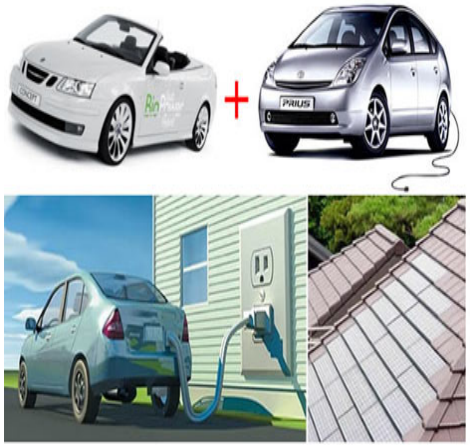
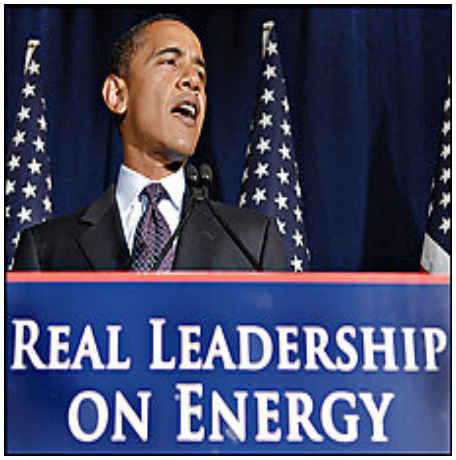


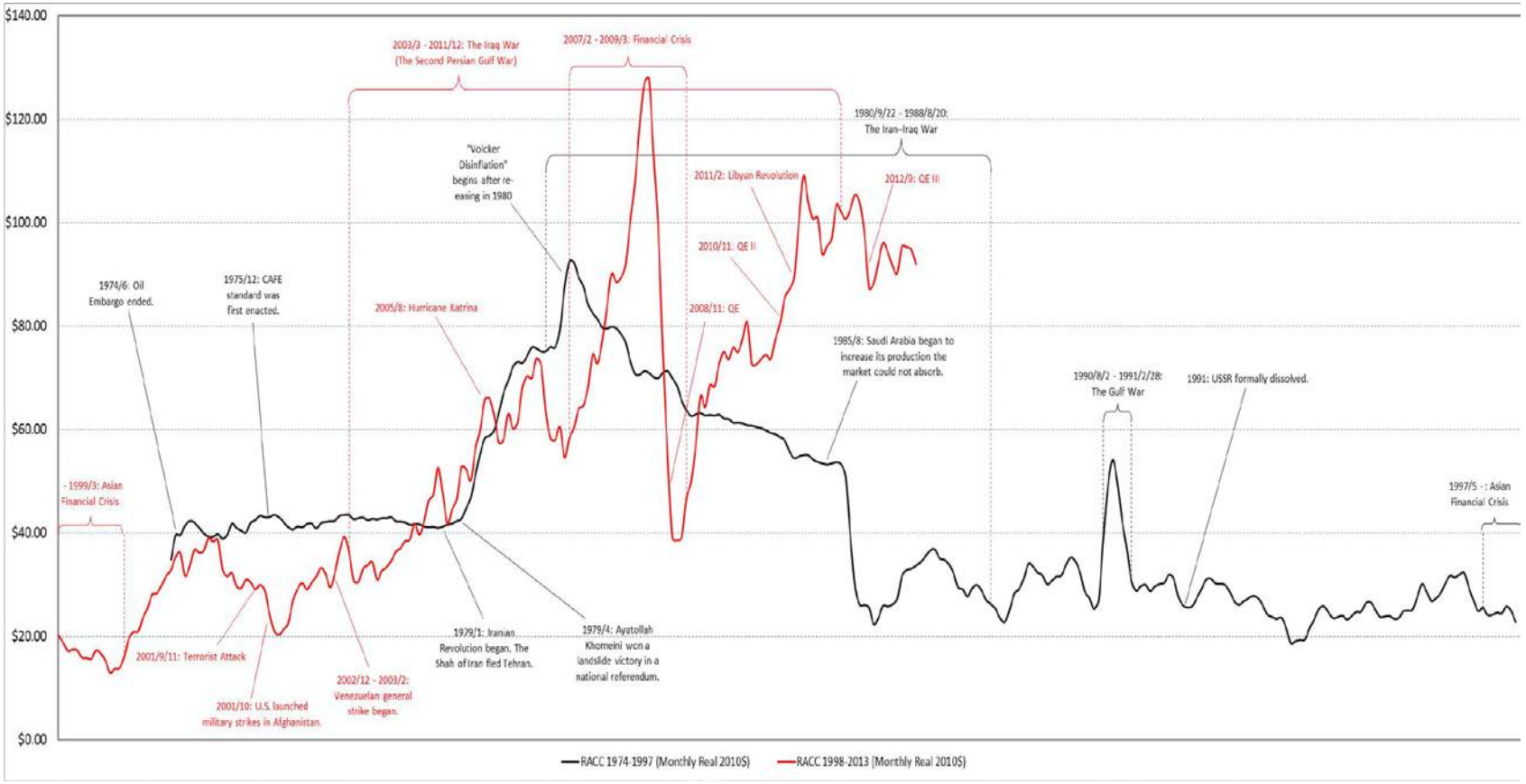


Amy Myers Jaffe
Executive Director
Energy and Sustainability
University of California - DAVIS

The Oil Price Conundrum: Cyclical, Geopolitical, or Technologically Structural?

ITS UCDAVIS
INSTITUTE OF TRANSPORTATION STUDIES

Oil has been a cyclical commodity, but current price decline reflects more than the usual cycle shift.



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

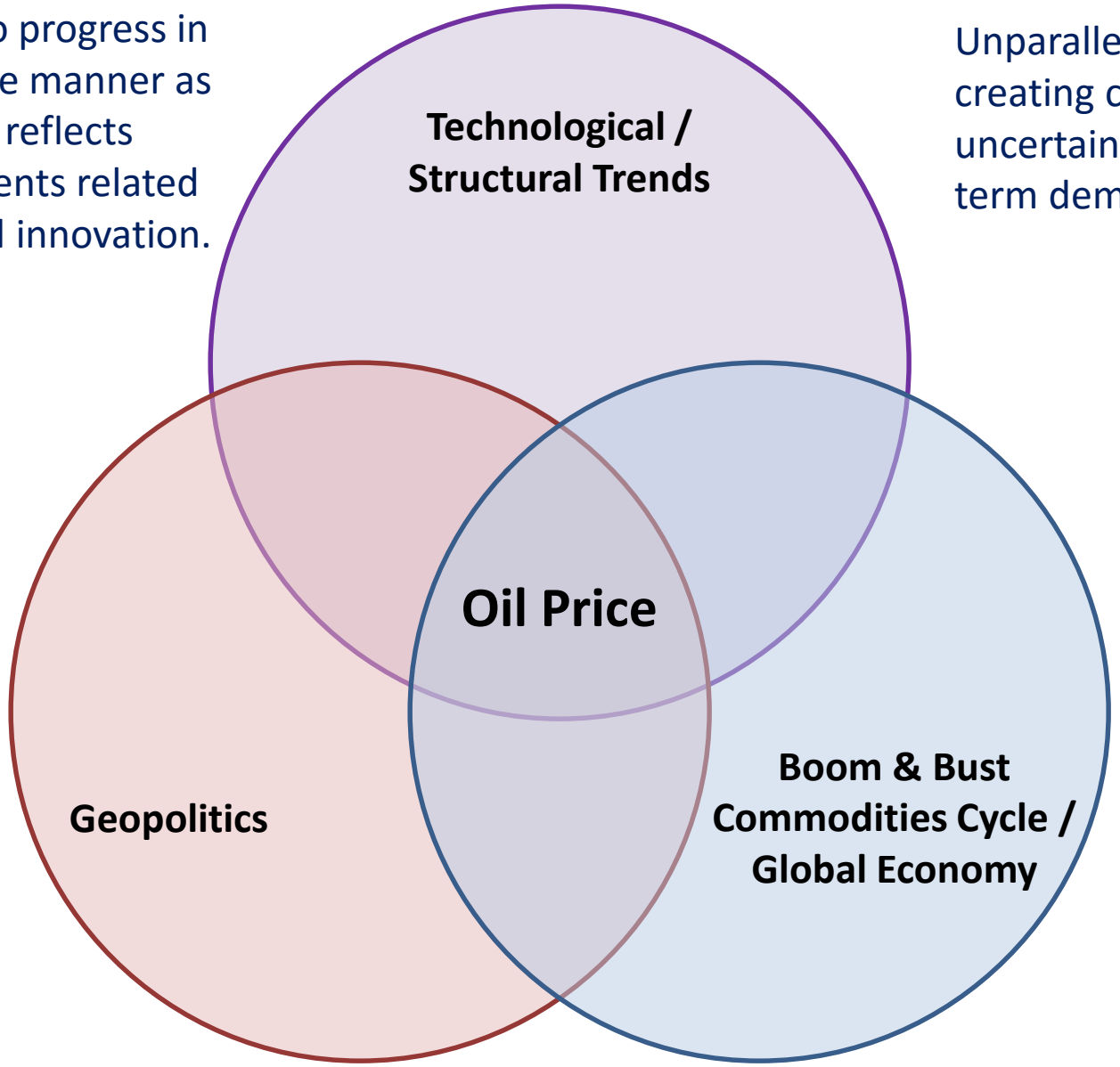
- Demand: OECD, China energy and climate policies (and the US and Chinese economic stimulus clean tech targets) lowered oil demand and enabled innovation and advanced clean energy solutions
- High oil prices stimulated drilling innovations, that has led to a supply bubble.

