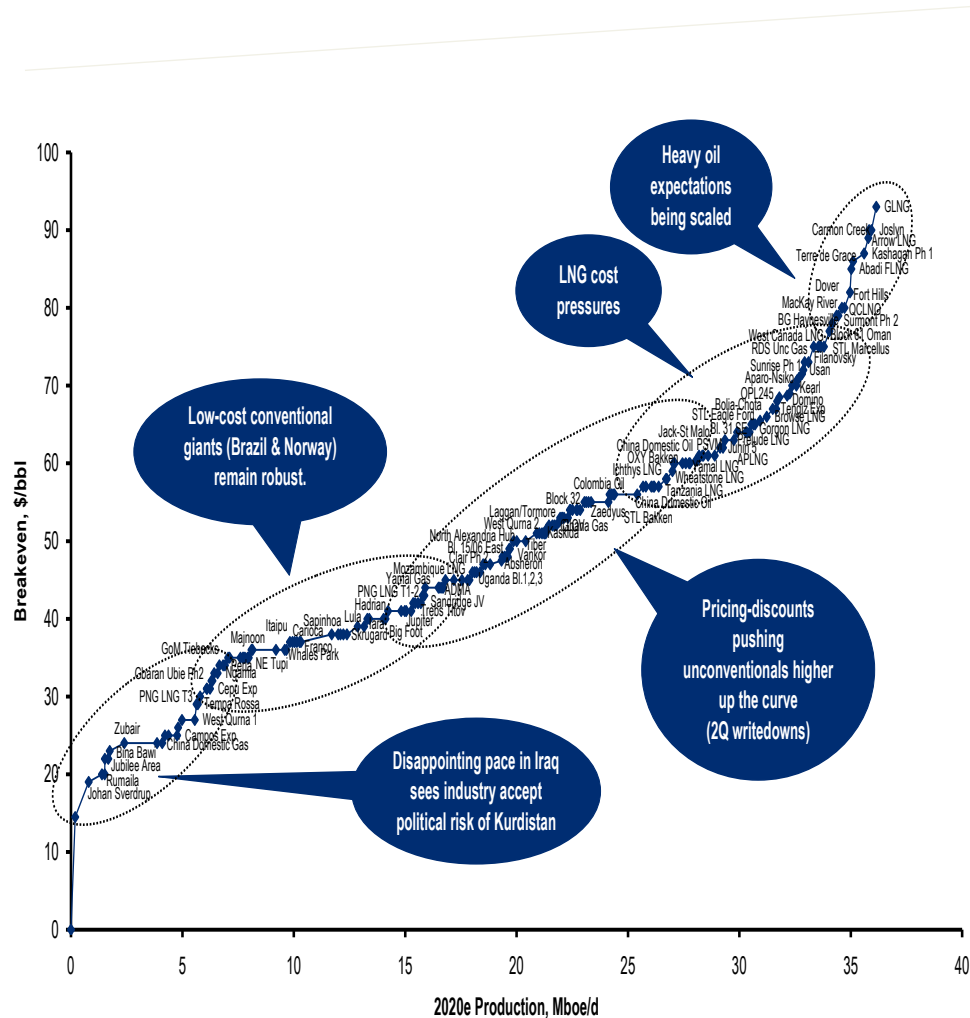
- North America accounts for the majority of shale gas. Qatar will have to discount prices to keep market share in geopolitically important countries, especially if Chinese shale can be developed.



# Breakevens for US shale oil and gas are lower than many other regions, developments

Unconventionals are not at the top of the scale for breakeven costs. Arctic and Mega-LNG projects could be most under pressure as global gas prices ease.

