Economic Determinants of the Global Natural Gas Balance*

Kenneth B. Medlock III[1]

Search and Discovery Article #70104 (2011)
Posted July 26, 2011

*Adapted from oral presentation at AAPG Annual Convention and Exhibition, Houston, Texas, USA, April 10-13, 2011

[1]James A. Baker III Institute for Public Policy, Rice University, Houston, TX (medlock@rice.edu)

Abstract

Over the past two decades natural gas has become increasingly important in meeting global energy needs. Projected demand growth, largely for power generation, in the U.S., China, and Europe has highlighted the need to expand long distance gas transport capabilities and develop new supplies. The former development has promoted rapid expansion of global trade in natural gas, while the latter has manifested in dramatic expansion of production from unconventional resources, such as shale gas.

As recently as ten years ago, natural gas markets were isolated from each other. Limited availability of regasification, shipping, and liquefaction capacity, as well as prohibitive costs, constrained development inhibited the flow of LNG from one region of the globe to another. Asia was the early focus of the LNG business, largely due to Japanese demands. The U.S., by most accounts, was set to become the focal point for growth in the LNG business at the beginning of the 2000s. However, technical achievements have rendered recovery of natural gas from shale formations to be economically viable thus unlocking a very large domestic resource. This has literally flipped expectations about the direction of the North American gas market upside down in less than a decade.

In North America, rapid growth in shale gas production has changed substantially and altered expectations regarding future prices, the development of frontier resources in Alaska and Northern Canada, and LNG import requirements. The latter prospect in particular has had a ripple effect to international LNG markets, and by displacement, markets in Asia and Europe. Furthermore, developments in North America have sparked interest in shale gas resource potential in other parts of the world, and the experience gained producing shale gas in North America may translate to those regions. The global implication is that the timing of LNG projects and the interest in expanding LNG infrastructure is running headlong into concerns about market availability. Moreover, the abundance of gas supply has forced producers and consumers to consider the effects of increasing gas-on-gas competition. Outside the US this development marks a dramatic shift from the traditional oil-indexed terms that have historically dominated gas transactions.

Sustained rapid development of shale gas is not a certainty. Environmental concerns regarding the potential contamination of water resources are major issues that will likely need to be addressed. In addition, climate policies and energy security policies - possibly including certain

renewable portfolio standards or CO_2 cap-and-trade programs that grandfather coal resources - will have consequences for global gas markets that can be difficult to project.

Economic Determinants of the Global Natural Gas Balance

Presentation to:
AIPN SC 2011

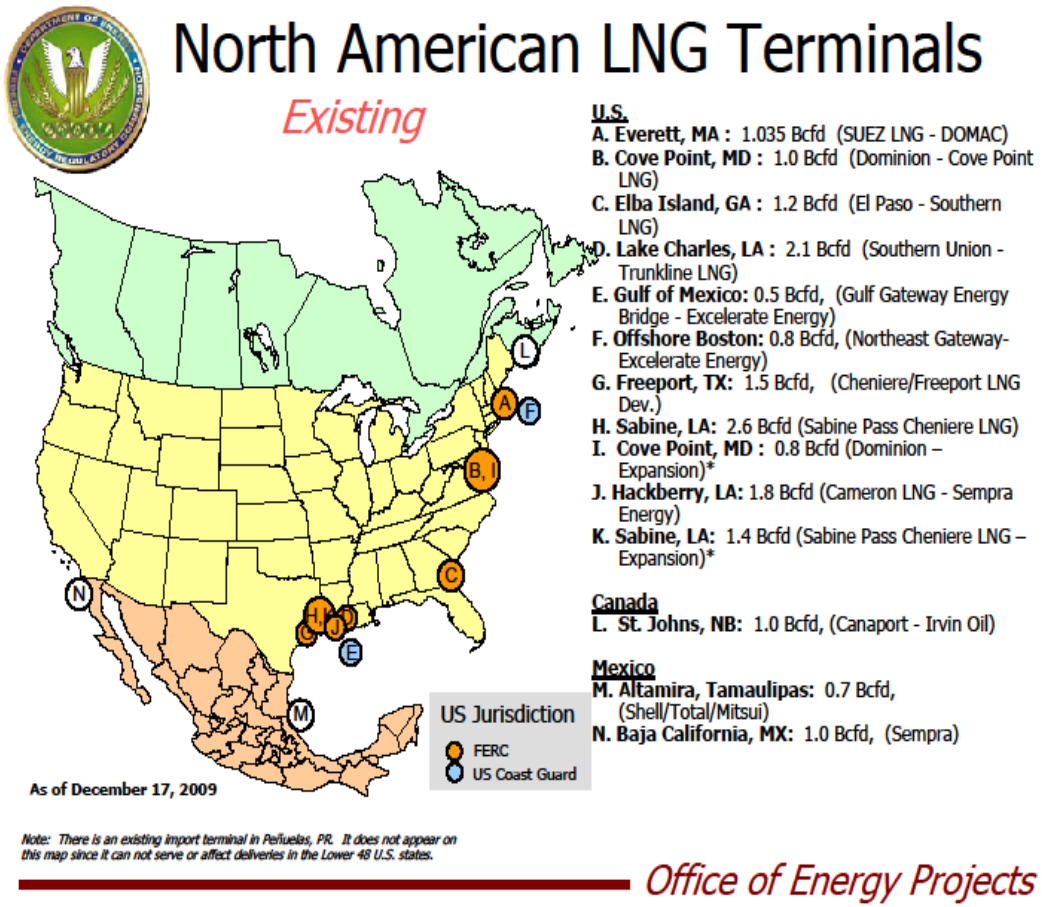
Kenneth B Medlock III
James A Baker III and Susan G Baker Fellow in Energy and Resource Economics, and
Deputy Director, Energy Forum, James A Baker III Institute for Public Policy
Adjunct Professor, Department of Economics
Rice University

April 12, 2011

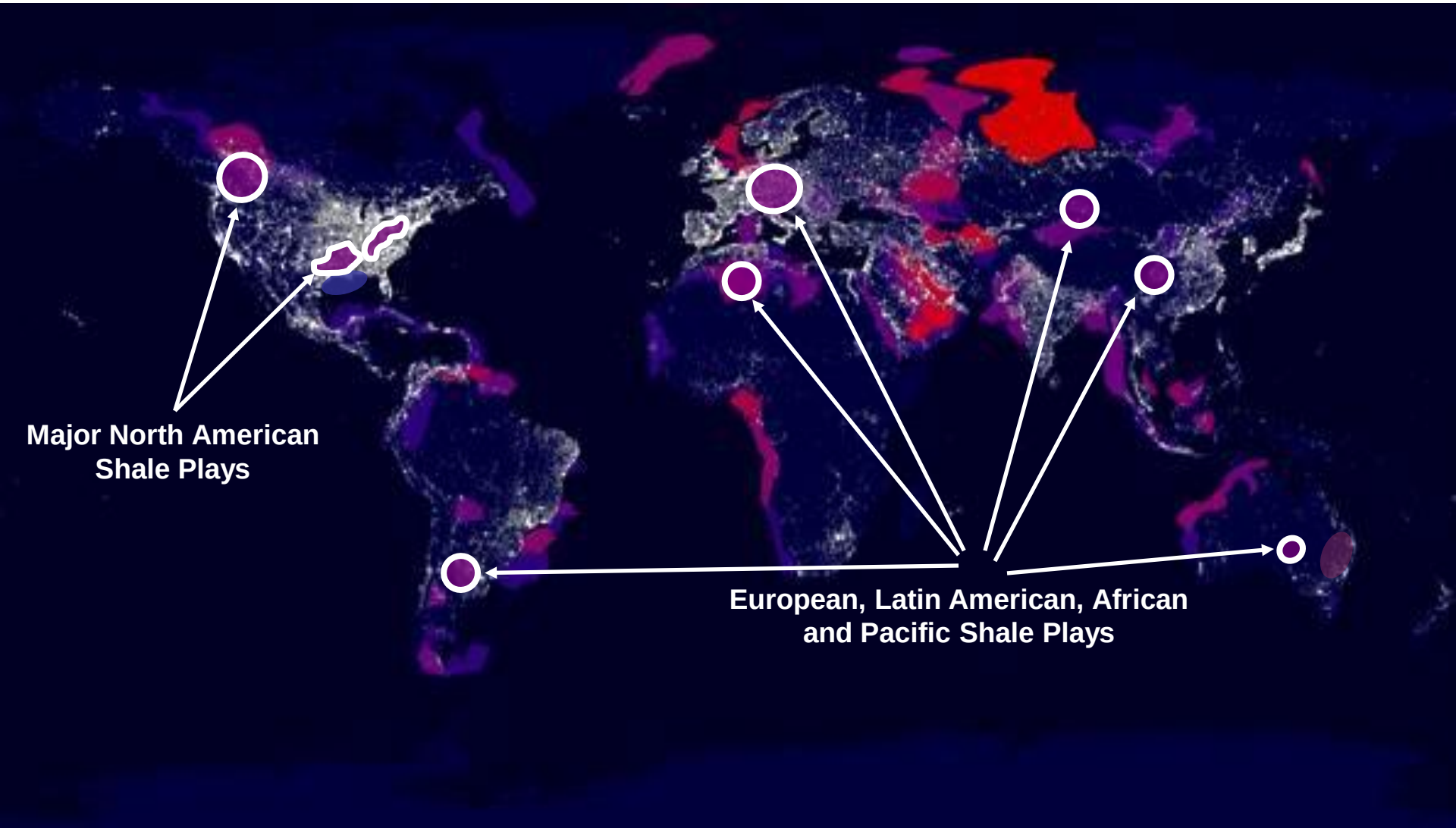
James A Baker III Institute for Public Policy
Rice University

