

AAPG ACE  
May, 2018

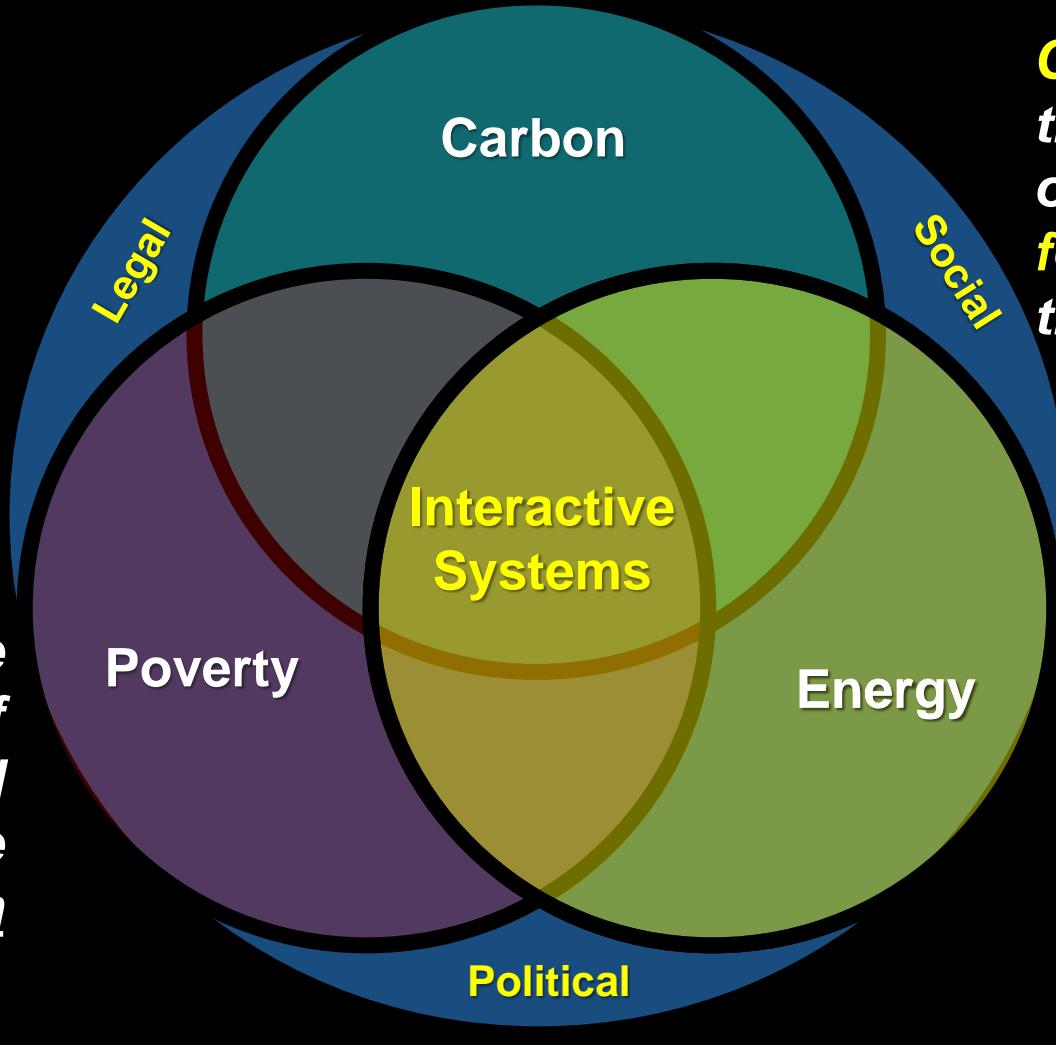
# The Evolution of Super-Basins



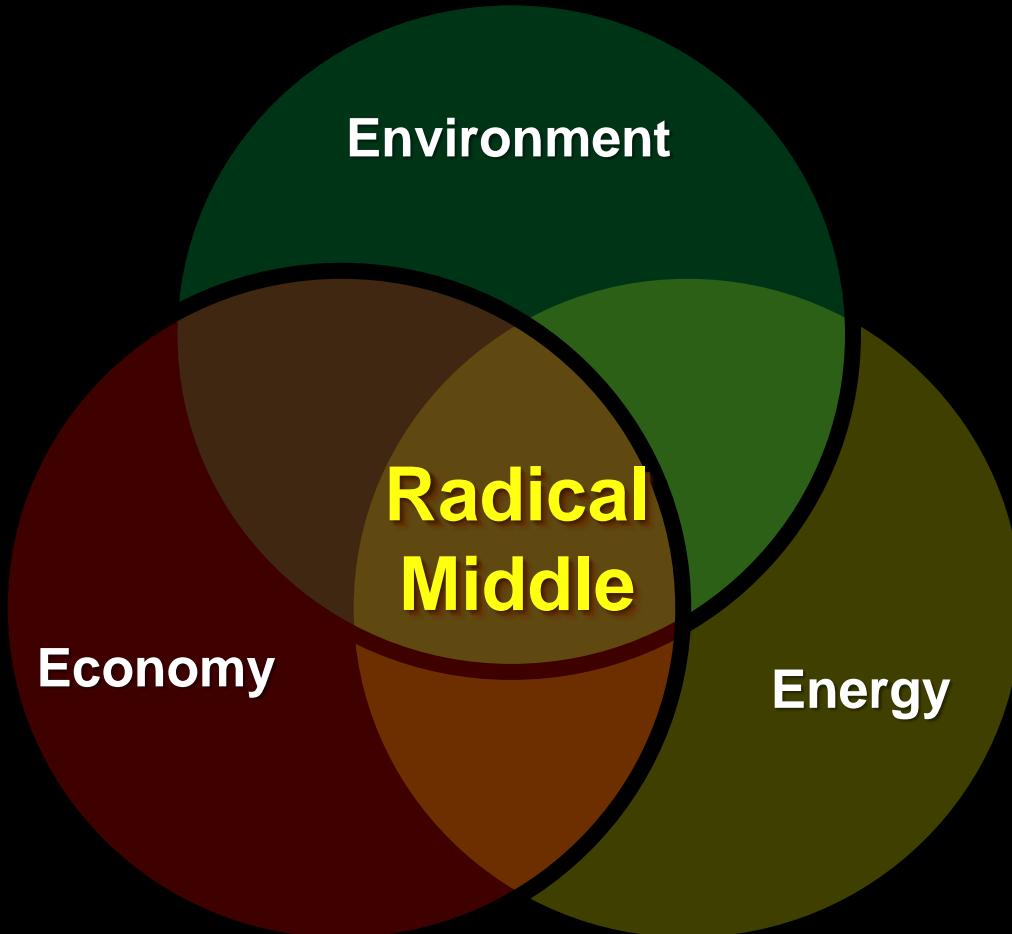
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ECONOMIC  
GEOLOGY

Scott W. Tinker

**Poverty** is the major issue of our time, and fossil fuels are the solution



**Climate Change** is the major issue of our time, and **fossil fuels** are the problem



# *What role will hydrocarbon Super Basins play?*

Energy

# Outline

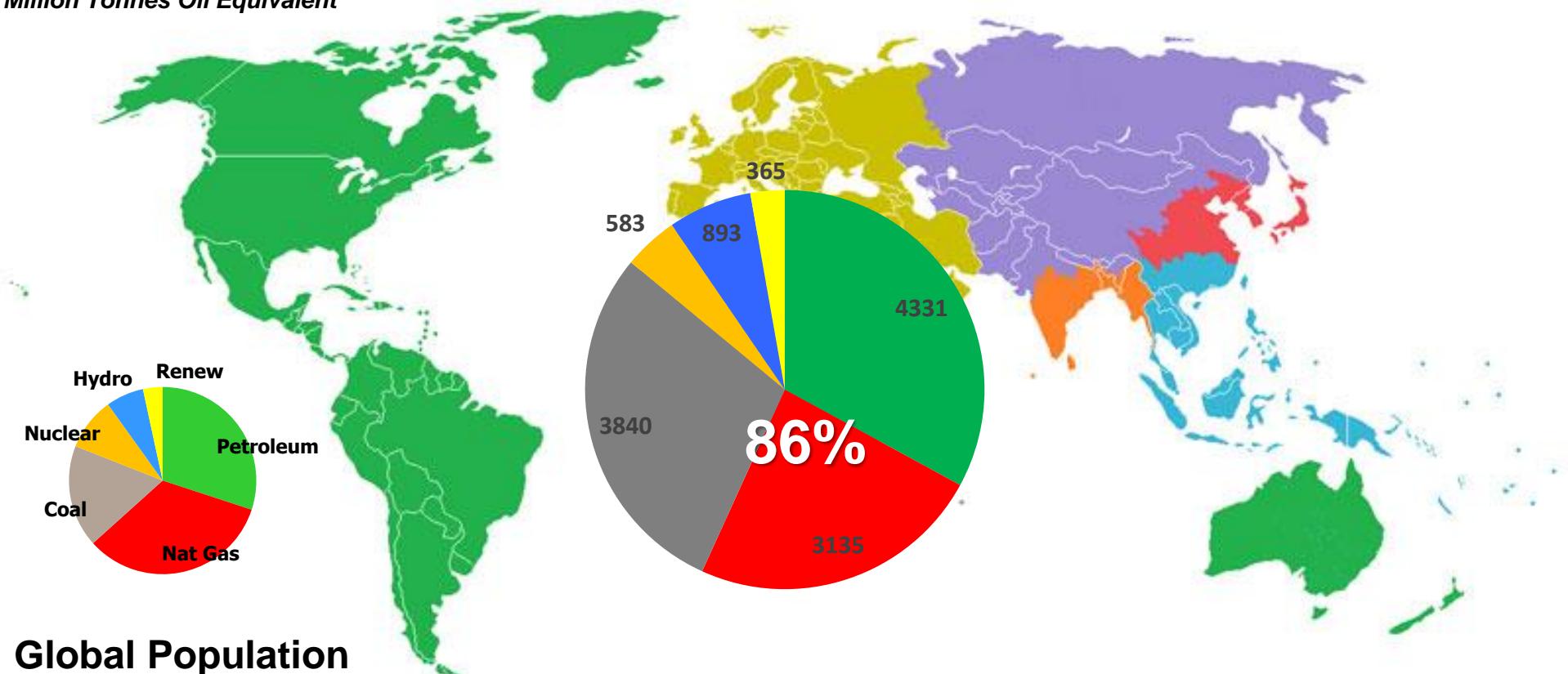
- ❖ Global Energy Mix
- ❖ US Shale Super Basins
- ❖ Super Basin Sustainability



