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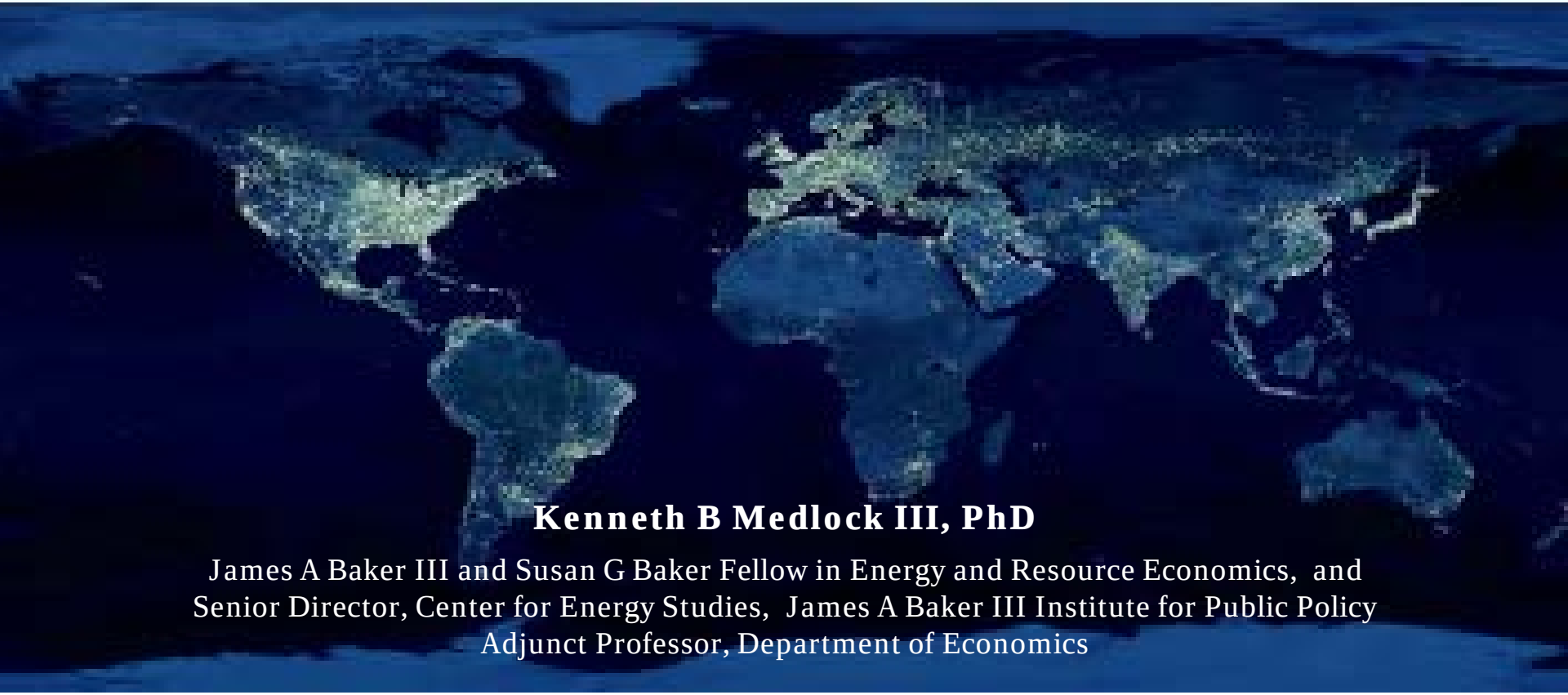
Natural Gas Price in Asia: What to Expect



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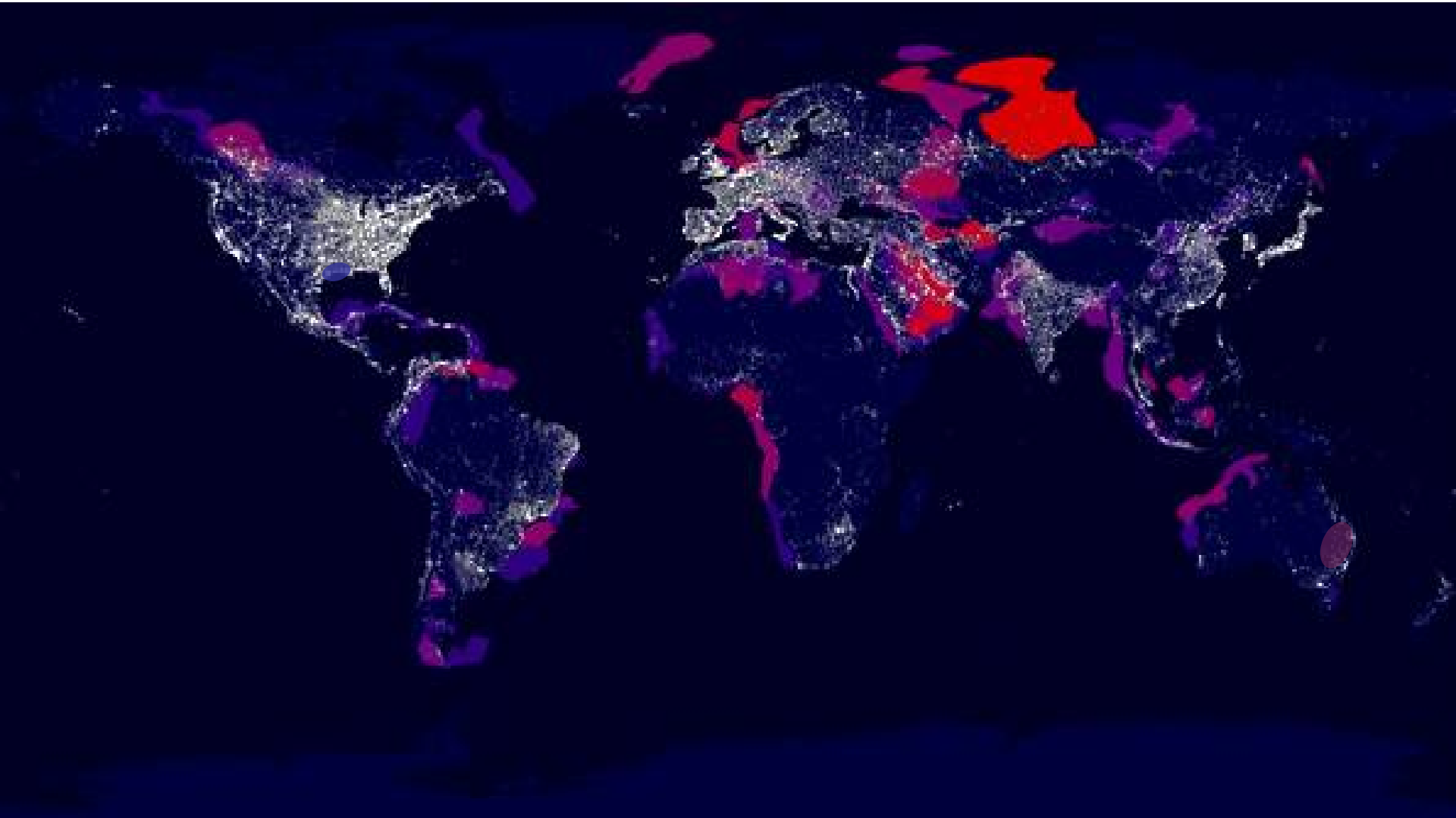
Senior Director, Center for Energy Studies, James A Baker III Institute for Public Policy
Adjunct Professor, Department of Economics