A Paradigm Shift

- The view of natural gas has changed dramatically in only 10 years
  - Most predictions were for a dramatic increase in LNG imports to North America and Europe.
  - Today, growth opportunities for LNG developers are seen in primarily in Asia.
- Many investments were made to expand LNG potential to North America in particular
  - At one point, 47 terminals were in the permitting phase.
  - Since 2000, 2 terminals were re-commissioned and expanded (Cove Point and Elba); 9 others were constructed.
  - In 2000, import capacity was just over 2 bcfd; It now stands at just over 17.4 bcfd.
  - By 2012, it could reach 20 bcfd.
- A similar story in Europe
  - In 2000, capacity was just over 7 bcfd; It is now over 14.5 bcfd.
  - By 2012, it could exceed 17 bcfd.
- Shale gas developments have since turned expectations upside-down



Shale is everywhere, and it has significant implications for global energy markets



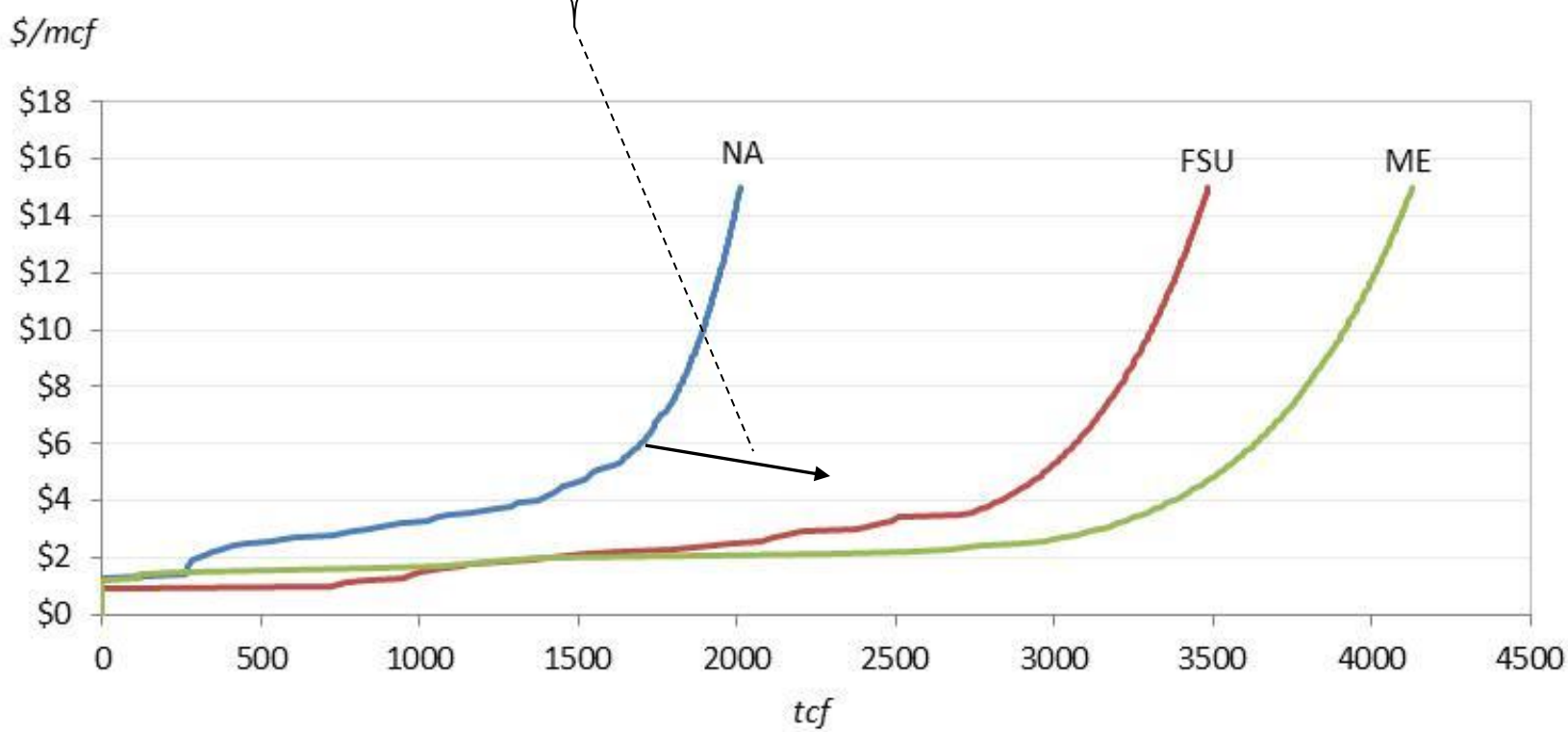
North American Shale (cont.)

- In 2003, the NPC used an assessment of 38 tcf of technically recoverable shale gas in its study of the North American gas market.
- In 2005, most estimates placed the resource at about 140 tcf.
- Recent estimates are much higher
  - (2008) Navigant Consulting, Inc. estimated a mean of about 520 tcf.
  - (2009) Estimate from PGC over 680 tcf.
  - (2010) ARI estimate of over 1000 tcf.
- Resource assessment is large. Our work at BIPP indicates a technically recoverable resource of 686 tcf.
- Point: We learn more as time passes!

	Mean Technically Recoverable Resource (tcf)	Breakeven Price
Antrim	13.2	$ 5.50
Devonian/Ohio	170.8	
Utica	5.4	$ 6.25
Marcellus	135.4	
Marcellus T1	47.4	$ 4.00
Marcellus T2	43.3	$ 5.25
Marcellus T3	44.7	$ 6.50
NW Ohio	2.7	$ 6.75
Devonian Siltstone and Shale	1.3	$ 6.75
Catskill Sandstones	11.7	$ 6.75
Berea Sandstones	6.8	$ 6.75
Big Sandy (Huron)	6.3	$ 6.00
Nora/Haysi (Huron)	1.2	$ 6.25
New Albany	3.8	$ 7.00
Floyd/Chatanooga	4.3	$ 6.00
Haynesville	105.0	
Haynesville T1	42.0	$ 4.00
Haynesville T2	36.8	$ 5.00
Haynesville T3	26.3	$ 6.25
Fayetteville	36.0	$ 4.25
Woodford Arkoma	8.0	$ 4.50
Woodford Ardmore	4.2	$ 5.75
Barnett	54.0	
Barnett T1	32.2	$ 4.25
Barnett T2	21.8	$ 5.75
Barnett and Woodford	35.4	$ 6.50
Eagle Ford	35.0	$ 4.00
Palo Duro	4.7	$ 6.25
Lewis	10.2	$ 6.25
Bakken	1.8	$ 6.50
Niobrara (incl. Wattenburg)	1.3	$ 6.50
Hilliard/Baxter/Mancos	11.8	$ 6.50
Paradox/Uinta	13.5	$ 6.50
Mowry	8.5	$ 6.50
Horn River	90.0	
Horn River T1	50.0	$ 4.50
Horn River T2	40.0	$ 5.25
Montney	65.0	
Montney T1	25.0	$ 4.75
Montney T2	40.0	$ 5.50
Utica	10.0	$ 6.25
Total US Shale	521.4	
Total Canadian Shale	165.0	
Total North America	686.4	

LNG Exports and North American Resources in a Global Context

- North American resources are large, but must be placed in a global context.
  - FSU and Middle East (pictured for comparison) are larger and generally less costly. However, access and transportation costs make North American resources preferential in the short-to-medium term *in North America*. But, prospects for large scale competition are limited by cost.
  - Cost reductions and higher recoverable resource estimates benefit the US supply picture.