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# The Global Energy Mix

Million Tonnes Oil Equivalent



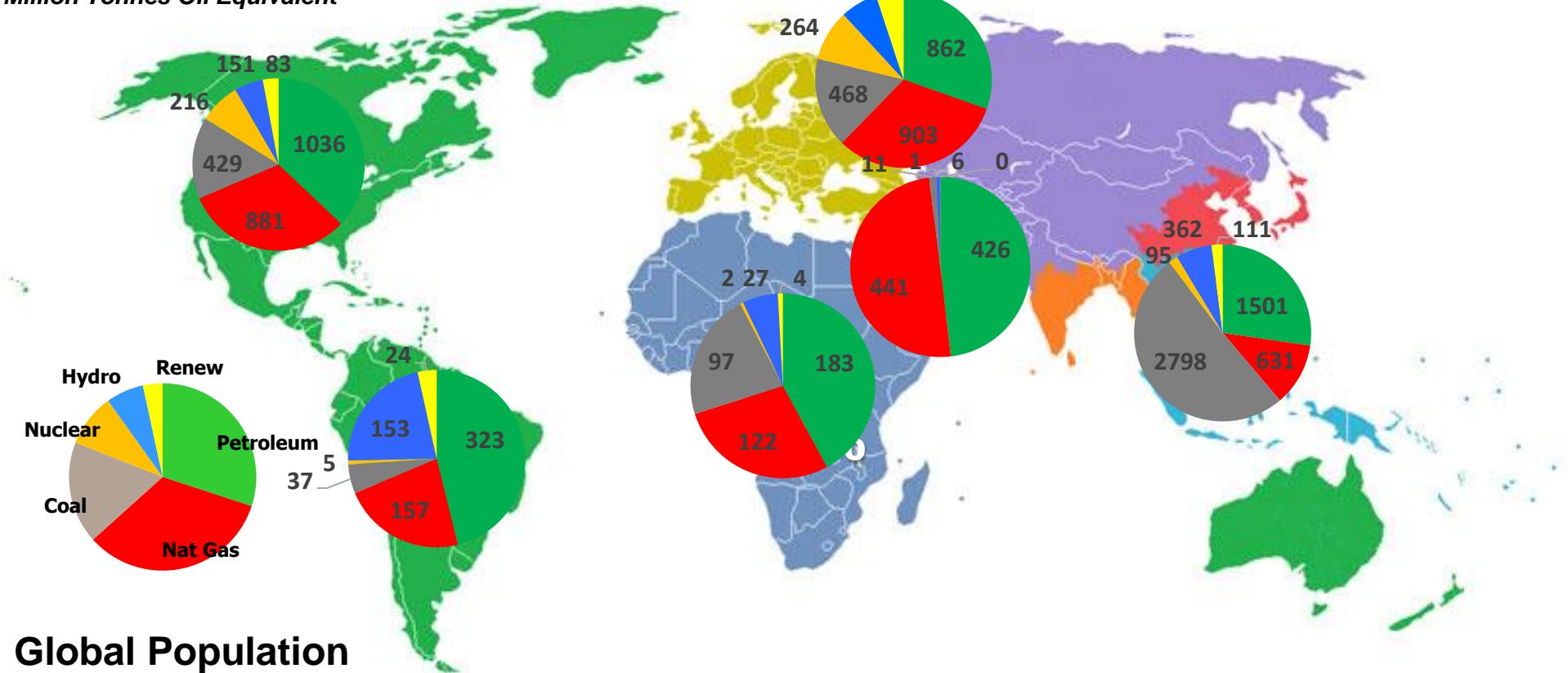
**Global Population**

Each color on the map represents ~ 1 billion people

Data: BP Statistical View of World Energy (2016)

# The Global Energy Mix

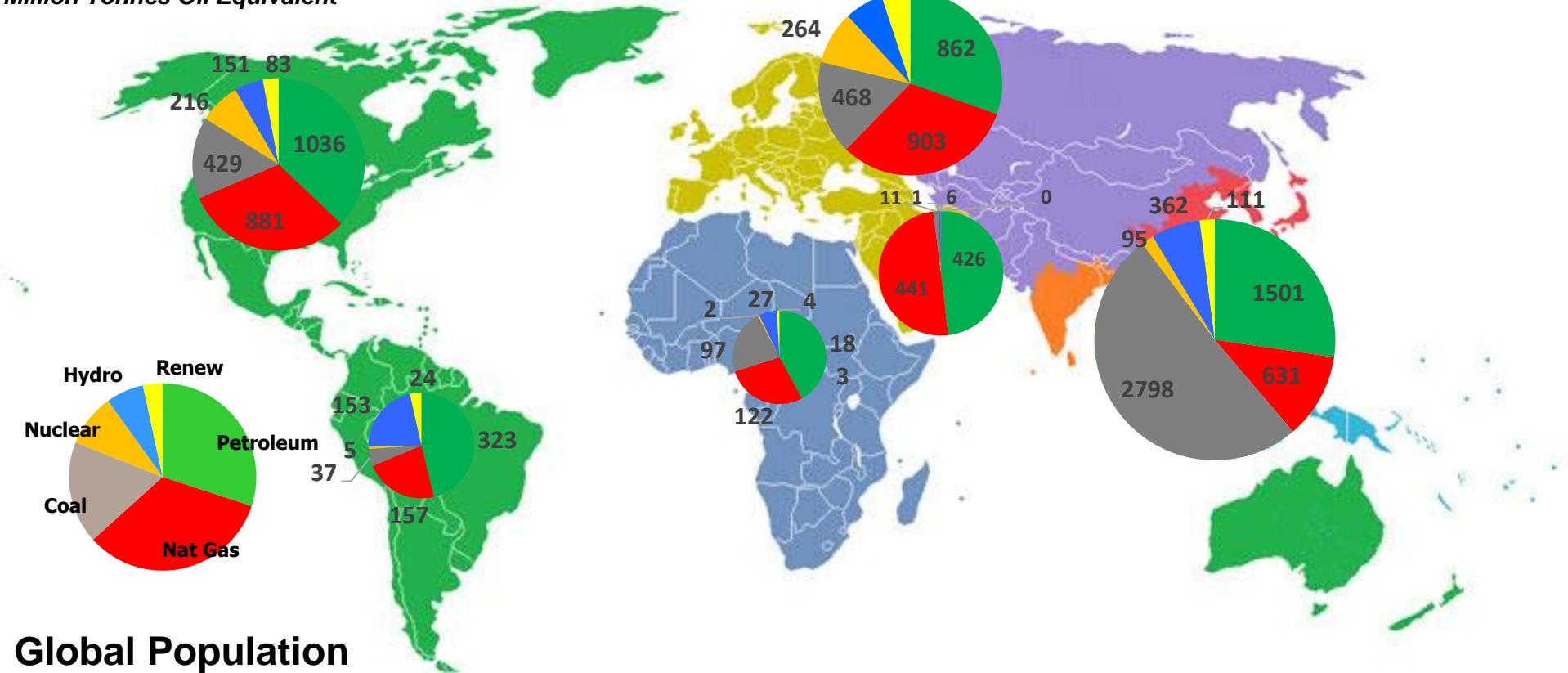
Million Tonnes Oil Equivalent



Data: BP Statistical View of World Energy (2016)