Technology Revolution is ushering in exponential gains in productivity, via transportational logistics, automation, big data, material science and biotech, artificial intelligence, 3-D printing.

This revolution will further decouple energy use and economic growth.

Cycle unlikely to progress in exactly the same manner as past cycles as it reflects structural elements related to technological innovation.

Unparalleled changes creating confusion and uncertainty about long term demand trends.



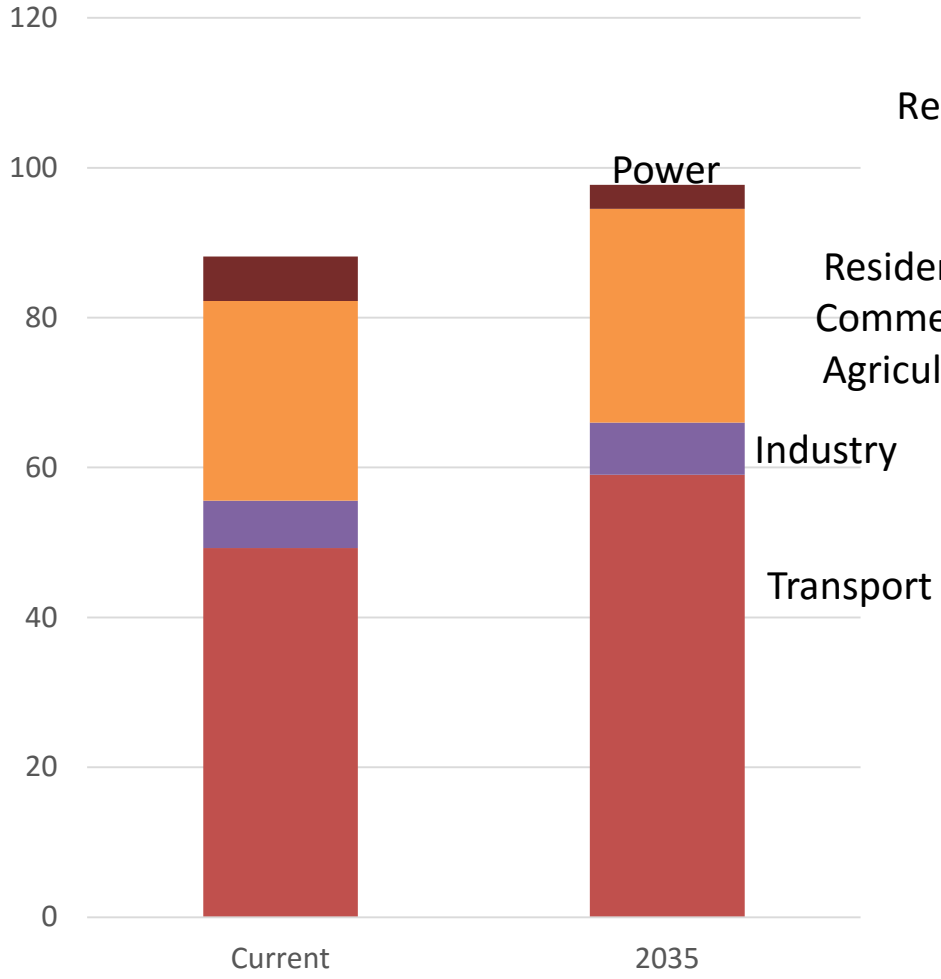
Old Vs New Forces Impacting Demand

Technology
Legislative and tax policy
Energy efficiency (energy per GDP declining)
Millennials reject vehicle ownership
Growth of alternative energy

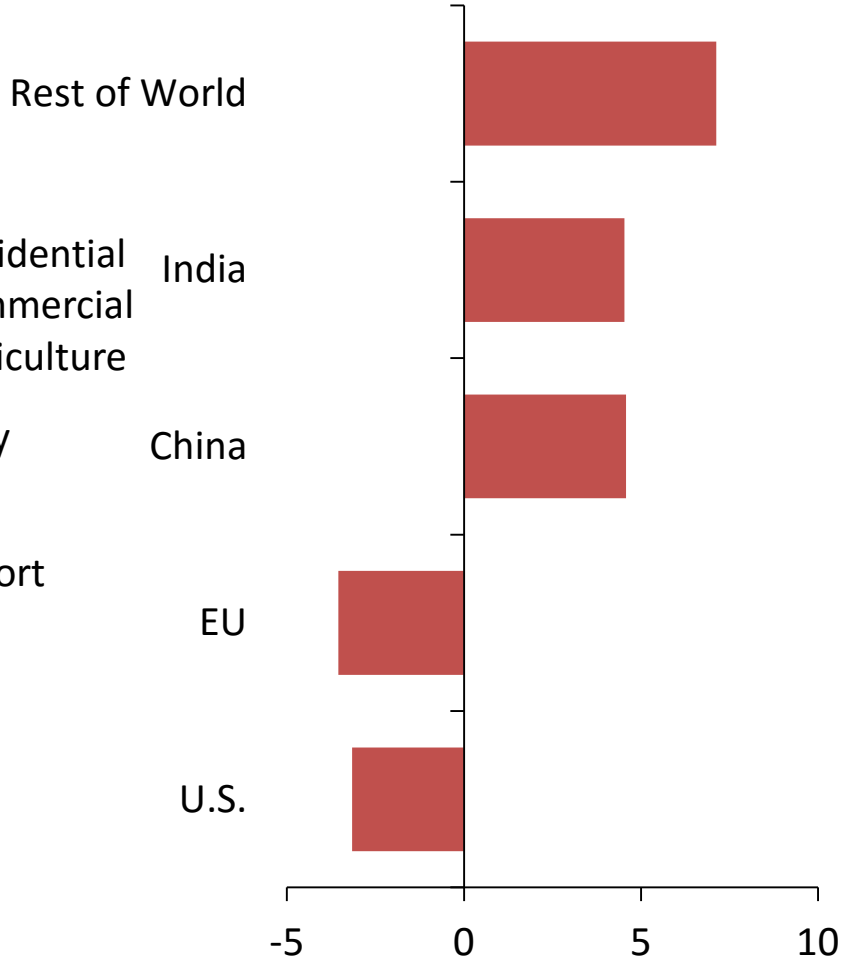
Population growth
Emerging economy expansion
Expanding global middle class

Mobility in Emerging Markets Driver of Future Oil Demand

Global Oil Demand by Sector
(Million Barrels of Oil per Day)