Rest of World Shale Gas

- There is tremendous uncertainty about shale resources outside of North America.
- To be certain, the estimates of resource in place are very large, and location is a premium with regard to prevailing market prices and energy security benefit.
- However, accessibility is critical. Not only do cost and technology matter, but market structure and government policy is equally as important.
  - Arguably, if the current market structure in the United States did not exist, the shale gas boom would not have occurred. This is due to the fact that the small producers who initiated the proof of concept had little to no risk of accessing markets from very small production projects. A market in which capacity rights are not unbundled from facility ownership does not foster entry by small producers.

	Mean Technically Recoverable Resource (tcf)	Breakeven Price
Austria	40.0	$ 5.75
Germany	30.0	$ 5.50
Poland	120.0	$ 5.25
Sweden	30.0	$ 6.00
China	45.0	$ 5.00
Australia	50.0	$ 4.00
Total non-North America	315.0	

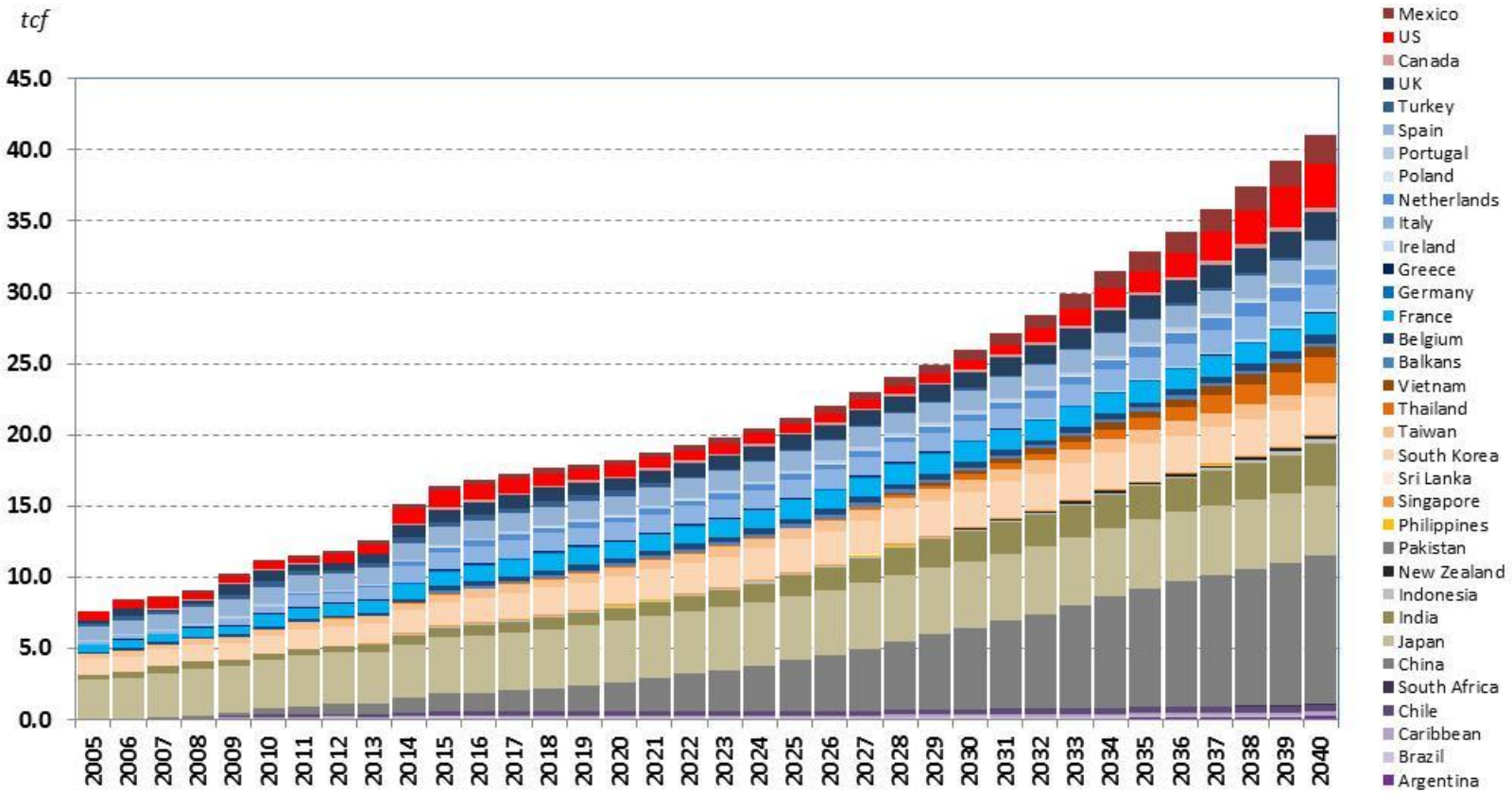
Note, ongoing work will likely add assessments for technically recoverable resource in Croatia, Denmark, France, Hungary, Netherlands, Ukraine, and the United Kingdom. Estimates are currently too preliminary to be presented in this case.

New ARI assessment under review for incorporation into the Reference Case.

