

Energy Markets: Energy and Climate Policy Challenges

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Estimated Short-Term Price Elasticities of Oil Demand

- **$e(I) = 0.3$ to 0.6 (higher in later studies)**
 - Rapid economic growth or recession drives oil demand.
- **$e(P)$ has significantly declined:**
 - -0.1 to -0.3 in the 1970s/1980s**
 - -0.01 to -0.06 since 2000**
 - Very large price changes are needed to change oil demand in the short term.

Source: C. Difiglio, "Oil, Economic Growth and Strategic Petroleum Stocks," *Energy Strategy Reviews*, Vol. 5, pp. 48-58, 2014

Why are Short-Term Price Elasticities of Oil Demand an Order of Magnitude Lower than Before

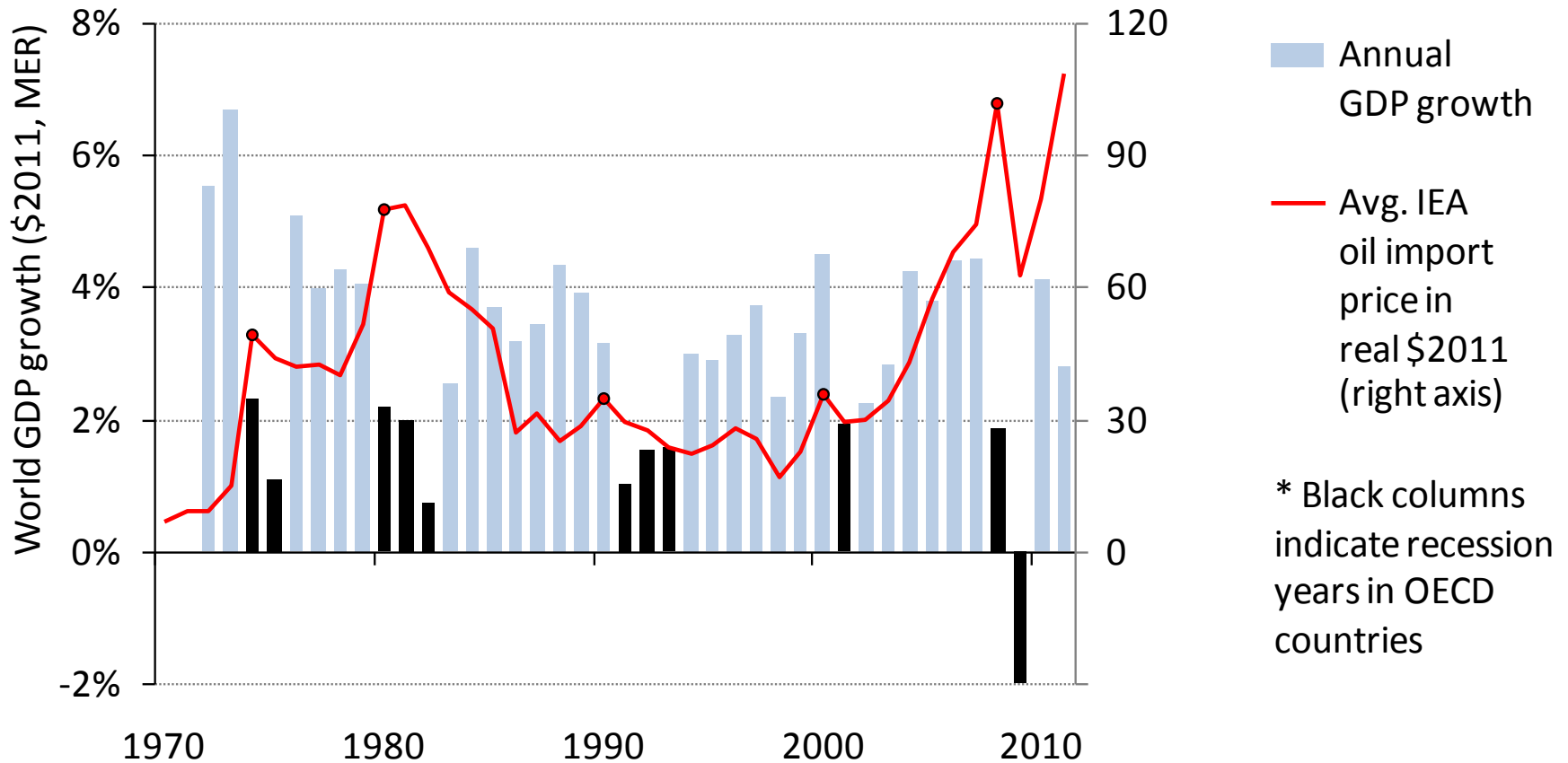
- Decreased use of oil in the power sector and industry for process heat
- Decreased use of oil for space heating
- The price of gasoline, distillate and jet fuel drives oil. No other products are important.
- Cannot reduce the consumption of these fuels without curtailing transportation services.
- Increased motor-vehicle fuel efficiency has also reduced the price elasticity of demand.

Short Term Price Elasticity of Oil Supply

- Short term oil supply responses:
 - **Backwardation or contango motivates stock draws or builds.**
 - **Higher or lower oil prices have motivated changes in OPEC spare production capacity.**
 - **Oil price changes affect E&P investment but do not significantly affect short-term production.**
 - **Even in the U.S., apart from drilled-but-uncompleted tight oil wells (DUCs), the short-term price elasticity of supply of tight oil is low.**
- **With inelastic oil supply and inelastic oil demand, unbalanced oil markets cause high price volatility.**