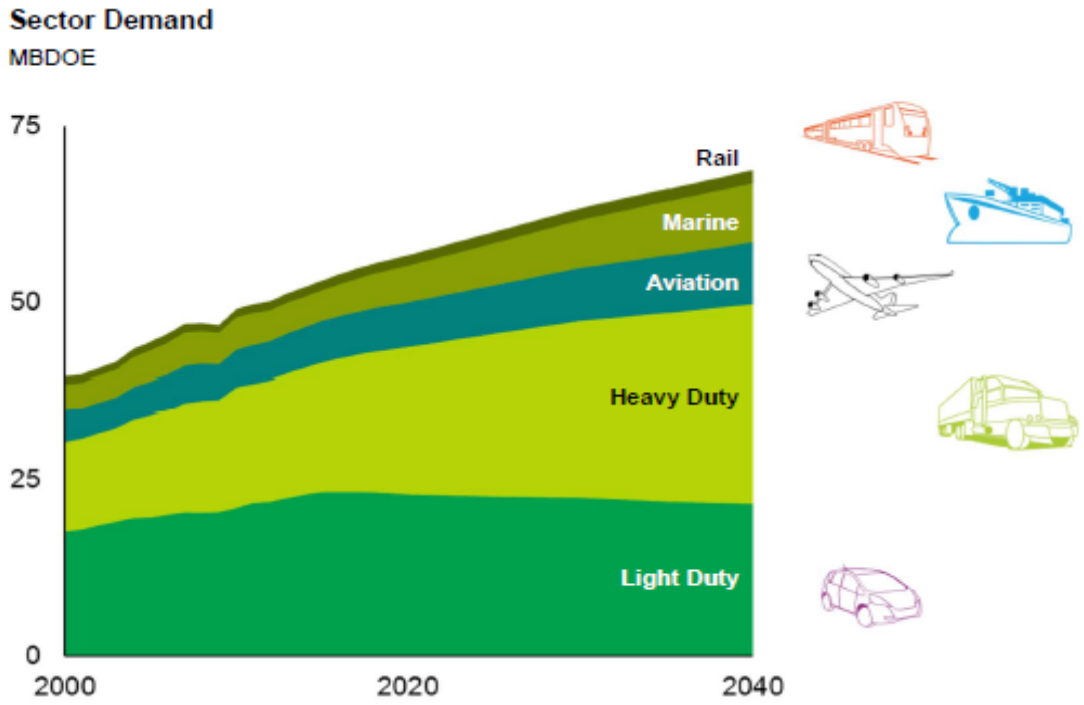
Global Oil Demand Growth by Region
(Million Barrels of Oil Equivalent/Day)



Source: IEA and Independent Analysis

ExxonMobil forecasts freight/diesel to dominate demand growth

Transportation Demand



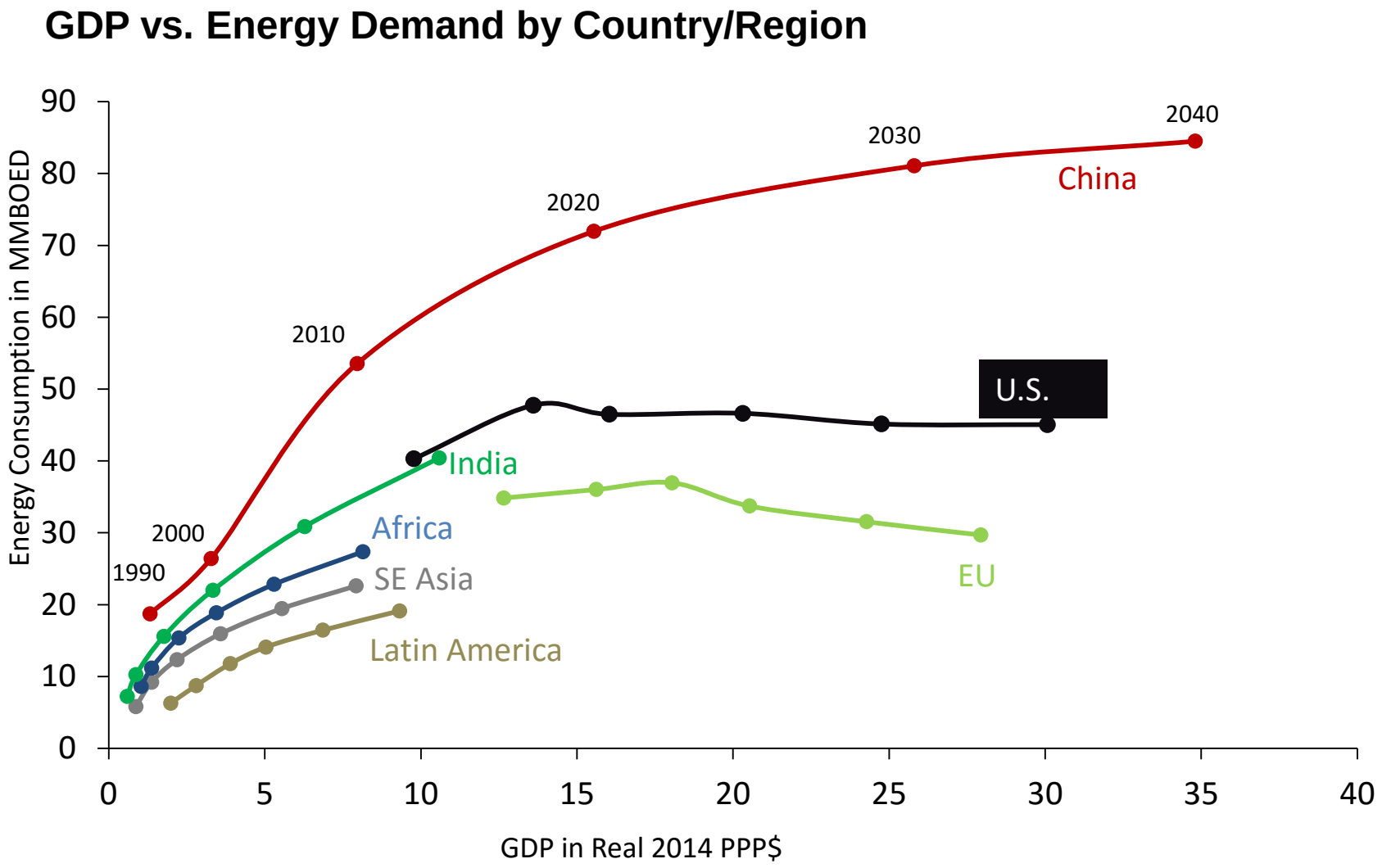
ExxonMobil

ExxonMobil 2015 Outlook for Energy

Key Indicators of the High Growth Worldview

- Population growth > 9 billion by 2040
- 5 billion people reach the Middle Class by 2030, up from 2 billion in 2014, according to Brookings Institution study
- Wealthier populations desire personal automobiles, world car stocks hit 1.7 billion cars, up from 825 million in 2010
- Economic growth driven by rising Asia, Africa, GDP per capita doubles in Brazil, Mexico, South Africa, Nigeria, Turkey, Iran, Thailand, Indonesia, other ASEAN
- Lower oil prices stimulate purchases of larger vehicles and more travel, autonomous vehicles increase VMT
- Strong global GDP growth (> 2% per annum) leads to increased energy demand, especially higher commercial transport, increasing difficulties for countries to meet COP 21 Paris commitments

Economies are Expanding, but Getting more Efficient



Source: IEA, IMF, and CVX Analysis

Technology revolution is already impacting costs across the entire energy chain.

- Shale economics
- Utility scale renewables
- Logistics planning
- Mobility services
- Energy efficiency and the industrial internet
- To come, energy storage

Rapidly falling costs causing some to predict an explosive S curve deployment effect that will strand fossil fuels

Three major linchpins to high oil price psychological "exuberance" have dissipated.