RWGTM Reference Case Results

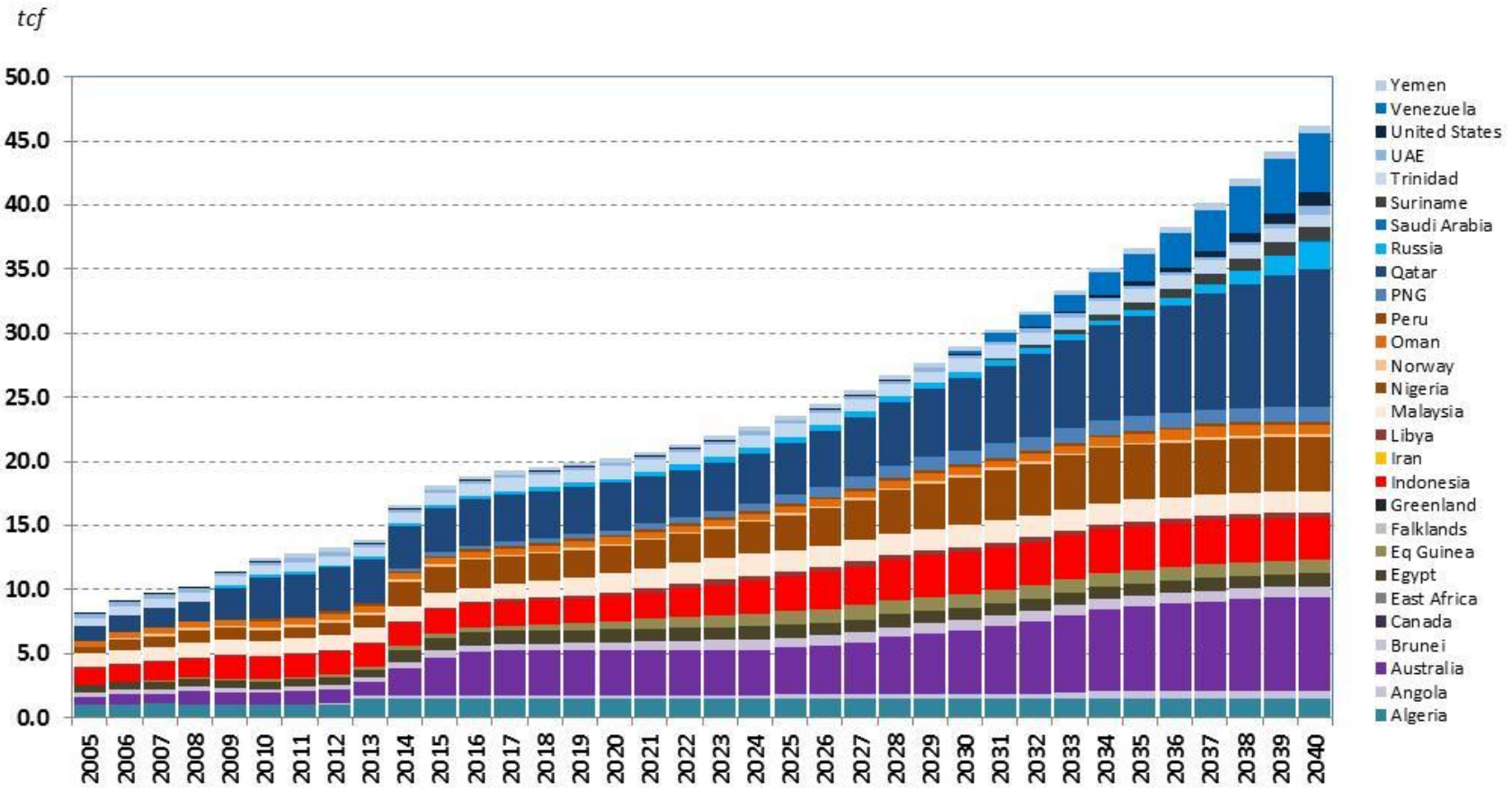
Global LNG Imports

- Most LNG import growth is in Asia, particularly in China and India. In fact, Asia accounts for over 60% of all LNG imports in 2040.
- The United States remains a minor LNG importers.



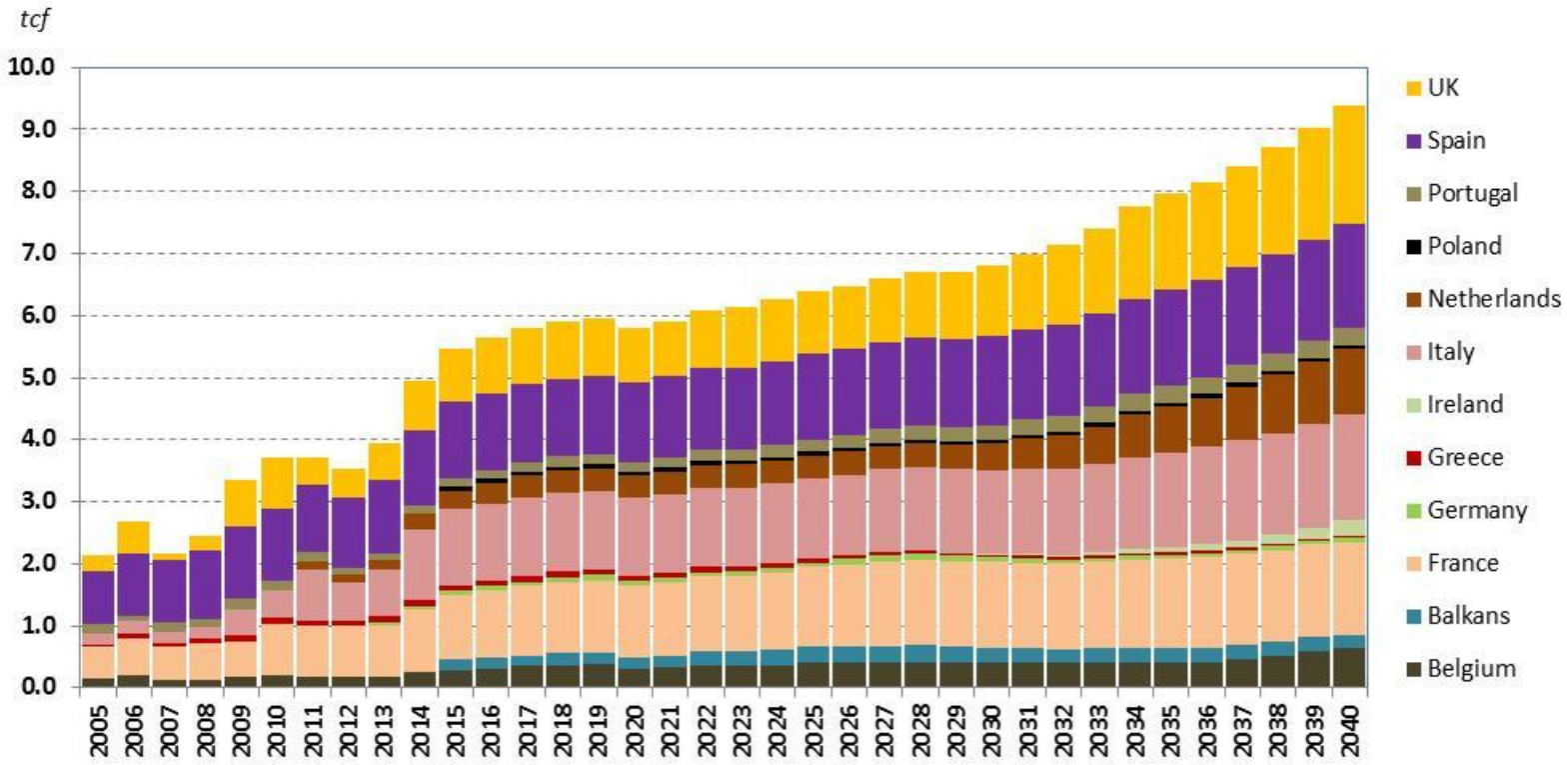
Global LNG Exports

- Qatar and Australia are the two largest LNG exporters in 2040, and, collectively, account for just under 40% of global *LNG* exports.



