



# **The Impact of the Shale Revolution**



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# **Understanding the Long Term Impact of Shale is Embedded in this Picture...**



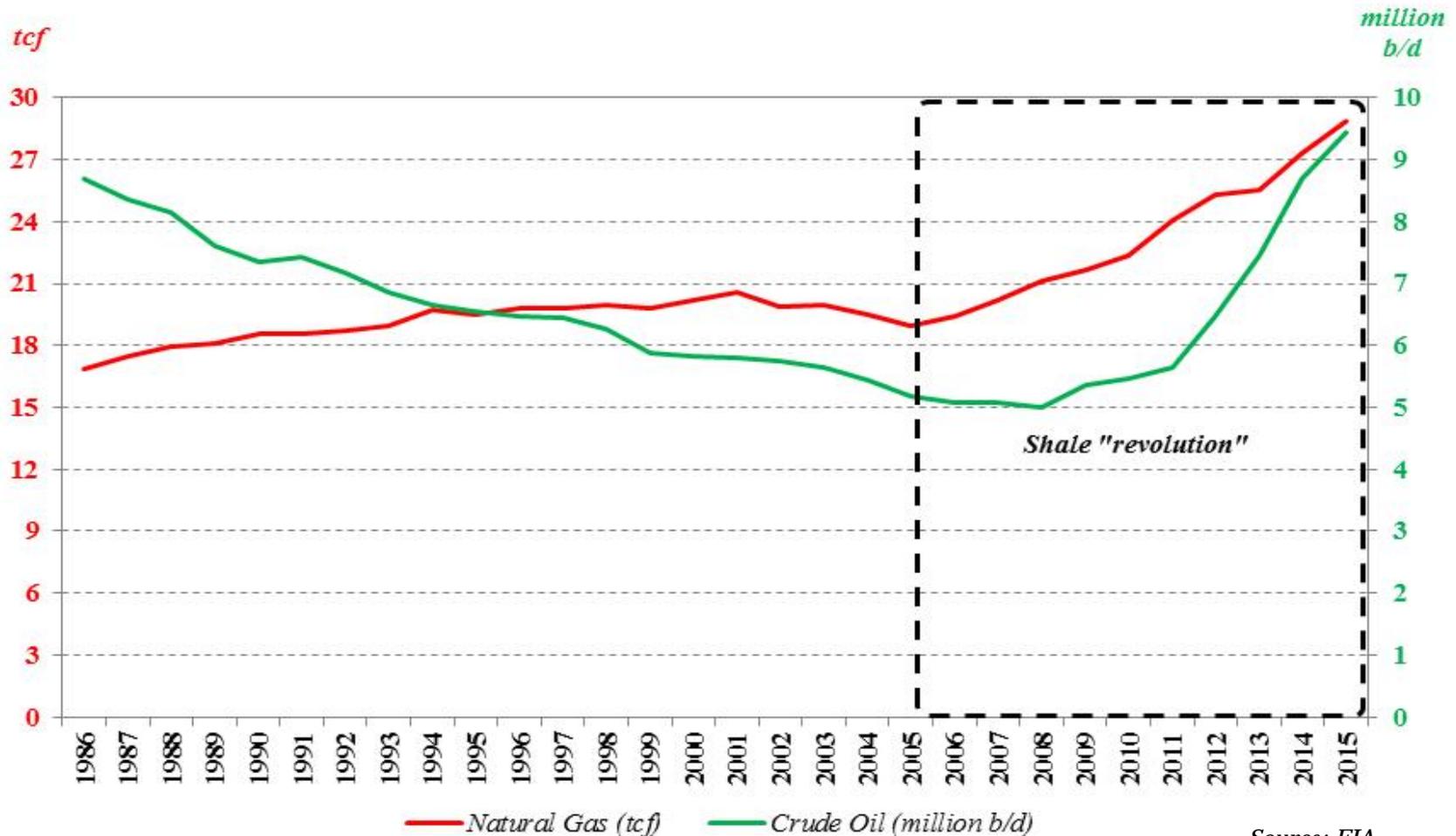
**Regardless of the view, crude oil and natural gas will be a significant proportion of the global energy mix for the next few decades. How do we meet this demand?**

**Shale has been paradigm shifting for both natural gas and crude oil markets, but it has been a US-centric development. Questions remain regarding the opportunities for shale and other frontier resources outside the US, but there is a potentially important and expanding role for energy in the Western Hemisphere.**

**Of course, energy efficiency will need to be a major part of any path forward, and will be a hallmark of any sustainable energy future. But, shale has played, and will continue to play an important role in the global energy market mix.**

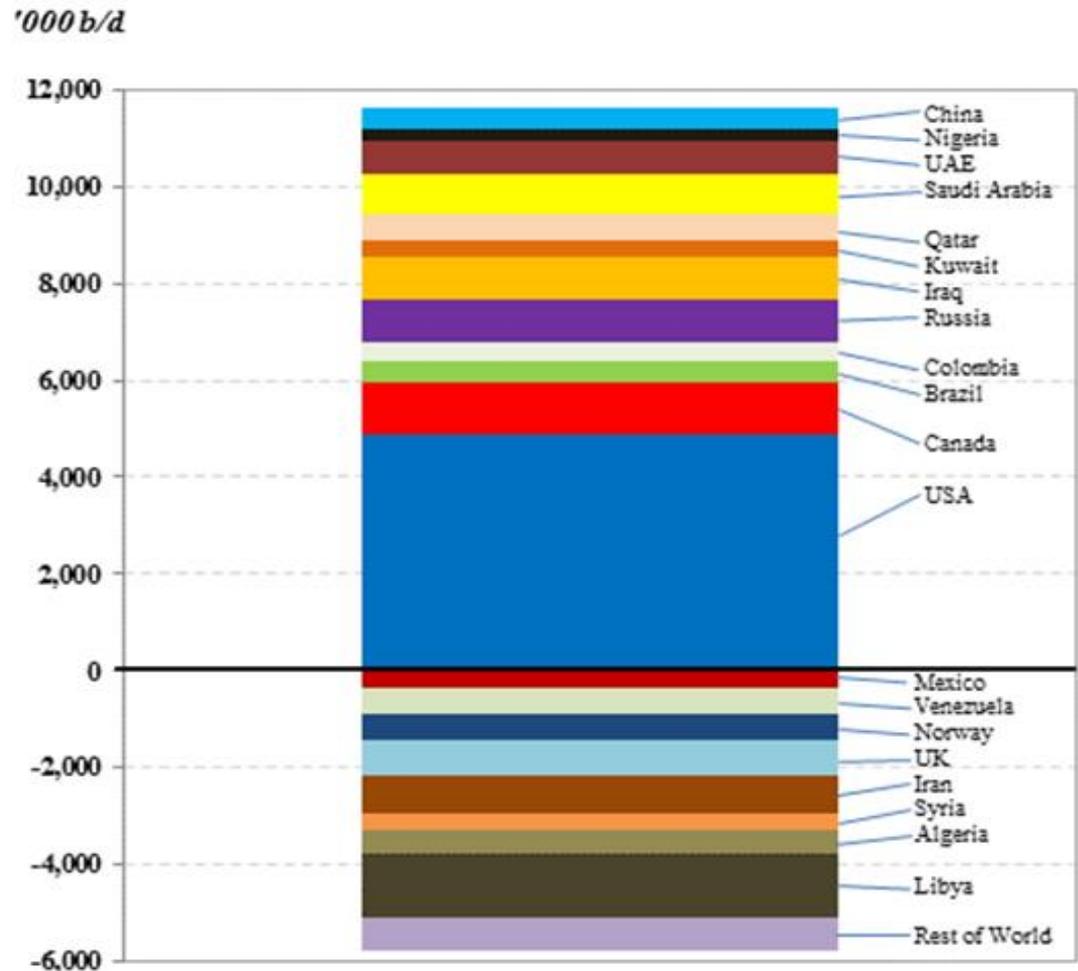
# Shale Drives Significant Change in the US

- The “Shale Revolution” has been paradigm shifting.