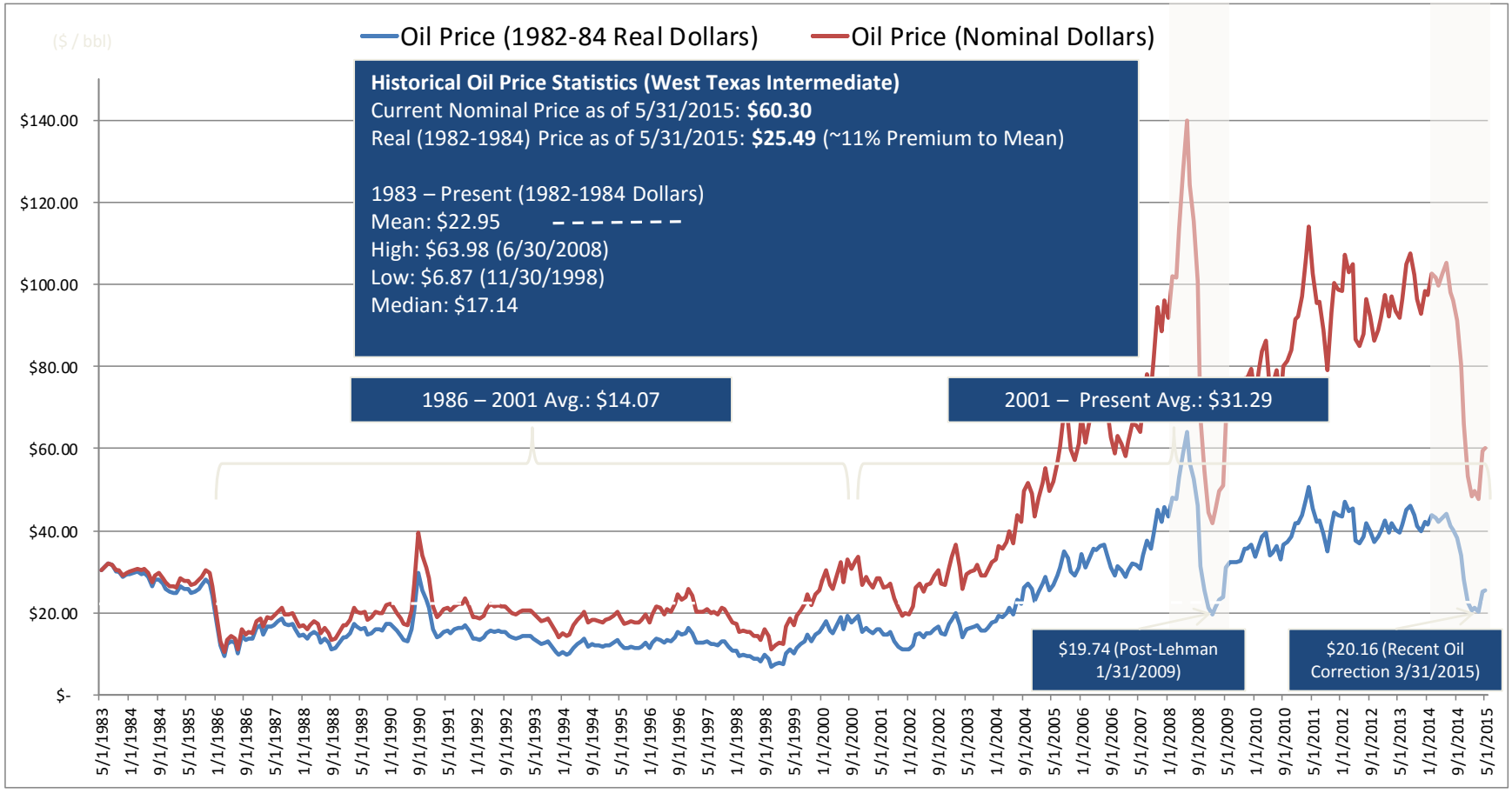
2002–2015 up-end of the price cycle was mainly driven by three characteristics that no longer prevail:

- "Peak Oil" theory
- Steady, rapid Chinese "demand" based on industrial growth
- Rising upstream services costs

In historical terms, 2000s look anamolous

Monthly Nominal and Real Oil Prices from May 1983 - Present

- Will Long term oil prices have reverted back to historical long-term mean?
- As US Shale production continues to come on line, coupled with technological advances in oil and gas recovery, oil price cycle could shorten
- 1986-2001 average price iimplies a potential low of ~$33/bbl in nominal terms

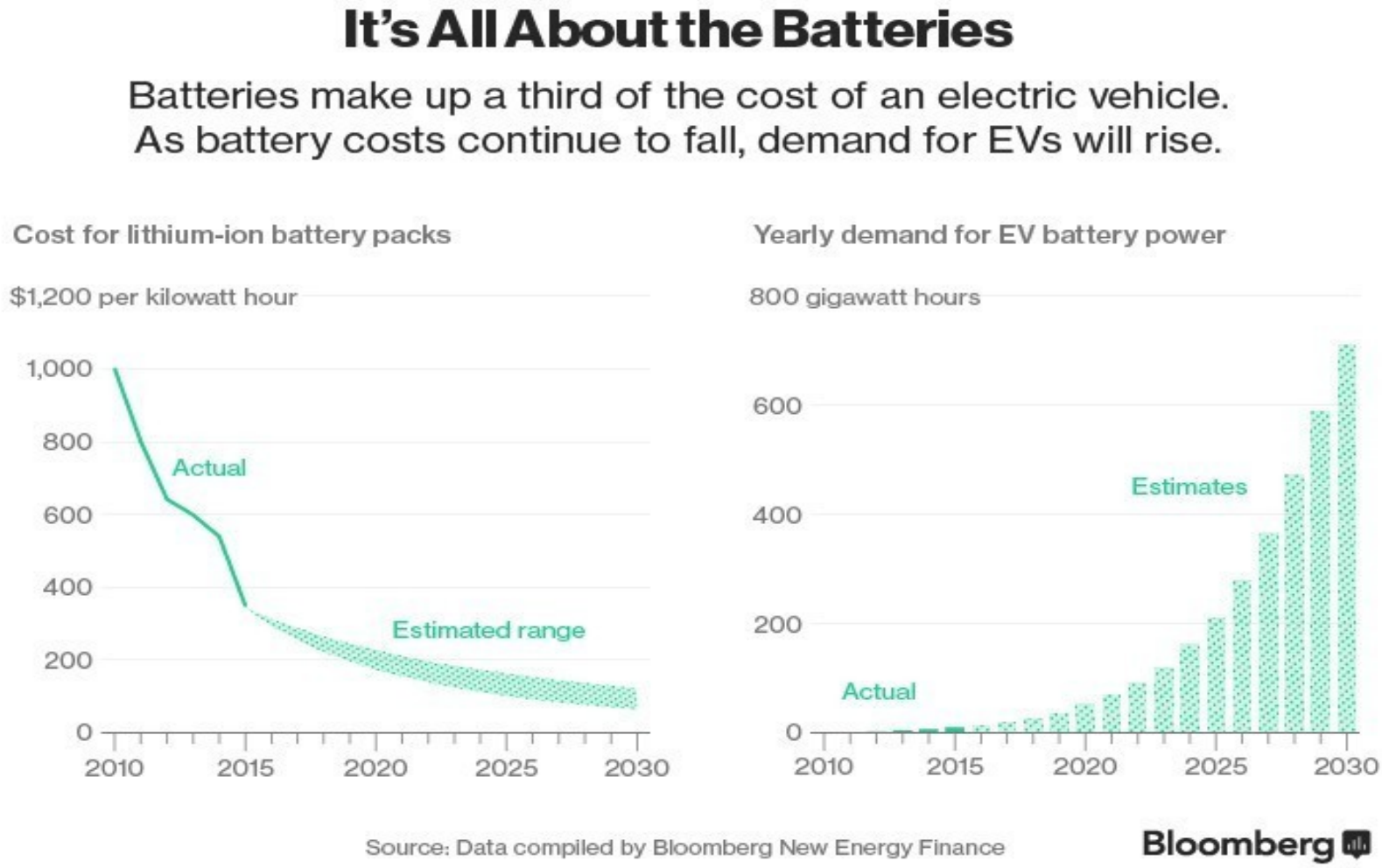


Source: Bloomberg, West Texas Intermediate (WTI) Cushing Crude Oil Spot Price: USCRWTIC Index, CPURNSA Index as of May 31, 2015