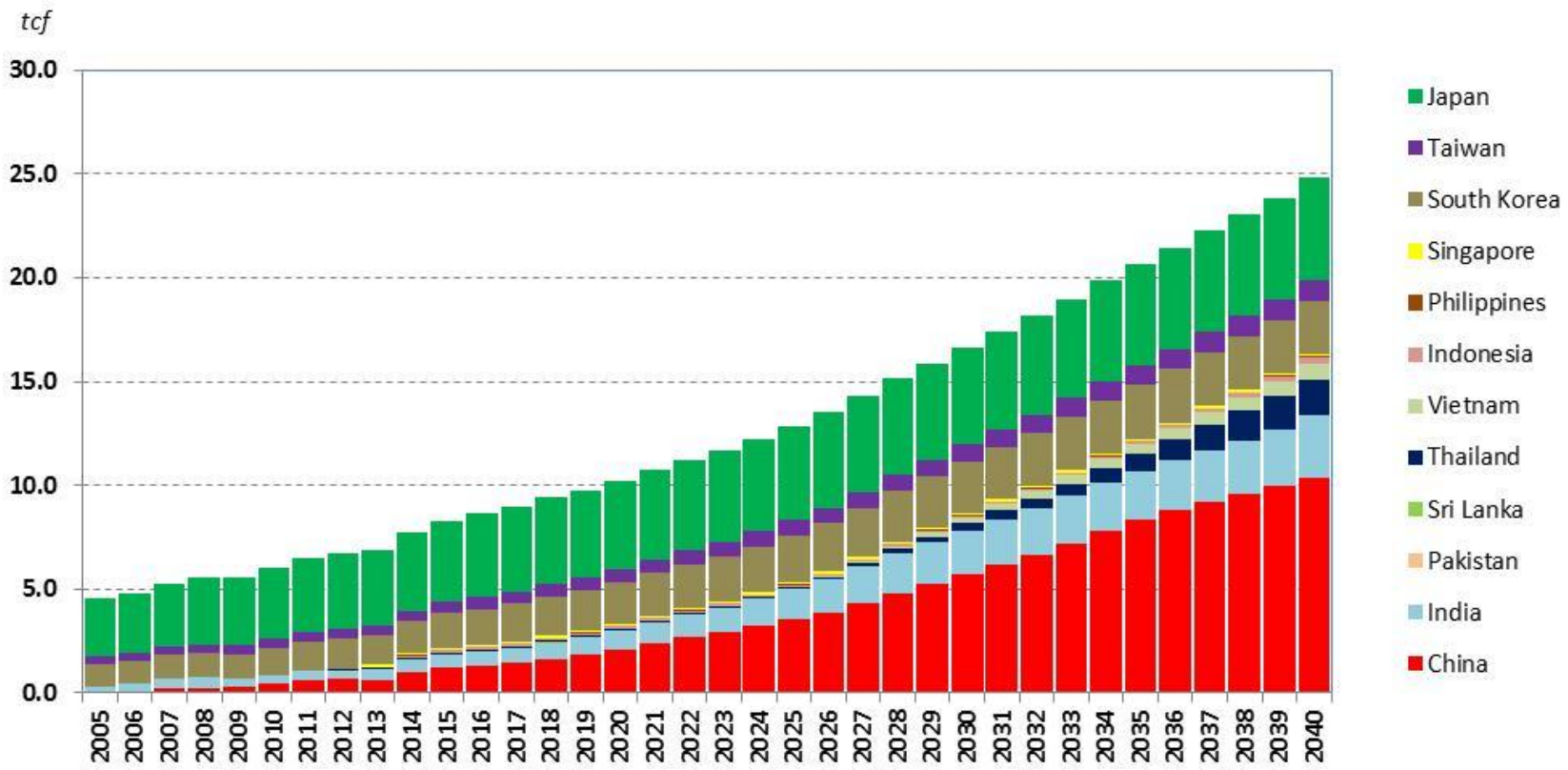
LNG Imports to Europe

- Growth in LNG is an important source of diversification to Europe. Indigenous shale gas opportunities abate this to some extent. However, shale production does not grow as strongly as in North America, so LNG imports in Europe rise.



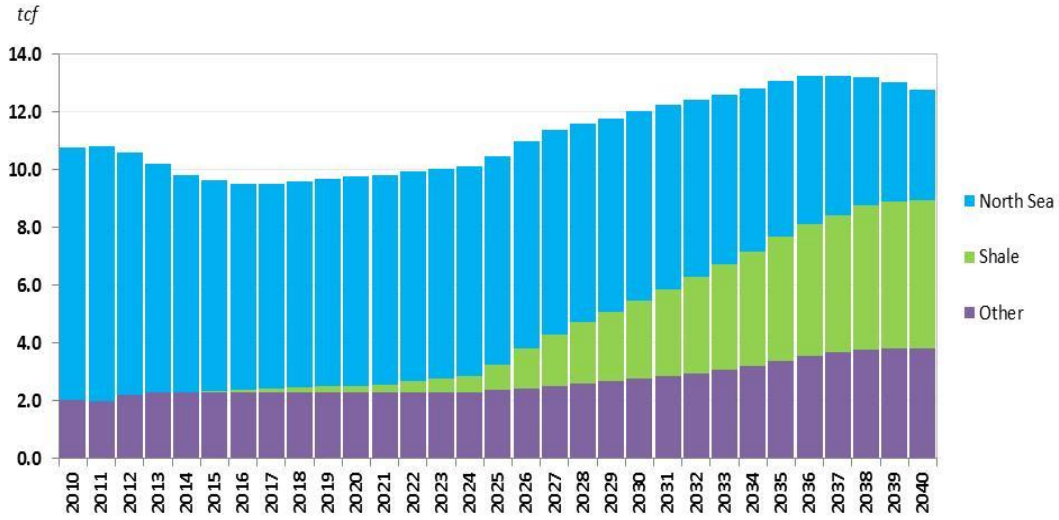
LNG Imports to Asia

- Strong demand growth creates a much needed sink for LNG supplies.
  - China leads in LNG import growth despite growth in pipeline imports and supplies from domestic unconventional sources.

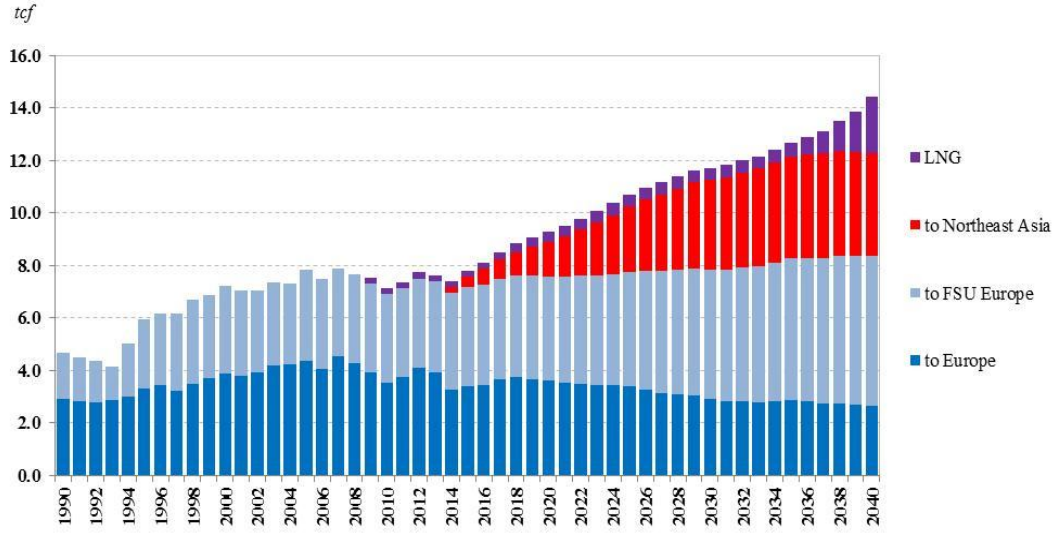


Impact of Shale Production in Europe

- European shale production grows to about 35% of total production by 2040. While not as strong as North America, it does offset the need for increased imports from Russia, North Africa, and LNG.