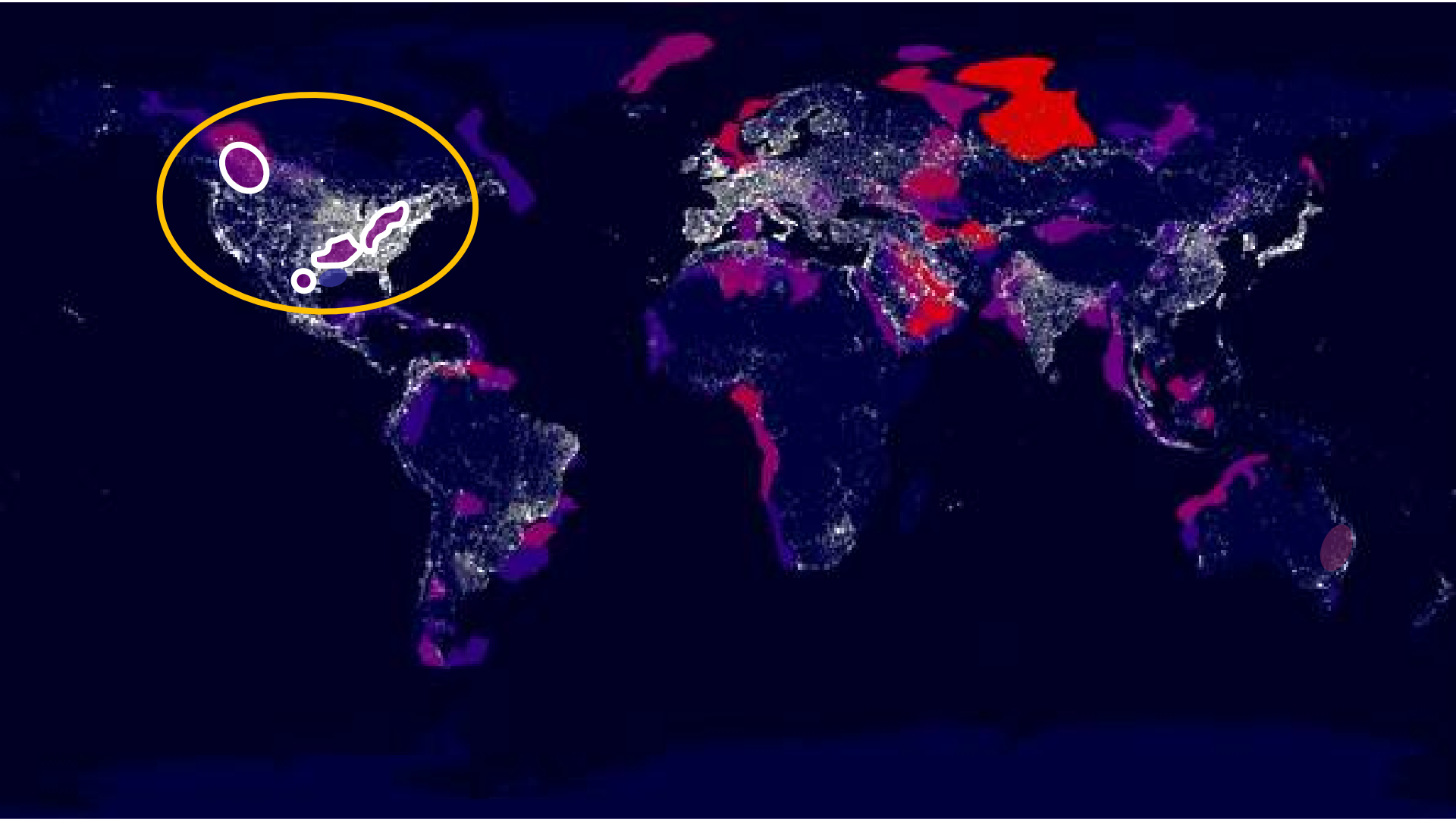
Presentation at IMF

March 27, 2014

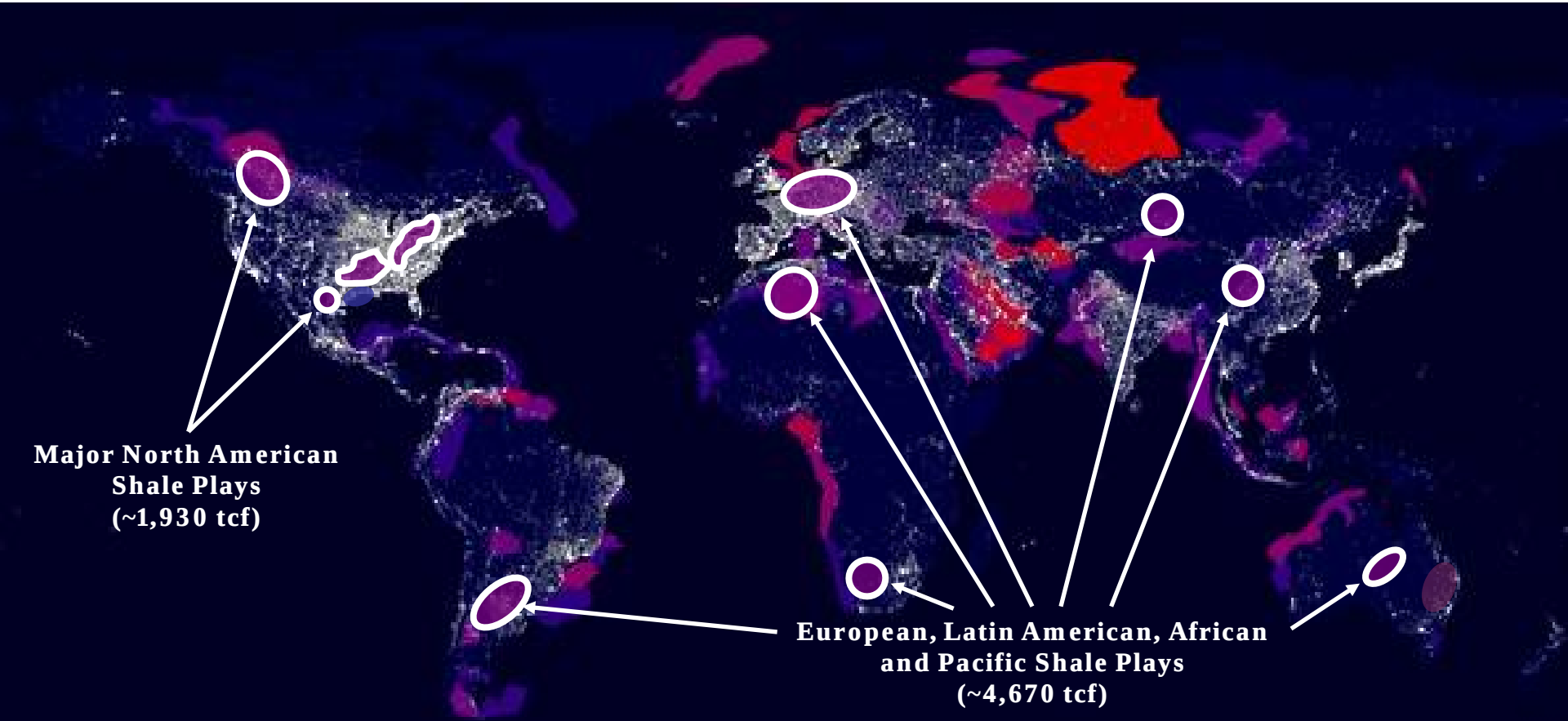
Rewind to 2003 – LNG is coming to North America



Then, shale happened in the US and Canada…



… and we realized shale resources are everywhere*



Over 6,600 tcf of shale according to ARI report, 2011

Broad Implications of US Shale Gas

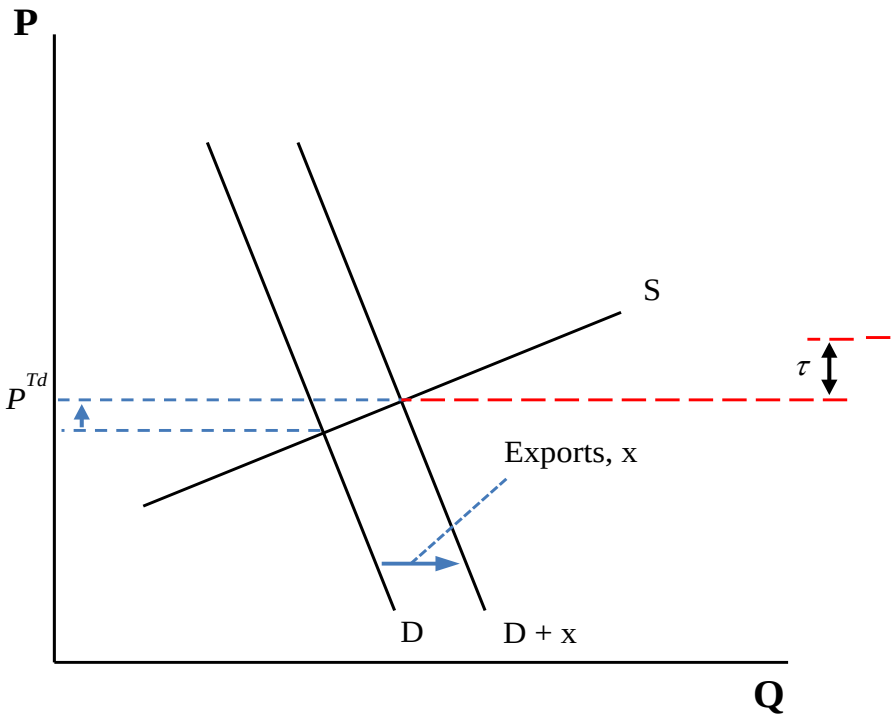
- Expansion of production from US shale plays has left LNG import capacity in the US virtually empty.
- It has had an impact on the relative price of oil and gas in the US, and it has raised the possibility of US LNG exports.
- Of course, when evaluating overall market impacts, all supply and demand responses should be in focus, not just exports.
- Shale gas makes the supply curve more elastic. This mitigates the potential for sustained long term increases in price and has implications for fungibility and price volatility.
- Lower relative gas prices encourages gas demand in power generation over coal, lowers costs in refining and pet-chems, and encourages new uses in transportation.

Let's focus on the export question, in particular with regard to Asian gas prices…

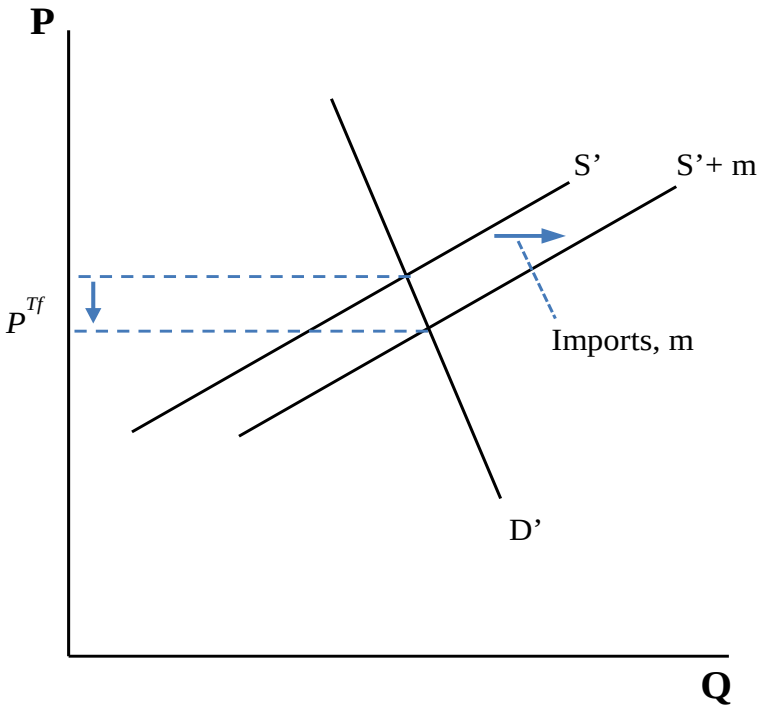
What does economic theory suggest will happen to the Asian LNG price?

An international trade paradigm…

- With trade between two markets, price in each adjusts. The adjustment depends on the elasticities of supply and demand.



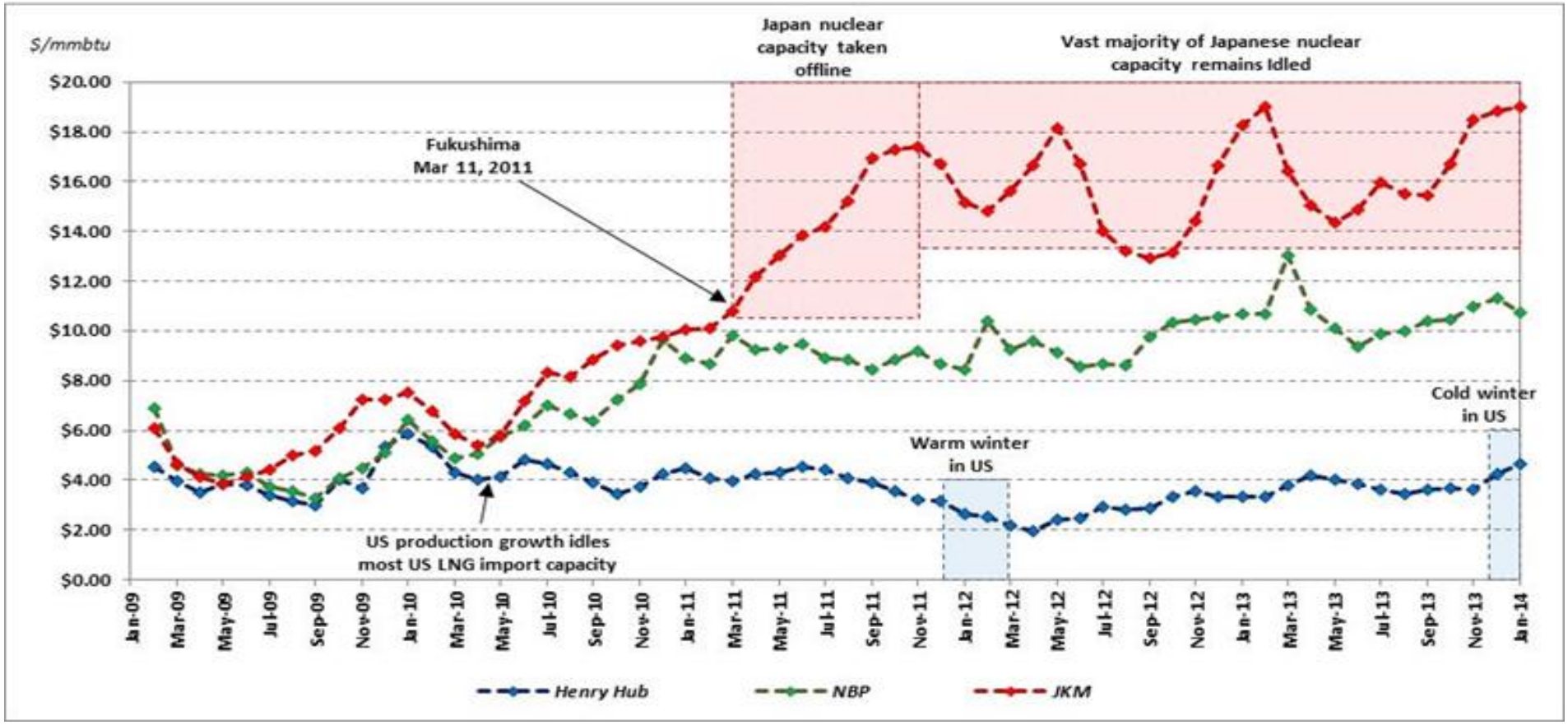
Domestic Market



Foreign Market

International natural gas spot prices

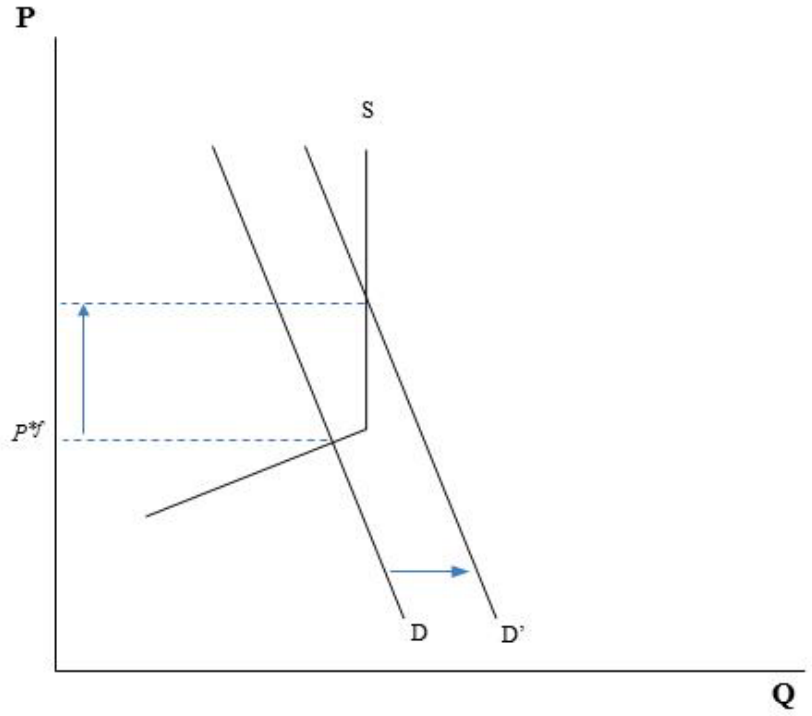
- Will the change in regional gas price relationships since March 2011 persist?
  - Unexpected demand shocks in Asia and the US have exacerbated spreads