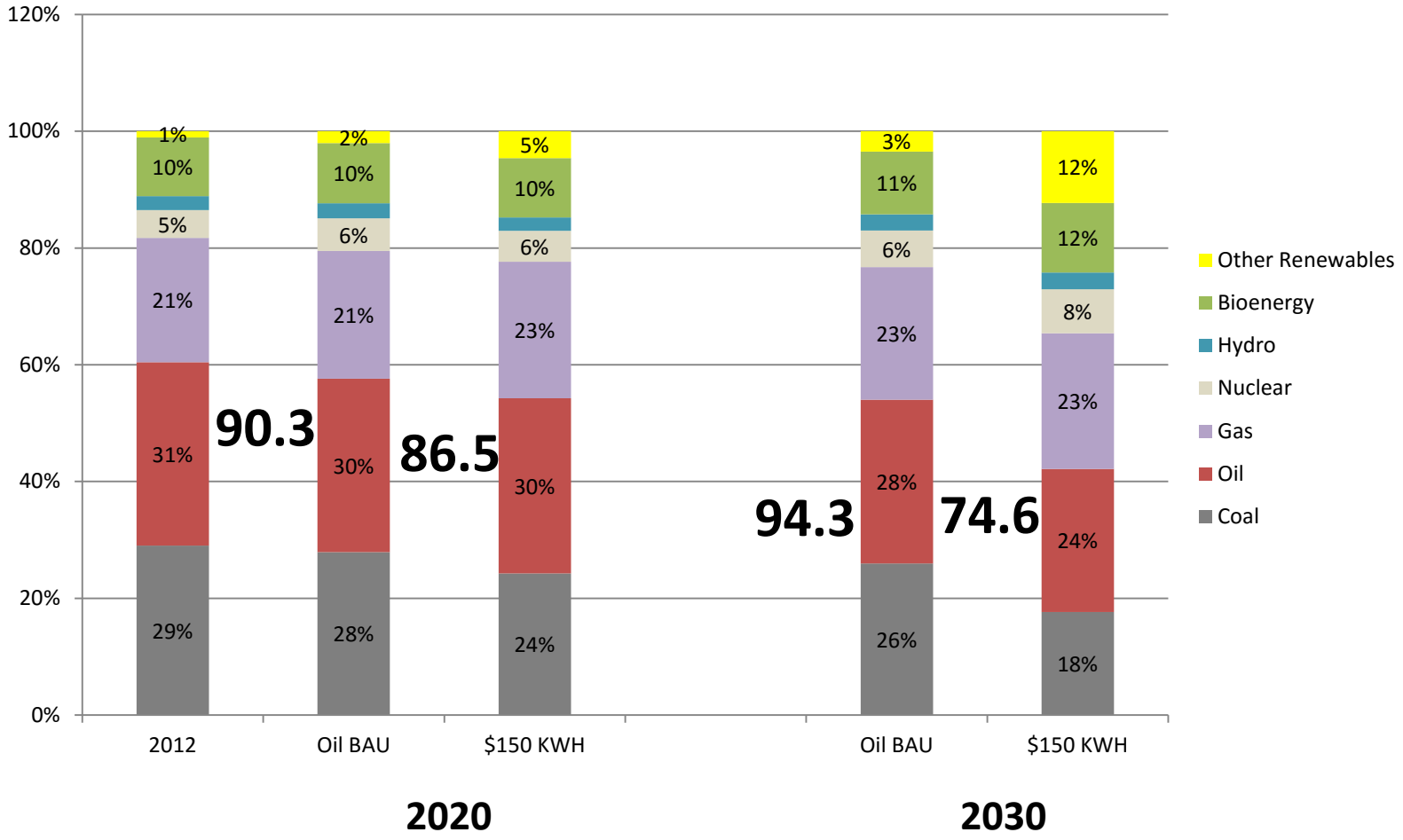
Oil Industry: Conventional Wisdom Increasingly Challenged

- Endless trending growth in oil demand is now increasingly questioned
  - Paris Climate Agreement
  - Slowing China and world growth and urbanization trend
  - Other technology advances on the horizon (eg. improved fuel economy standards, improved logistics, battery breakthroughs, small scale technologies)

Are Batteries The Next Great Disruptor?



Battery Breakthrough Scenario - Oil Demand Impact Takes Many Years to Unfold

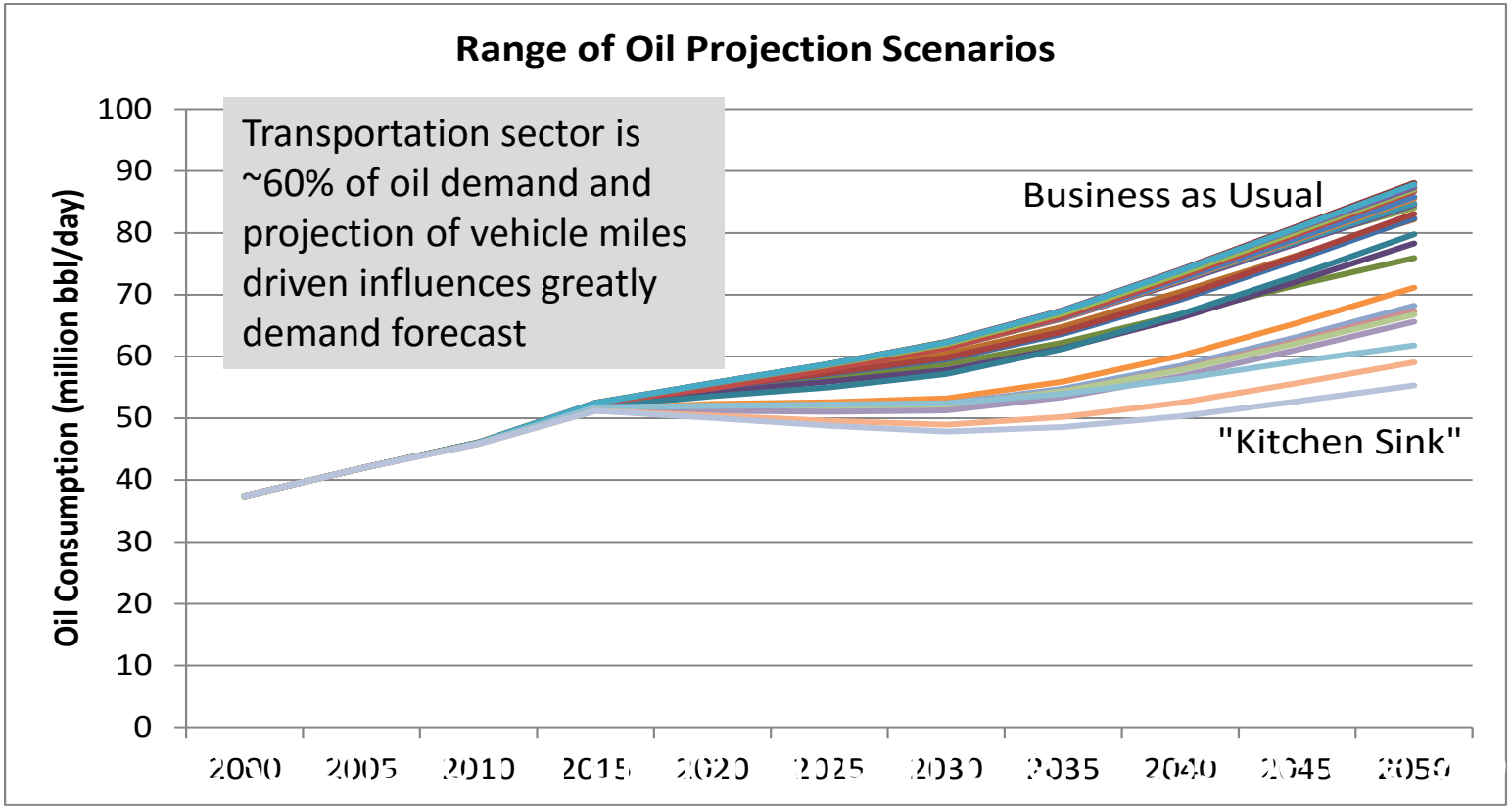


Oil in million b/d

Comparing Battery Breakthrough Scenario to Other Forecasts

	2040	% change	Notes
IEA New Policy	103	Up 14%	Fossil fuels remain 75%
IEA 2 Degrees	74.1	Down 19 %	
Statoil Renewal	79	Down 15%	EV growth = Oil less than 40% of transport
50% Battery cost decline scenario	74.6	Down 19%	EVs at close to 20% of all new car sales by 2030

Technological factors could be sufficient to reduce demand in the next two decades, but given the overwhelming influence of population growth, permanent peak in oil demand likely requires policy intervention.