# Global Energy Demand

Million Tonnes Oil Equivalent



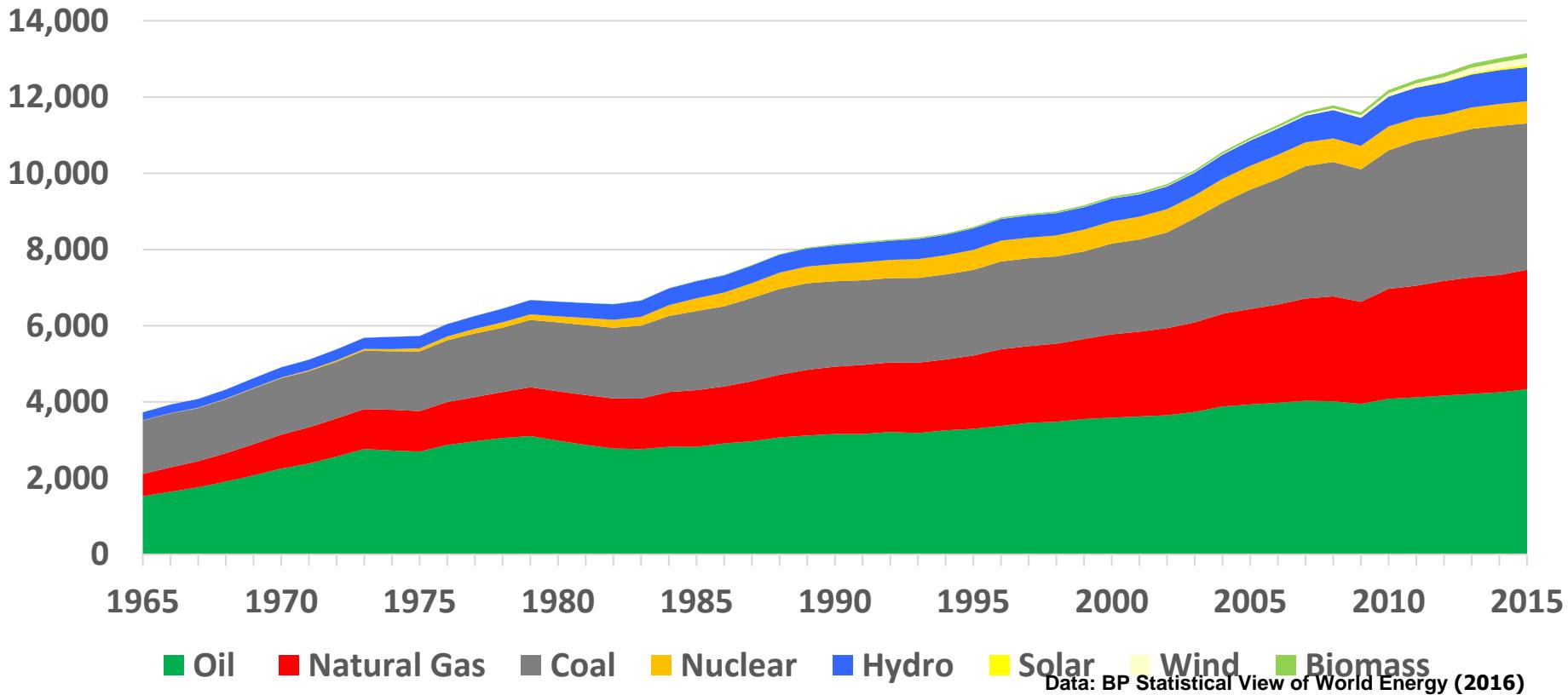
## Global Population

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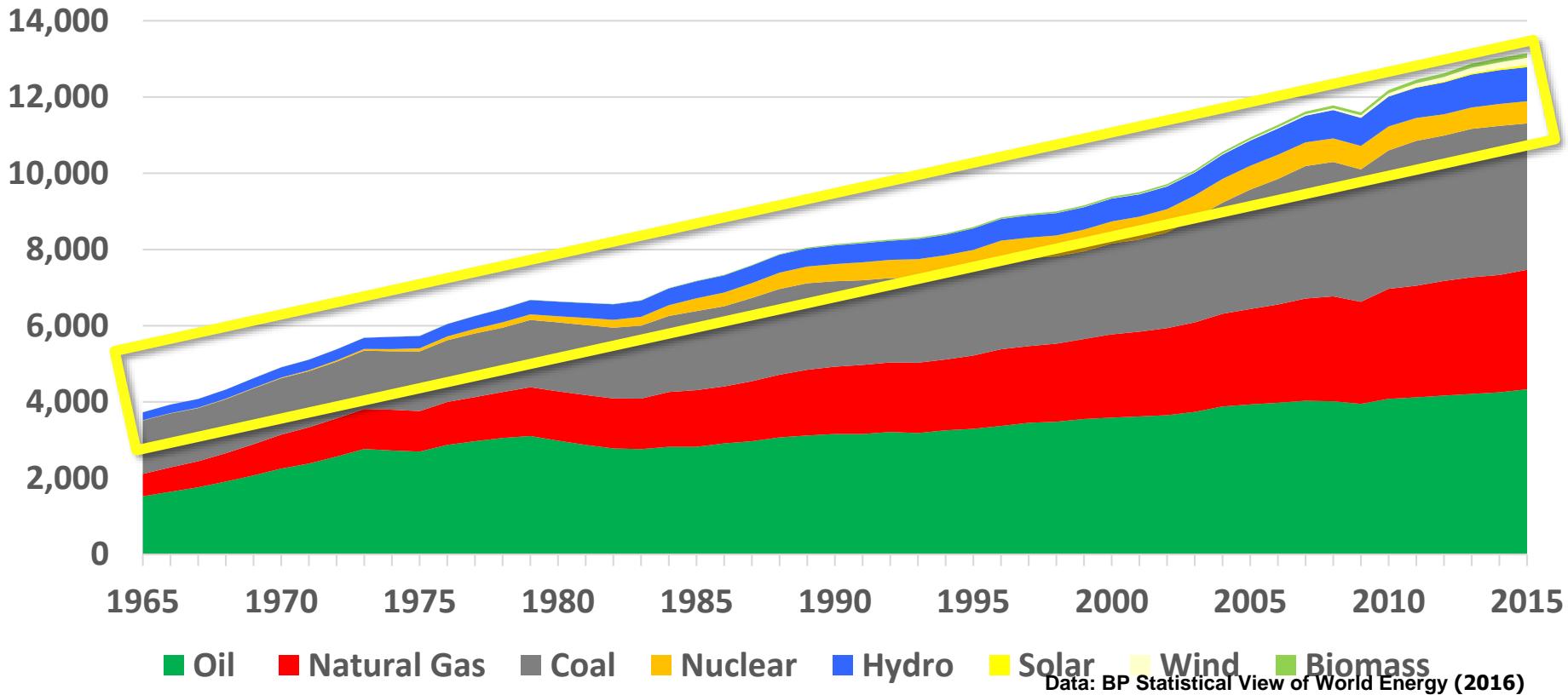
# Global Energy Mix

## Global Energy Consumption (MTOE)



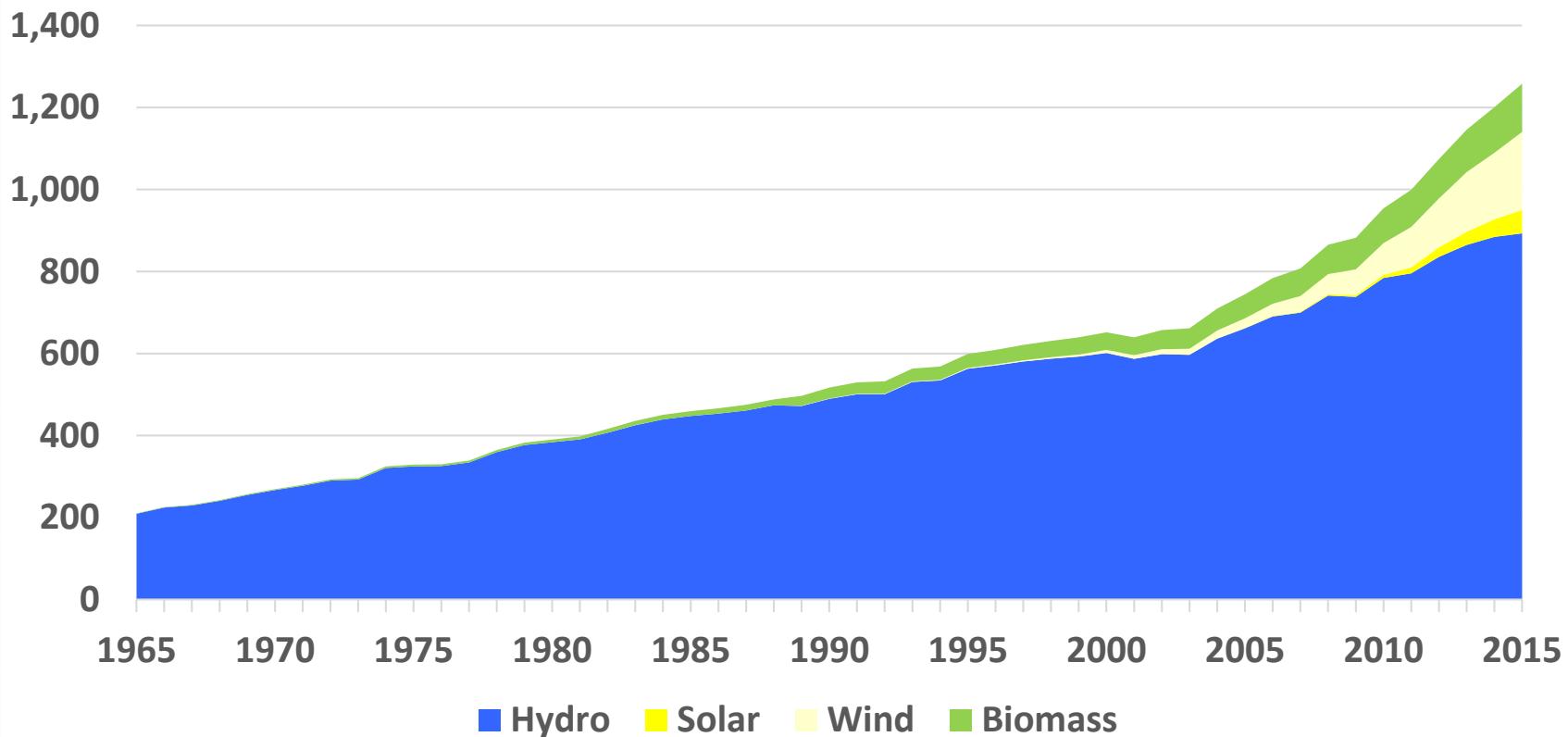
# Global Energy Mix

## Global Energy Consumption (MTOE)



# Global Energy Mix

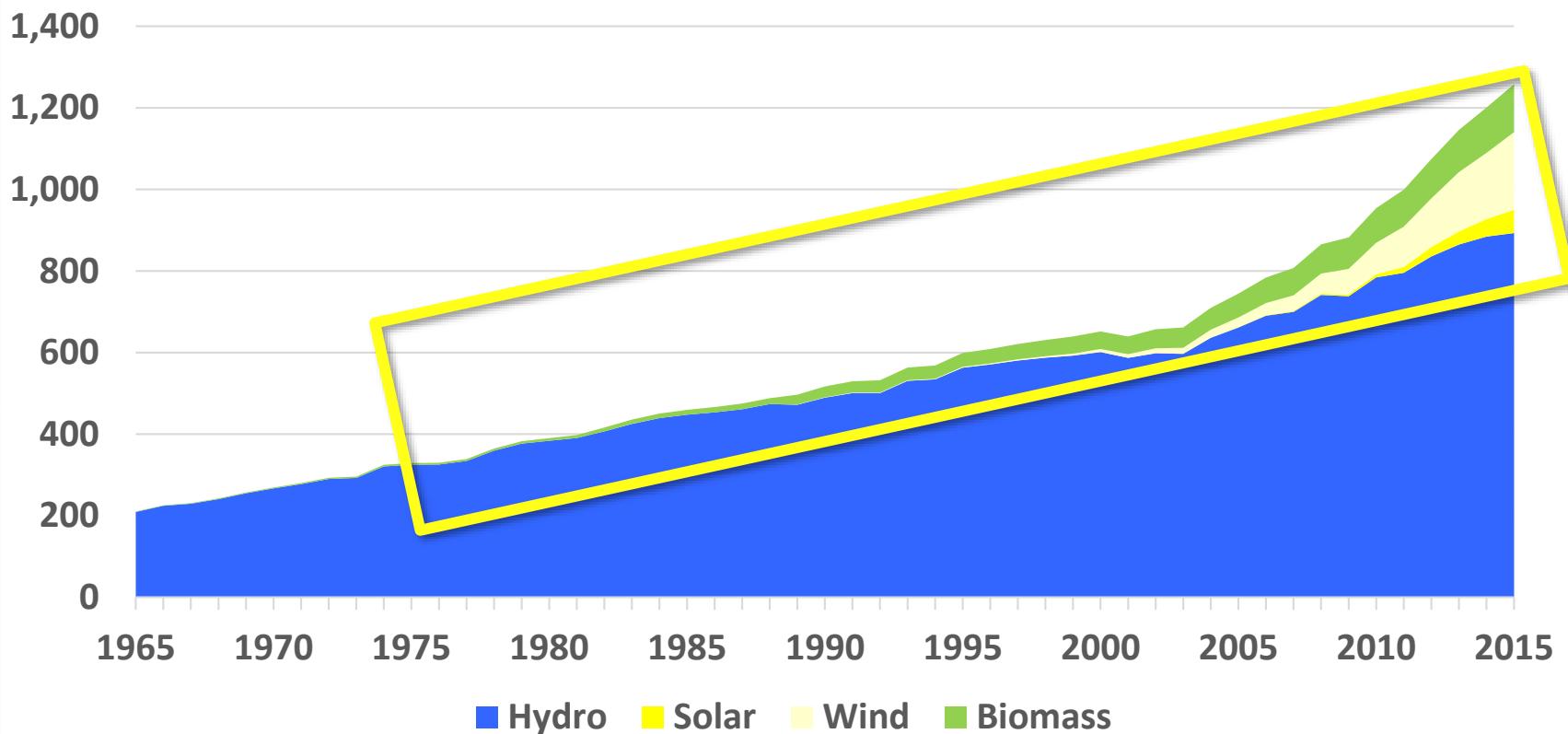
## Renewable Consumption (MTOE)