Oil Price Volatility: Oil Price Spikes Clearly Hurt the World's Economies

International crude oil prices and global GDP growth



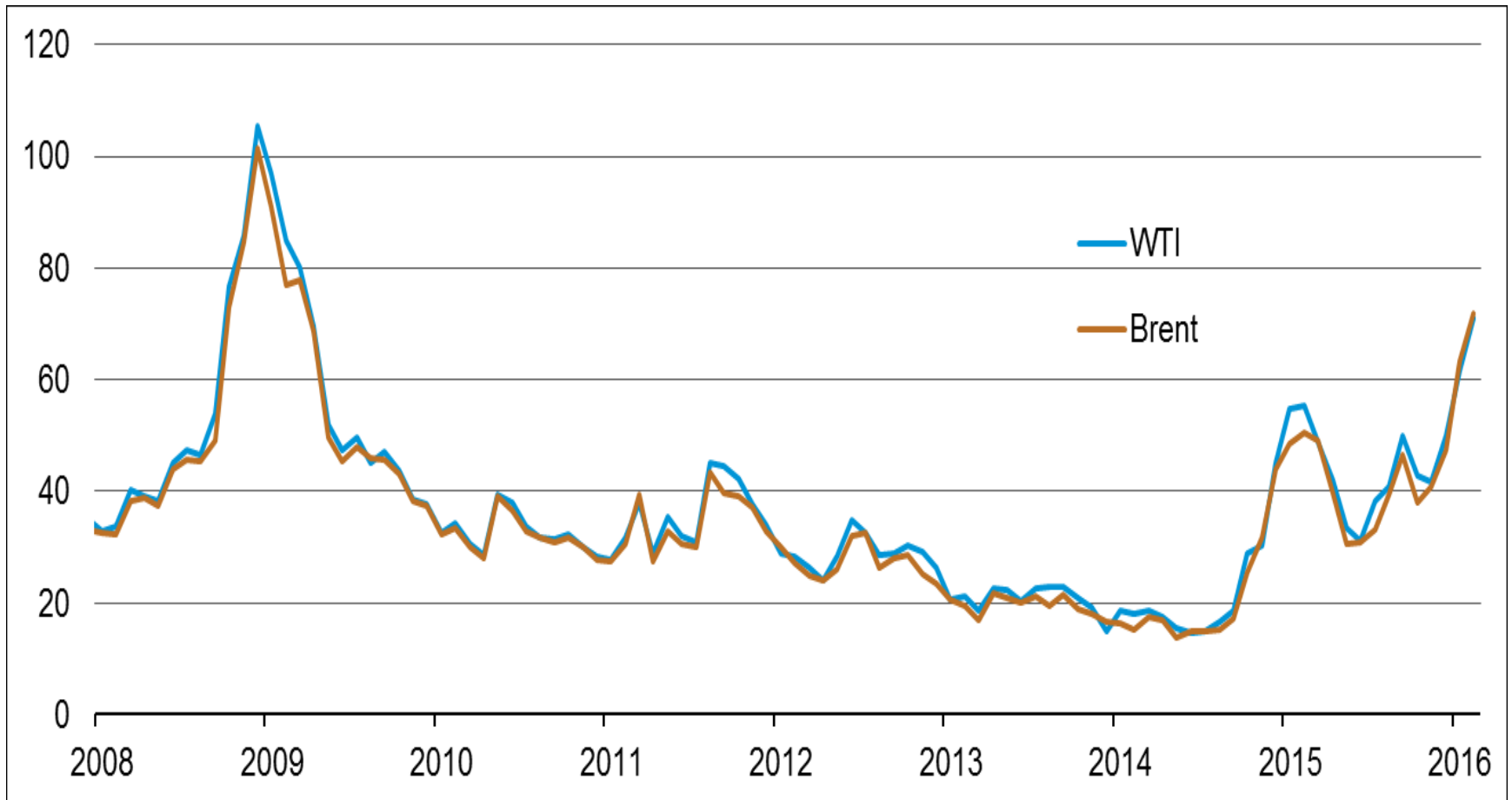
Why Oil Price Shocks Reduce Growth

- Reduced income available for other goods and services cause dislocations in these industries.
- The automobile industry is particularly affected by oil price shocks.
- The multiplier effects of these dislocations cause the economy to operate below its potential output until a new equilibrium can be established.
- These dislocations are only caused by large oil price increases (e.g., if they set a new high for the previous 3 years).

[Source: James Hamilton, "What is an Oil Shock?" Journal of Econometrics, 113, 363-398, 2003]

Oil Price Volatility: At its highest levels in years & suggests large uncertainty in oil markets

monthly average implied volatility
annualized percent



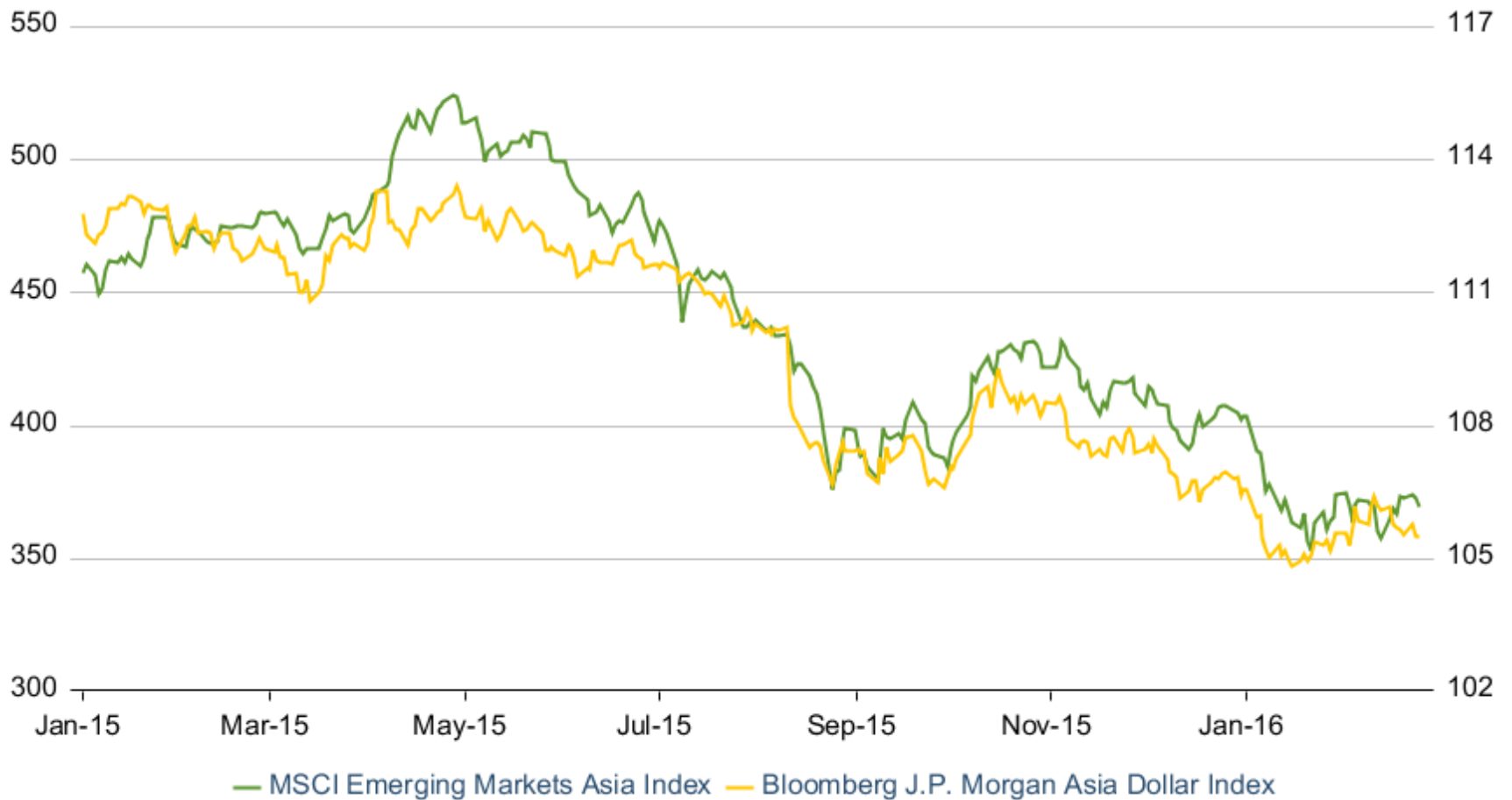
Even with Low Oil Prices, Volatility Can Hurt Economies

- Lower oil demand reflects global economic weakness.
- Oil's strong negative correlation to the U.S. dollar transmits its impact on the broader macroeconomic landscape.
- The co-movement of these major global assets, oil and the USD, has driven much of the risk currently confronting global markets.
- Including corporate credit fears to the pace of Fed tightening.