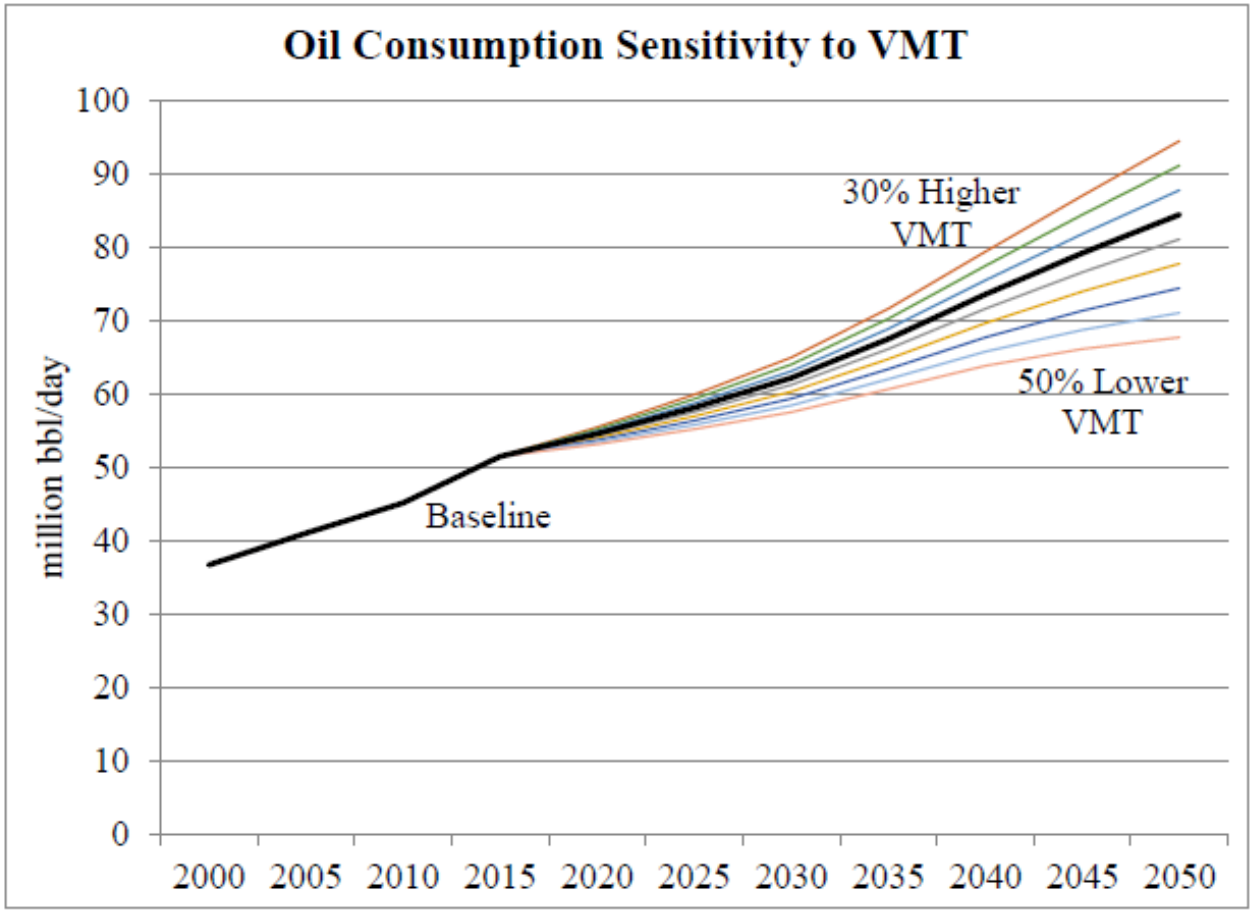
UC Davis Oil Demand Scenario Study: Testing Sensitivities of Peak Demand Transport Scenarios

Oil consumption projections through 2050.

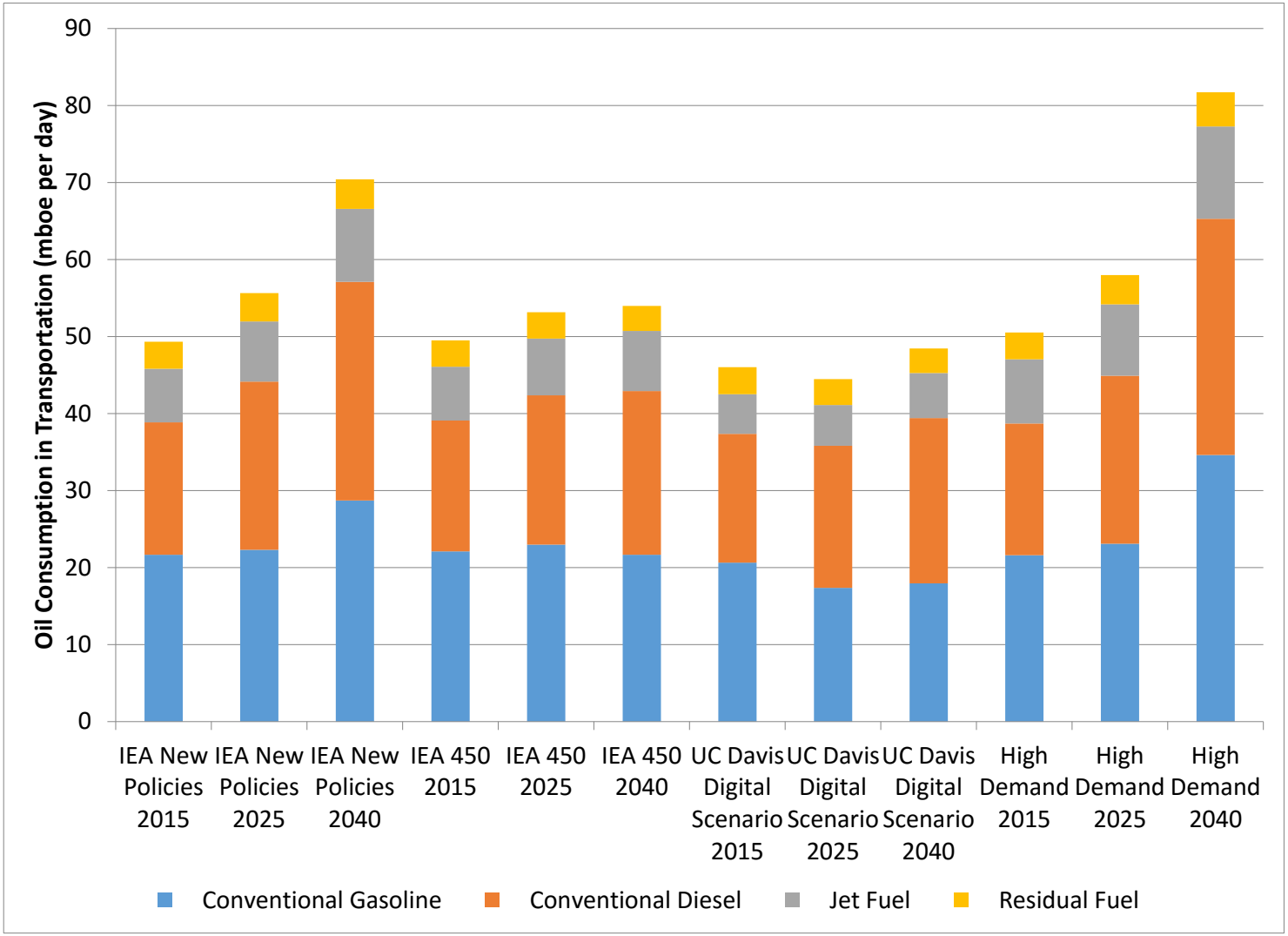
Projected Oil Consumption (million bbl/day)