Data: BP Statistical View of World Energy (2016)

# Global Energy Mix

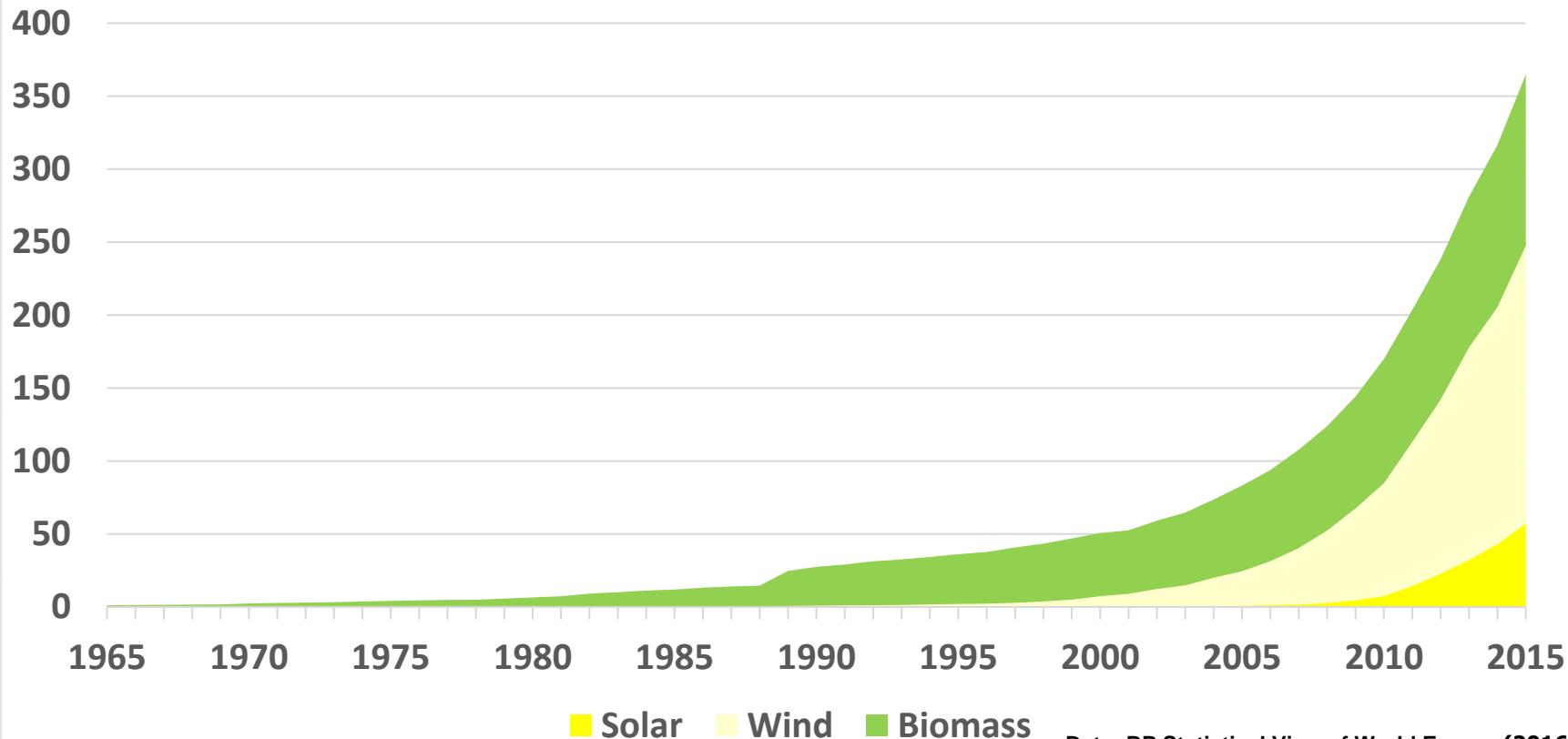
## Renewable Consumption (MTOE)



Data: BP Statistical View of World Energy (2016)

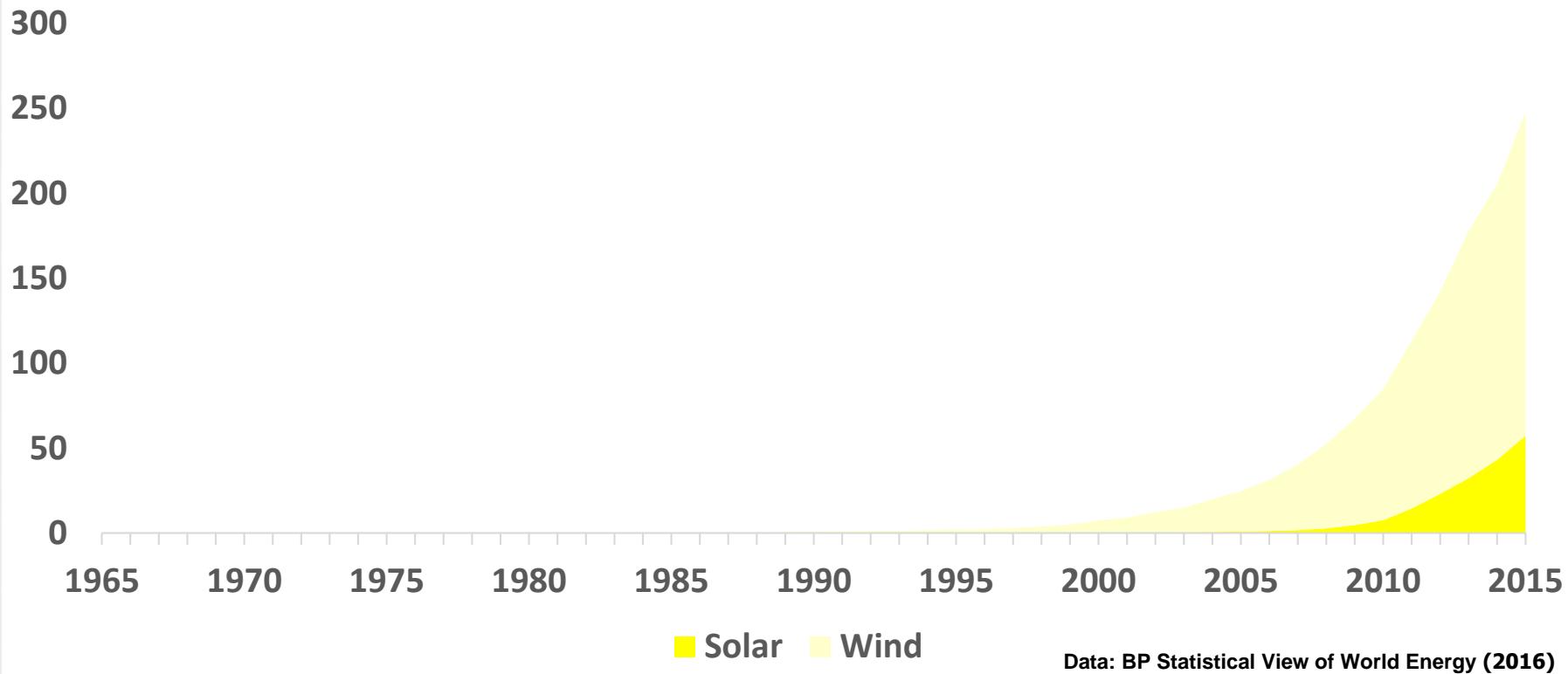
# Global Energy Mix

## Renewable Consumption (MTOE)



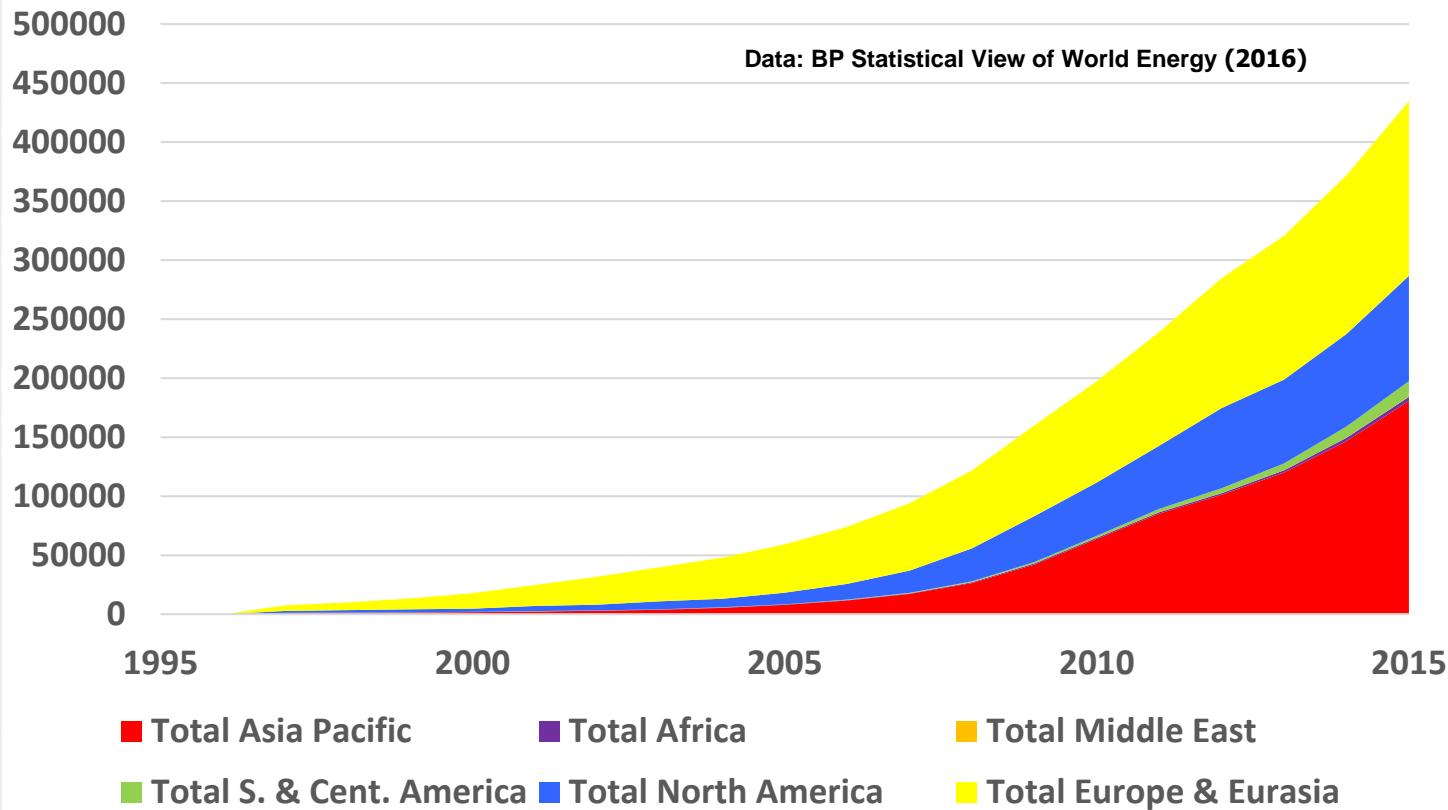
# Global Energy Mix

Renewable Consumption (MTOE)