Price data from Platts; LNG Oil-Index author's calculation

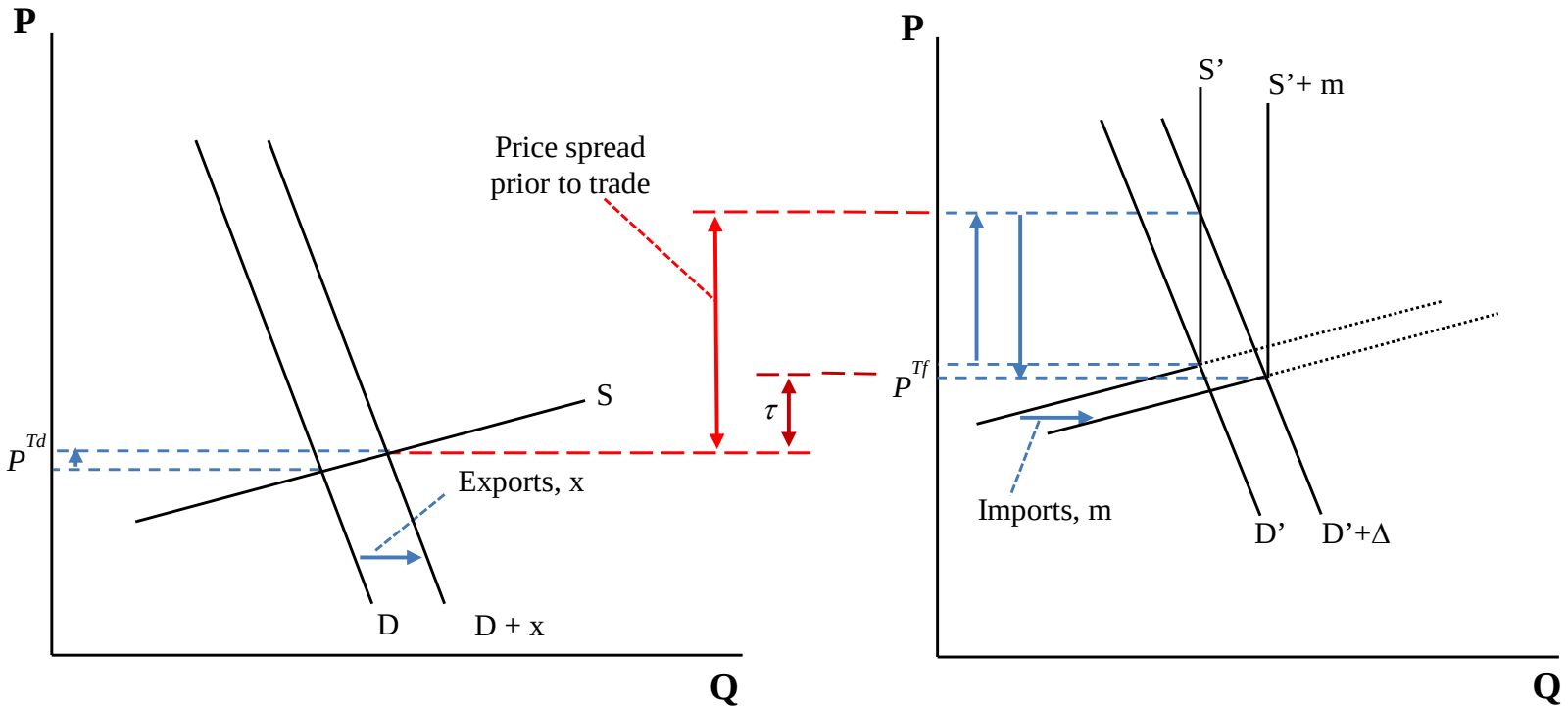
The Short Term

- A wide divergence in price is exactly what we should expect to see if the ability to deliver is constrained…
  - Increased Japanese demand in the wake of Fukushima is an *unexpected* demand shock, which stresses delivery capability.



Moving past the short term

- US exports and other supplies to Asia will apply downward price pressure.
- This will be exacerbated by demand reductions and supplies from China shale, East Africa, Australia, Russia.



Implications

- Lots of weight given to current international spot price, but several factors are often ignored, such as
  - short term capacity constraints and domestic market interactions with markets abroad, and
  - a weak US dollar.
- US LNG could put a lot of pressure on international price.
  - Current filings exceed current global liquefaction capacity.
- In fact, it is questionable that the well-publicized Dow position advocating limiting exports is optimal given the company's asset positions in Asia and Australia, particularly since most of the price impact will occur at the point of the constraint, which is in Asia.
- Prices will adjust, and greater liquidity will alter the market paradigm in a substantial way.

The Rice World Gas Trade Model

A tool for market analysis

The Rice World Gas Trade Model (RWGTM):
A Forecasting Tool for Policy Analysis

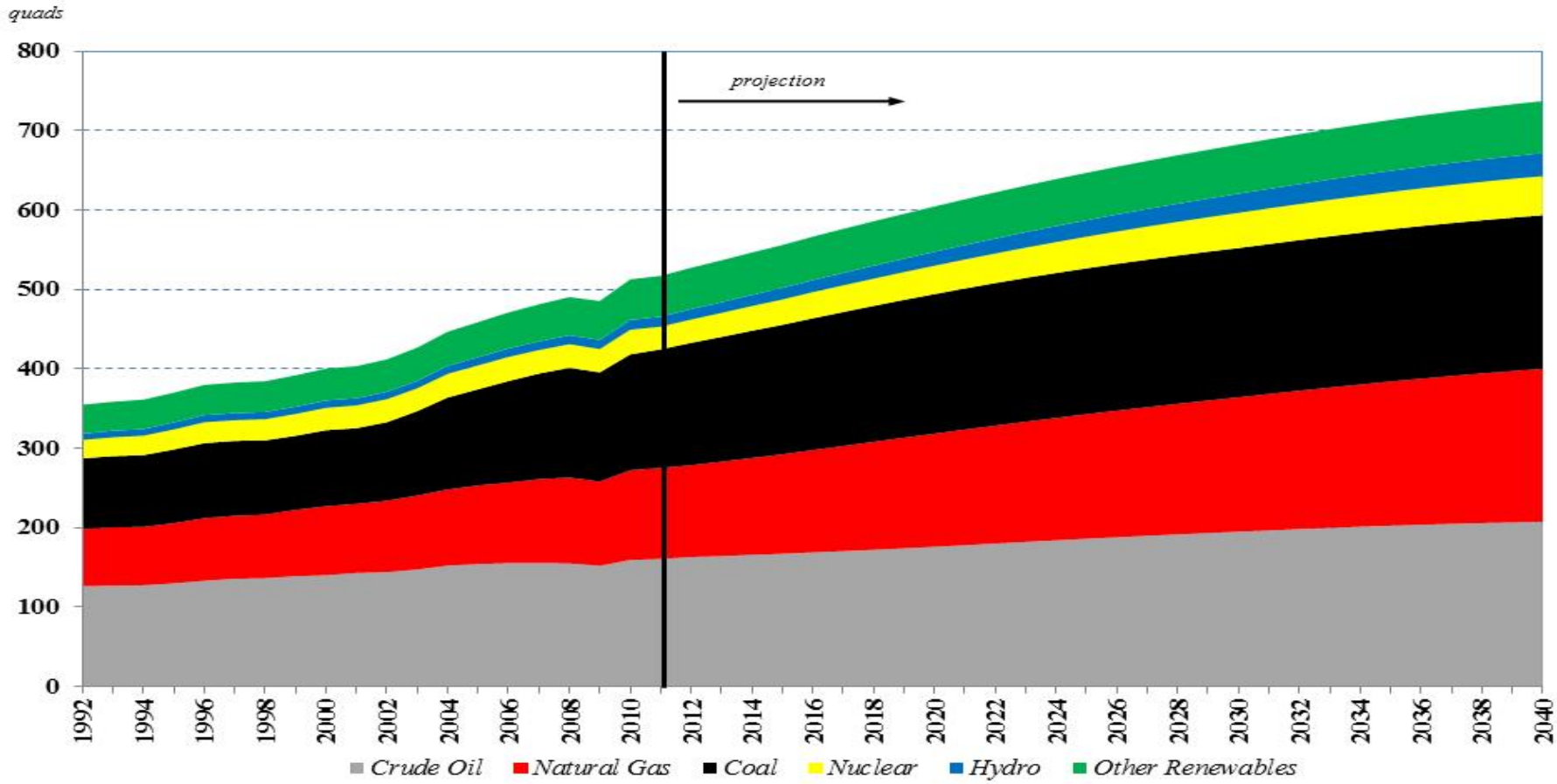
- The RWGTM has been developed to examine potential futures for global natural gas, and to quantify the impacts of geopolitical influences on the development of a global natural gas market.
- The model predicts regional prices, regional supplies and demands and inter-regional flows.
- Regions are defined at the country and sub-country level, with extensive representation of transportation infrastructure
- The model is non-stochastic, but it allows analysis of many different scenarios. Geopolitical influences can alter otherwise economic outcomes
- The model is constructed using the *MarketBuilder* software from Deloitte MarketPoint, Inc.
  - Dynamic spatial equilibrium linked through time by intertemporal optimization
  - Capacity expansions are determined by current *and* future prices along with capital costs of expansion, operating and maintenance costs of new and existing capacity, and revenues resulting from future outputs and prices.

The RWGTM: Demand

- There are over 290 regions
  - Regional detail is dependent on data availability and existing infrastructure.
  - In US, sub-state detail is substantial and is based on data from the Economic Census and the location of power plants.
    - For example, 10 regions in Texas, 4 regions in Louisiana, 3 regions in Massachusetts, 4 regions in California, etc.
  - In Rest of World, sub-national detail varies based on infrastructure and data availability.
    - For example, 5 regions in India, 7 regions in China, 6 regions in Germany, 4 regions in the UK, 6 regions in France, 10 regions in Australia, 1 region in Bangladesh, 1 region in Thailand, etc.
- Demand model links TPER to GDP and population with fuel shares determined by relative prices and policy (RPS, nuclear, etc.). Demand is projected for every country.

TPER: World

- Summary of global TPER by energy source. Reported as a sum across all sectors, all countries and all fuel sources.