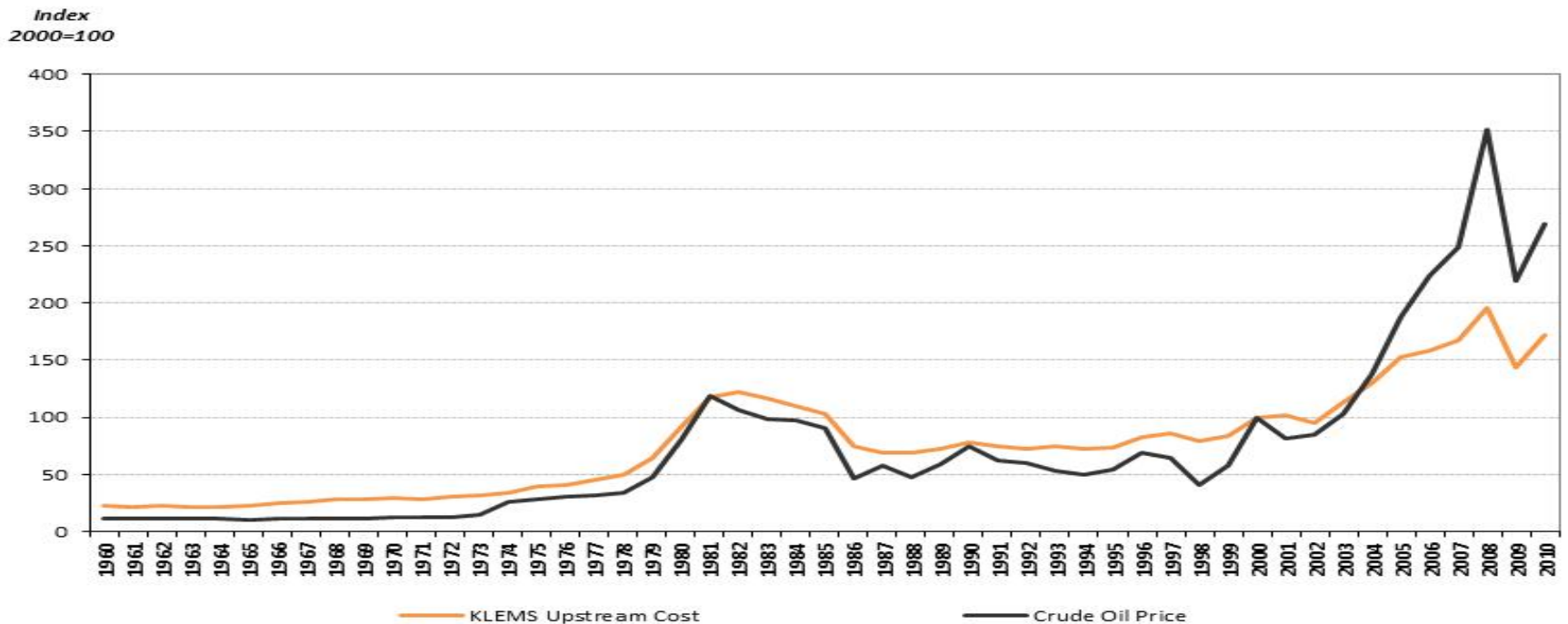
Field	Breakeven	OPEX
Marcellus (gas)	\$2.50	\$1.30
Barnett (gas)	\$3.80	\$1.60
Haynesville (gas)	\$3.60	\$1.30
Eagle Ford (oil)	\$37	\$7-\$8
Permian (oil)	\$49	\$10-\$12
Bakken (oil)	\$37	\$7-\$8
Mississippi an	\$43	\$7-\$8