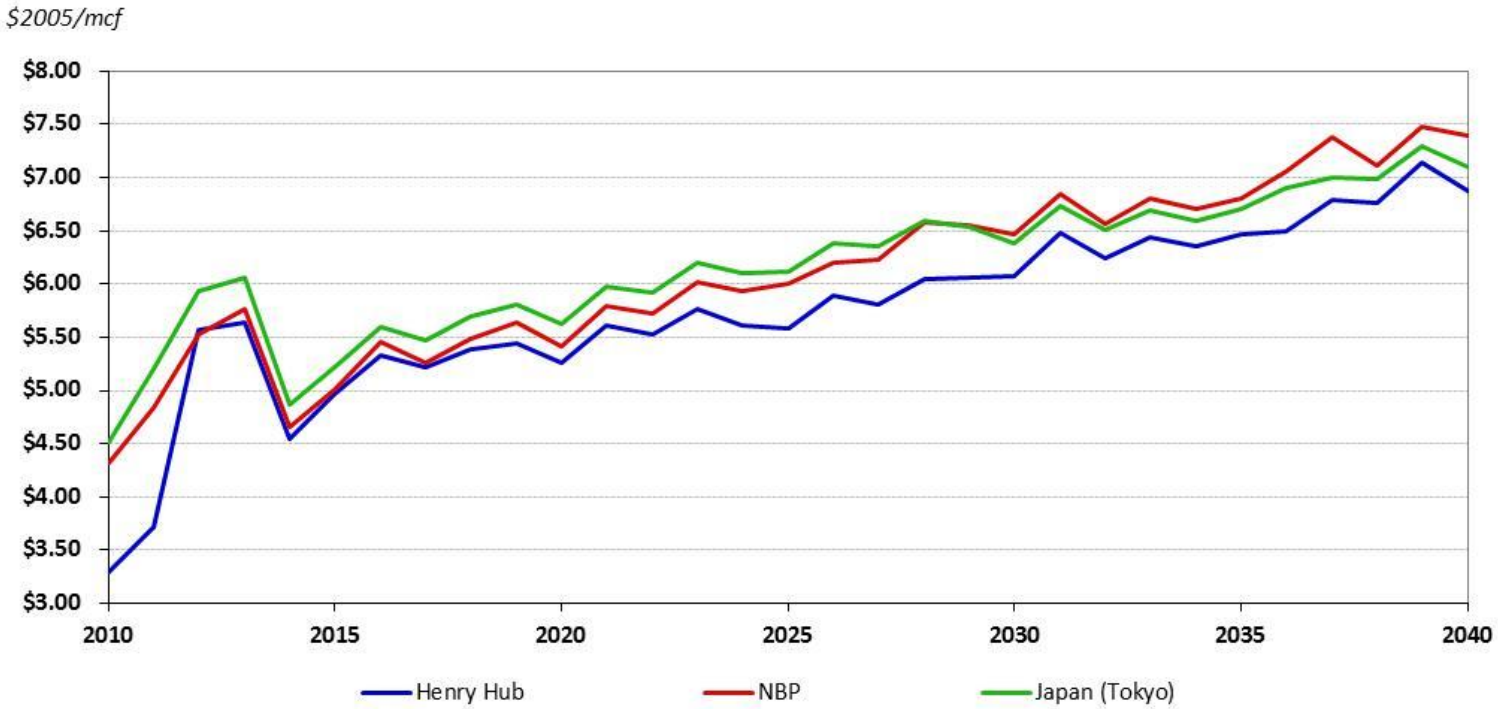


- The impact of shale growth in Europe is tilted toward offsetting Russian imports. In fact, Russian market share in non-FSU Europe declines from 20% currently to 11% by 2040.



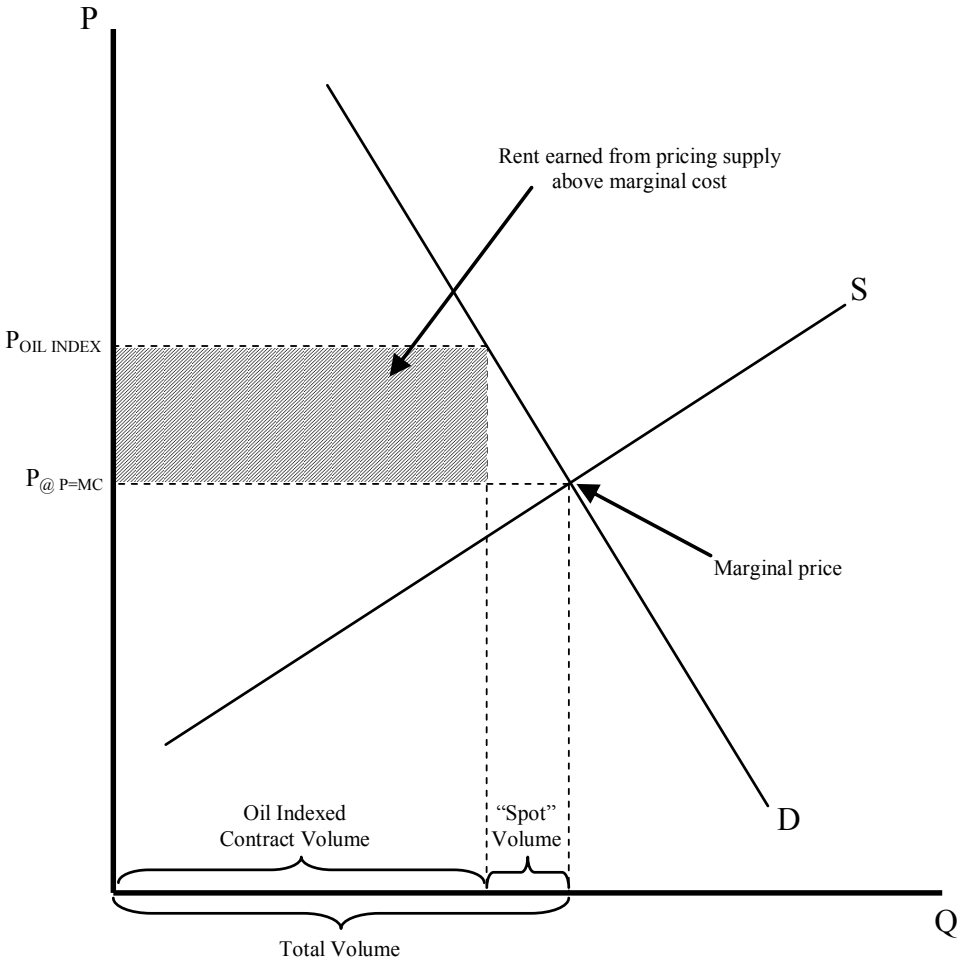
Select Regional Prices

- Prices tend to rise over time as lower cost supplies are depleted.
- Prices tend to move together as LNG growth increasingly connects markets. Note this occurs despite lack of substantial LNG trade into the US because arbitrage *opportunity* forces equilibrium.
- NBP and Tokyo average about $0.50 over Henry Hub longer term. Note this is spot delivery. Contracted flows are priced differently…



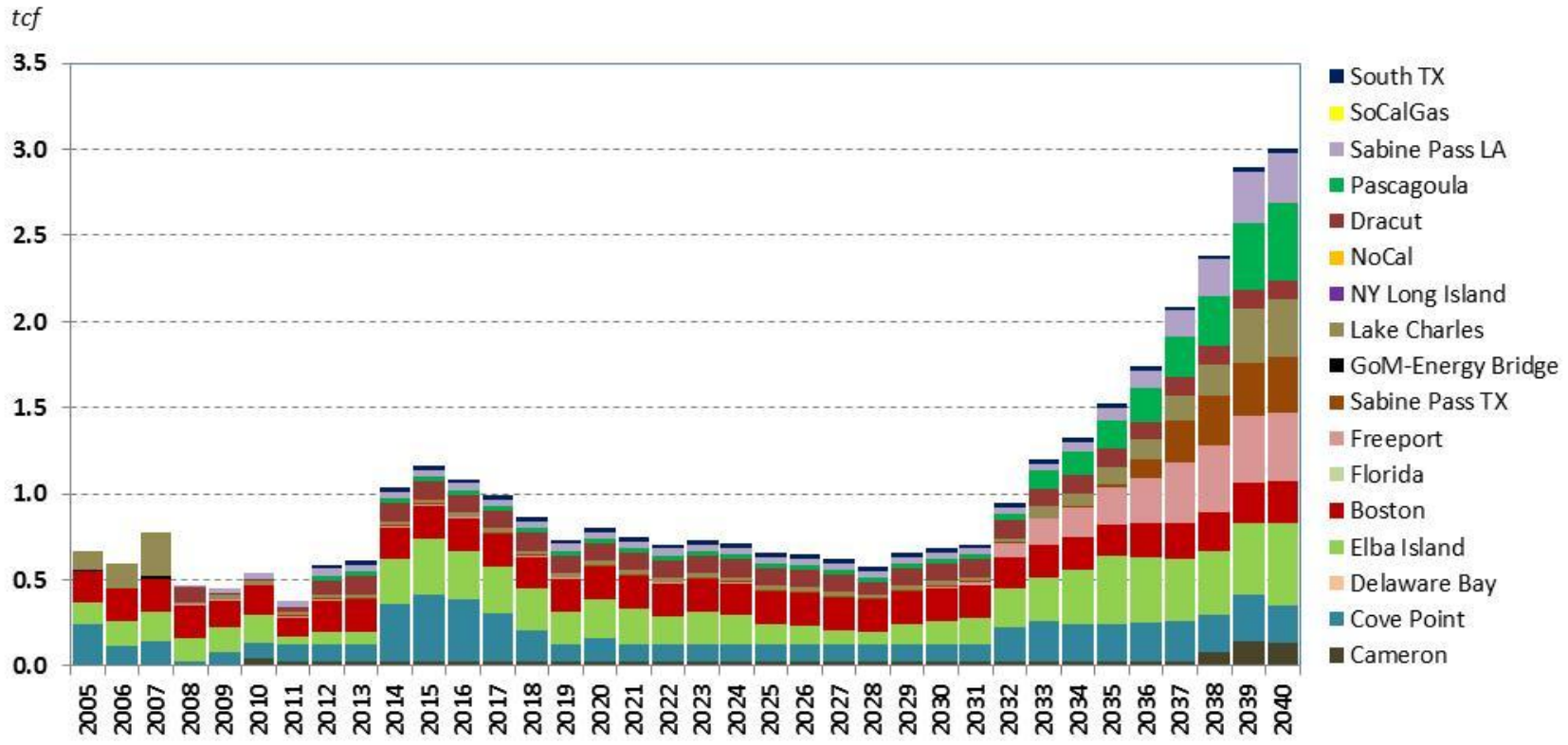
A Comment on the Role of Oil Indexation

- 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.
  - Both conditions are met in Europe and Asia, but not in North America.
    - Lack of transport differentials in Europe is evidence of discrimination.
- 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.
- Evidence of a weaker ability to price discriminate is emerging in Europe.
  - Recent changes in contractual terms