# Global Energy Mix

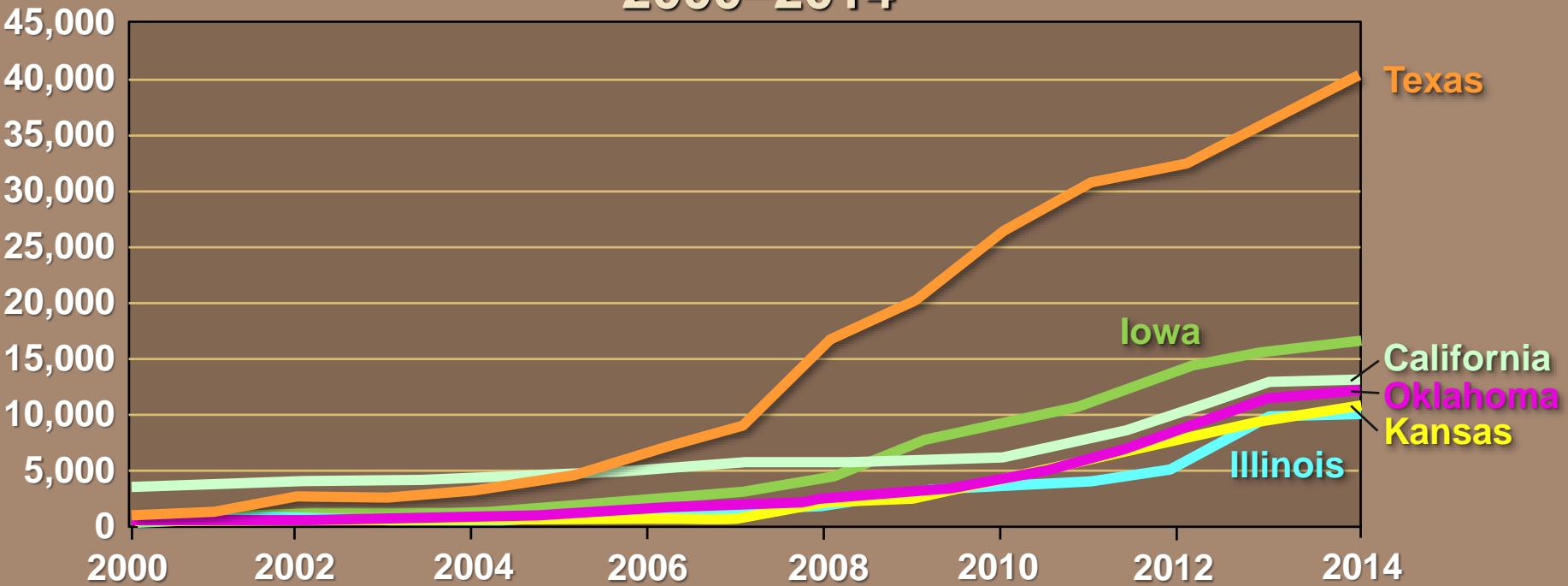
## Installed Wind Capacity (MW)