Source: Citi Research

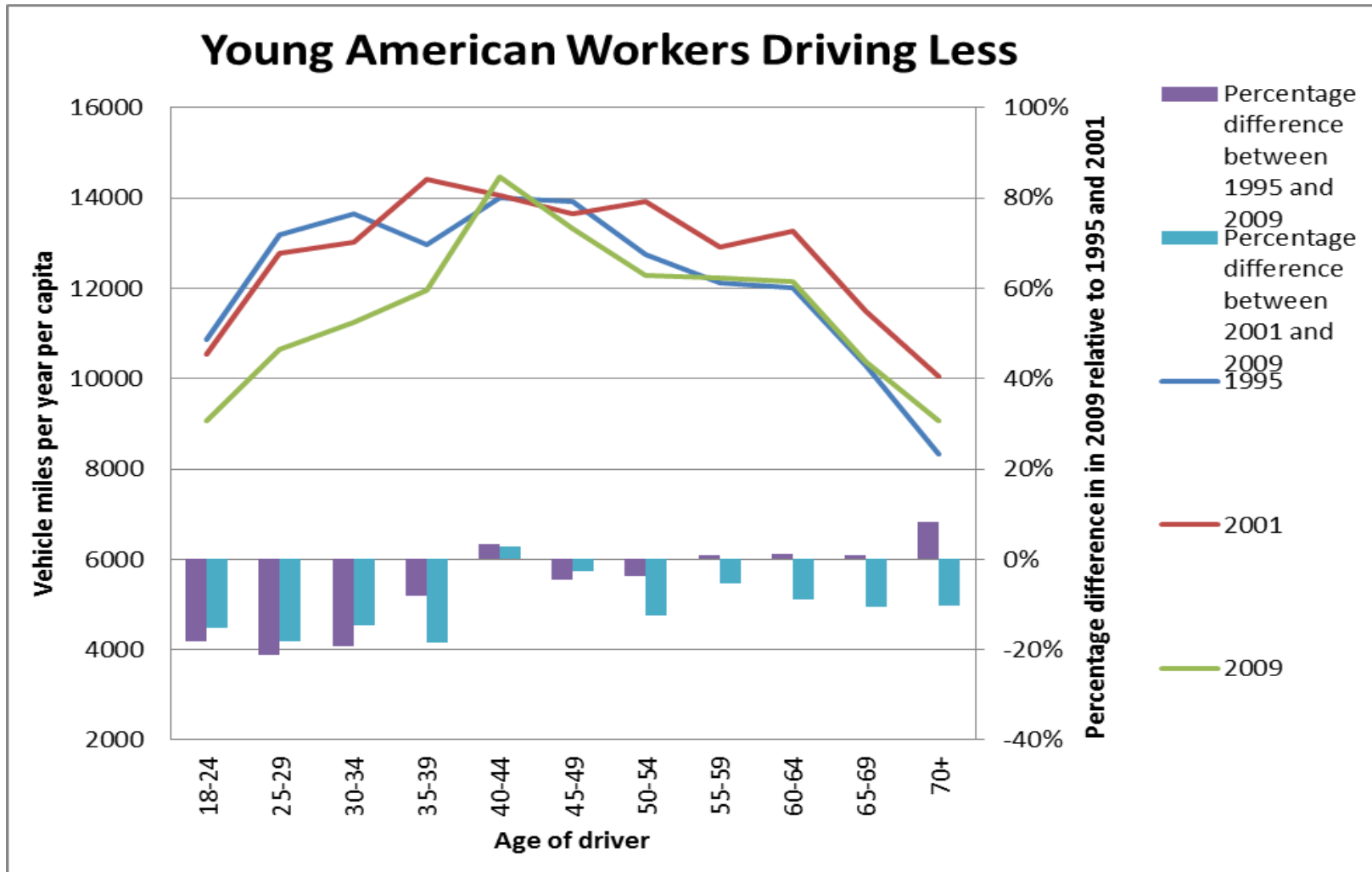
# Costs and Oil Prices Move Together

- *Chicken egg effect: As prices rise, more drillers expand activity, increasing demand for equipment and rigs and raising costs. Equal and opposite effect seen when prices fall.*
- *It is not correct that cost increases will be permanently rising based on complexity. Cost management-technology improvement, accelerated development cycle times, and improved well productivity can all reduce **COSTS**.* (source for graphic: Kenneth Medlock, *The Oil Price Cycle Presentation*, Baker Institute)



# Generational shift in Attitudes Towards Automobiles and Climate Change

Younger Americans More Urban, Less Interested in Car Culture



# **US will follow different models towards low carbon energy. Local policy is driver.**



- **Smart homes and net zero energy communities fit US interest in resilience and response to extreme weather events**
- **Debate beginning on new utility models, distributed energy and net metering. Resistance to “death spiral” of falling electricity demand, maintenance cost of transmission.**
- **Sharing economy and millennial purchasing patterns changing the way transportation “services” (eg ride sharing), urban planning, and consumer facing household technologies will develop.**
- **Expect more disruptive technologies to come out of the US**



# The US Strategy for COP21



- **US negotiator Todd Stern expresses support for New Zealand proposal in October 2014, country by country “legally binding” pledges with mandatory accounting, but not an int’l binding treaty, removing distinction between developed and developing world considered desirable.**
- **US-China meetings in early November focus on possible areas of agreement on climate change. US expecting to lead, not follow in global dialogue.**
- **Little appetite in US Congress, Obama administration focused on policies that can be implemented by executive order.**
- **US-China energy and climate dialogue focusing on clean tech collaboration and investment strategies**
- **China-California collaboration on air pollution, EV strategy**