## Crude Oil: Changes in Global Supply, 2008-2014

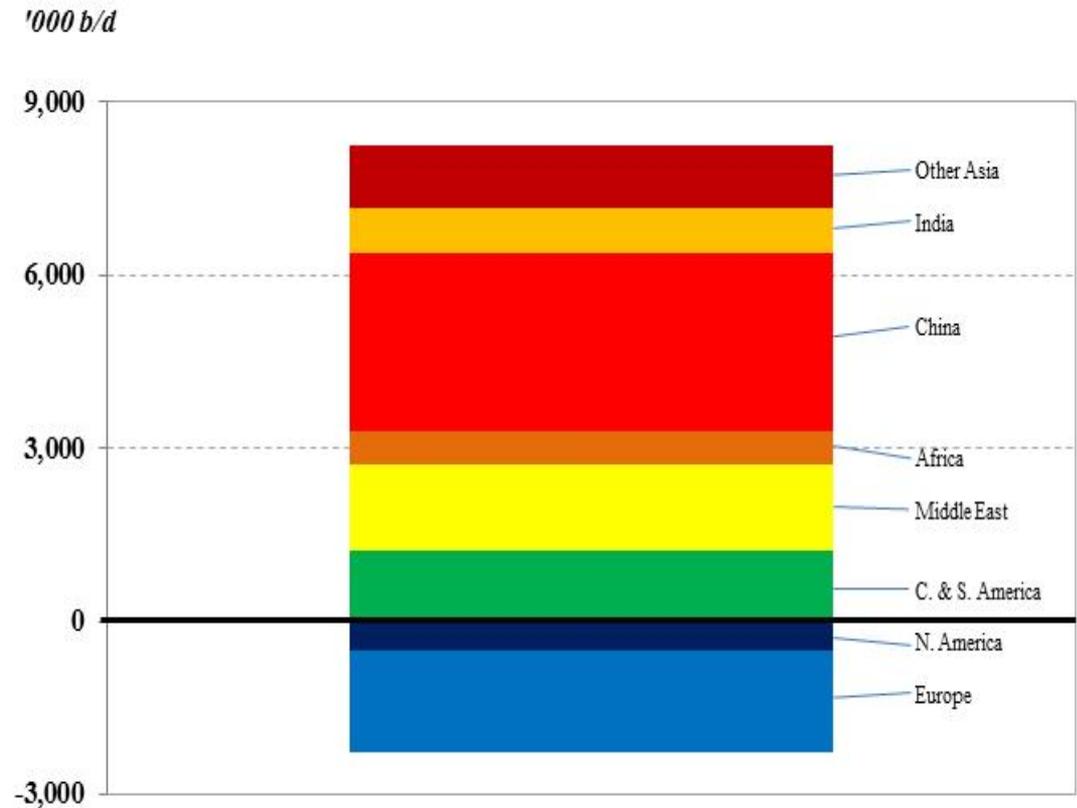
- Production declines have been largely in regions with civil strife, sanctions, or sector mismanagement. Less than a third of decline is due to geologic factors.
- Growth in the US offset the declines due to above-ground factors, and high prices encouraged a positive supply response from other regions.
- Production remained robust into 2015, exacerbated by efforts for market share by OPEC. Near term market balance now hinges largely on global demand.



Source: BP

## Crude Oil: Changes in Global Demand, 2008-2014

- Demand declined in the developed economies of the OECD, while it grew in developing economies in South America, the Middle East, and especially Asia.
- In fact, Asian demand growth accounted for over 80% of the increase in global demand, with China comprising just over three-fifths of that increase.
- However, in the latter half of 2014 to 2015, signs of global demand weakness emerged, setting the stage for a price adjustment.

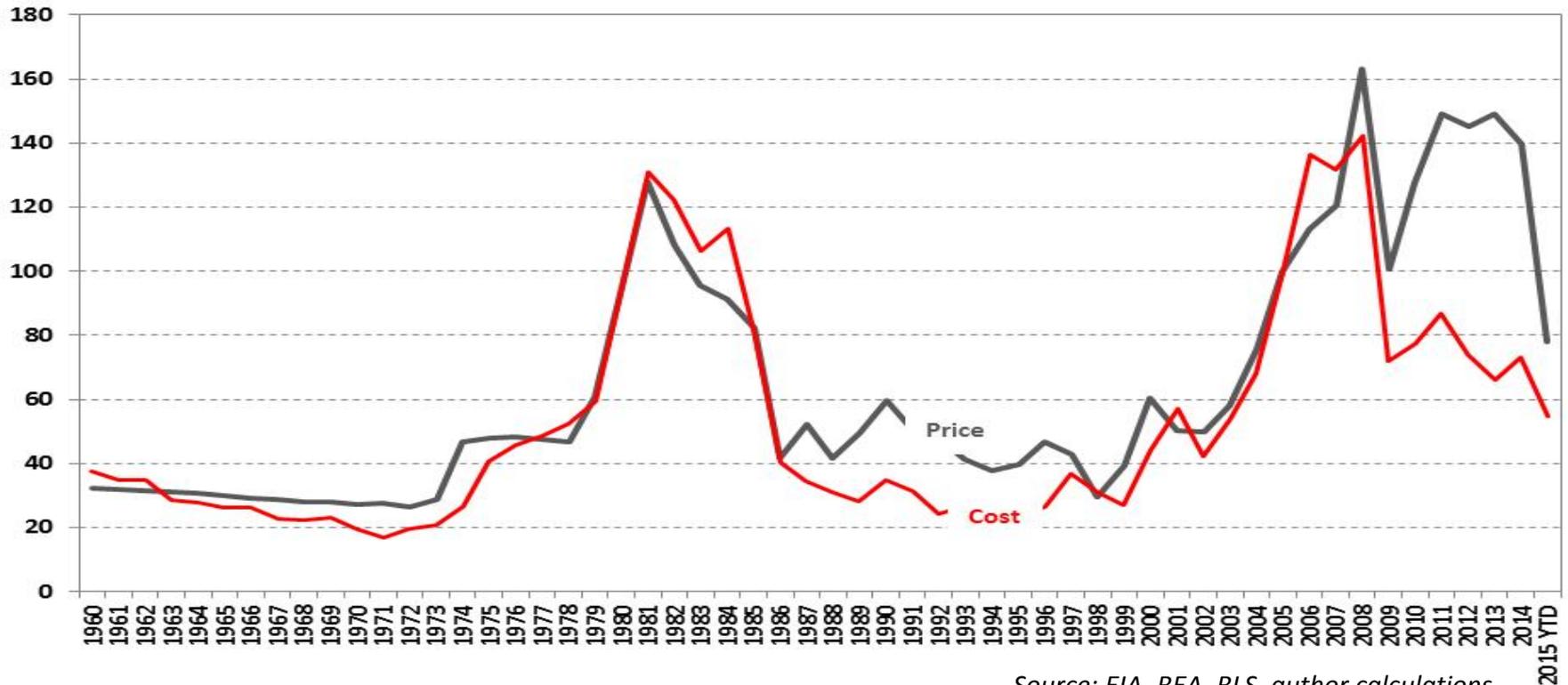


Source: BP

## Crude Oil: Price versus Cost (Real, \$/b vs \$/b)

- Today's cost environment is below the mid-trend of the cycle, but if today is the "new normal" then long term costs indicate a real oil price of \$50-60/b. The long term mid-trend is \$5-10/b higher. This is critical for shale.

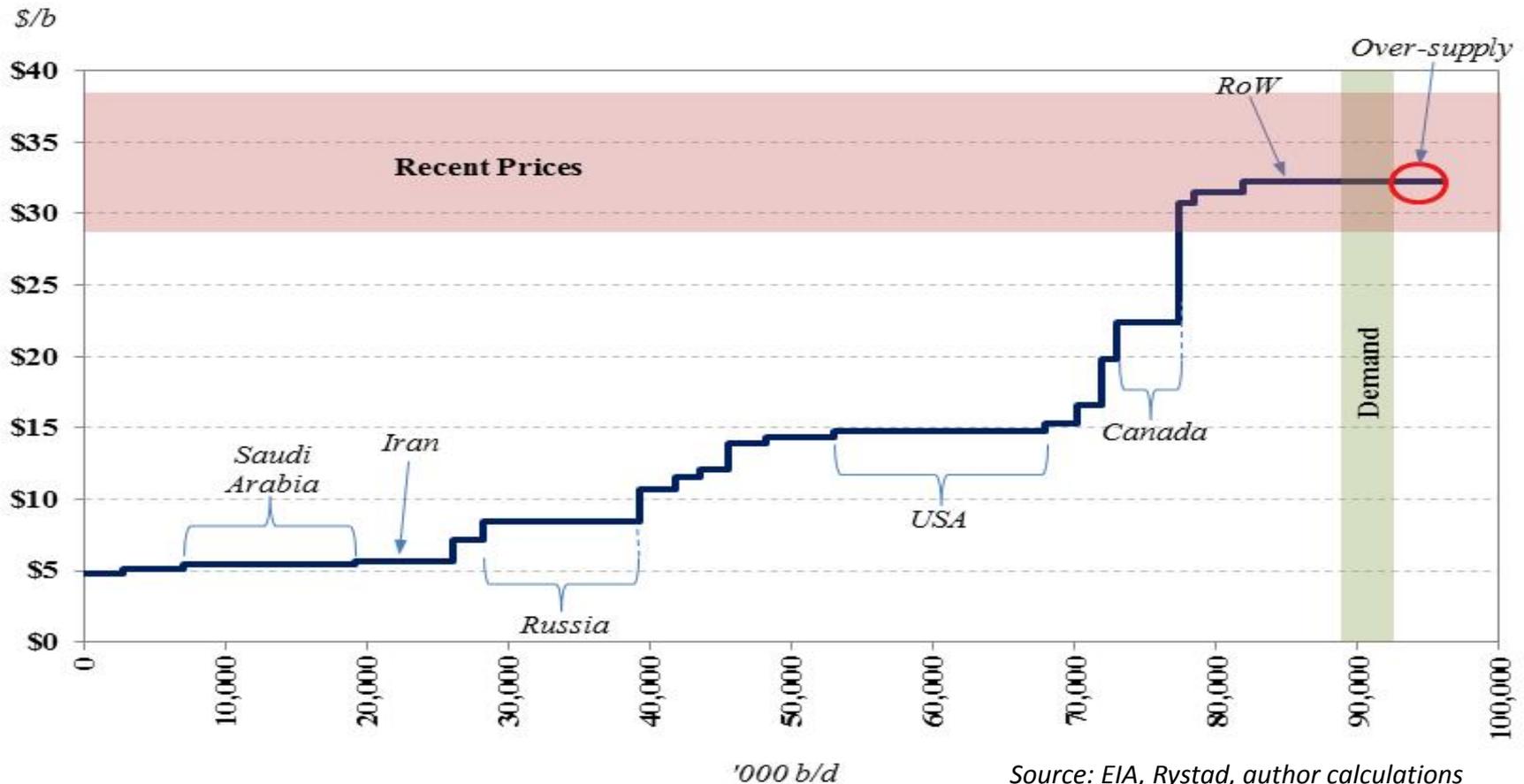
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2005=100