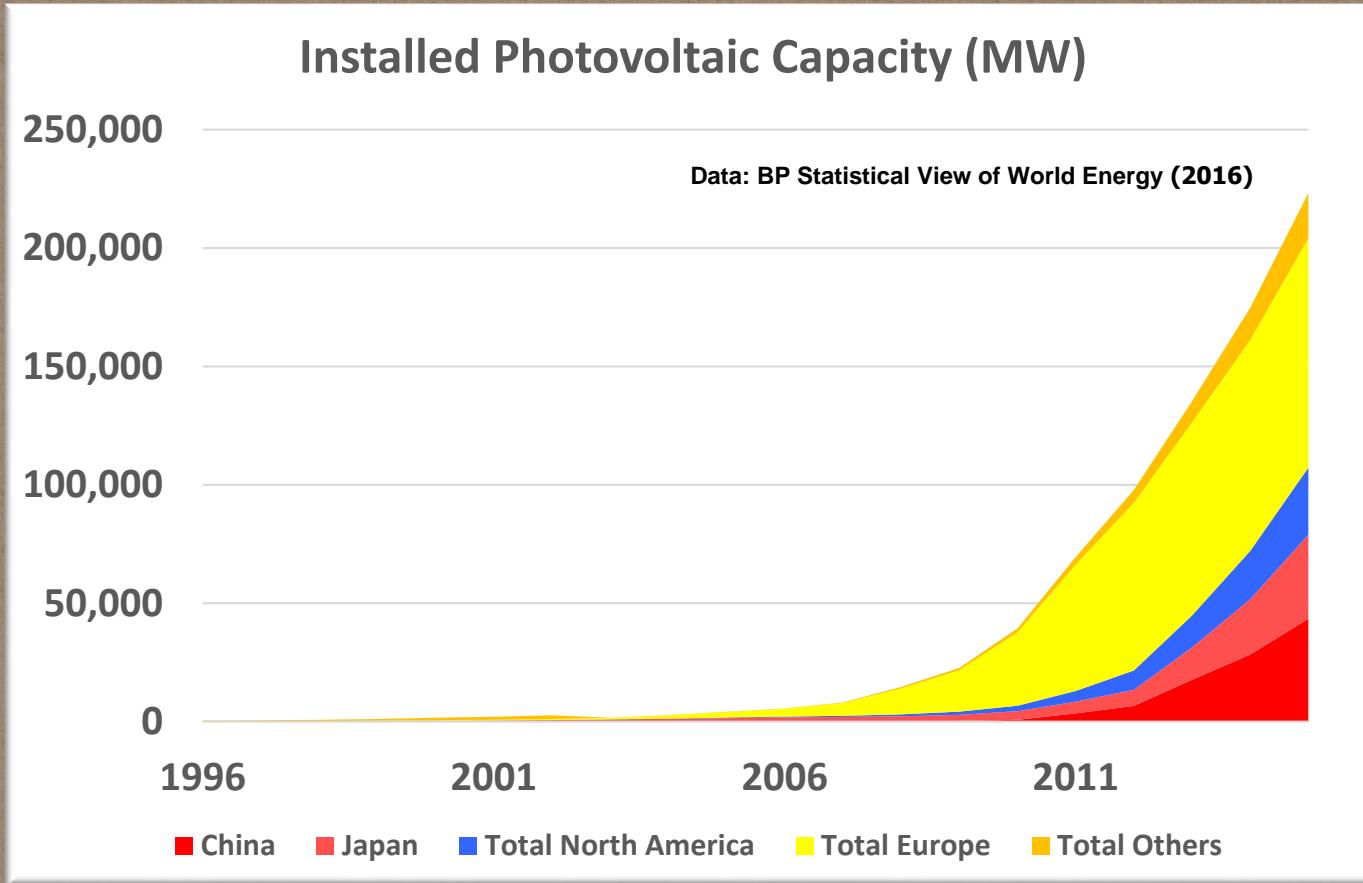
# Global Energy Mix

## Growth in U.S. Wind Generation 2000–2014

Million Kwh

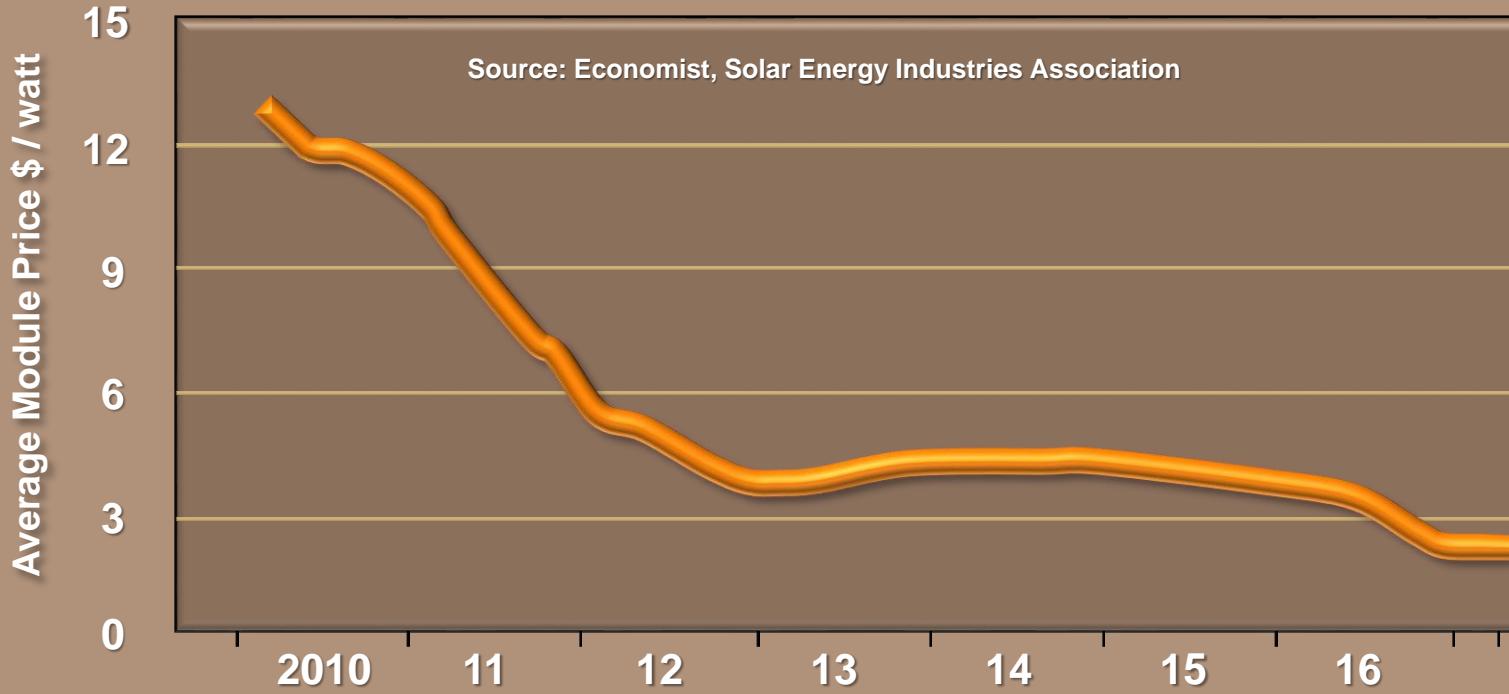


# Global Energy Mix



# Global Energy Mix

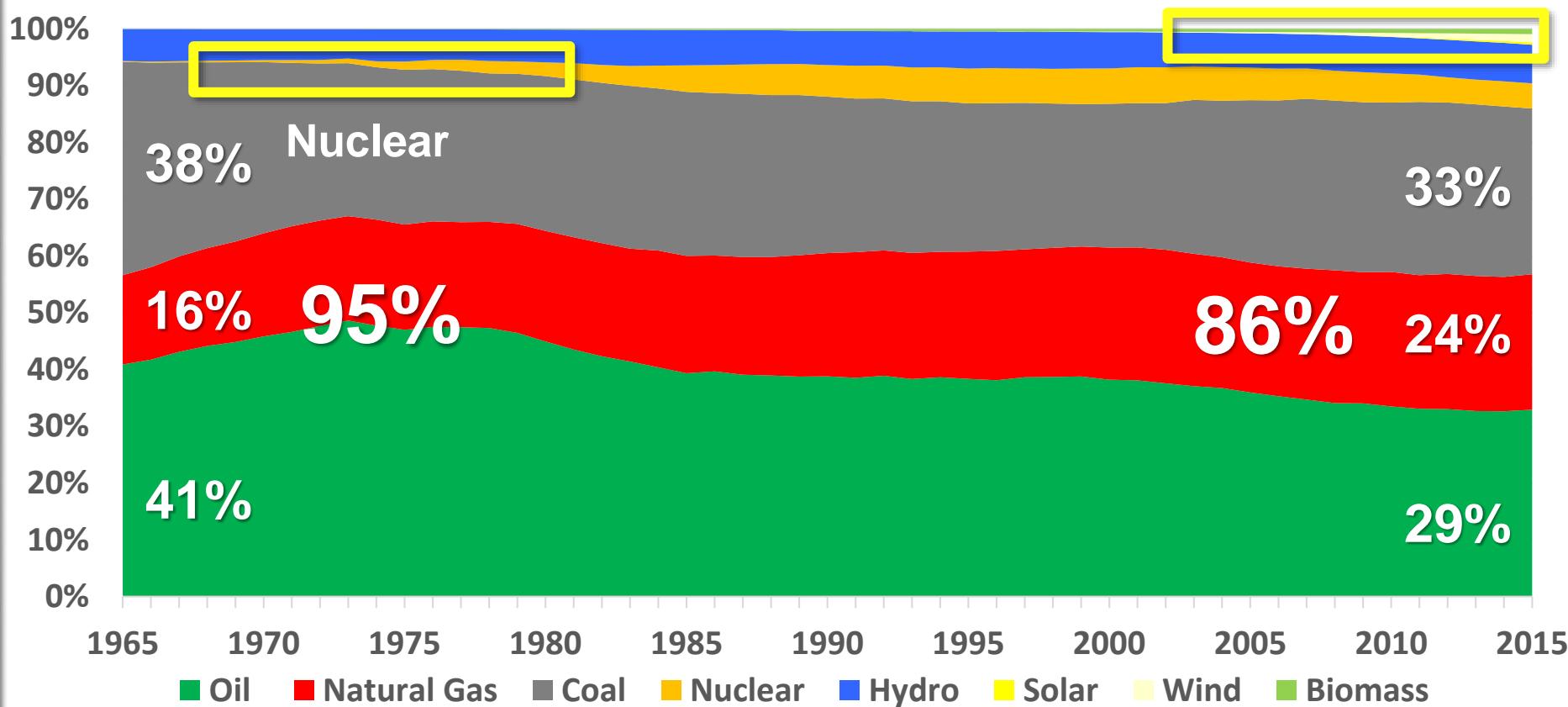
## United States Solar photovoltaics



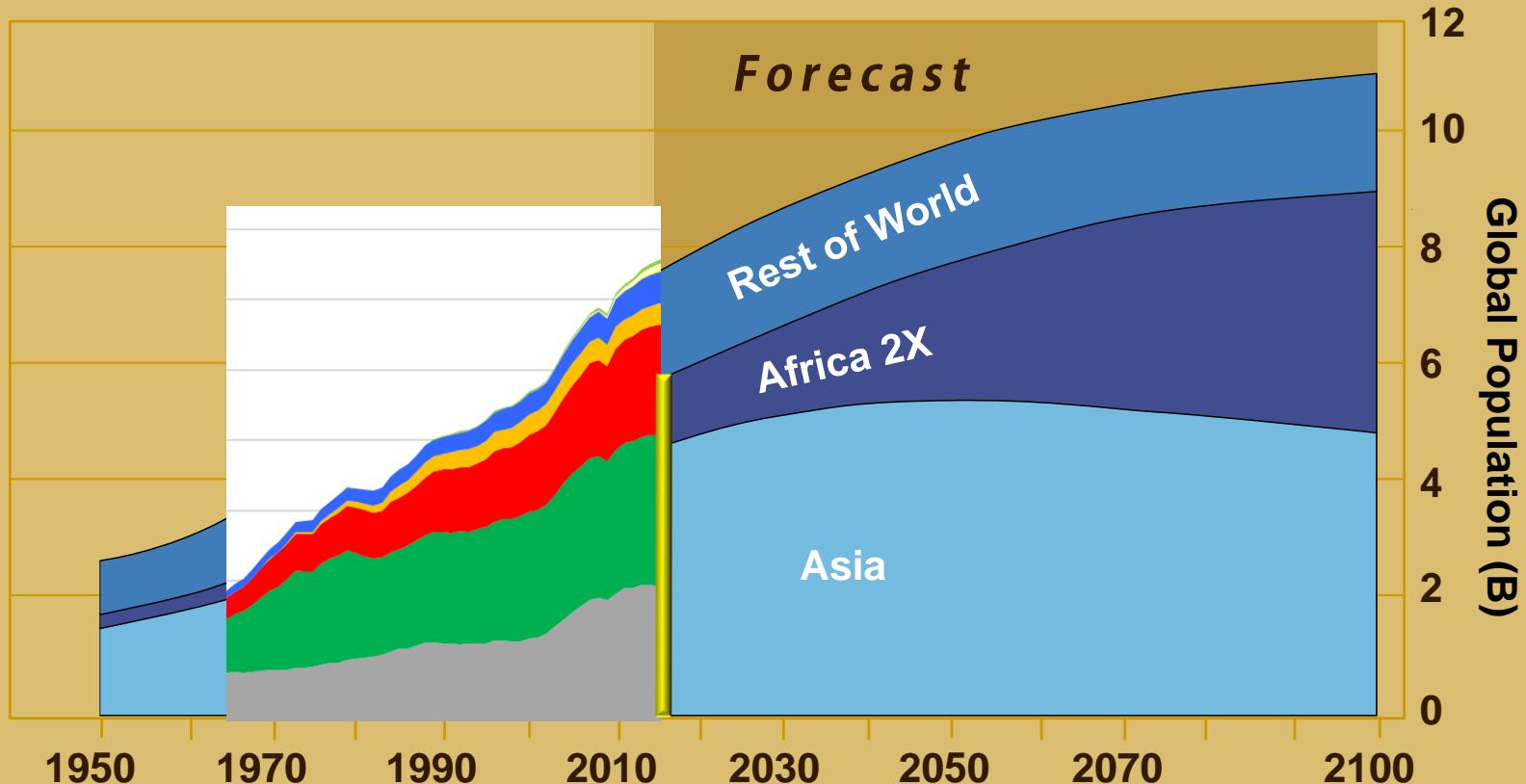
Source: Economist, Solar Energy Industries Association