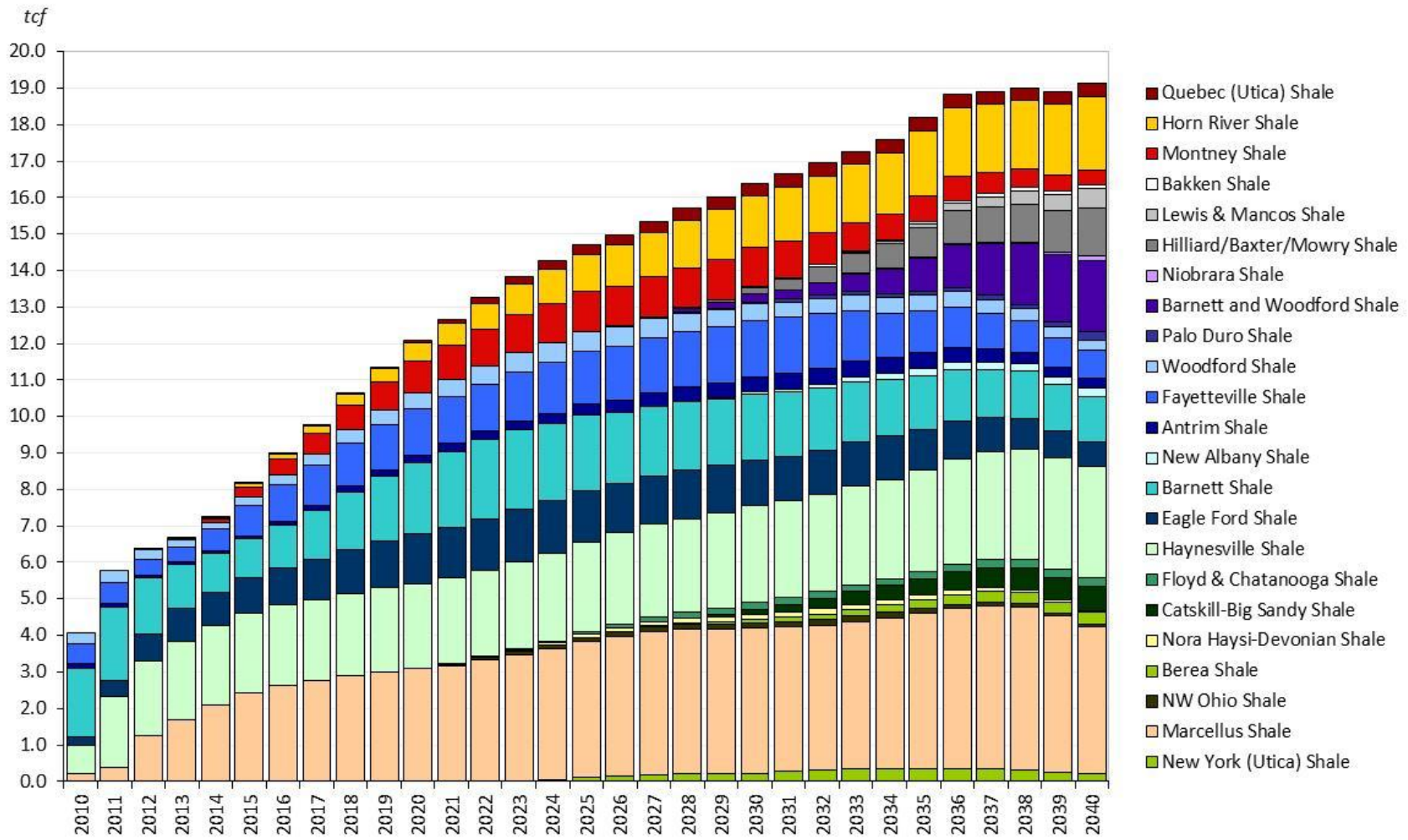


U.S. LNG Imports

- Very low re-gas terminal capacity utilization through the mid-2030s.
- Slight uptick in imports in 2014 due to timing of export capacity.
- LNG imports eventually rise as declines in conventional basins accelerate.
- Important point: A larger shale assessment can change this!