Note Trade Weighted Dollar vs. Oil Prices – Counterpart to BRICS Currency Weakness



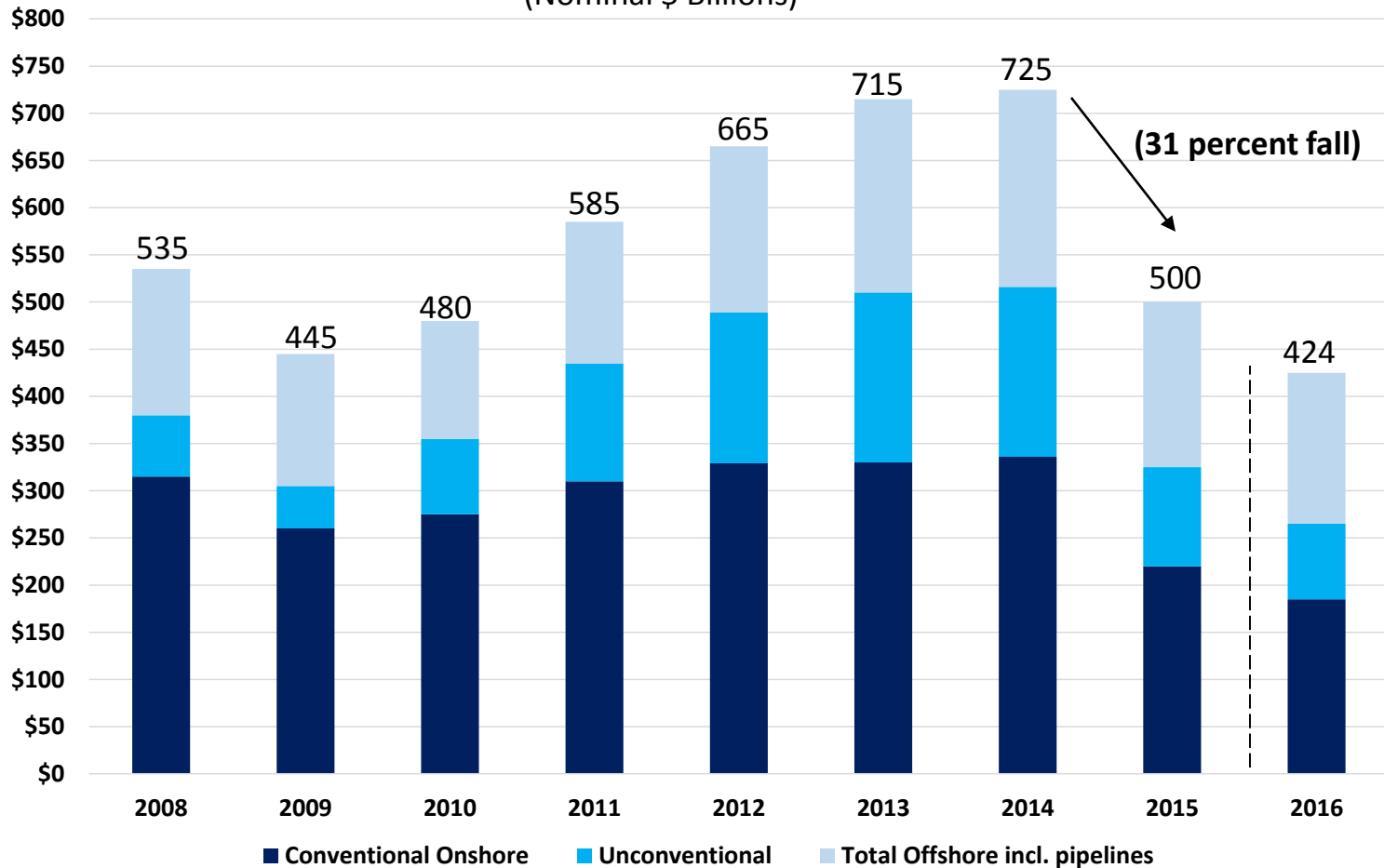
Oil Price Volatility: Downward Trend in Asian Currencies



Going Forward: The Consequences of Low Oil Prices on Oil Production Investments

Exploration & Production Onshore and Offshore CAPEX

(Nominal \$ Billions)



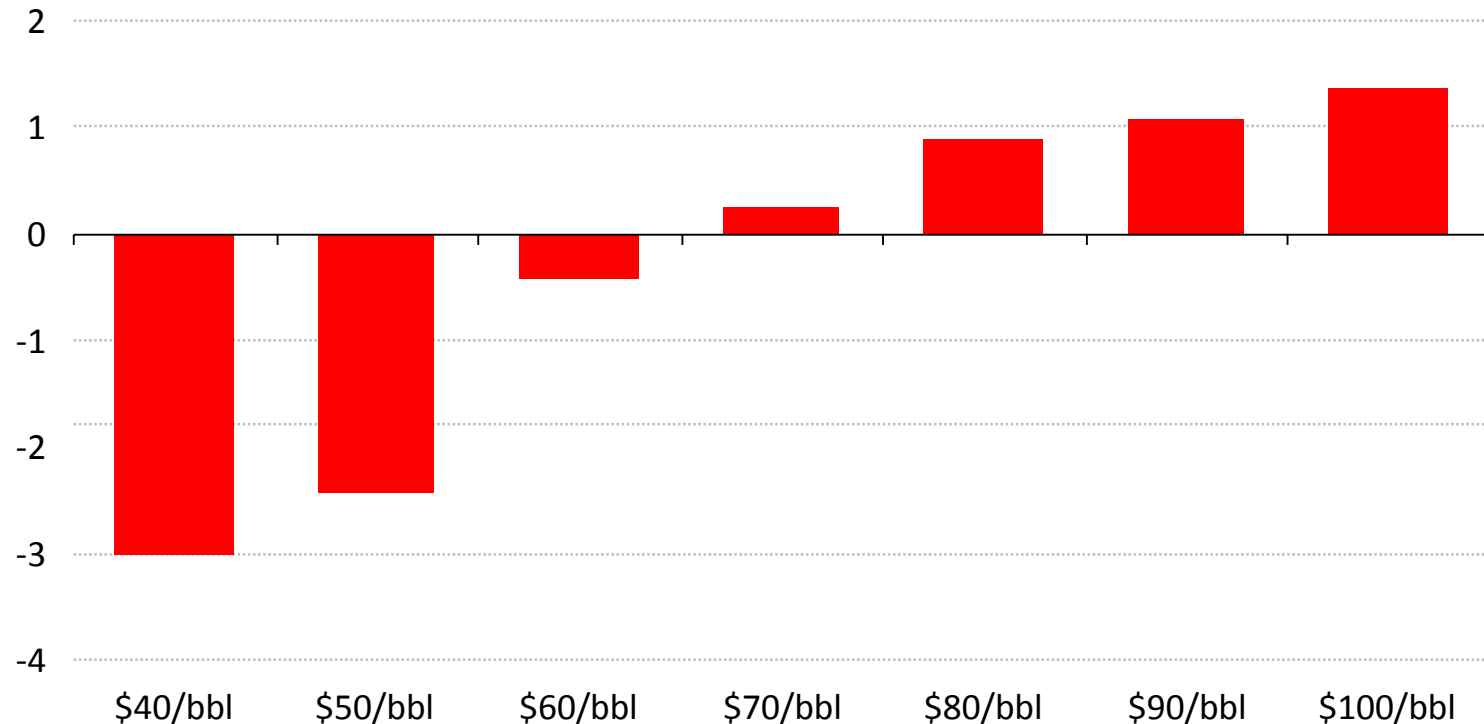
Source: IHS

U.S. Tight Oil Production Growth at Different Projected 2020 Oil Prices

Change in production (2015-2020) of U.S. tight oil for a range of 2020 oil prices