# Global Energy Mix

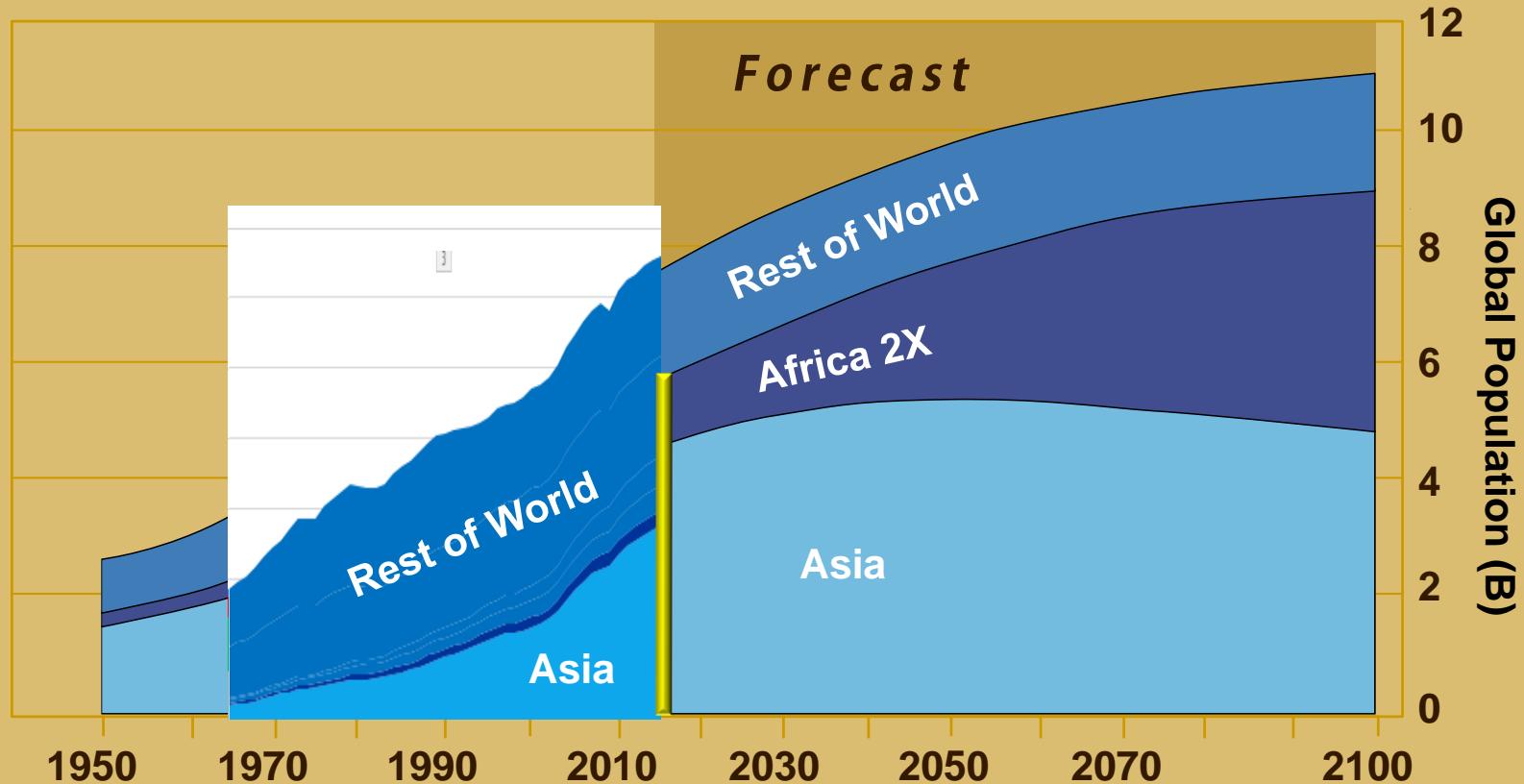
## Global Energy Consumption Mix



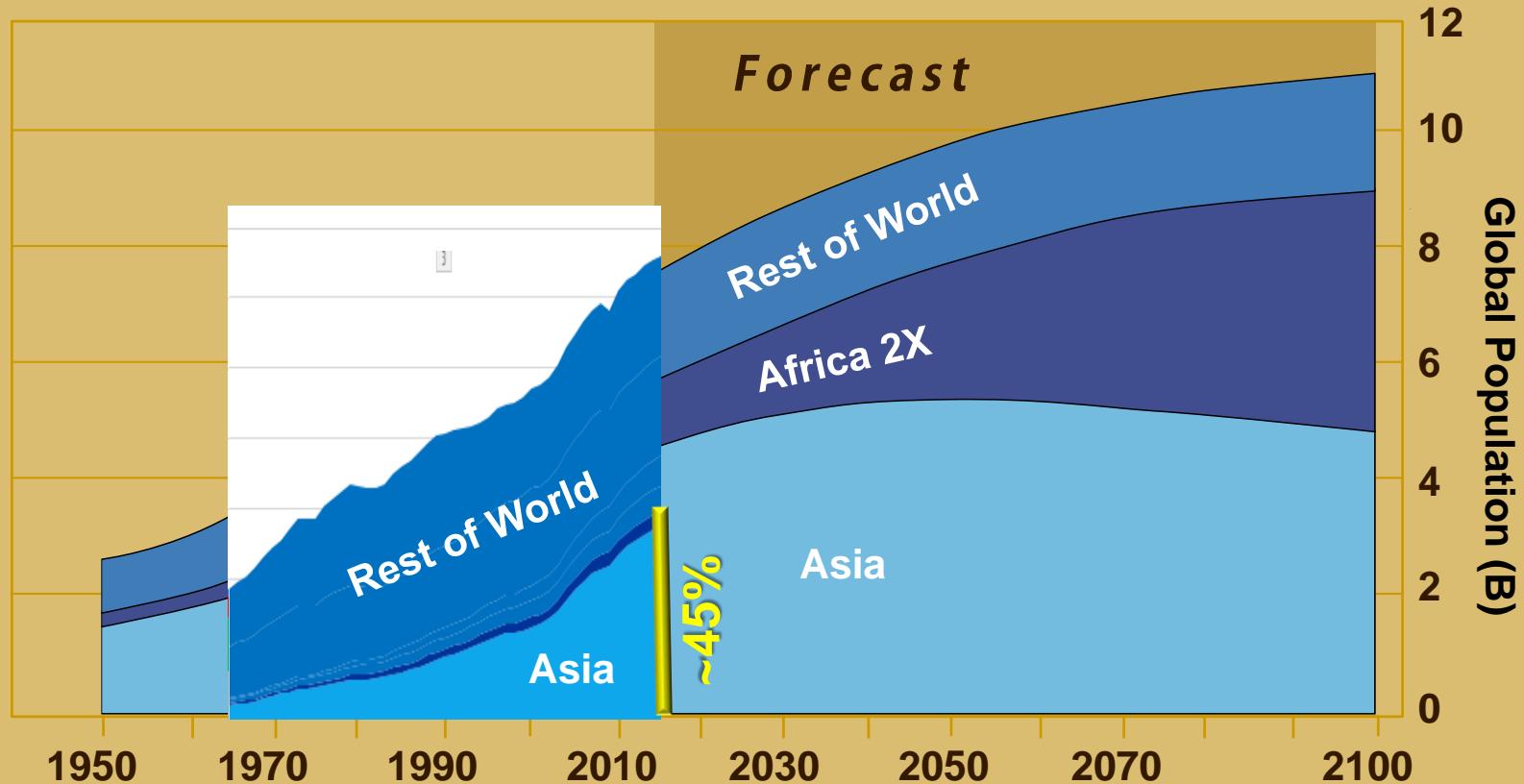
# Population and Energy



# Population and Energy

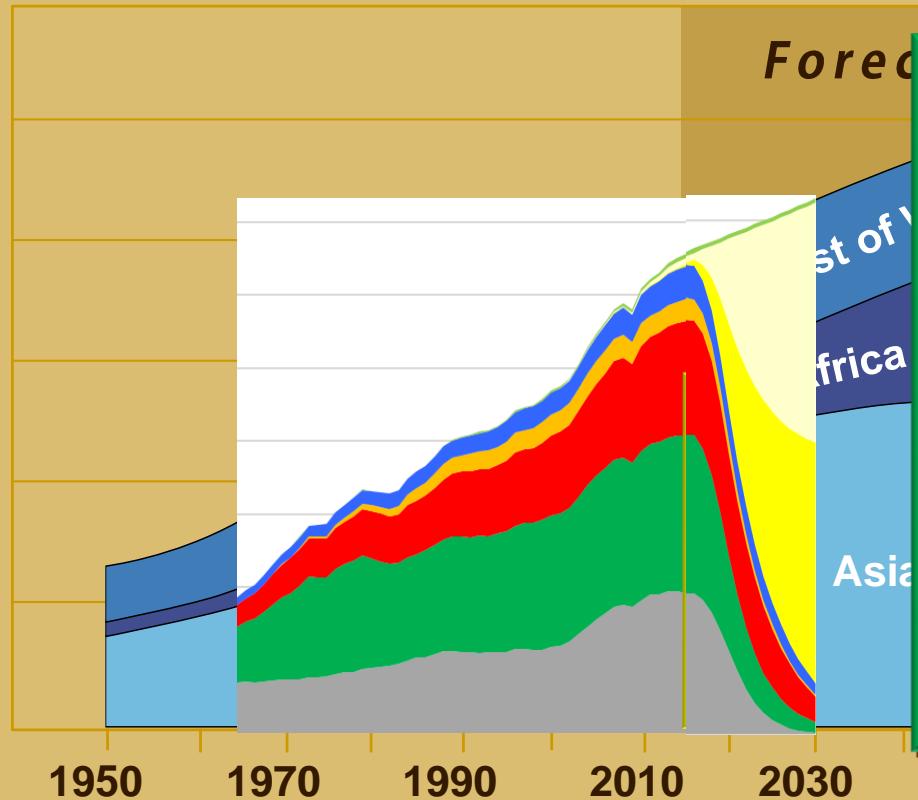


# Population and Energy



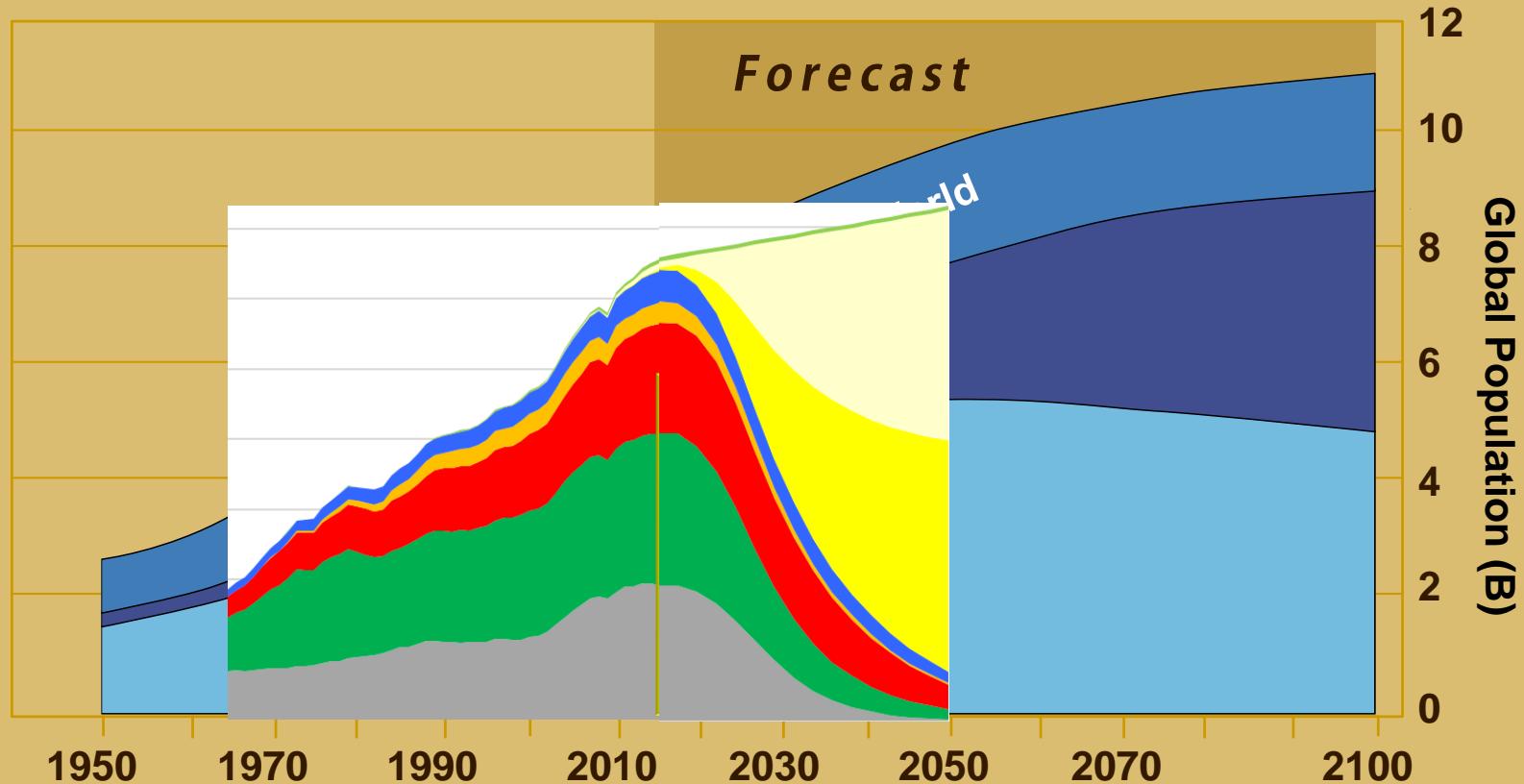
# Population and Energy

12