	2015	2020	2025	2030	2035	2040	2045	2050	% Reduction Relative to Baseline 2050
Baseline	52.5	55.7	58.8	62.3	67.5	74.1	81.0	88.1	
No China-India Growth	52.1	54.5	56.5	58.7	62.3	66.9	71.6	76.0	**13.8%**
Global GDP Growth Reduction 10%	51.8	53.6	55.0	57.1	61.2	66.8	73.1	79.8	**9.4%**
No China Growth	52.4	55.1	57.6	60.4	64.8	70.4	76.4	82.2	**6.7%**
Shipping Logistics Improvement	52.4	55.0	57.2	59.5	63.7	69.2	75.7	82.3	**6.5%**
Road Freight Efficiency Improvement	52.4	55.1	57.3	59.8	64.0	69.7	76.3	83.1	**5.7%**
China-US-India GDP Parity	52.5	55.7	58.8	62.4	67.1	72.9	78.6	84.1	**4.6%**
Ridesharing	52.5	55.4	58.2	61.4	66.1	72.1	78.3	84.5	**4.0%**
China-US GDP Parity	52.4	55.4	58.2	61.5	66.3	72.3	78.6	84.8	**3.8%**
ASEAN Extra Congestion	52.3	55.1	58.0	61.3	66.2	72.4	78.9	85.5	**2.9%**
Congestion	52.3	55.1	58.0	61.4	66.3	72.5	79.1	85.8	**2.6%**
Air Traffic	52.5	54.9	57.9	61.4	66.5	72.9	79.8	86.7	**1.6%**
Natural Gas Trucks Share Increase	52.5	55.6	58.6	62.0	67.0	73.4	80.2	87.0	**1.2%**
Electric Vehicle Advancement	52.5	55.7	58.8	62.3	67.5	73.9	80.6	87.4	**0.8%**
ASEAN Only Congestion	52.5	55.7	58.8	62.3	67.4	73.9	80.8	87.8	**0.3%**

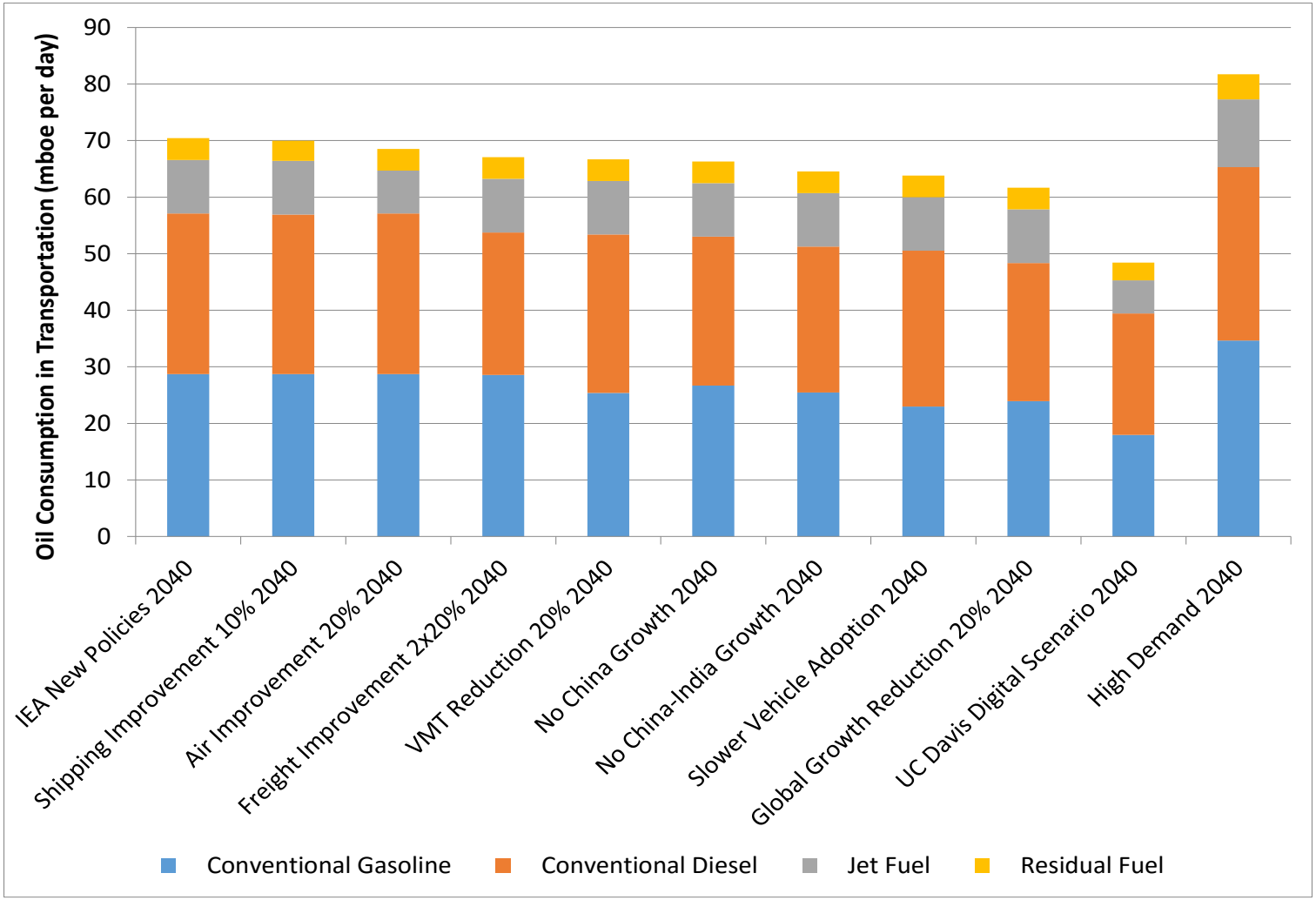
How sensitive is oil demand to vehicle miles traveled?