mmb/d

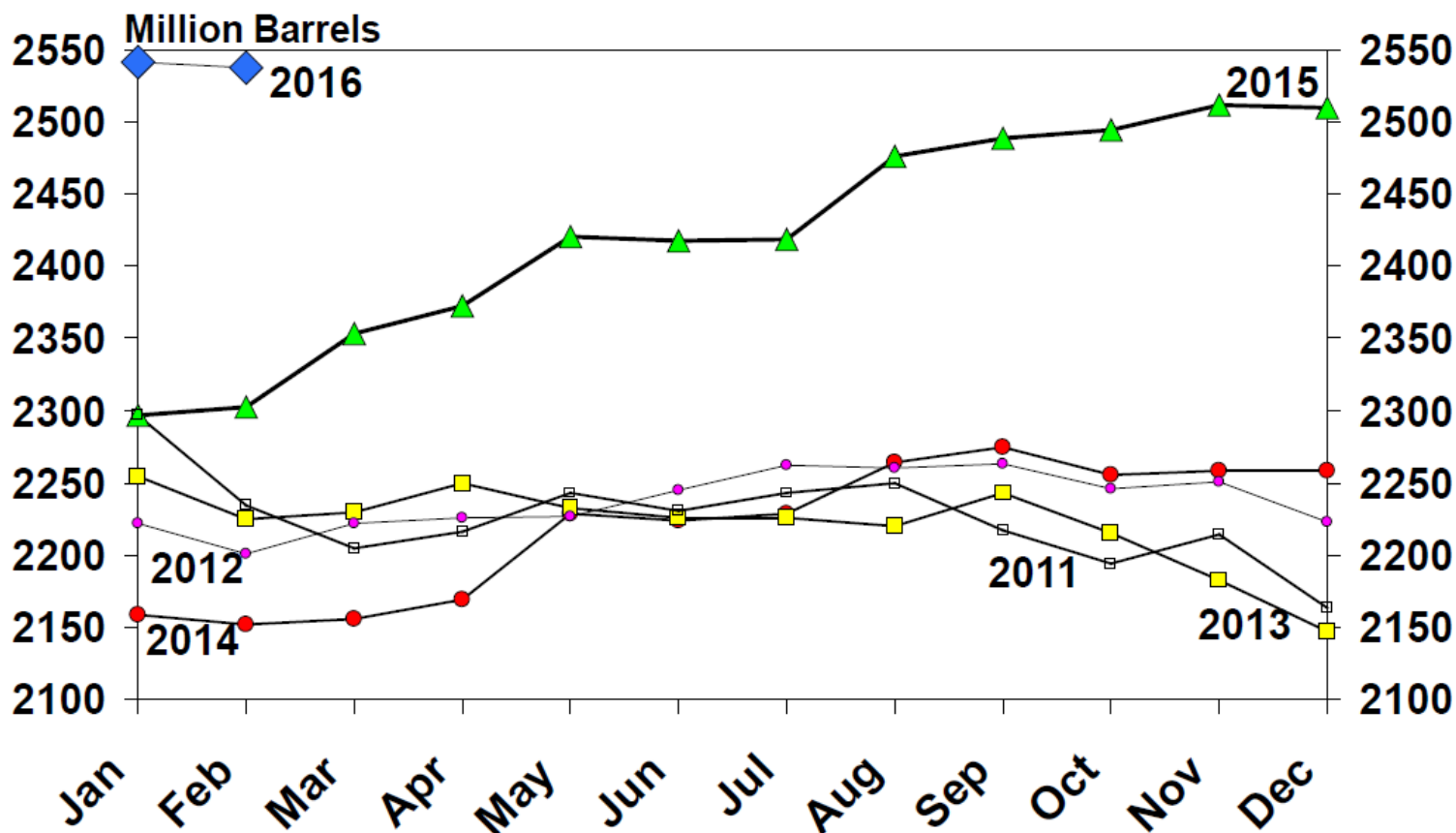
Source: IEA 2015 *World Energy Outlook*



**\$60/b not estimated to halt a decline in U.S. tight oil production.
Robust growth requires \$80/b.**

Total Commercial Crude & Product Stocks in the 3 Major OECD Markets

U.S., Europe, Japan

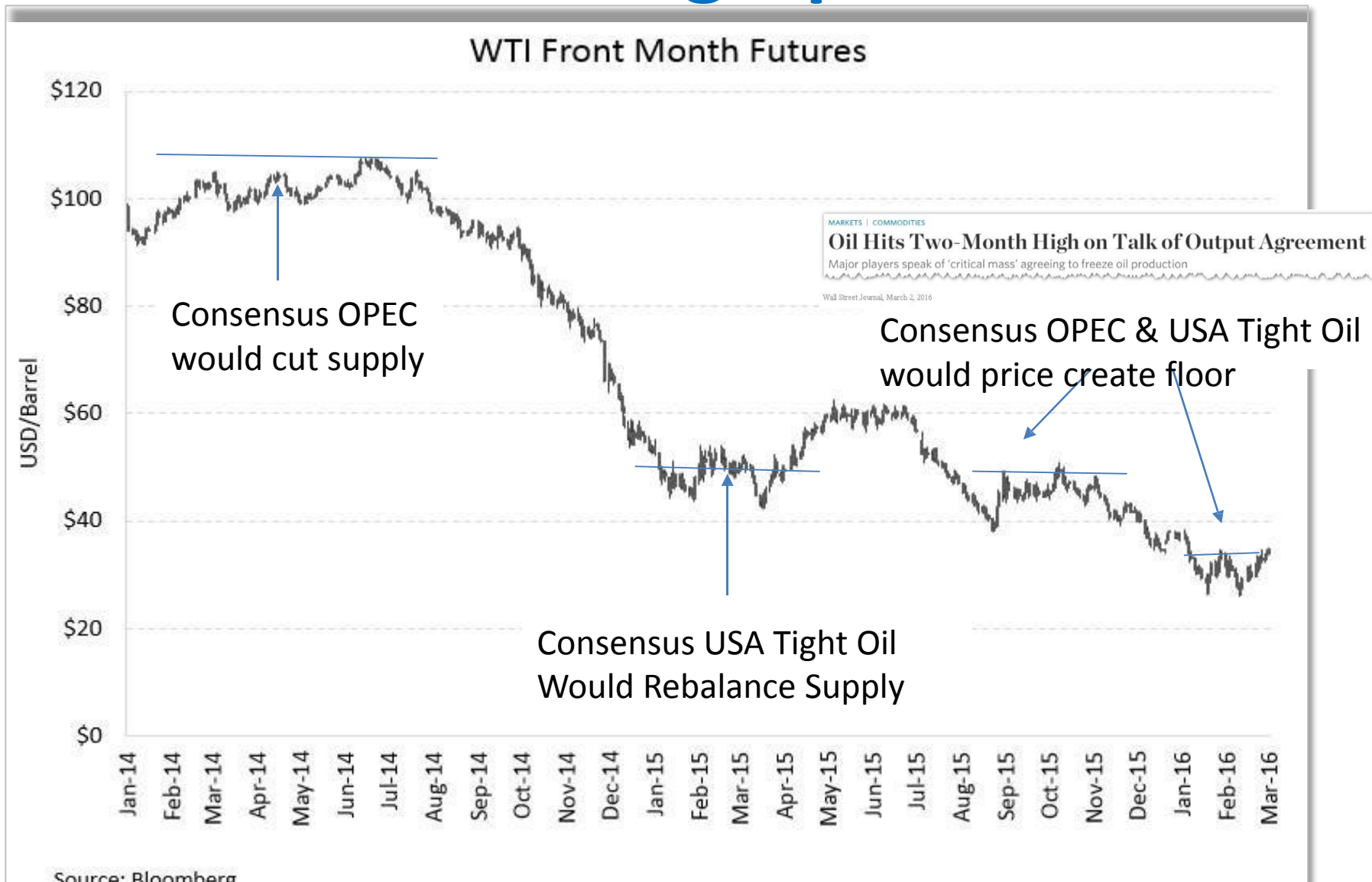


Source: PIRA

Working Off the Supply Glut

- Increased oil prices would be met with increased supplies from stocks and U.S. DUCs, pushing prices back down.
 - **Excess worldwide oil stocks could be as high as 600 mmb.**
 - **Stock draws could add 1 mmb/day to world supplies for almost 2 years before returning to normal inventories.**
 - **Fracking U.S. DUCs would quickly add supplies at higher oil prices.**