Source: EIA, BEA, BLS, author calculations

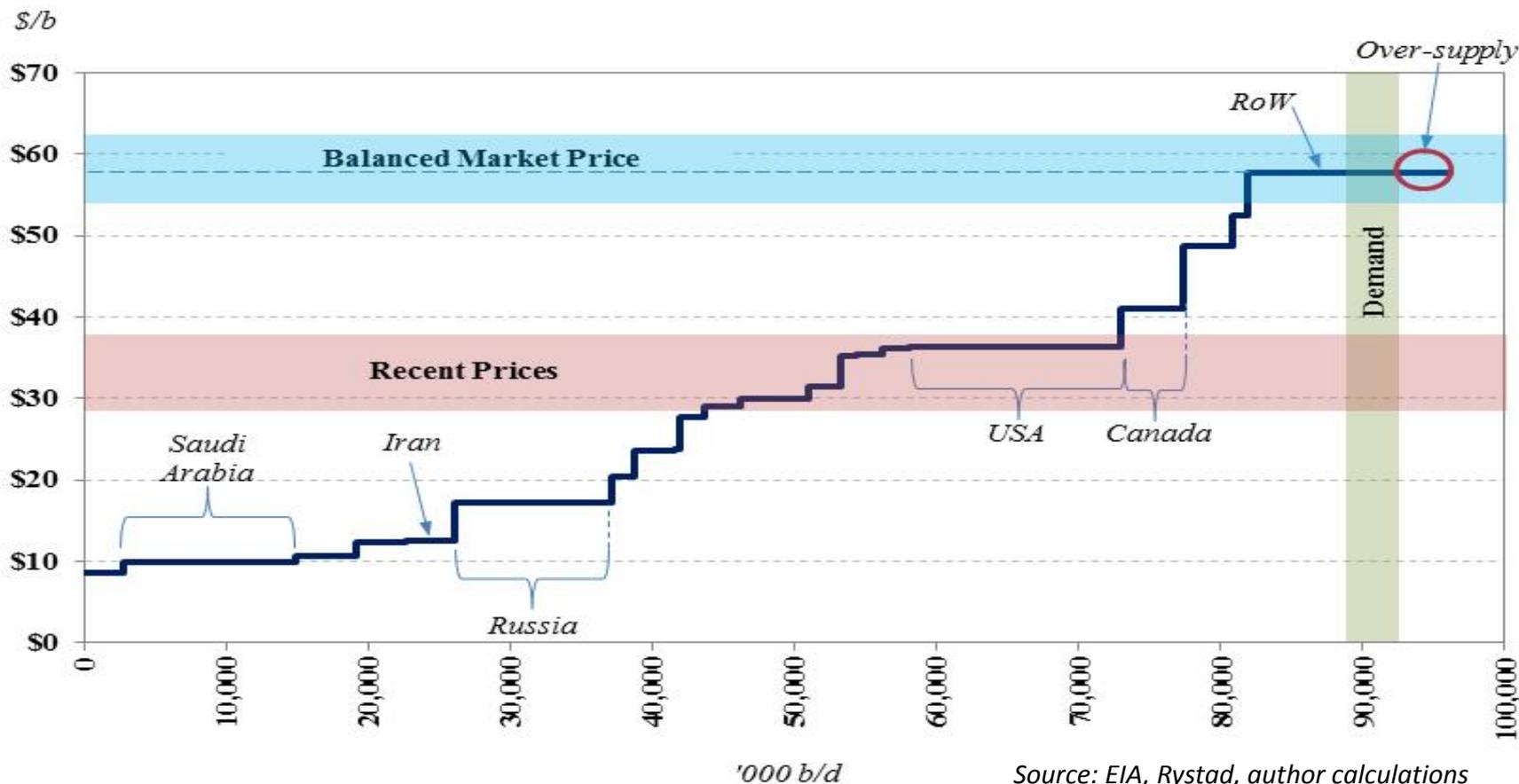
# Crude Oil: Near Term Price and Short Run Cost

- Inventory build results in price collapse. Previously expended capital continues to operate as long as variable costs are covered. But, low price will not incentivize new capex until output decline and demand recovery eliminates the inventory overhang.



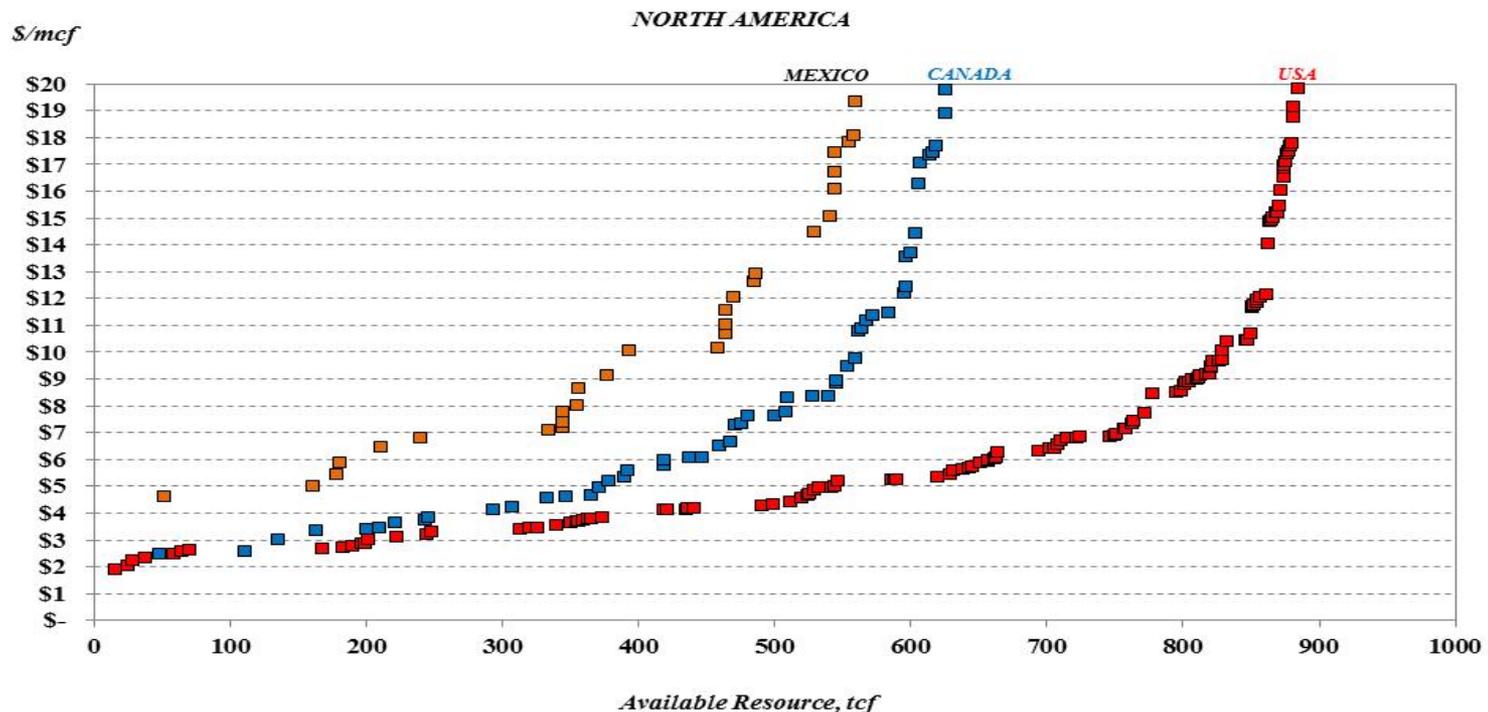
# Crude Oil: Long Term Price and New Investment

- Price must recover to incentivize new capex. But, to what level?
- Cost is dynamic, so understanding the drivers of cost is critical. The graph below is a snapshot... in reality costs change with various fundamental drivers.