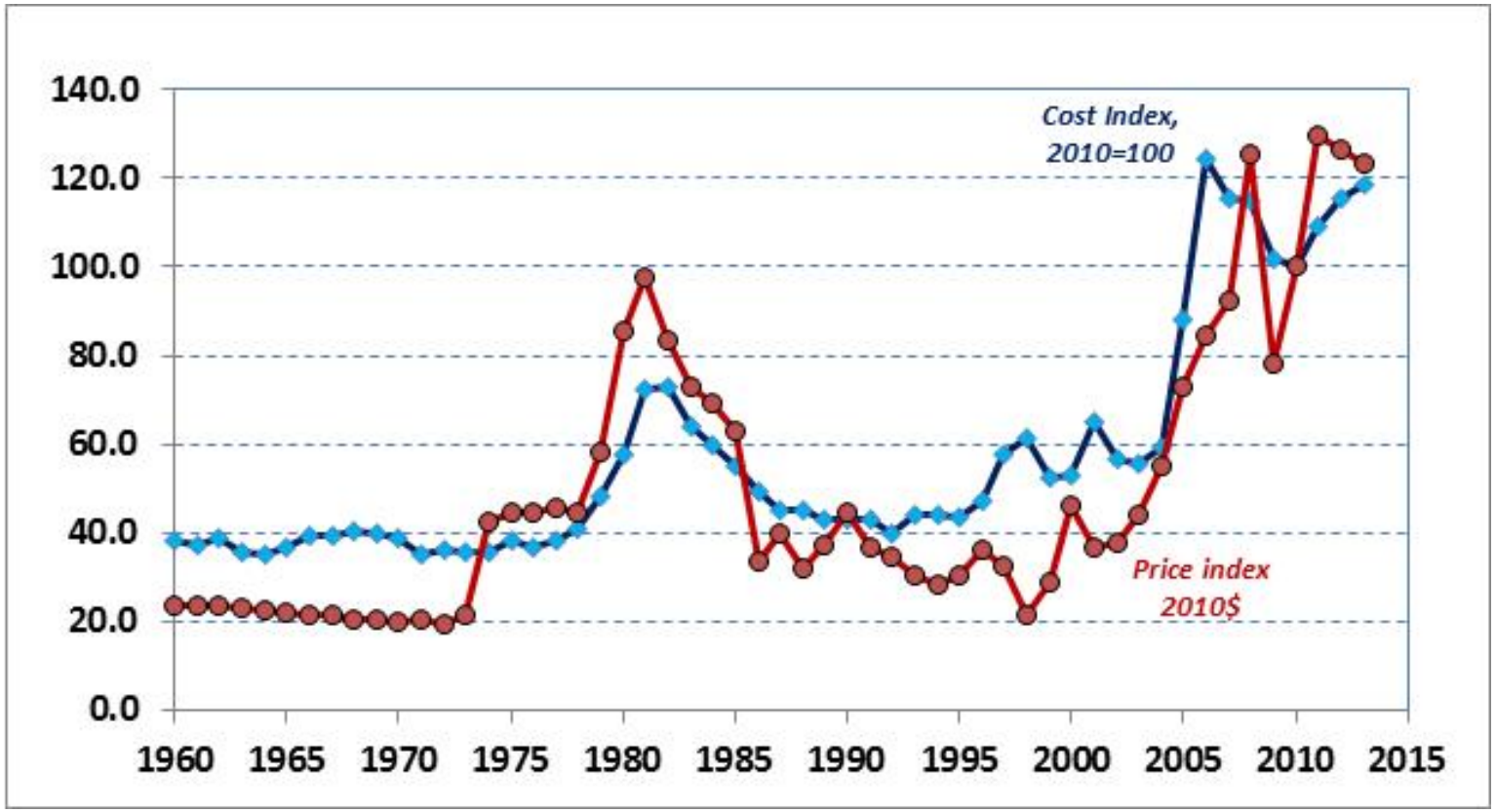


The RWGTM: Supply

- There are over 140 supply regions represented
- Natural gas resources are represented as…
  - Conventional, CBM and Shale in North America, China, Europe and Australia, and conventional gas deposits in the rest of the world. We incorporate the analysis of the recent ARI assessment of shale around the world.
- … in three categories
  - proved reserves (Oil & Gas Journal estimates)
  - growth in known reserves (P-50 USGS and NPC 2003 estimates)
  - undiscovered resource (P-50 USGS and NPC 2003 estimates)
    - Note: resource assessments are supplemented by regional offices if available.
- North American cost-of-supply estimates are econometrically related to play-level geological characteristics and applied globally to generate costs for all regions of the world.
  - Long run costs increase with depletion.
  - Short run adjustment costs limit the "rush to drill" phenomenon.
  - We allow technological change to reduce mining costs longer term

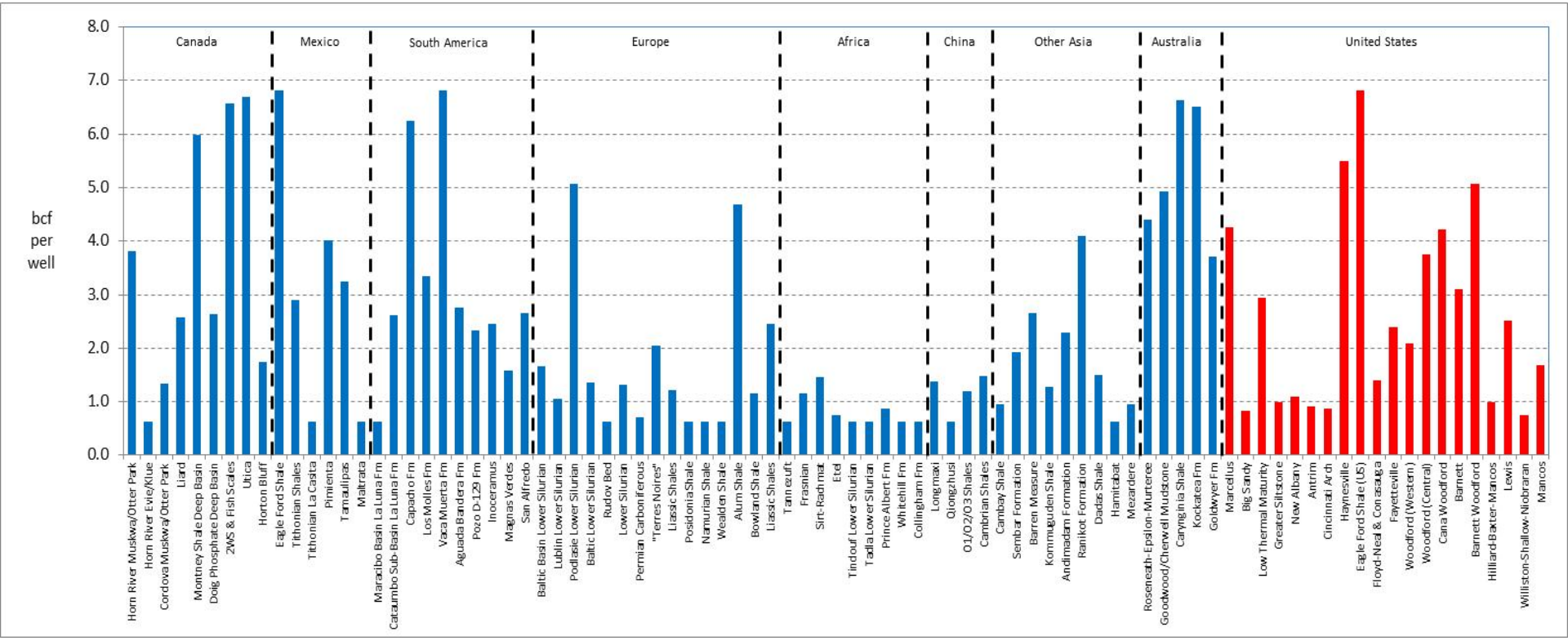
Cost to Drill and Complete, 1960-2013

- Cost moves with oil price. A critical assumption in making projections is the long term outlook for the cost environment.



Global Shale Plays

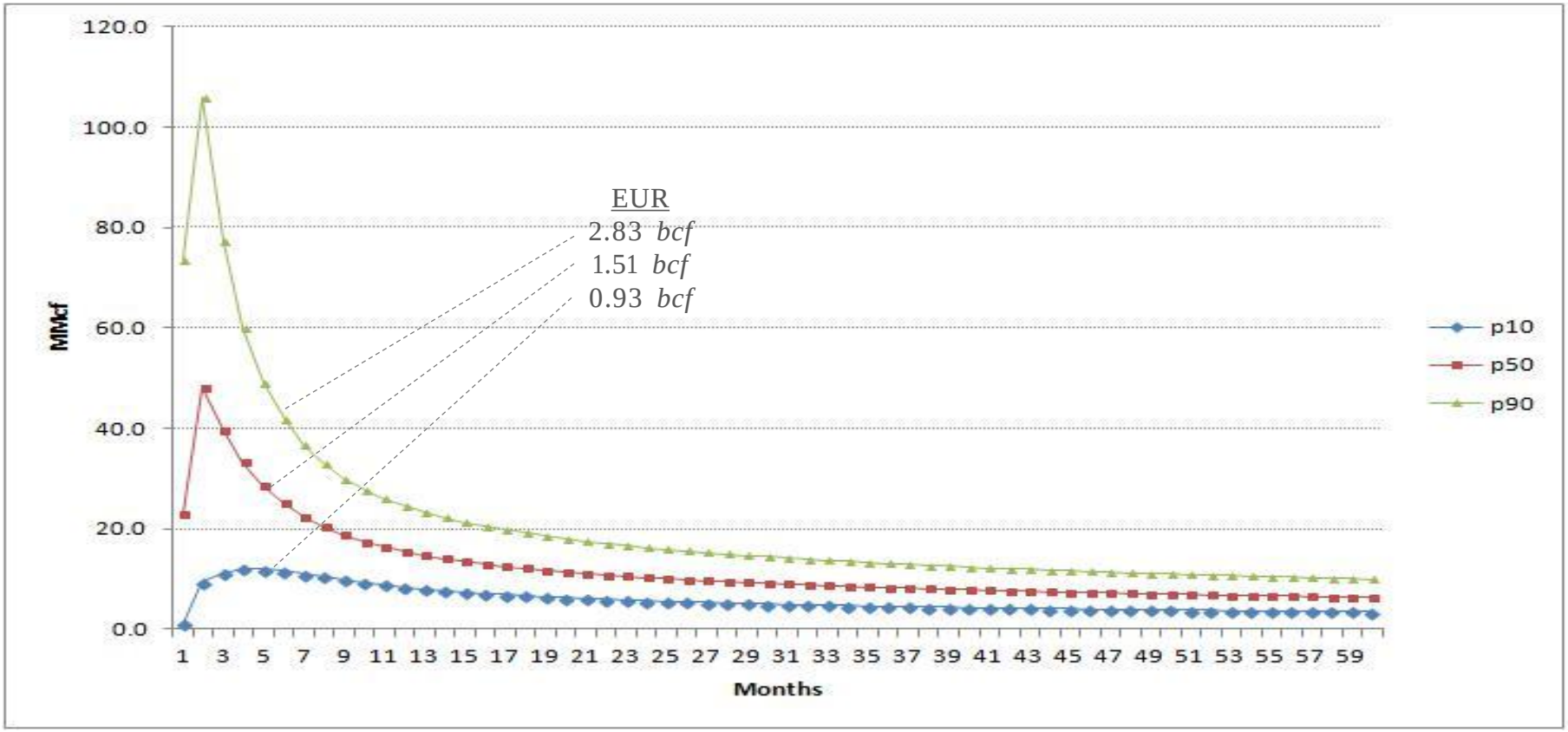
- EURs estimated using geophysical data for known shale plays in North America and econometrically fit for RoW shales.



- Drilling and Completion costs estimated using known North American plays and econometrically fit to drilling depth. Adjustments are made regionally based on published information.