- Absent OPEC cuts and surprising economic growth, world oil markets will be well supplied at current low oil prices past 2017. Prices could begin to climb ~ 2018-2019.
- “Talking up” oil prices with reports of forthcoming OPEC cuts have merely increased price volatility.

Effects of Talking Up Oil Prices



Longer term consequences of prices below the marginal cost of non-OPEC oil production

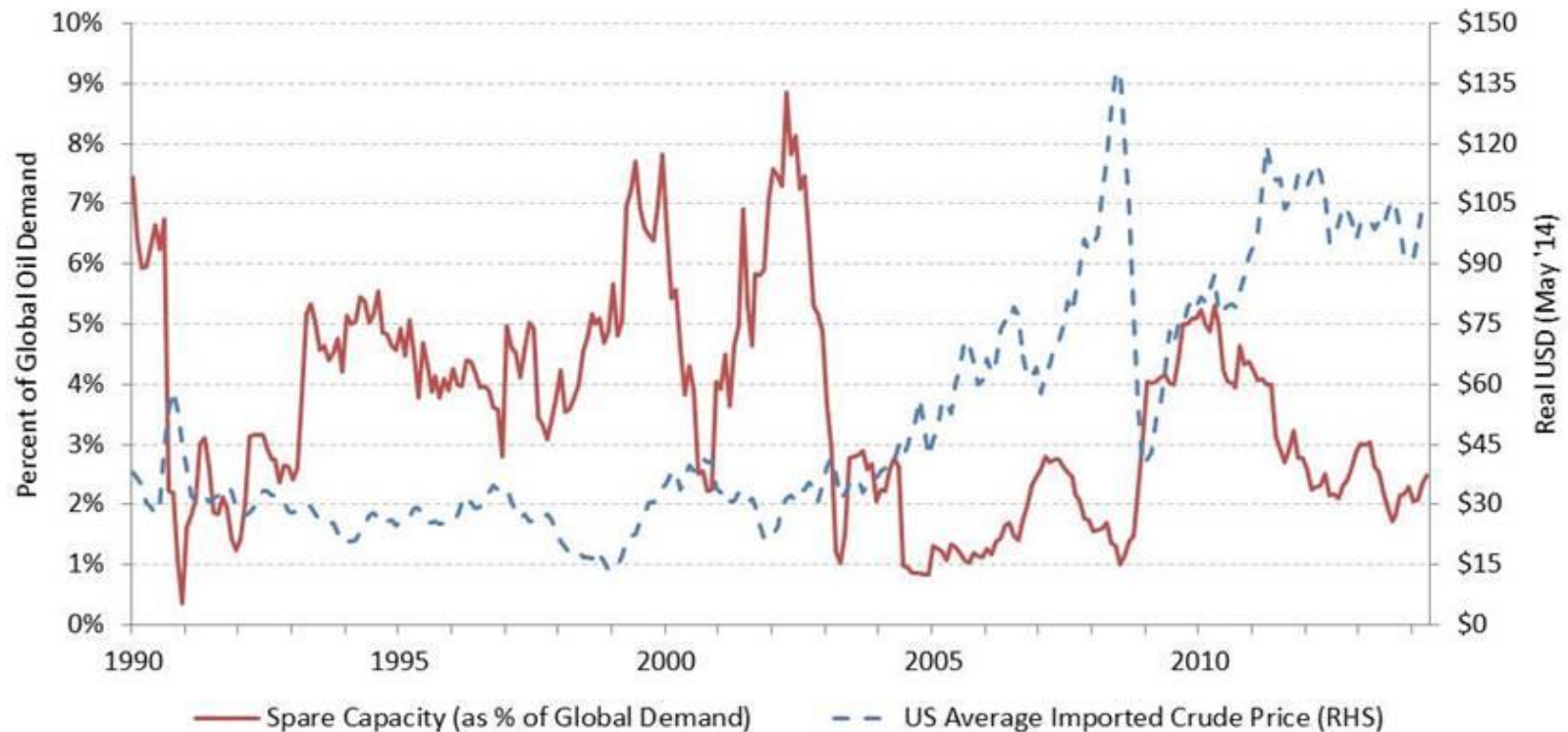
- MENA OPEC gains world market share.
- With oil prices below non-OPEC marginal cost, lower E&P investments by private oil companies.
- Non-OPEC supply growth stalls and then declines.
- The demand for oil is still increasing: demand growth could overtake supply growth.
- Outcomes not smooth or predictable.
- Especially if we experience more unplanned oil supply outages (several MENA scenarios).
- VOLATILE OIL MARKETS BUT AT HIGHER PRICES.