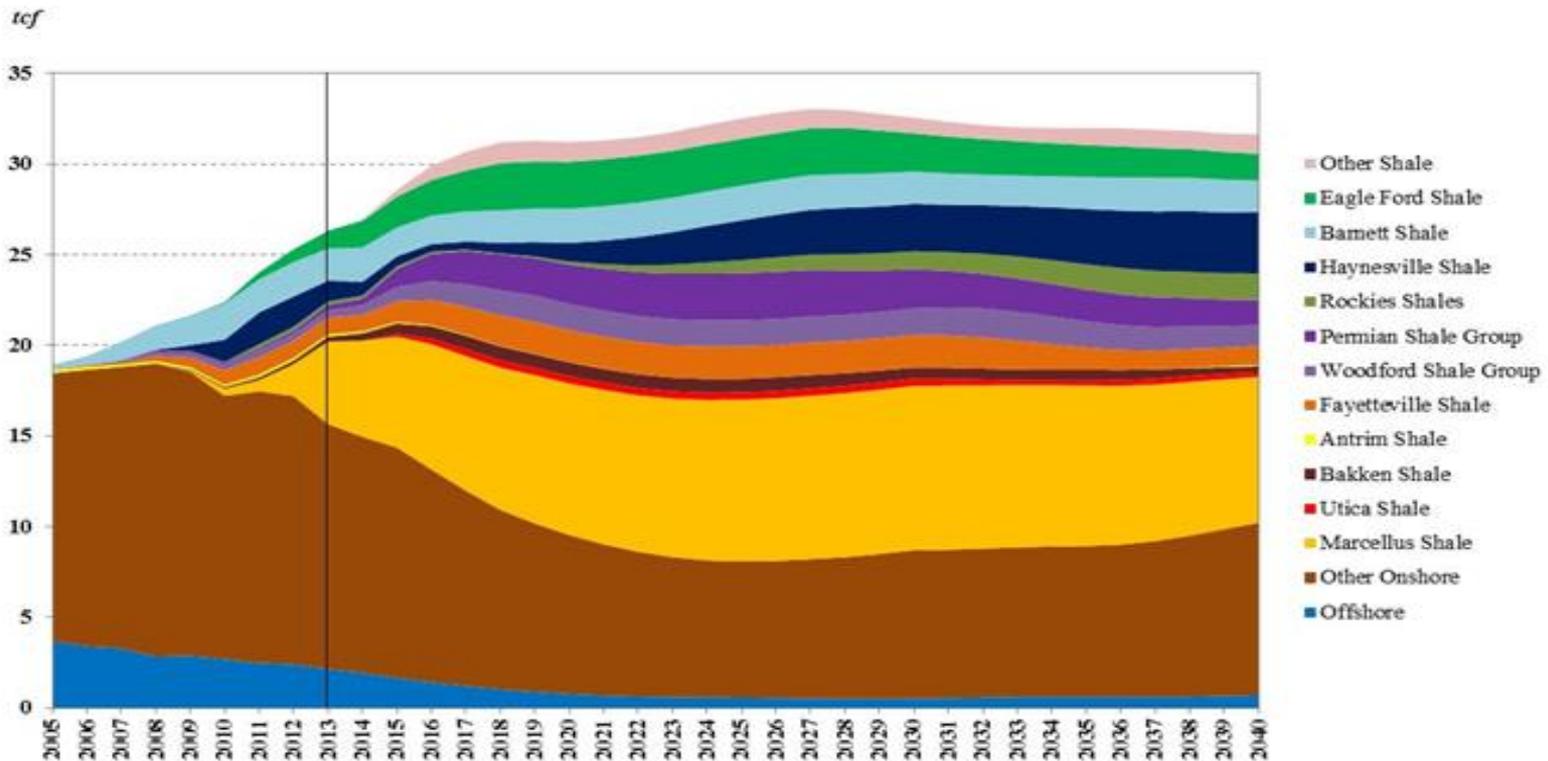
# Natural Gas: There is a *Long Term North American Shale Gas Opportunity*

- There is about 1,400 tcf of shale gas (pictured below) seated in about 2,500 tcf of total gas resource, all available at wellhead prices below \$6.
- Importantly, sustained development will require lots of activity.



## Natural Gas: US Production Outlook\*

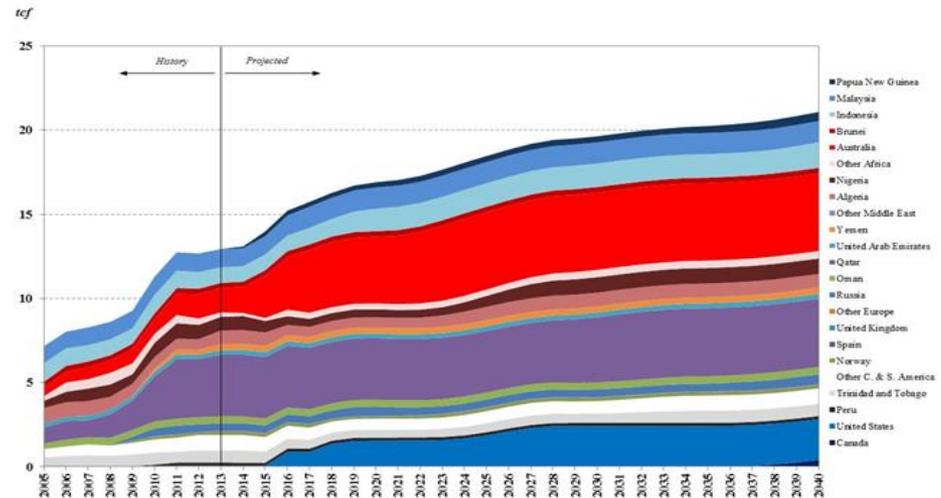
- A shale dominated picture emerges, highlighting a need for infrastructure development as well as opportunities for deeper North American integration.



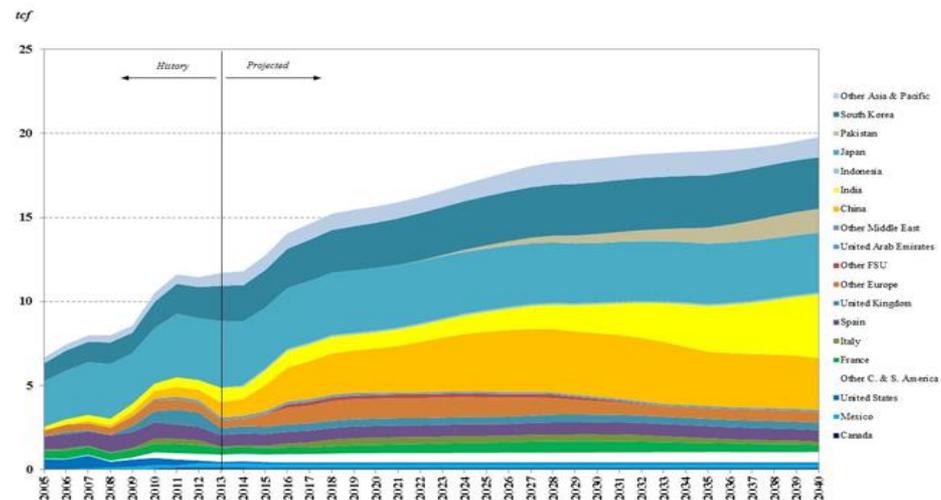
\* The results are from the Rice World Gas Trade Model (RWGTM). The RWGTM was developed by Kenneth B Medlock III and Peter Hartley at Rice University using the MarketBuilder software platform provided through a research license with Deloitte MarketPoint, Inc. The architecture of the RWGTM, the data inputs, and modeled political dimensions are distinct to Rice and its researchers. Data depicted are from the recent CES/Oxford study completed for the US DOE, "The Macroeconomic Impacts of Increased US LNG Exports."

## Natural Gas: LNG Trade\*

- LNG exports increase in multiple locations, with the US emerging as the 3<sup>rd</sup> largest LNG exporter in the world behind Australia and Qatar, and...