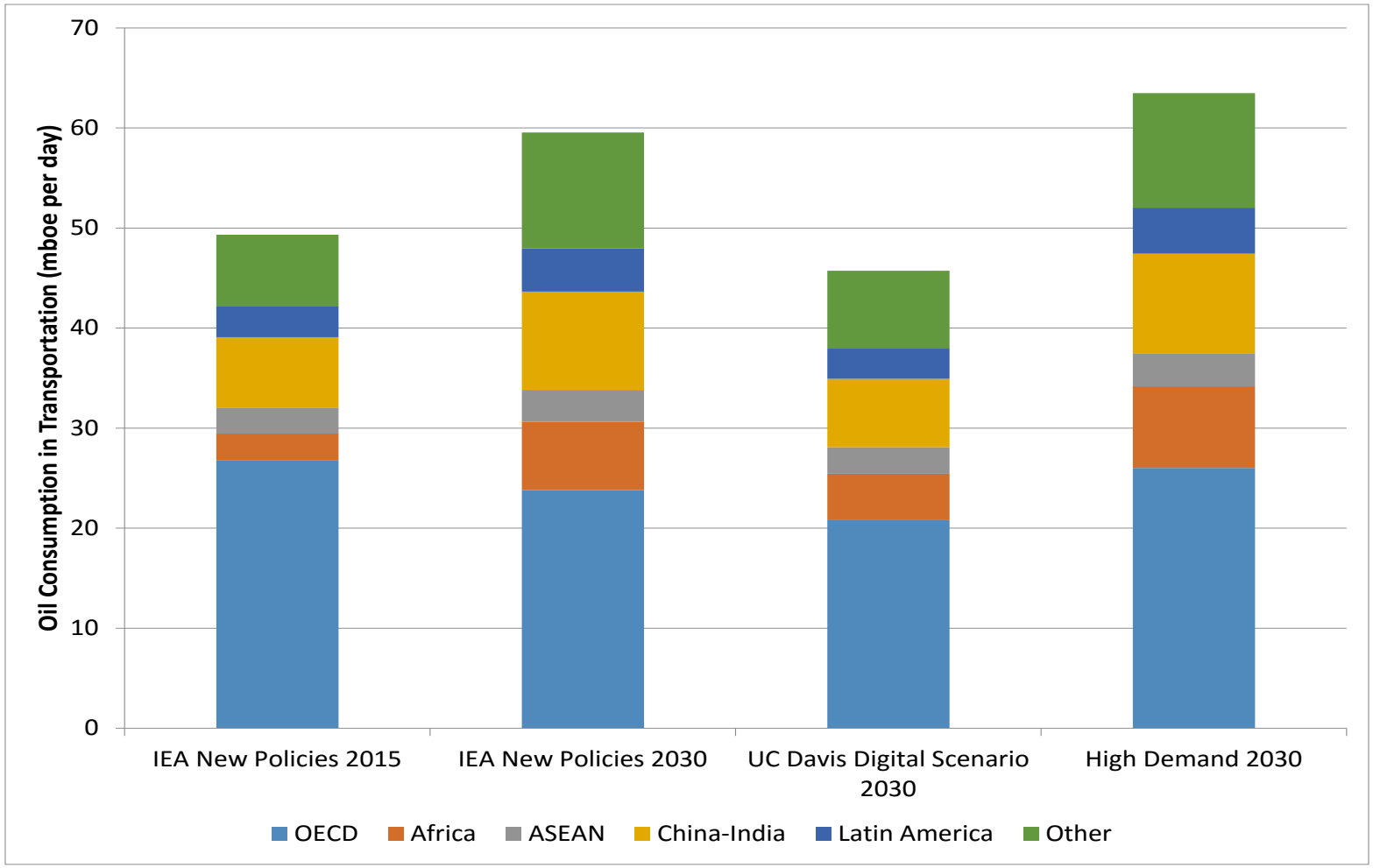
Demand Scenarios Per Fuels



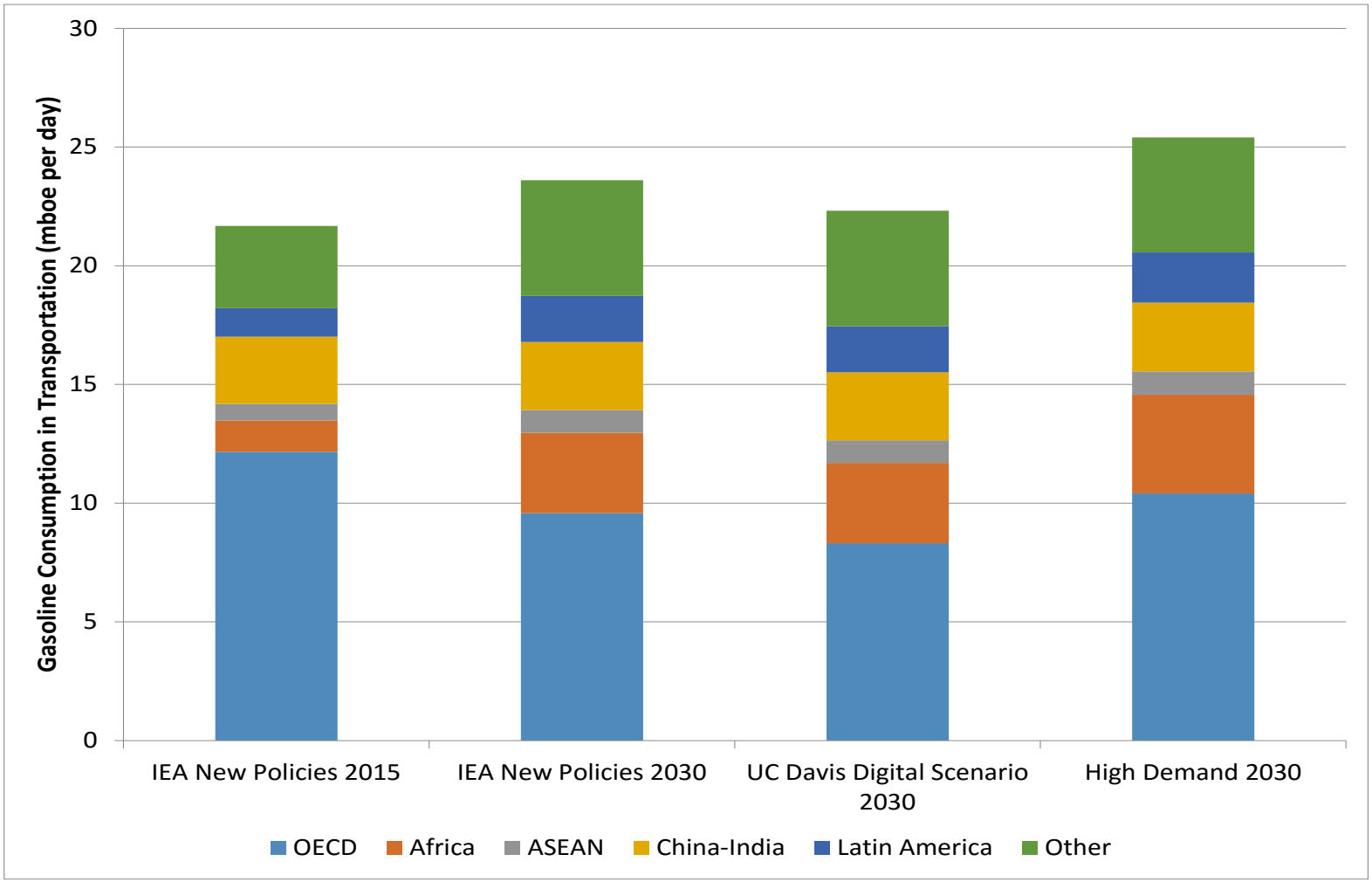
Comparing Indicators per Fuels



Regional Distribution Oil Demand per Scenarios



Regional Distribution per Demand for Gasoline



Comparing Battery Breakthrough Scenario to Other Forecasts

	2040	% change	Notes
IEA New Policy	103	Up 14%	Fossil fuels remain 75%
IEA 2 Degrees	74.1	Down 19 %	
Statoil Renewal	79	Down 15%	EV growth = Oil less than 40% of transport
50% Battery cost decline scenario	74.6	Down 19%	EVs at close to 20% of all new car sales by 2030

30 years of conventional wisdom is over now, forever

- Since 1980s, conventional wisdom held that "**easy oil**" in non-OPEC would be depleted by 2010s and the world would be **increasingly reliant on OPEC oil**.

- OPEC responded to this view by taking a revenues oriented strategy in the 2000s. Gulf countries viewed reserves as increasing in value over time for "future generations."

- Paris climate accords and US shale boom throws this future reserves scarcity model into question

- Uncertainty about long term demand outlook shifting strategic calculus of largest reserve holders

Implications for OPEC

- Flattening or peaking global oil consumption can lead to the situation where not all oil producing countries will be able to exhaust their reserves.
- In such a situation, question becomes whether it is optimal for either OPEC or private oil companies to delay development and production of reserves.
- Musical chairs syndrome –timing to monetize reserves moves forward

New Market Realities

"Freeze" dynamic led all players to seek higher output from which to begin agreement

- Not a repeat of 1998: Context for freeze is long term adjustments that might be required to address peak in oil demand

- Game of Survivor: winner takes all
    - Downstream
    - Exploration

New Market Realities

Majors shift from a growth business model to a sales business model

- Monetize legacy assets
- Each time technology adoption eliminates demand, price of oil and gas will fall again