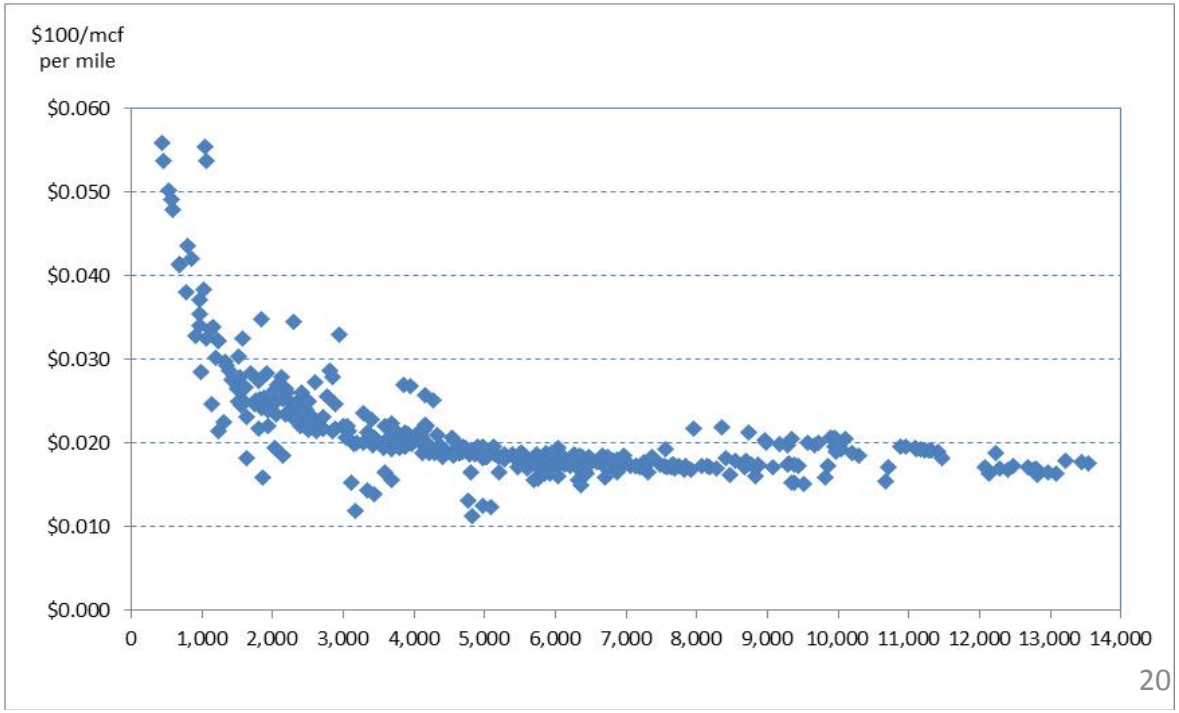
Research on shale gas well performance…

- Well-specific EURs can vary within a shale play substantially
  - Some wells are profitable at $2.65/mcf, others need $8.10… median is $4.85.
  - This information is used to construct "tiers" within the resource plays.



The RWGTM: LNG Shipping

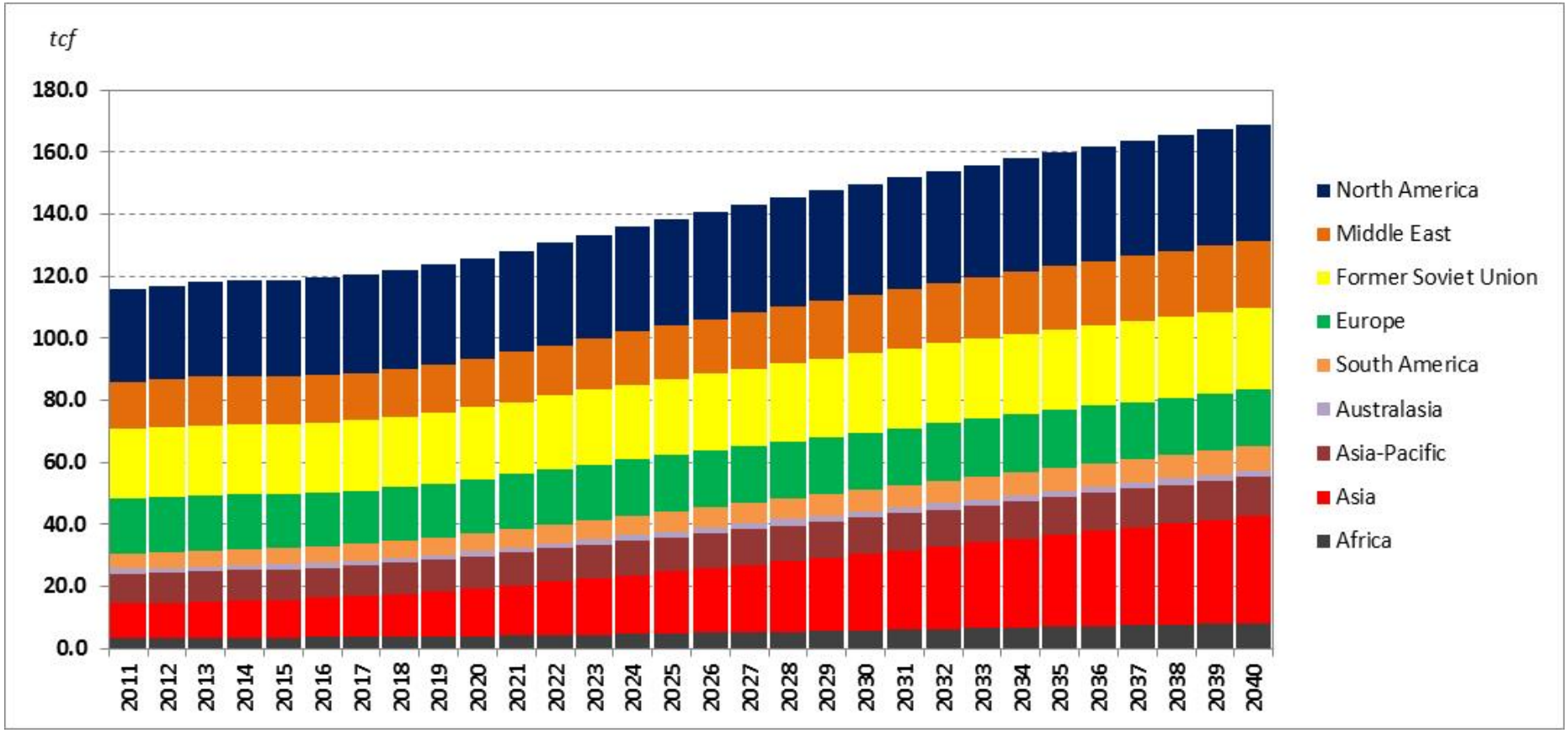
- Changed the manner in which LNG shipping is modeled.
  - Old approach: LNG is represented as a hub-and-spoke network, reflecting the assumption that capacity swaps will occur when profitable.
  - New approach: LNG is modeled as a point-to-point network where initial LNG route capacities are calibrated to 2010 flows. As before, shipping rates are based on lease rates and voyage time.
- Swaps are allowed to occur, but shipping capacity must be added in order to implement.
- All possible shipping routes and costs are implemented. For unknown routes, costs were econometrically fit to known data.



RWGTM "Status Quo" Results

Status Quo Case: Demand by Super-Region, 2011-2040

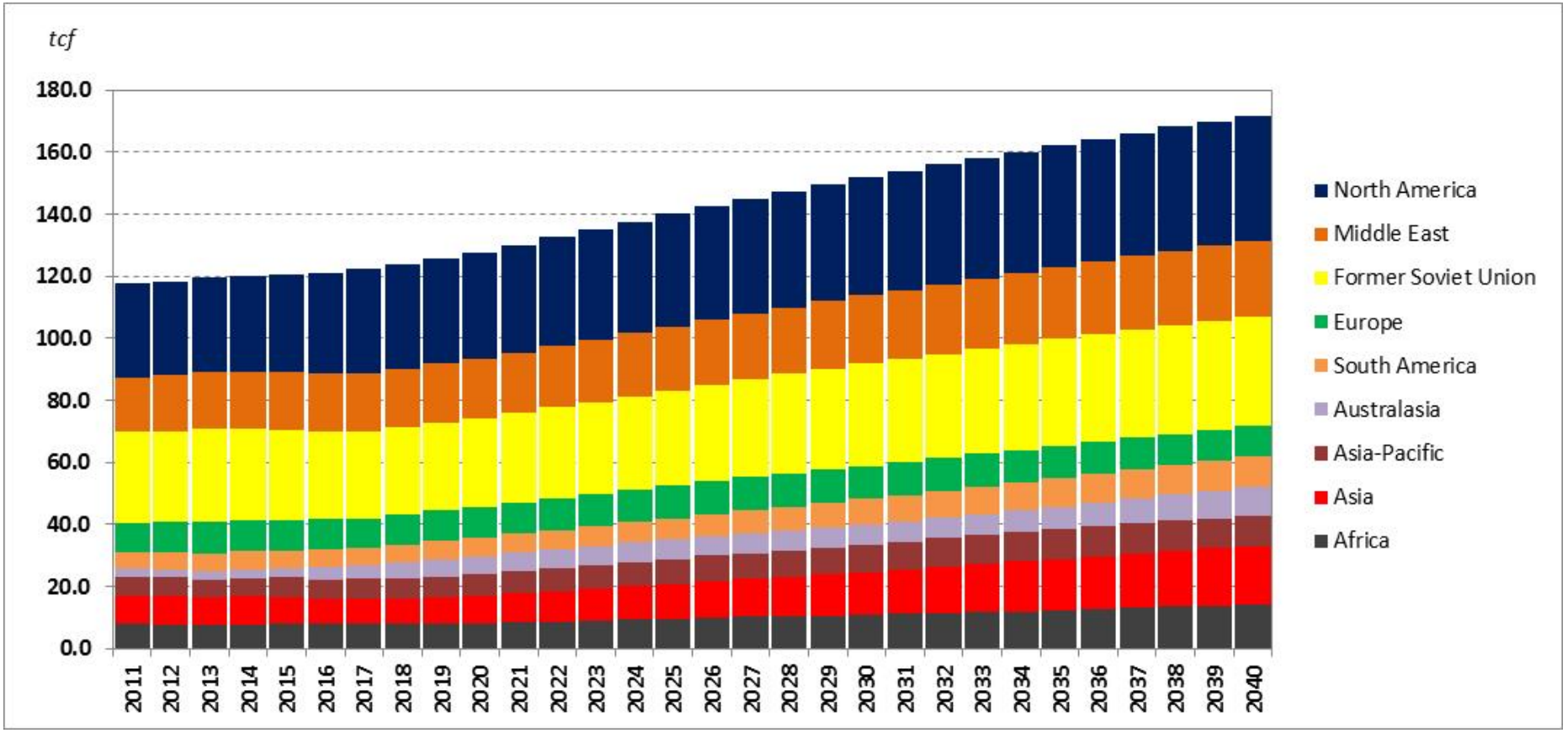
- Asian demand sets the trend for global natural gas demand growth, averaging over 4.1% growth per year through 2040.