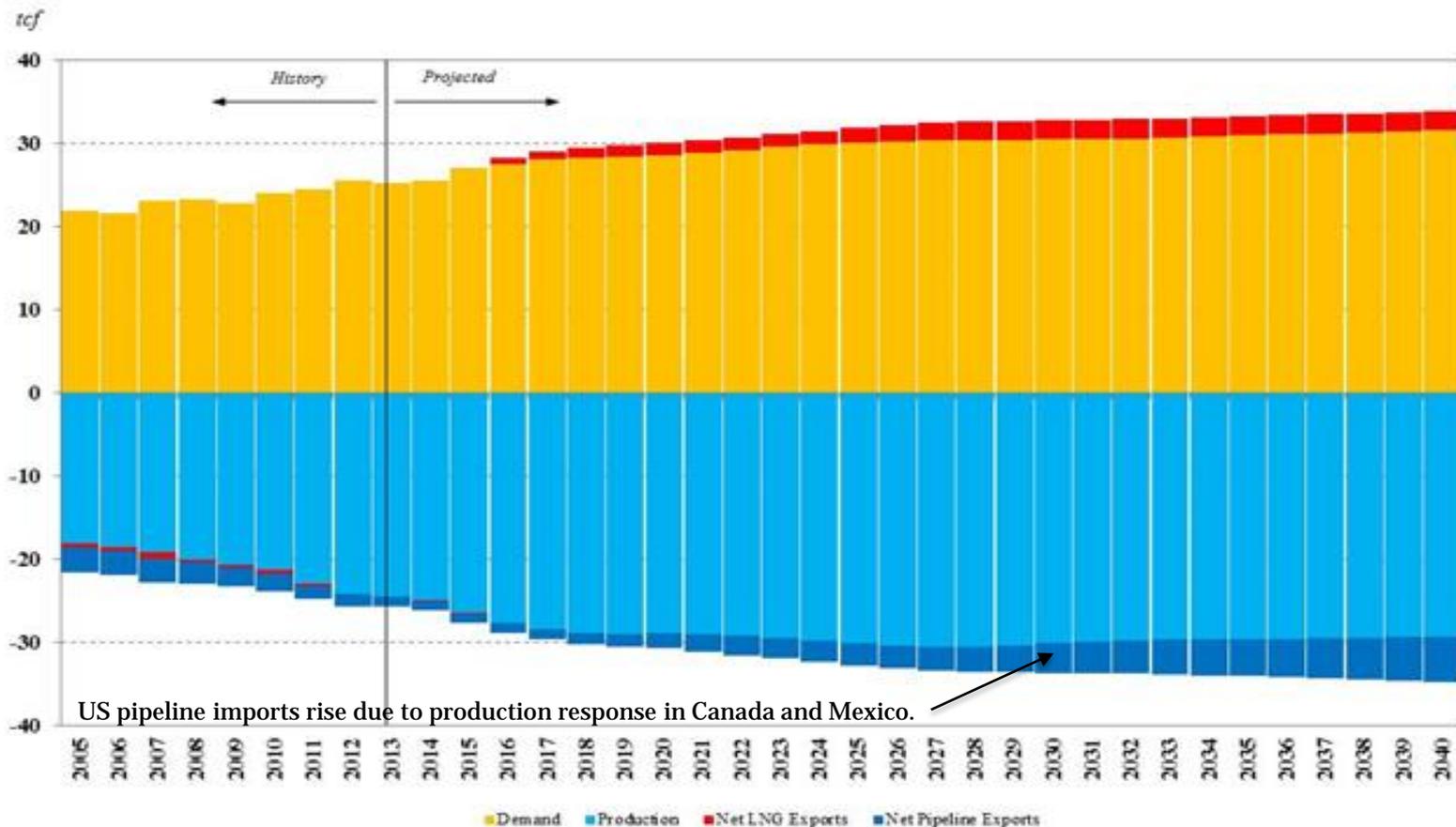
- ... new consumers enter the market as global demands increase.



\* Data depicted are from the recent CES/Oxford study completed for the US DOE, "The Macroeconomic Impacts of Increased US LNG Exports."

## Natural Gas: US Market Balance\*

- US production responds positively to new demands for **North American** gas, but so does production in Canada and Mexico... the market is deeply integrated!



\* Data are from the CES/Oxford study completed for the US DOE, "The Macroeconomic Impacts of Increased US LNG Exports."

## **Geology *AND* Market Structure Yields the Recipe for Success... and Competitive Advantage**

- Geology is a *necessary* condition for vibrant and successful upstream activity...
- ... but it is *NOT sufficient!*
- A host of above ground factors must be aligned for commercial success to be realized.
- Once in play, commercial success builds on itself because it encourages entrepreneurial activity, and creates an environment that is attractive to capital inflows.
- Thus, a variety of regulatory and market institutions must be in place if North America is to reach its full potential in terms of energy security and economic well-being.
- What about the rest of the world? It is not so simple...

## ***The Sufficient Conditions...***

- Upstream firms negotiate directly with landowners for access to mineral rights.
- A market in which liquid pricing locations, or hubs, exist and are easily accessed due to liberalized transportation services being unbundled from pipeline ownership.
- A well-developed pipeline network that can accommodate new production volumes.
- A market in which interstate pipeline development is relatively seamless due to a well-established governing body – the Federal Energy Regulatory Commission (FERC) – and a comparatively straightforward regulatory approval process.
- A market in which demand pull is sufficient, and can materialize with minimal regulatory impediment thus allowing new supplies to compete for market share.
- A market where a well-developed service sector exists that can facilitate fast-paced drilling activity and provide rapid response to demands in the field.
- A competitive service sector that strives to lower costs and advance technologies in order to gain a commercial advantage.
- A rig fleet that is capable of responding to upstream demands without constraint.
- A deep set of upstream actors – the independent producer – that can behave as the “entrepreneur” thereby facilitating a flow of capital into the field toward smaller scale, riskier ventures than those typically engaged by vertically integrated majors.

## Where are Global Energy Markets Going?

- Currently, inventories are swollen as supply has outpaced demand, and the role of OPEC in balancing the market remains uncertain.
  - Oil demand growth potential is high in developing Asia, which accounts for almost 3 billion people at average per capita incomes below \$7,000. Economic growth through 2030 will see over 400 million people enter the middle class.
- It is important to not be myopic. Price depends on multiple factors, and, even in the presence of persistent constraints, fundamentals ultimately win.
  - Cost environment, demand (economic growth, environmental policy, efficiency, etc.), technology, new production frontiers, and geopolitics.
- There are many “frontier” resources are in the Western Hemisphere, which will have significant bearing on the global market for next 20 years. Shale is at the center of the new “unconventional” frontier.
- The development of shale resources will deepen markets and introduce new and expanding lines of international oil and gas trade. This will challenge existing market paradigms by adding significant physical, and ultimately financial, liquidity.

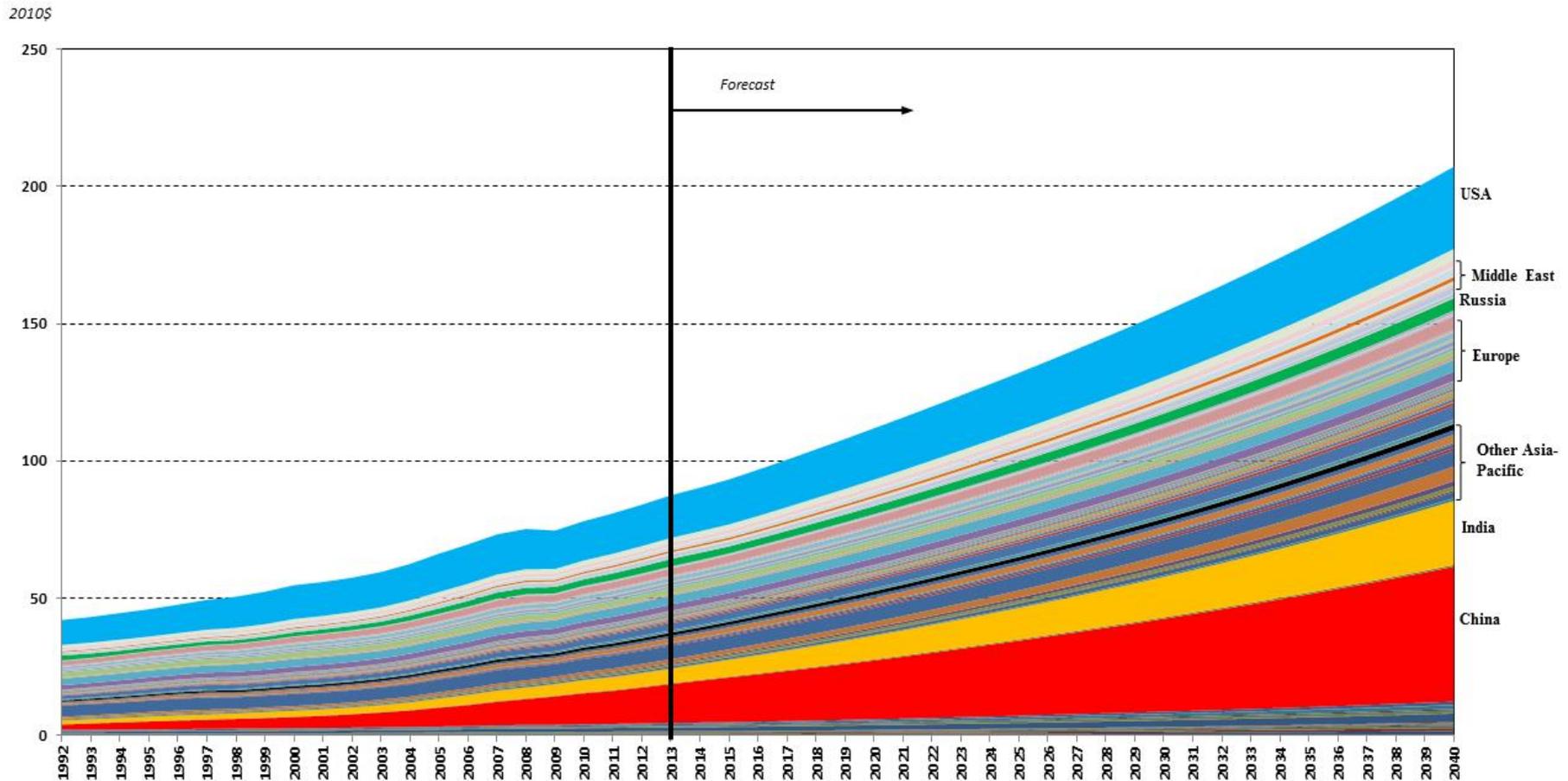
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## **Bonus Material**