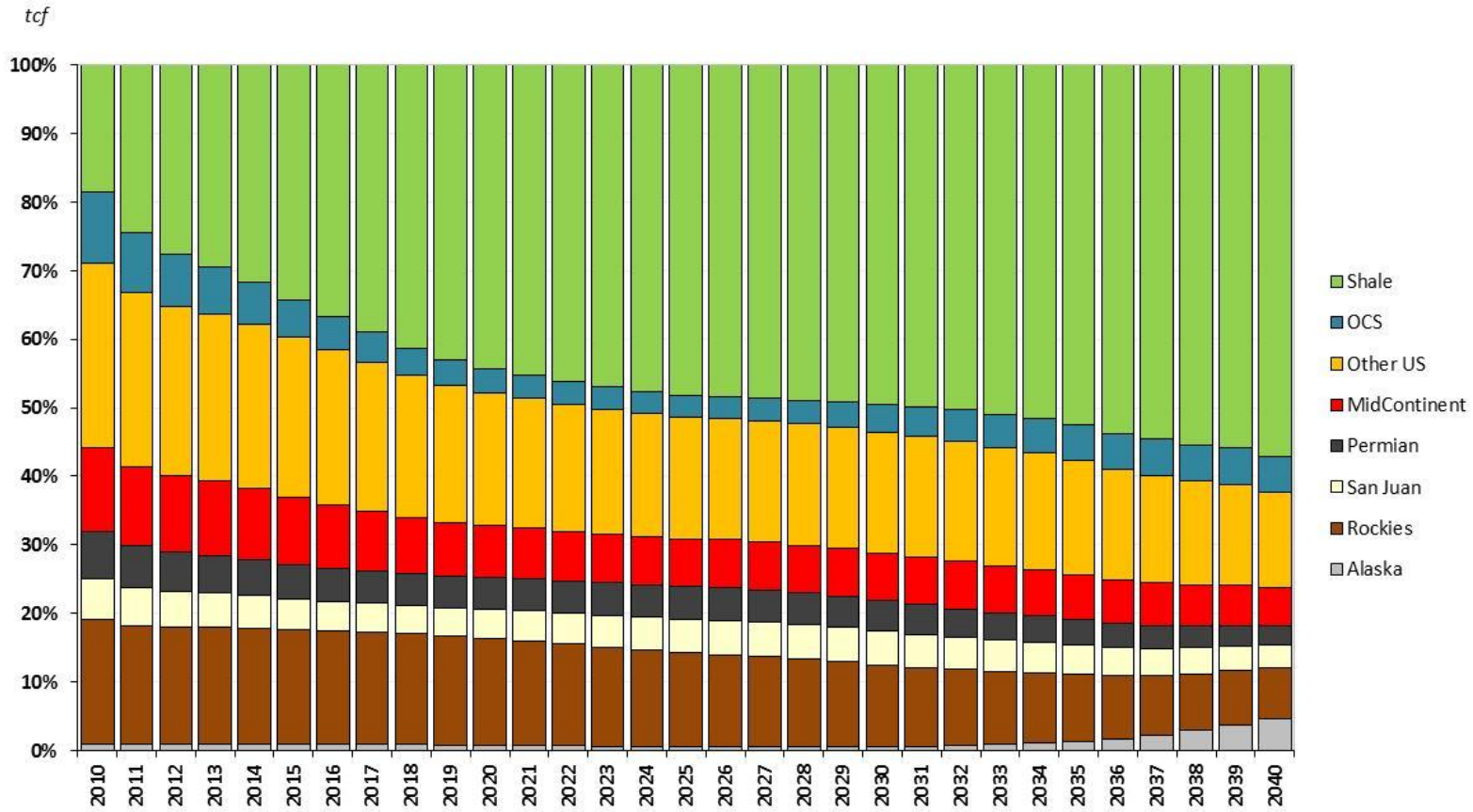


North American Shale Production



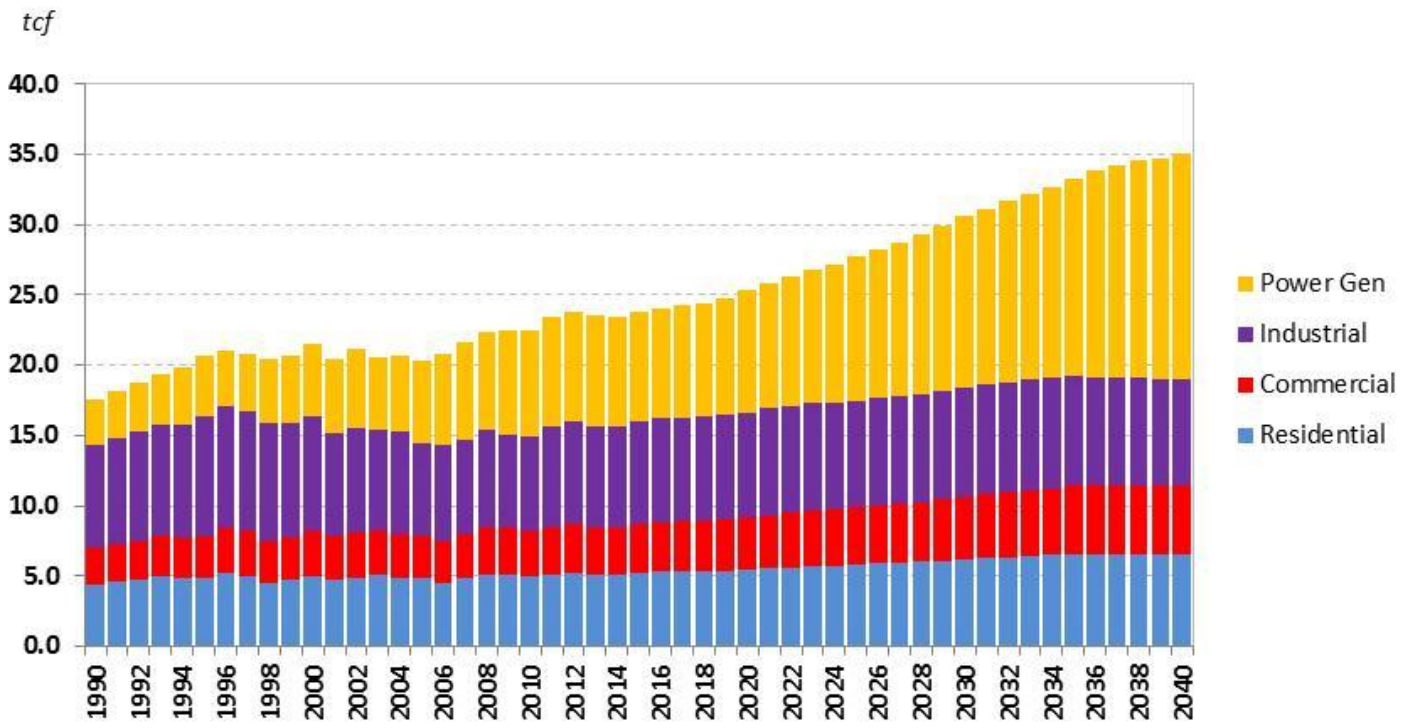
Composition of U.S. Production

- US shale production grows to about 50% of total production by early 2030s.
- Canadian shale production grows to about 1/3 of total output by 2040 (not pictured). This offsets declines in other resources as total production remains fairly flat.



U.S. Demand

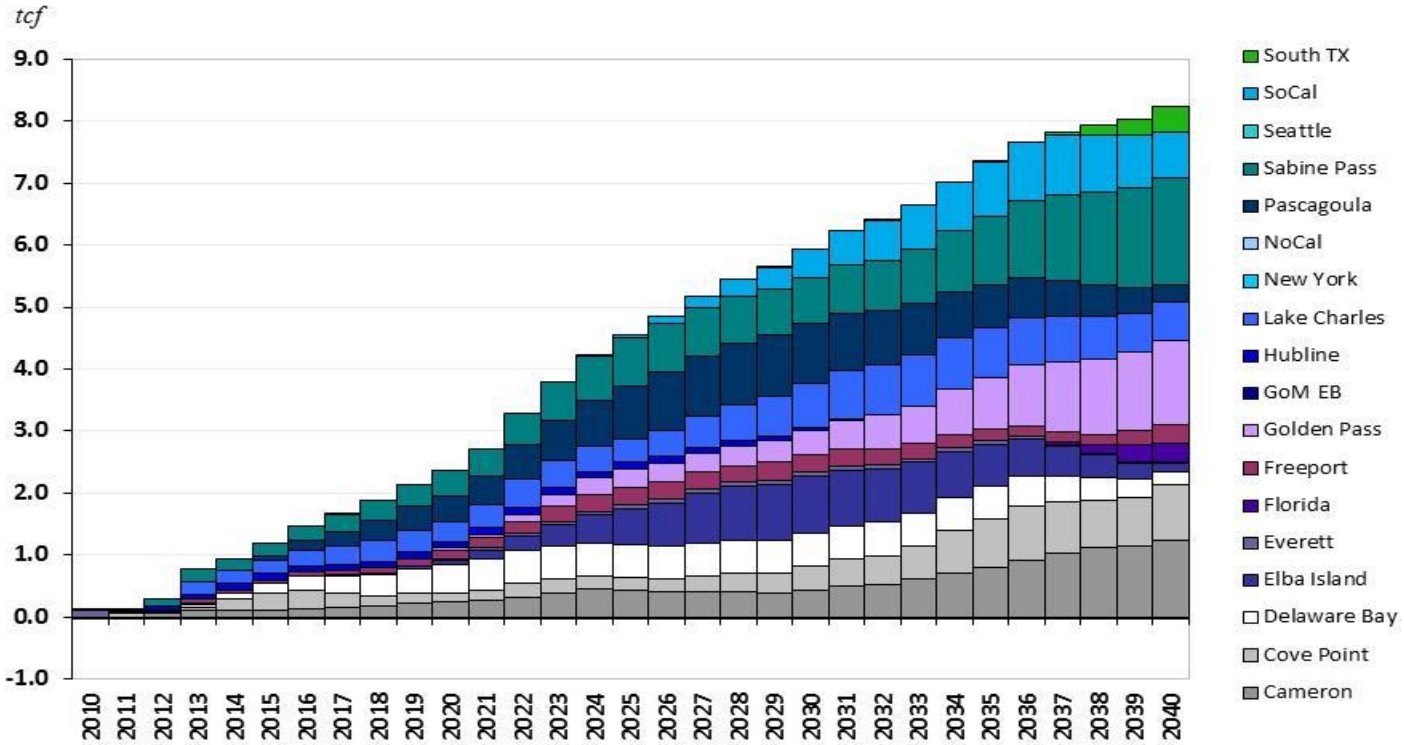
- Largely driven by growth in power generation.
- Average annual growth by sector:
  - Power Gen (2010-2040): 2.48%
  - Industrial (2010-2040): 0.36%
  - Residential (2010-2040): 0.84%
  - Commercial (2010-2040): 1.38%



A World without Shale?
Reminiscing on the View 10 Years Ago.

- Snapshot: US LNG imports are much higher (see below), and demand is lower (not pictured).
- Big winners in this case: Iran, Venezuela, and Russia
  - Iran and Venezuela LNG exports are accelerated 10-15 years earlier.
  - Russian market share in Europe only declines to 18%. Still enjoys growth in Asia.
- Study sponsored by the US DOE. Full results available in early May.

Graphic indicates the incremental change in U.S. LNG imports if we revert to the "pre-shale world"



Questions