Adding to Volatility – Not Likely to Have the Balancing Role of OPEC Spare Capacity

US Imported Crude Prices and OPEC Spare Capacity

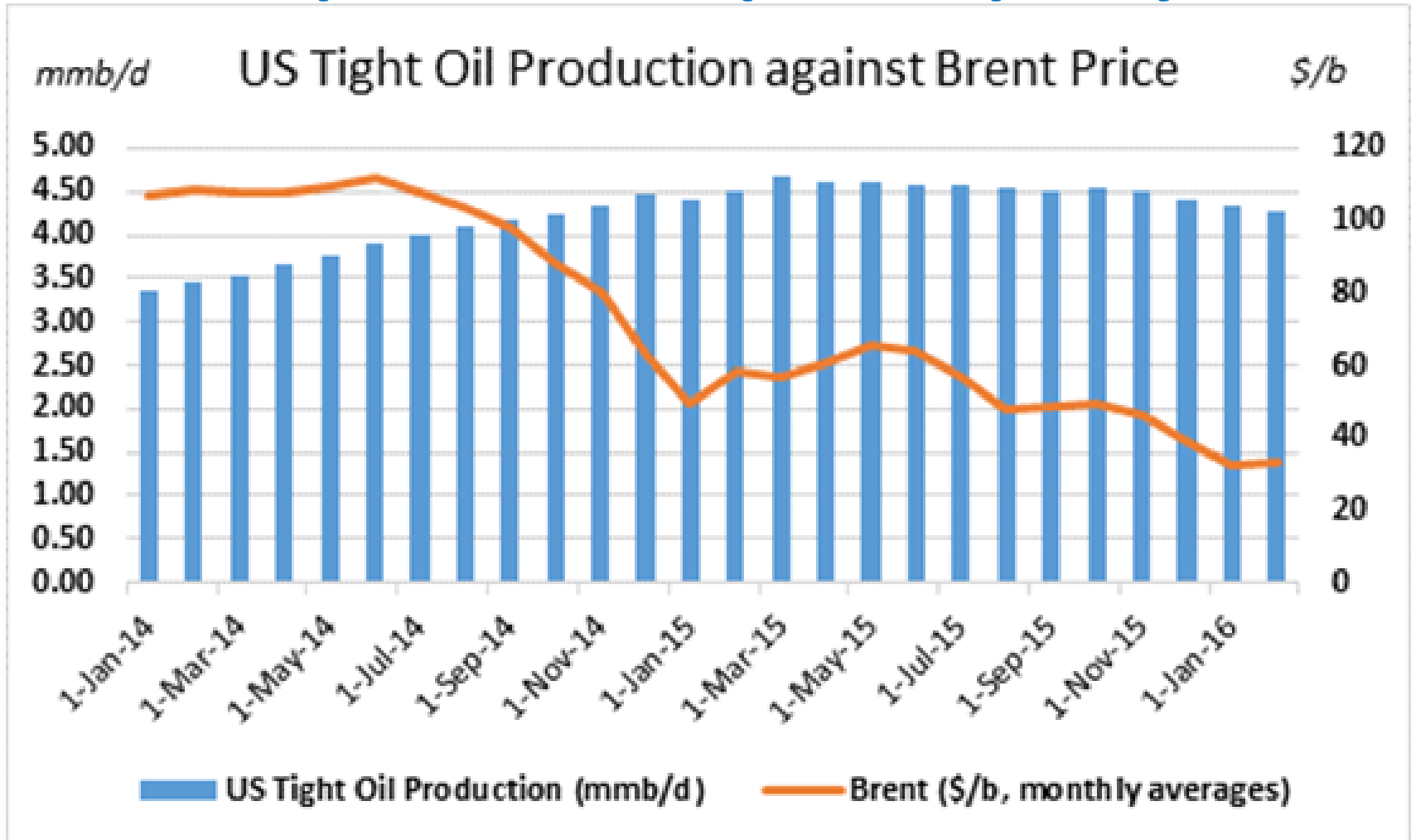
THE RAPIDAN GROUP
GLOBAL ENERGY INSIGHT

Source: EIA



Movements of OPEC spare capacity clearly countercyclical but effectiveness begins to wane in 2007-2008, appears to target \$100/b after Libyan cutoff & isn't employed in 2014 (Saudi Arabia accepts market pricing of oil).

Going Forward: U.S. Tight Oil Does Not Replace OPEC Spare Capacity



The short term price elasticity of U.S. tight oil supply is also very low, even though it may be more price elastic than conventional oil in the longer term.

Back to high prices or do we have a new oil paradigm?

- Low prices forever?
 - The growth in Chinese distillate demand may have peaked as their economy turns inward towards domestic demand and away from industrial exports.
 - U.S. tight oil production may continue to grow.
 - Tight oil technologies could be applied in promising worldwide basins.
 - With climate policies, we may be seeing peak oil demand.
 - Among the 3 oil giants, Saudi Arabia, Russia & the U.S., no deal to limit production is possible since the USG does not control U.S. oil production.

Or?

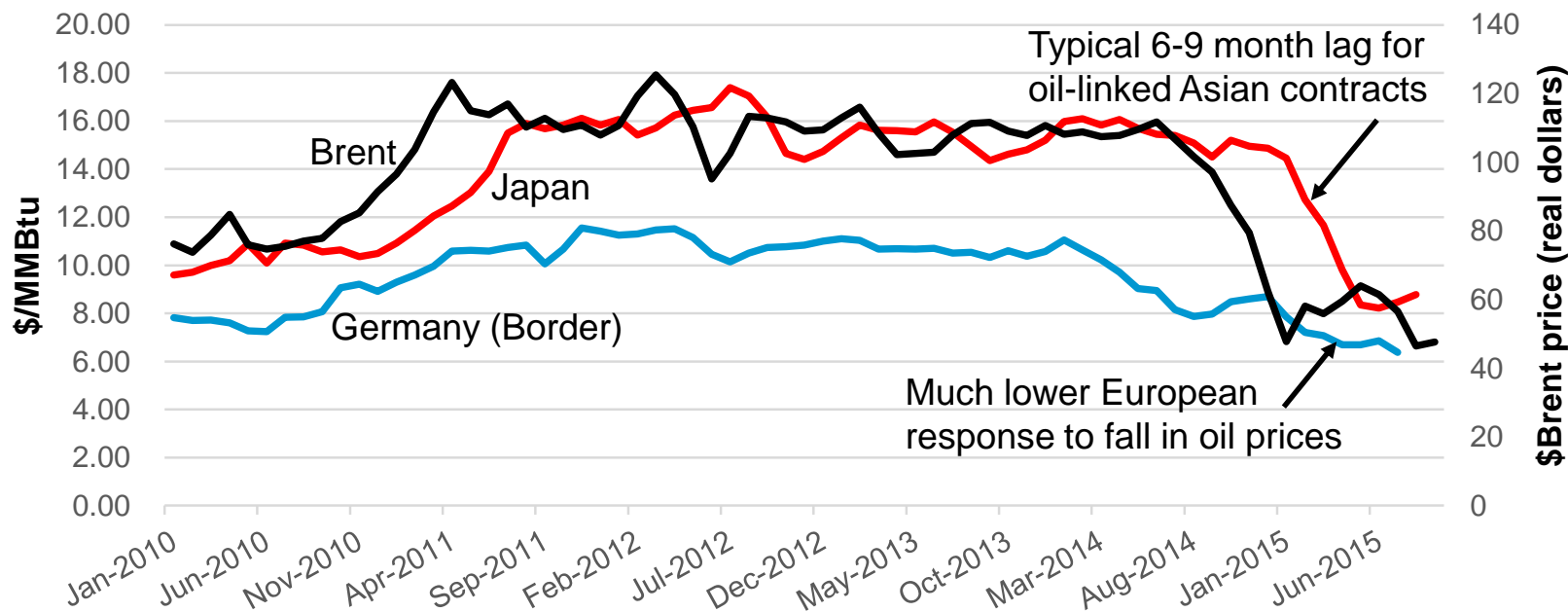
- The growth in Chinese gasoline demand will replace distillate growth as the Chinese auto fleet grows.
- The U.S. Bakken basin may be nearing a production peak & growth in the Permian and Eagle Ford basins may slow.
- Higher population densities or more difficult geology may limit development of other U.S. basins.
- With low prices, financing and E&P services will suffer. [Half of U.S. oil loans are in default.]
- Above and below ground problems make tight oil production more difficult outside of North America.
- World wide electric vehicle demand may not grow much.
- Without cartels, the free market will result in greater price volatility.
- **???** – **Outcomes uncertain.**