# **Economic Growth and Energy Demand: A Fundamentals Driven View**

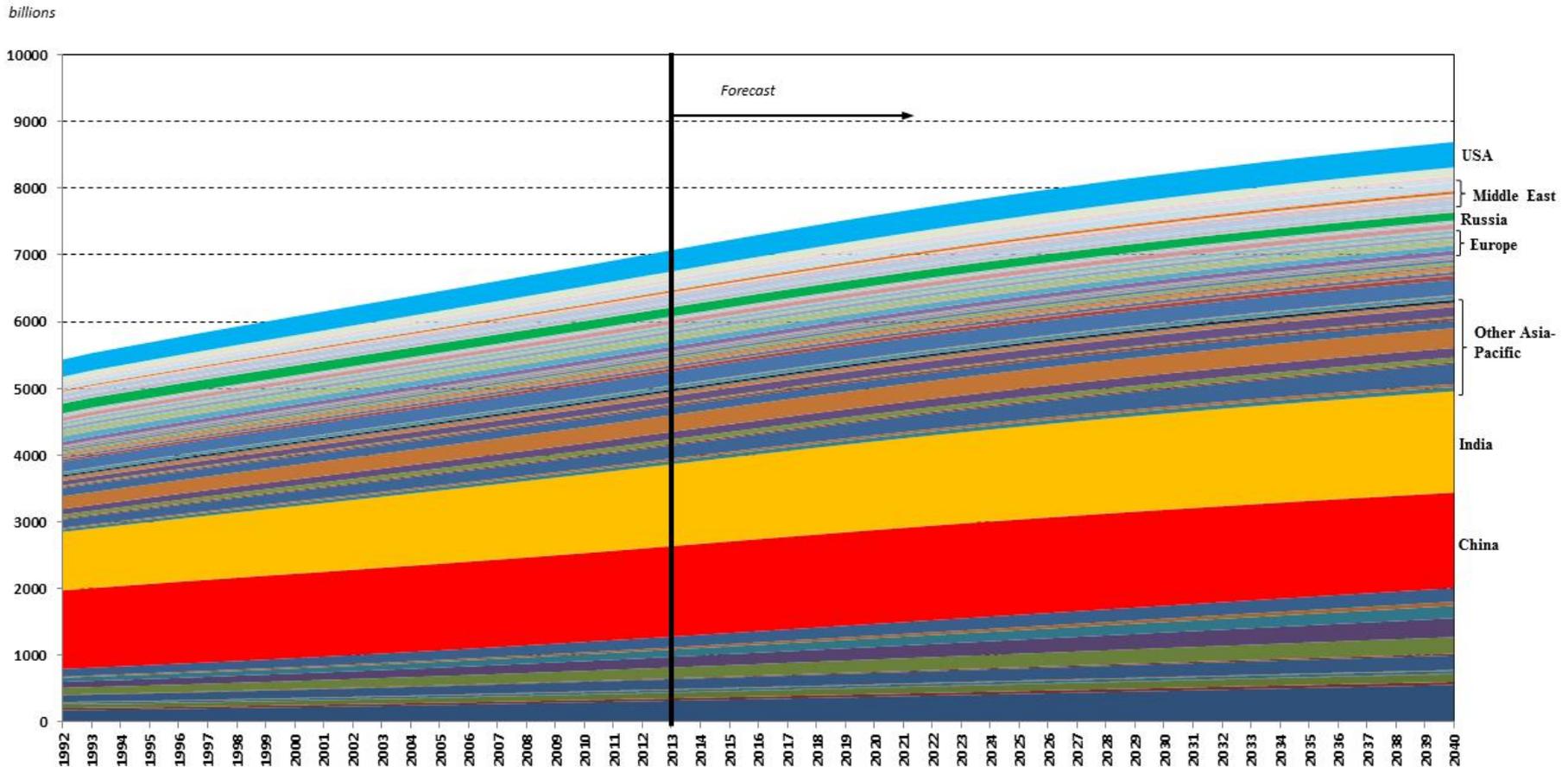
# Global GDP by Country

- Baker Institute CES forecast, 1992-2040



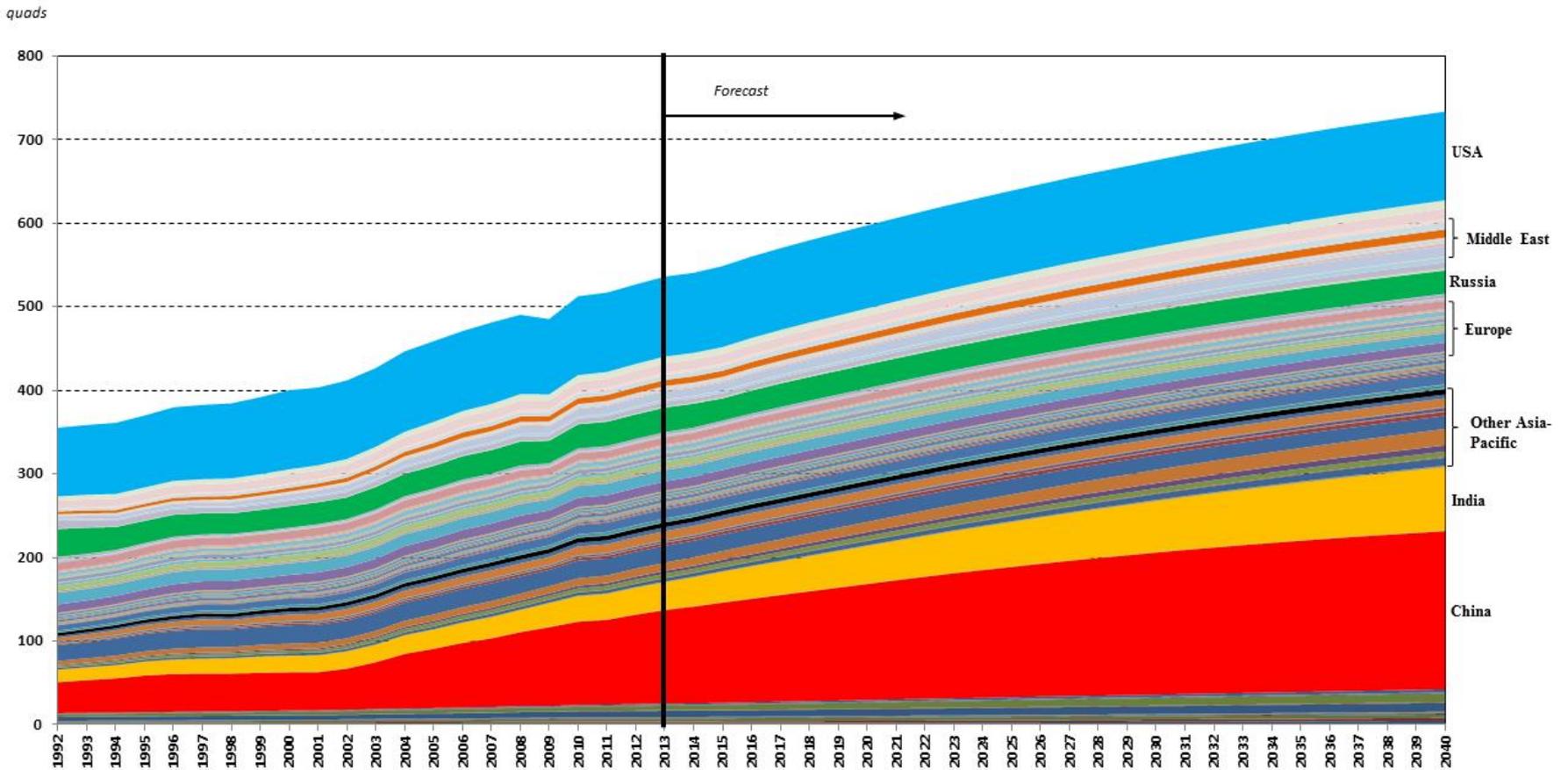
# Global Population by Country

- Baker Institute CES forecast, 1992-2040



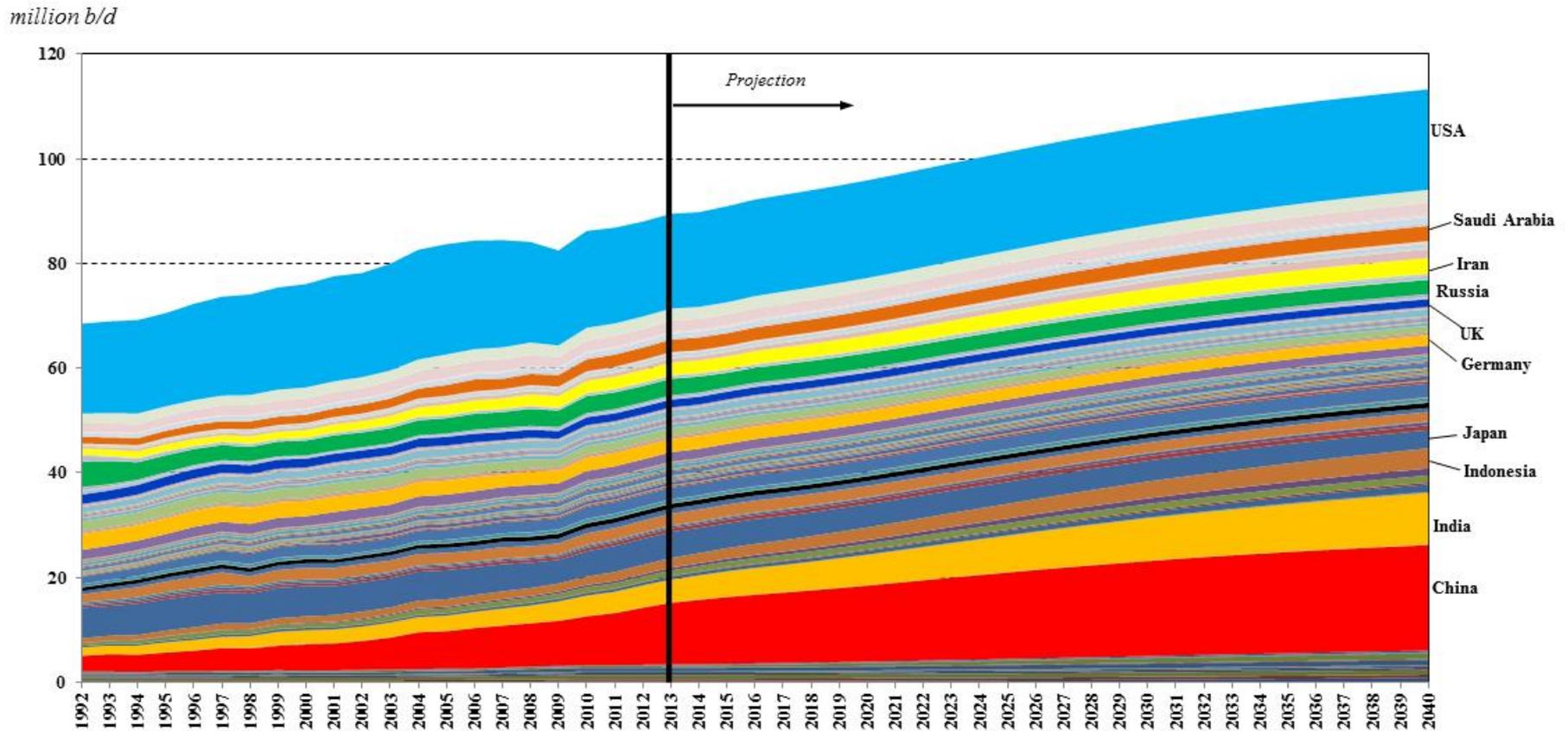
# Total Primary Energy Requirement by Country

- Baker Institute CES forecast, 1992-2040



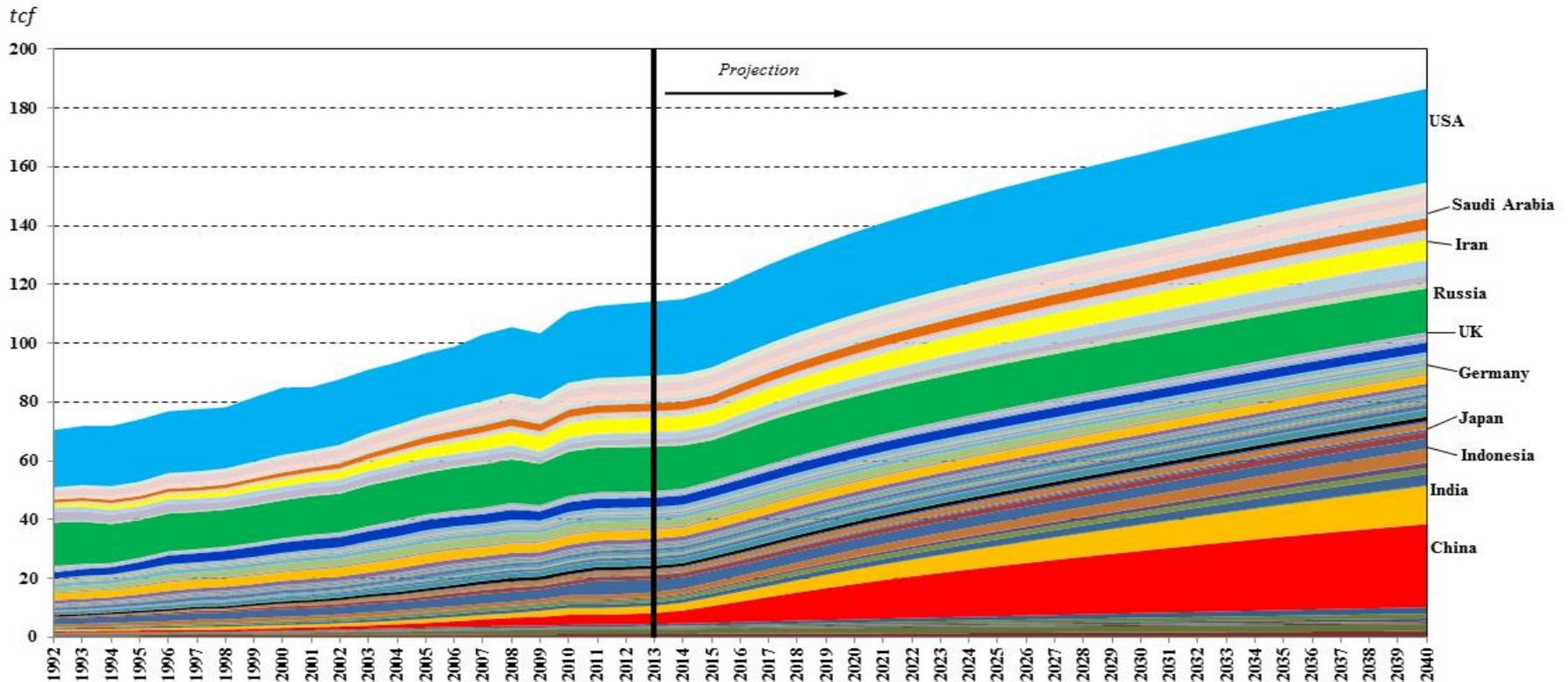