Source: Baker Institute RWGTM February 2014

Status Quo Case: Supply by Super-Region, 2011-2040

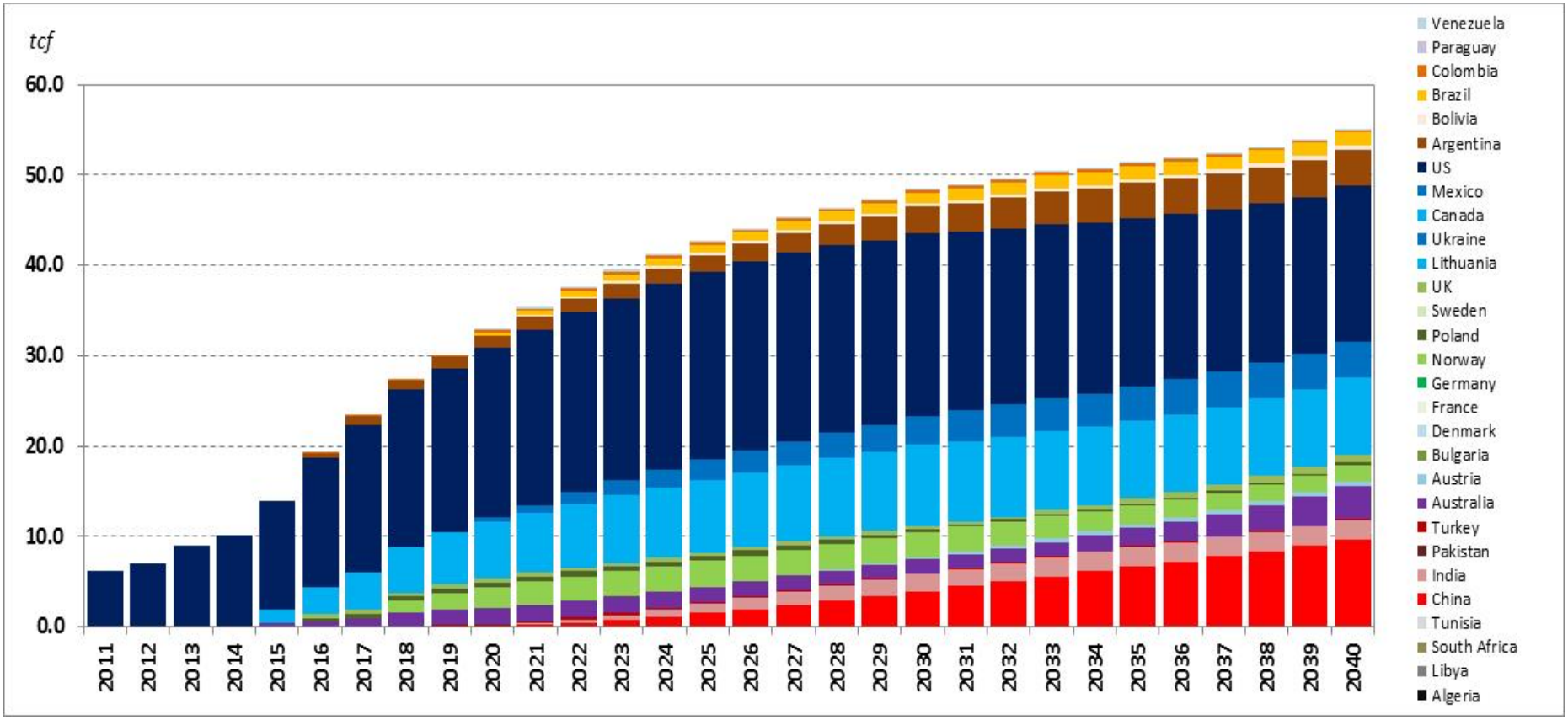
- Sources of supply are more diverse than demand, with strong growth seen where shale resources are developed – North America and Asia.



Source: Baker Institute RWGTM February 2014

Status Quo Case : Global Shale Production, 2011-2040

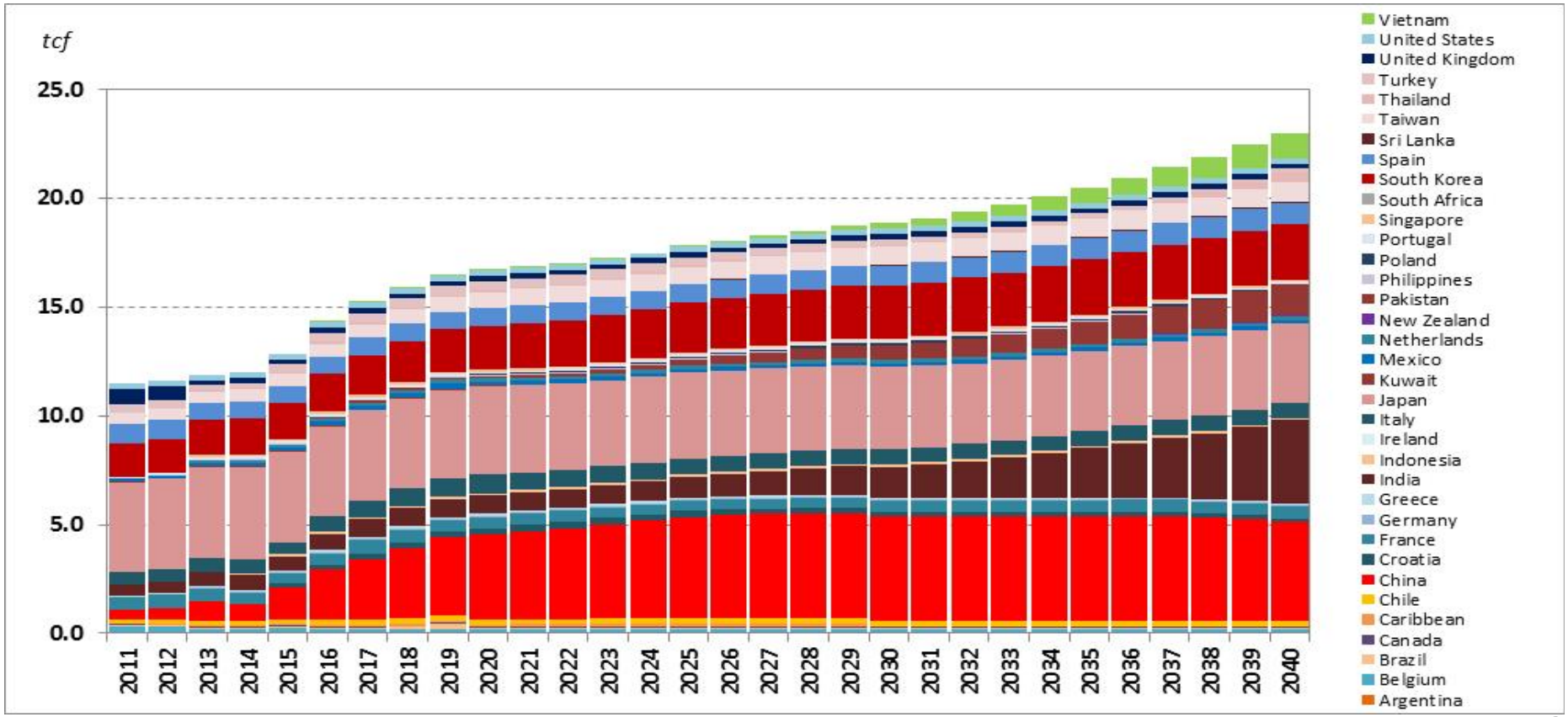
- North America accounts for the majority of shale gas, but long term growth occurs in China and other markets aimed at serving China after 2020.



Source: Baker Institute RWGTM February 2014

Status Quo Case: LNG Imports by Country, 2011-2040

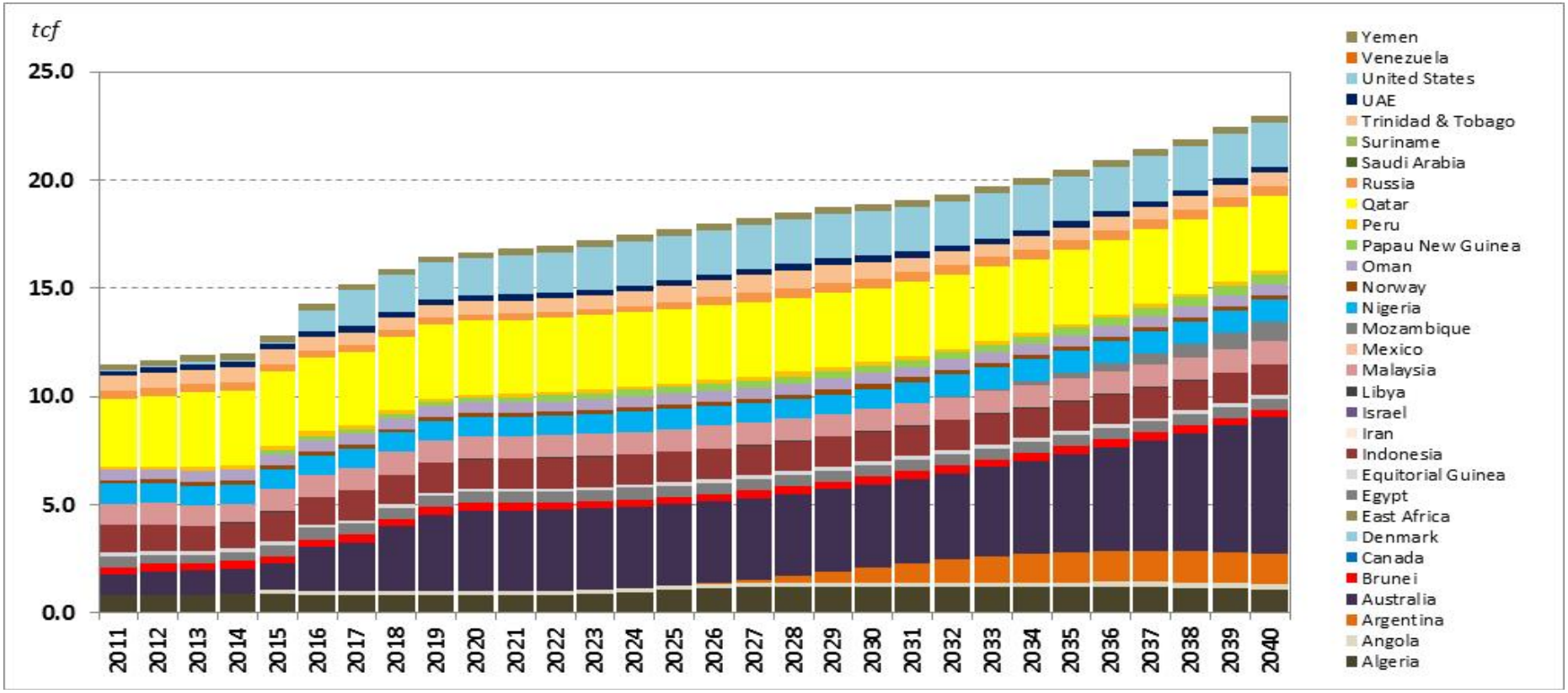
- Diversity in the LNG import picture, with China surpassing Japan in the mid 2020s, and India emerging in the 2030s.



Source: Baker Institute RWGTM February 2014

Status Quo Case: LNG Exports by Country, 2011-2040

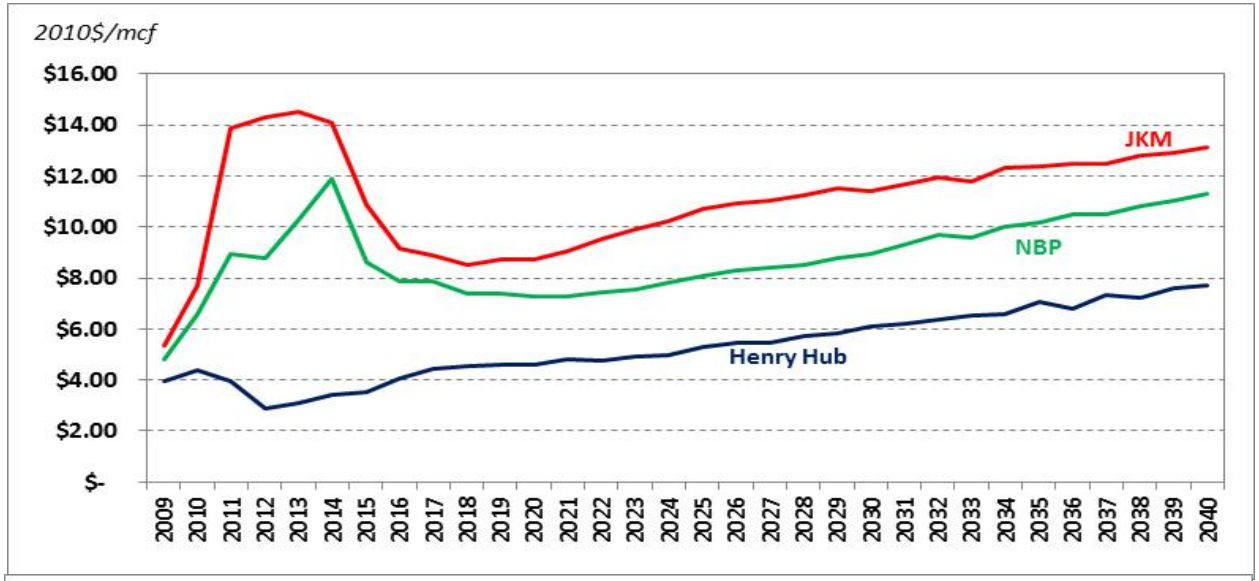
- Qatar and Australia account for over 40% of global *LNG* exports, and the US enters in 2016 which drives price decline in Asia (later slide).