What we *can* expect

- The short-term price elasticities of oil demand and supply will remain very low.
- U.S. tight oil does not change this.
 - U.S. tight oil production did not decline until 1 year *after* Brent prices crashed from over \$100/b to \$50/b.
 - Apart from DUCs, U.S. tight oil growth will take time after prices increase.
- Oil prices can stay well above or well below the long-term marginal cost of non-OPEC oil production for considerable periods of time.
- The one thing we can be sure of is VOLATILITY.

Oil-Linked Contracts Affecting World LNG Prices

- Oil-linked contracts in Asia and Europe
- Competition to oil-linked contracts emerging in Europe (NBP hub pricing) and Asia
- Europe more decoupled than Asia



The Oil Story is also a Natural Gas Story

- Apart from the impact of low oil prices on oil-linked LNG contracts, the natural gas market has become much weaker for the same reasons oil prices are low: oversupply as a result of past high prices and slack economic growth.
- As with oil production investments, pipeline projects and many LNG export terminal project proposals are on hold.
- However, U.S. and Australian LNG projects are proceeding: They will contribute to LNG supply growth despite weak prices.

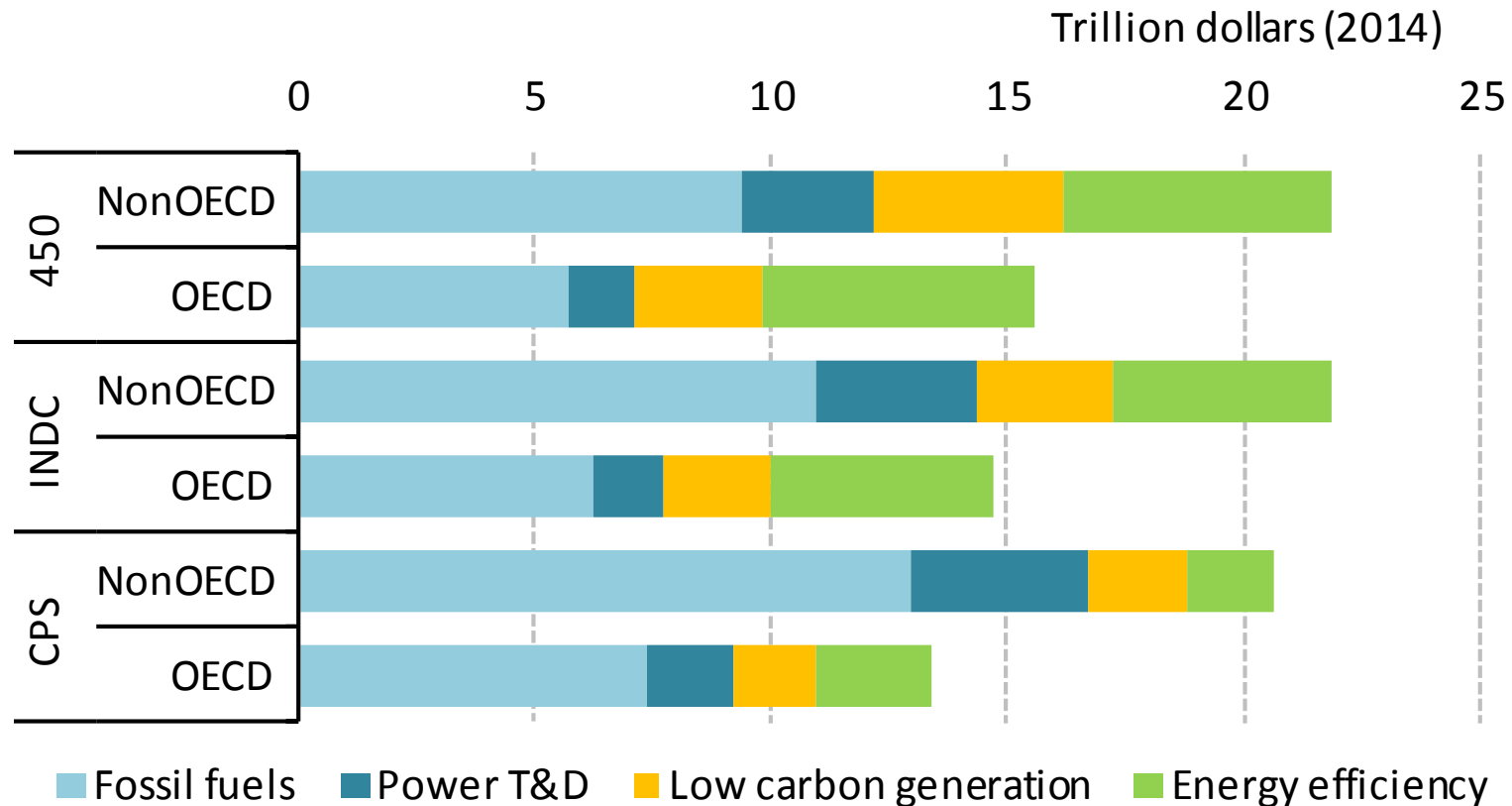
Why is this relevant to the ICEC?

- Uncertain oil and natural gas markets have important implications for energy investments and economic growth.
- Episodes of very low fossil fuel prices can retard investments in cleaner energy alternatives.
- Low-GHG policies are not as easily adopted in countries with low economic growth as compared to robust growth.
- Energy investments and low-GHG investments are most needed in the developing economies.