## Oil Demand by Country

- Baker Institute CES forecast of petroleum demand by country, 1992-2040
  - Demand will grow, driven largely by China, India and the ASEAN region.



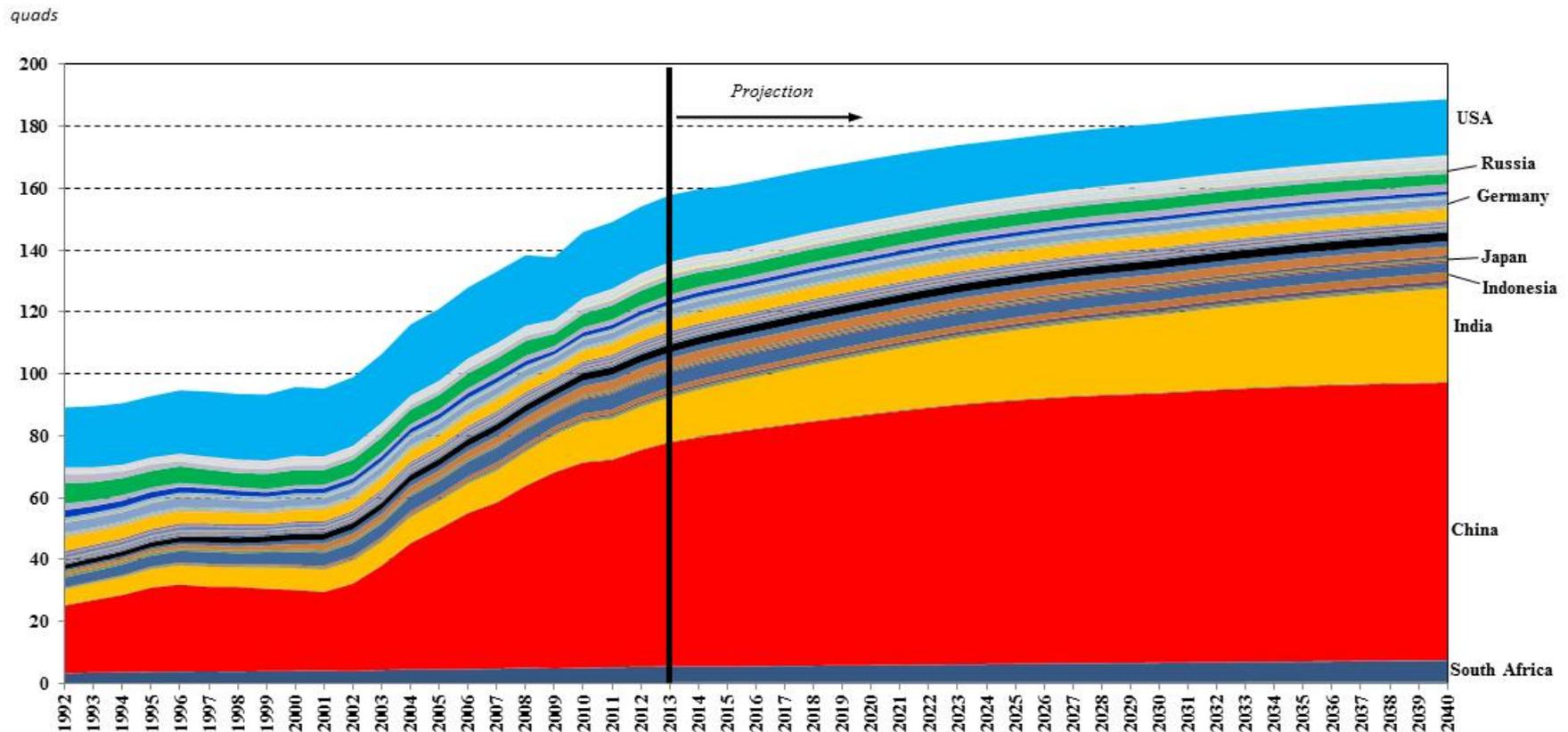
## Natural Gas Demand by Country

- Baker Institute CES forecast of natural gas demand by country, 1992-2040
  - Similar patterns as with oil... demand driven by Asia
  - Unlike oil, natural gas demand continues to grow beyond 2050.