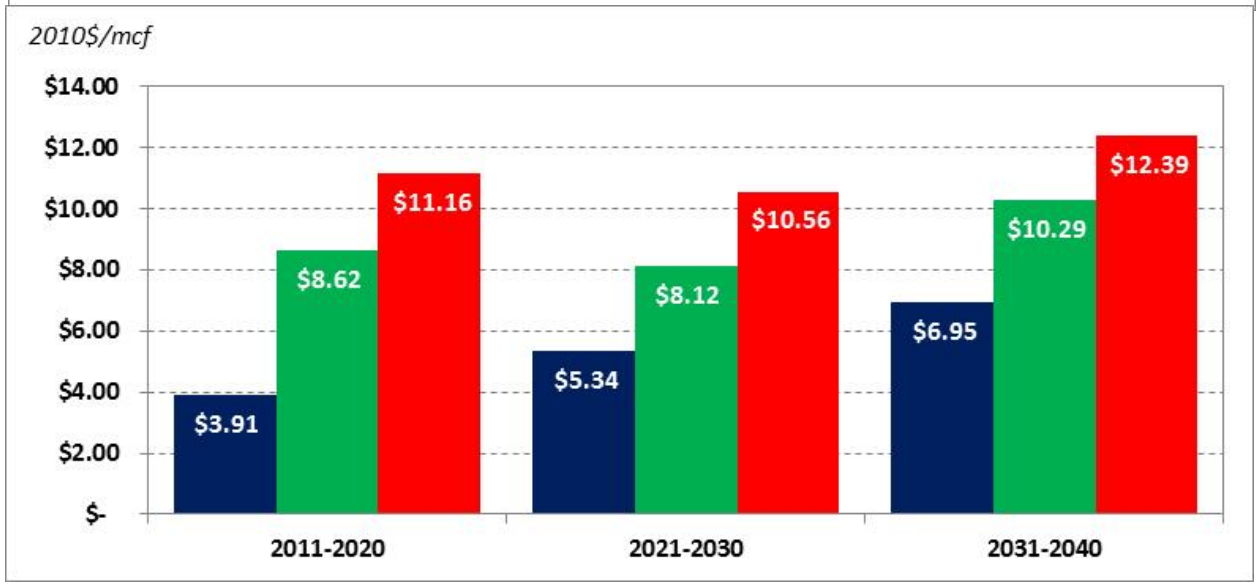


Source: Baker Institute RWGTM February 2014

Status Quo Case: Global Marker Prices, 2011-2040

- The prices indicated are *spot* prices rather than *contract* prices.
- Global prices remain above the US price, but trade closes the spread.

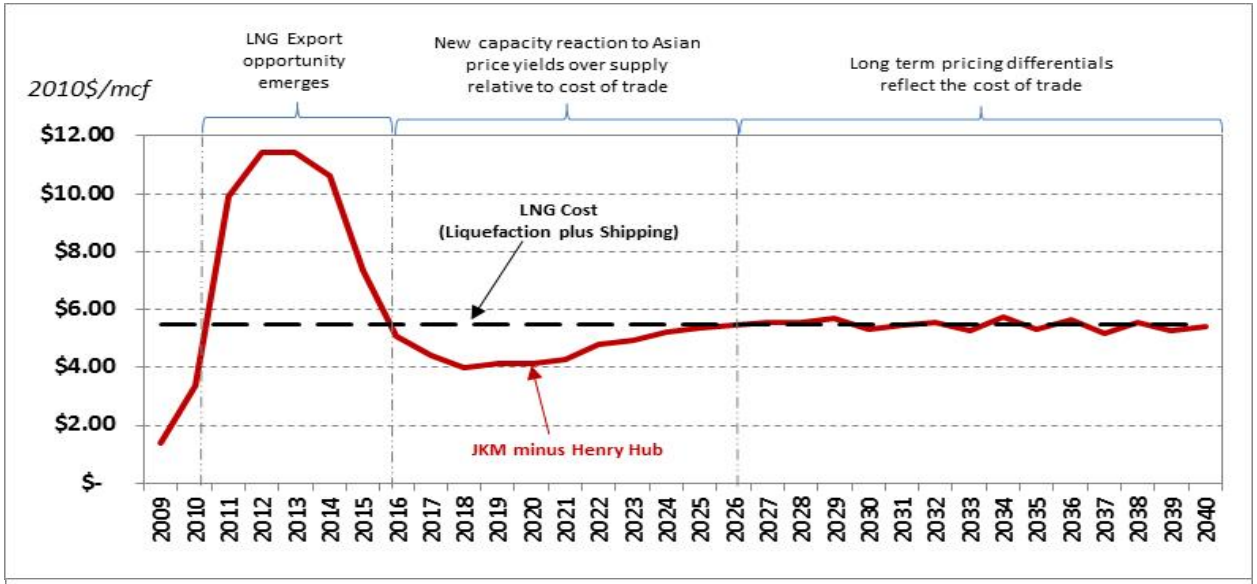


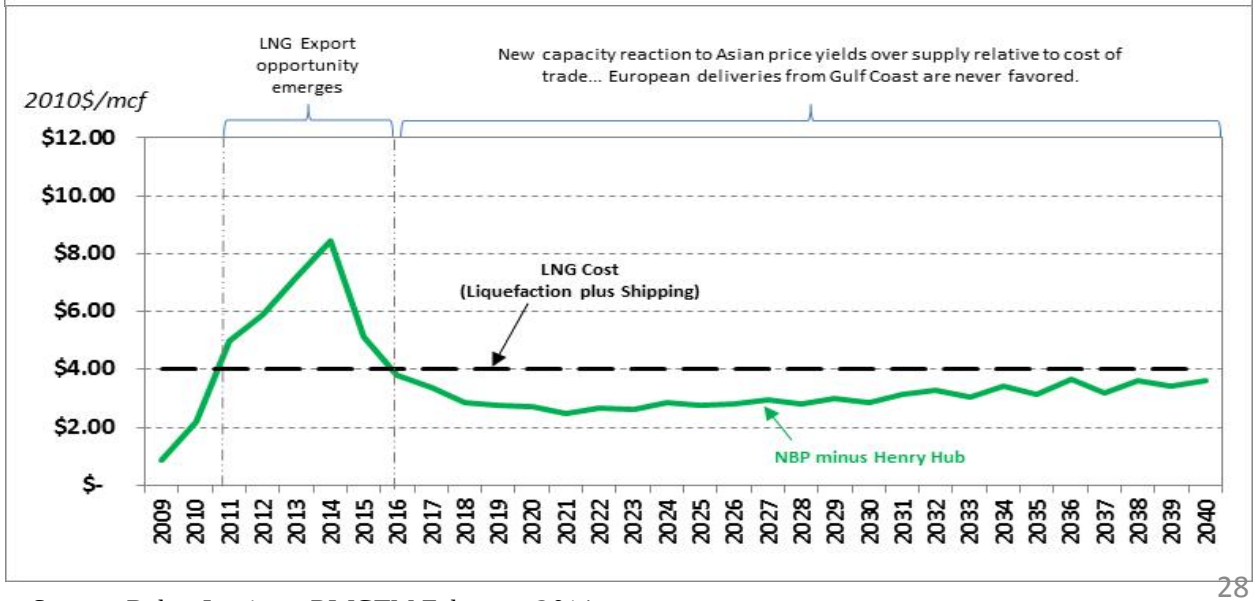


Source: Baker Institute RWGTM February 2014

Status Quo Case: Price Spreads and LNG Costs, 2011-2040

- Planned LNG capacity yields a reduction in price differentials that overshoots the mark for profitable trade, inclusive of fixed costs. But, ...
- ... in Asia, further demand growth eventually makes trade profitable.

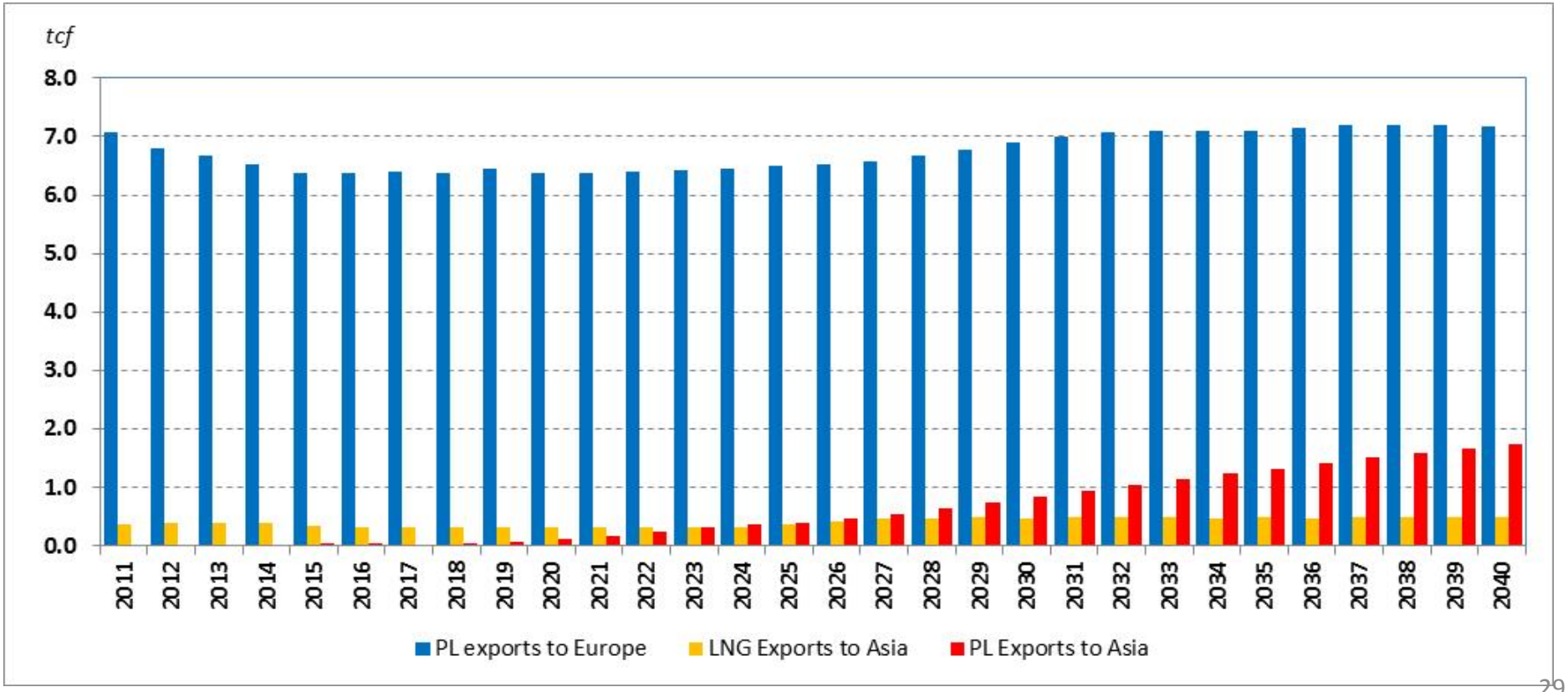




Source: Baker Institute RWGTM February 2014

Status Quo Case: Russia eventually moves into Asia

- Russian market share in Europe declines initially, but strong demand pull from Asia works to grow Russian volumes in both directions.



Source: Baker Institute RWGTM February 2014

Questions/Comments

Bonus Material

More on the impacts of LNG Exports: Exchange Rates and Contracts – LNG price in Asia will fall, and when it happens, it will happen fast!