OECD vs. non-OECD Energy Investment

450 vs. Intended Nationally Determined Contributions vs. BAU

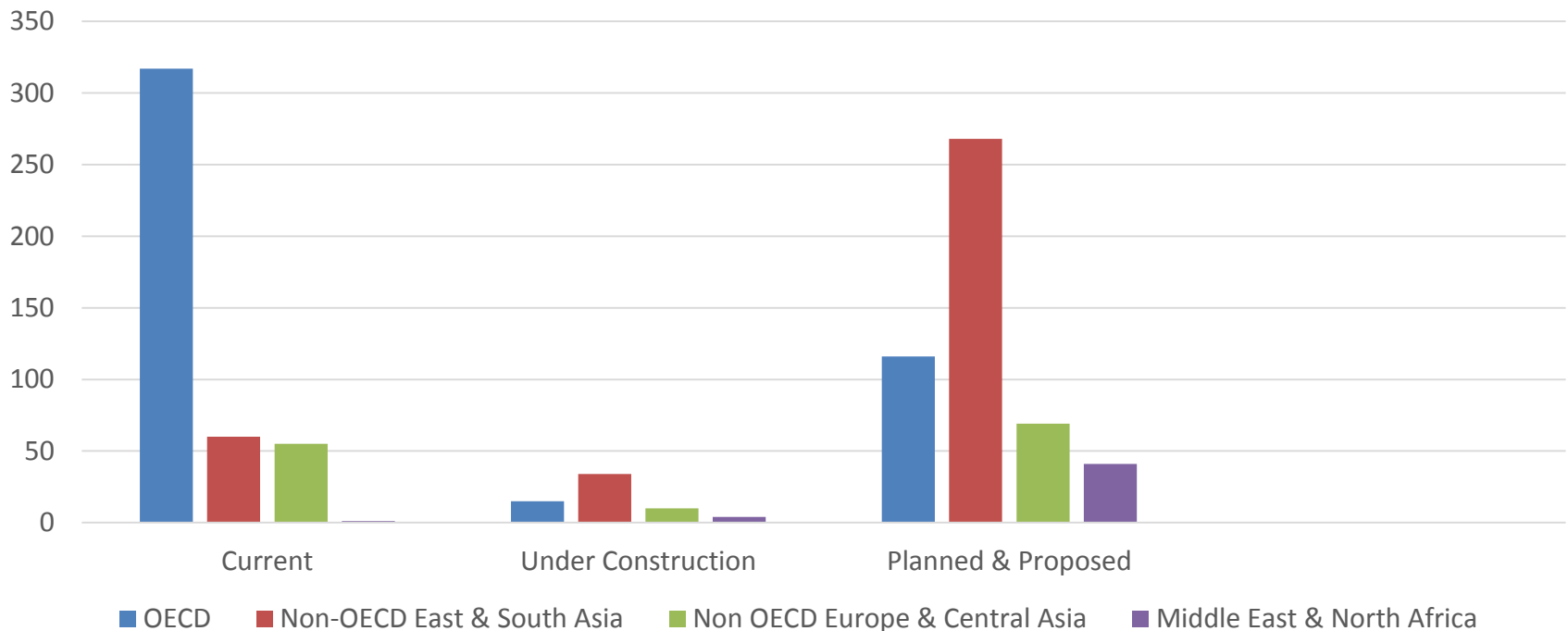
Cumulative investment in the 450, INDC and Current Policies Scenarios (2015-2030)



Source: IEA *Energy and Climate Change - World Energy Outlook Special Report*

The Expected Growth of Nuclear Power is Outside of the OECD

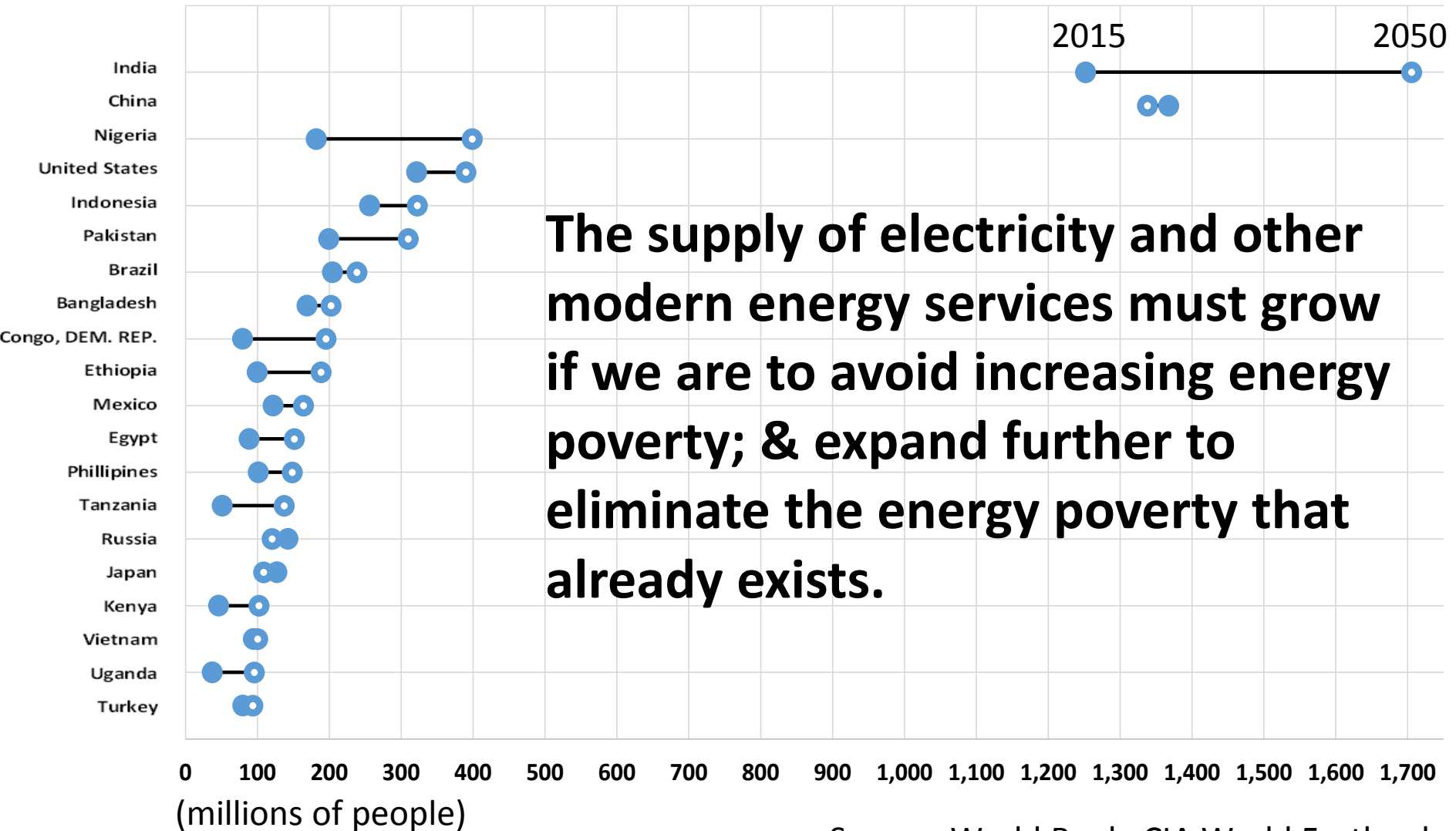
World Nuclear Association Nuclear Reactor Table, January 2016



If nuclear power is to be deployed safely in countries without a current commercial nuclear program, it is necessary to have (partial list):

- **An independent regulatory agency with both authority and resources.**
- **A commitment to transparency in management practices and communication, and a strong continuity of institutions.**

20 Most Populous Countries in 2050 and their Populations in 2015



Conclusions

- Oil price shocks sharply reduce world economic growth & throw OECD countries into recession.
- Low & volatile oil prices bring their own problems, even for oil importing countries.
- The “main-culprits” are the tiny short-term price elasticities of oil demand and supply.
- Volatility will complicate energy investments & clean energy progress, especially in developing economies.
- This is but one factor, among many, that complicate energy & climate policy making.
- There is a need for IICEC energy & climate analysis that reflects these challenges and complexities.