## Coal Demand by Country

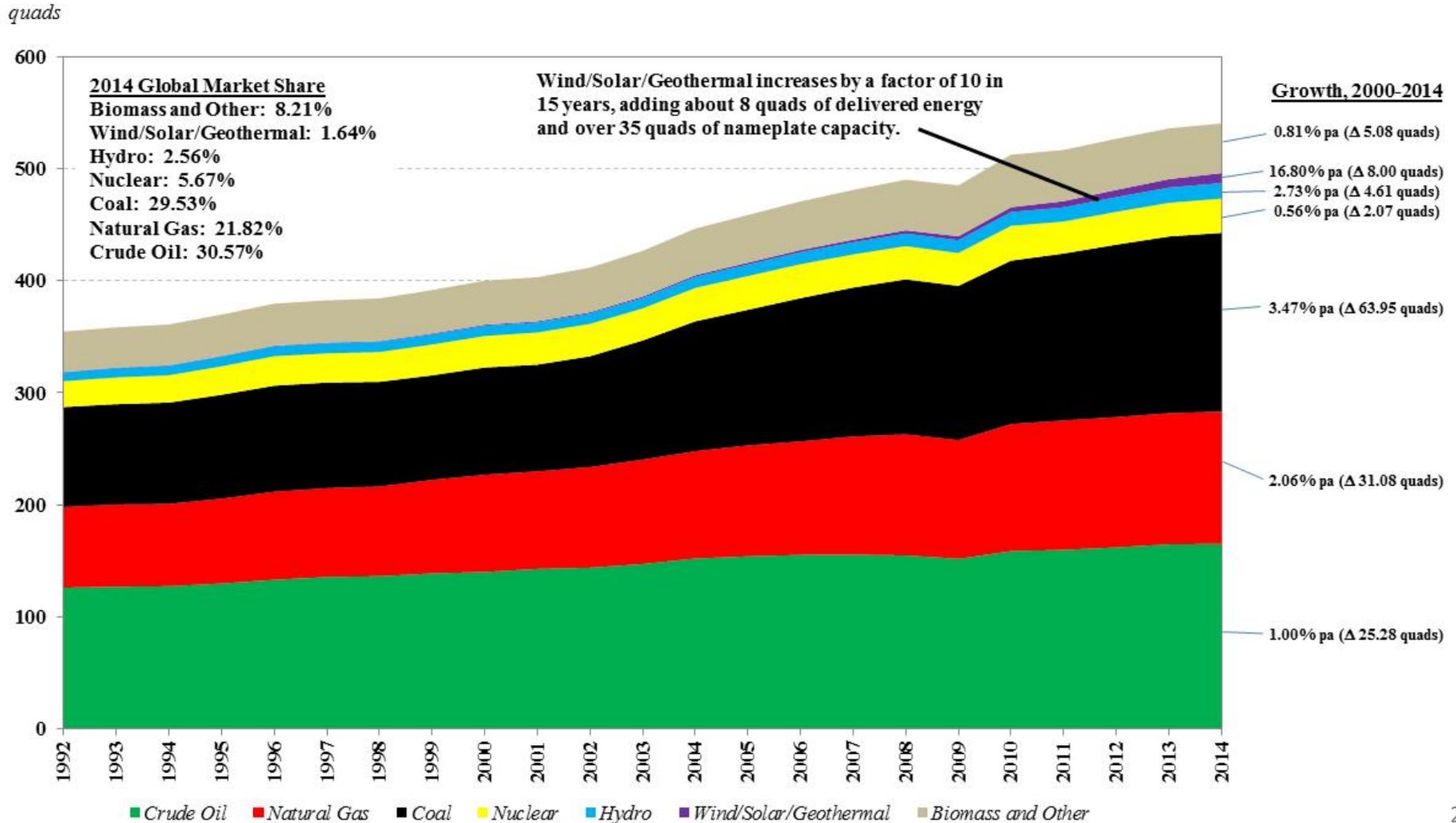
- Baker Institute CES forecast of coal demand by country, 1992-2040
  - Recent developments in Asia have shaped coal's future for the next few decades.



# **Renewables, Demand, and COP21 Aspirations...**

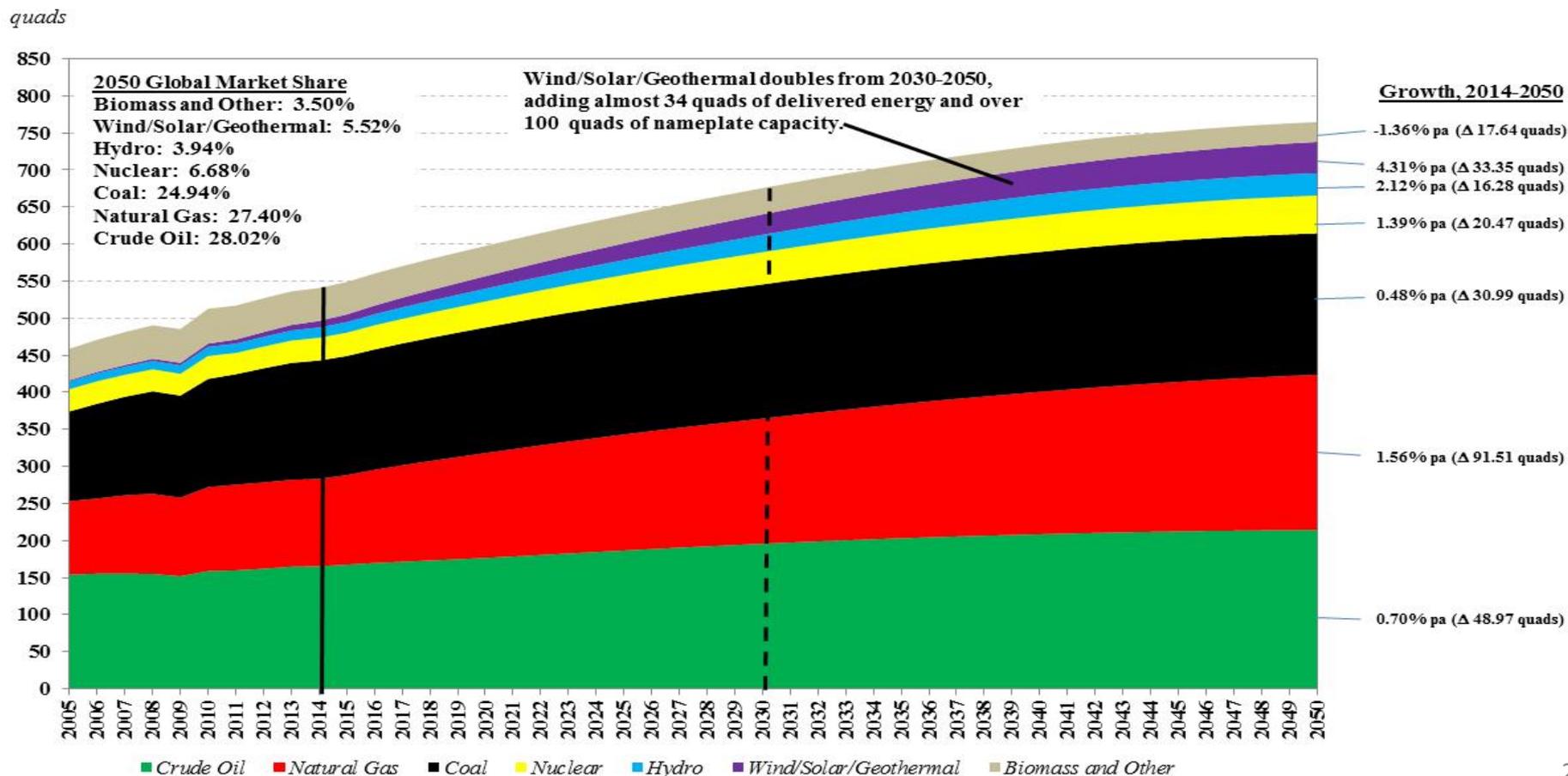
**Charting a new course will require unprecedented levels of investment. Countries must figure out the most impactful measure of capital investment given the desired goals.**

# TPER and Renewable Energy



## A “Business as Usual” View to 2050

- Renewables continue to be the fastest growing energy source with a scale of investment globally that increases. But, the base is small, meaning the growth, while appreciable, takes a while to have a large impact globally.



# A Different View to 2050

- The scale of investment to drive this outcome is unprecedented, and much of it must occur in the developing world.
- Are there other pathways? Technological innovation is critical!