The Effect of the Exchange Rate

- Another factor that is important to the **export** issue is the exchange rate. In fact, this matters for **US industrial** sector competitiveness as well.
  - Exchange rate impacts: $P_{US} - P_{UK} \cdot XR \cdot HR = arb\ value$

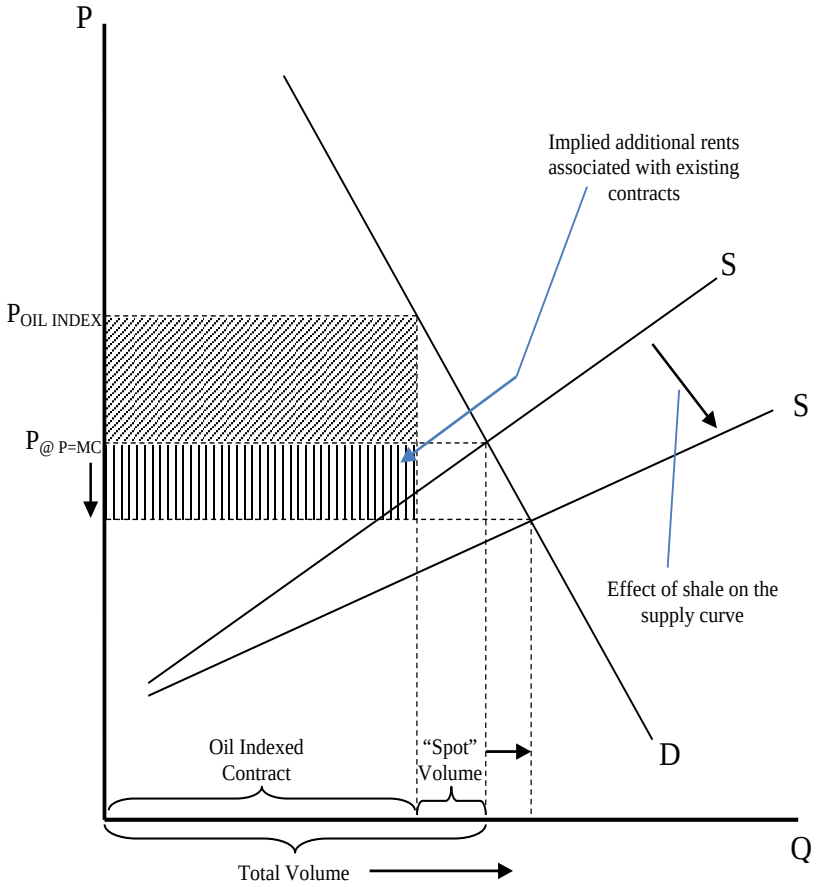
Trade-Weighted Value of US $, Major Currencies (Daily, Jan 1973 – Jan 2013)

Source: US Federal Reserve Bank

Contracts and Liquidity

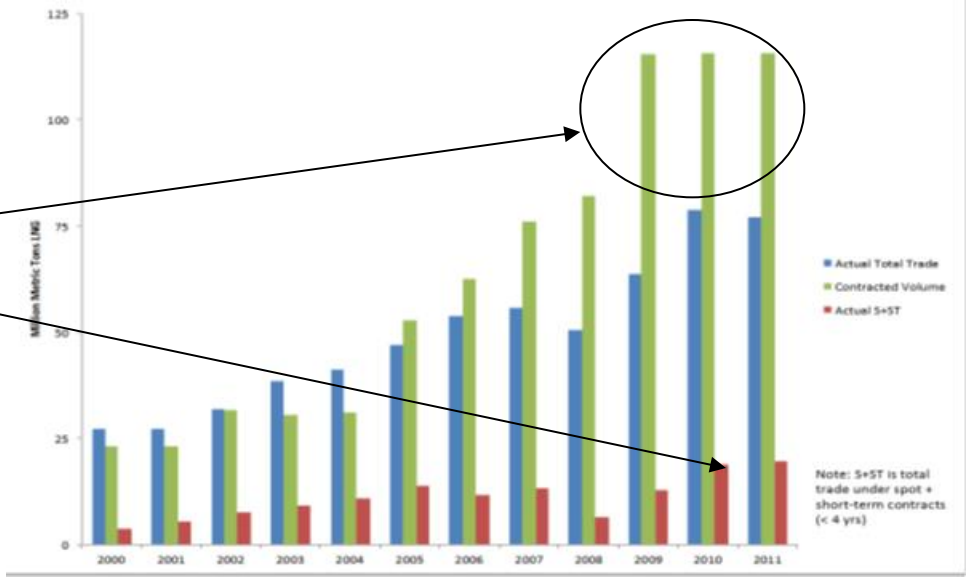
- Absent storage and physical liquidity, oil indexation provides an element of price certainty.
- Oil indexation is a form of price discrimination
  - (1) Firm must be able to distinguish consumers and prevent resale.
  - (2) Different consumers have different elasticity of demand.
- Increased ability to trade between suppliers and consumers (physical liquidity) violates condition (1).
  - This will happen in a liberalized market, or as LNG trade grows, or as hubs emerge in end-use markets.

The Supply Curve Effect of Shale and Implications for Price

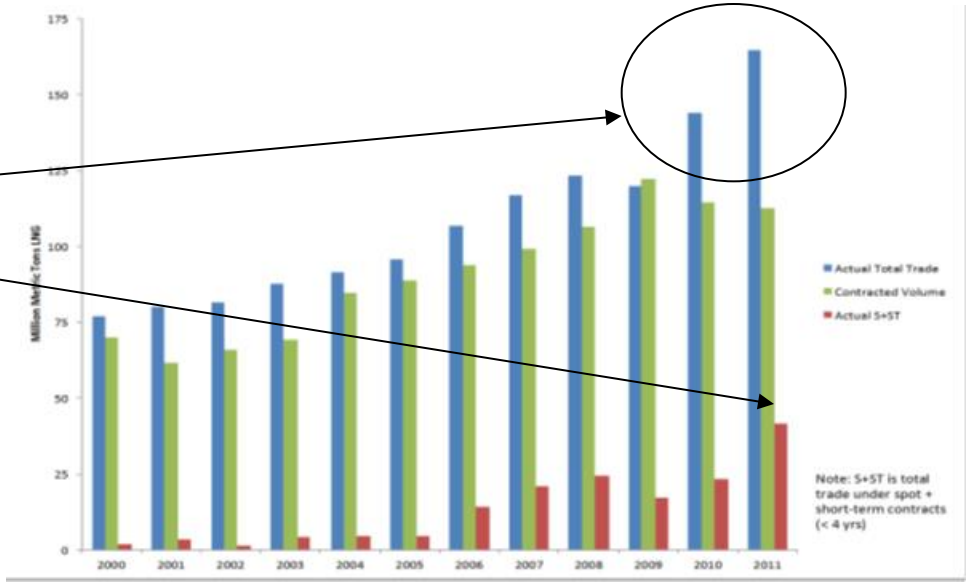


Contracts and Flows

- Atlantic Basin LNG diverted…
  - short term volumes expand



- … Pacific Basin LNG expands.
  - short term volumes expand



Data Sourced from the International Group of Liquefied Natural Gas Importers (GIIGNL)

More on US LNG Exports

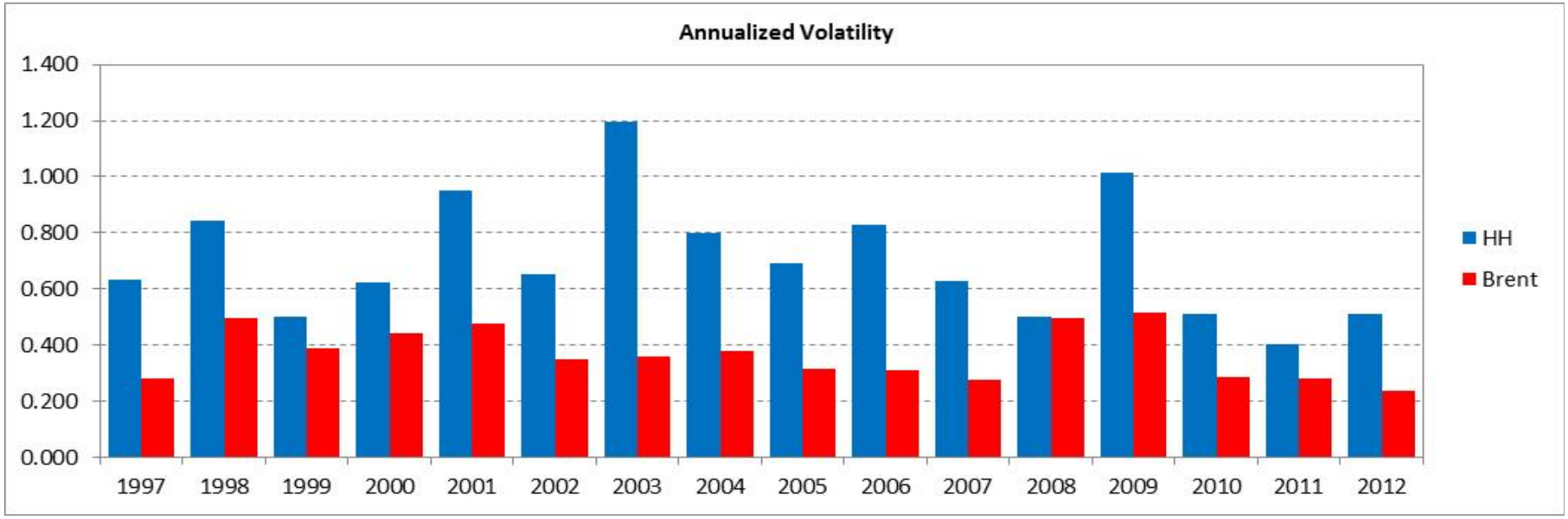
- Export capacity will be built on the expectation that rents from arbitrage will "pay" for the fixed cost.
  - But, some terminals will not earn the *ex-ante* required rate of return, contingent on the off-take agreement and who bears risk.
- Expect seasonal flows. If *seasonal* price differences among the regional markets are sufficient, US exports will be profitable during those periods. This serves to dampen volatility everywhere.
- **US LNG exports will link global markets to storage in the US. Thus, liquidity will spill over and contribute to very different market paradigm. This will be felt most heavily in Asia.**
- **The Asian gas market is about to be become substantially deeper over the next 5-10 years.**

A comment on long term prices

While we should recognize that there will be demand-driven volatility, the extremes and durations are likely to be mitigated relative to history. The nature of production and becoming connected to the international market will each enhance fungibility. Anything that lowers the incentives to invest in the upstream will work against this. Indeed, we are where are today due to the unique regulatory frameworks that exist in the US gas market with regard to accessing resource development opportunities and transporting natural gas to end-users.

Effects on Price Volatility?

- Gas has traditionally been more volatile than oil and coal.



- Economic theory predicts this. The more fungible (or tradable) a commodity is, the lower its price volatility, all else equal.
- We see this in microcosms historically at traded hubs after pipeline expansions in North America.
- The demand for storage? Counterintuitively, it should go up.

So what about the foreign opportunities for shale? Not as Fast. The US is Unique.

- Stable and conducive regulatory and institutional frameworks.
  - **Resource Access** – mineral rights ownership; acreage acquisition; resource assessments; environmental opposition; etc.
  - **Market Structure** – transportation regulation (unbundled access vs. incumbent monopolies) and bilateral take-or-pay obligations vs. marketable rights; existence of infrastructure; pricing paradigms; etc.
- Many other issues face shale development.
  - **Water** – use in production; water rights and management; flowback options (recycle and/or treatment and disposal) and native infrastructure; concerns about watershed protection (casing failures and fracture migration); etc.
  - **Other issues** – earthquakes related to injection of produced and treated water; long term effects of methane escape; concerns about contamination from produced water; ecological concerns over land use and reclamation; etc.
- **BUT, other supplies do not face the same impediments**
  - East Africa, Australia, Russia…

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