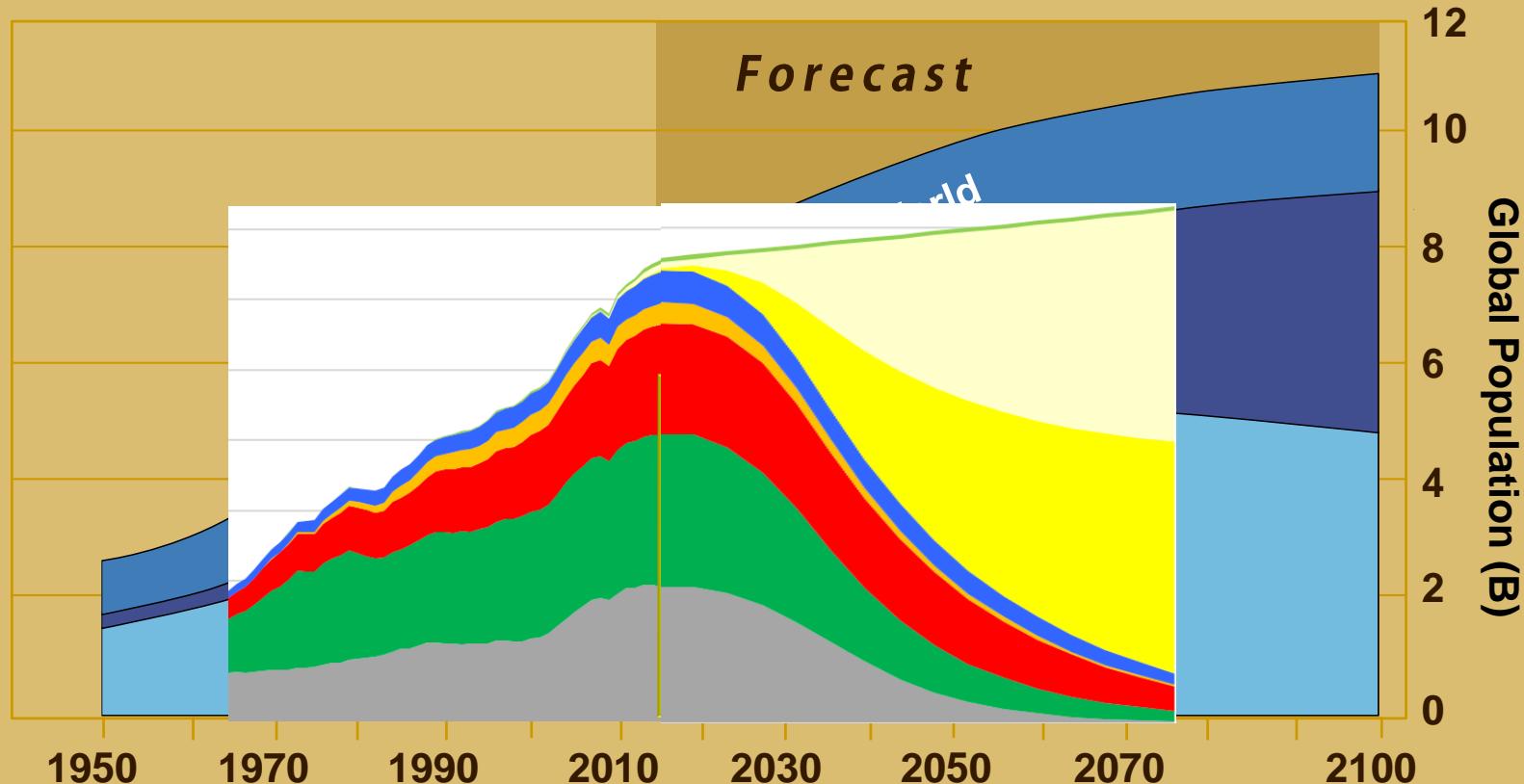


“The world could be 100% wind, wave and solar by 2030, if just for political will...”

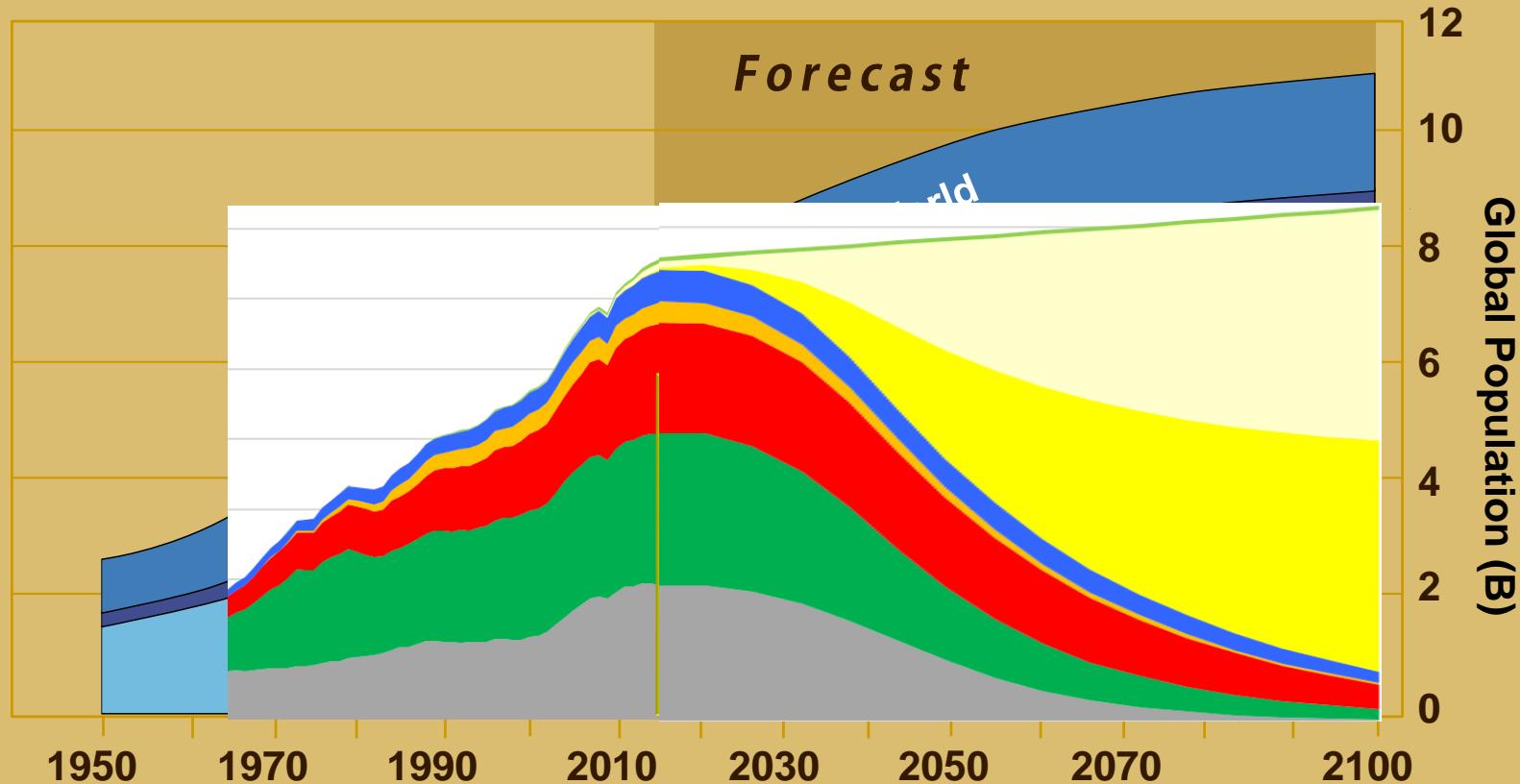
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# Population and Energy



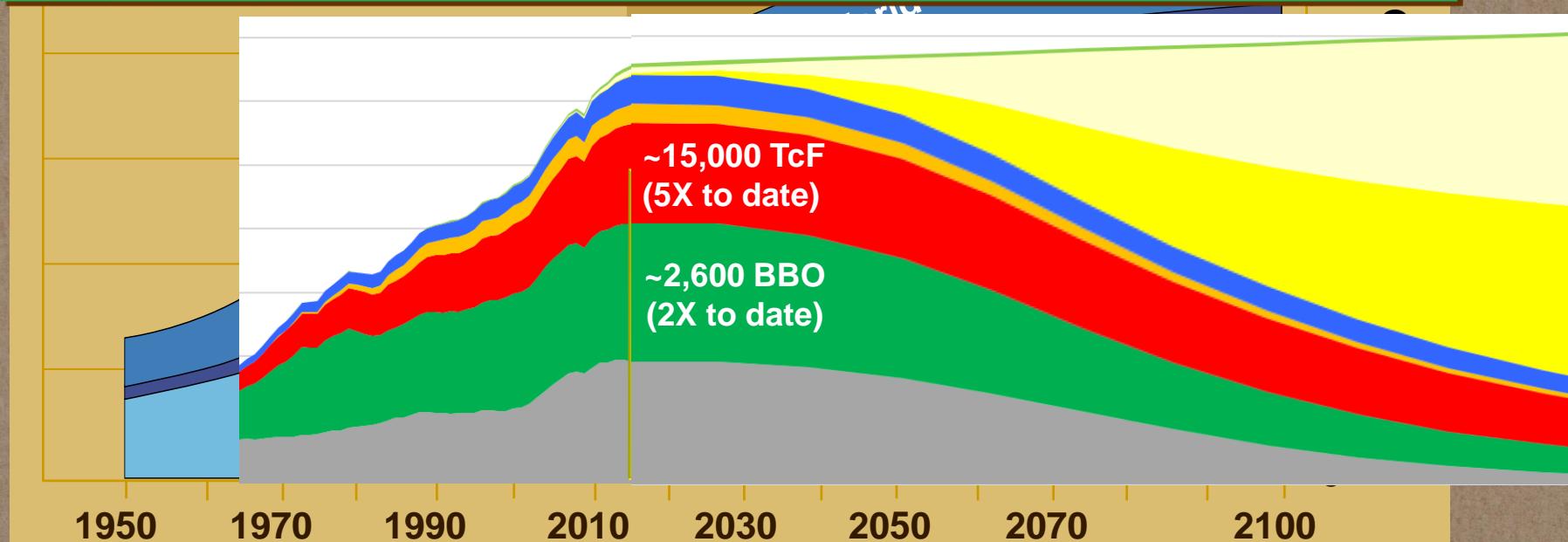
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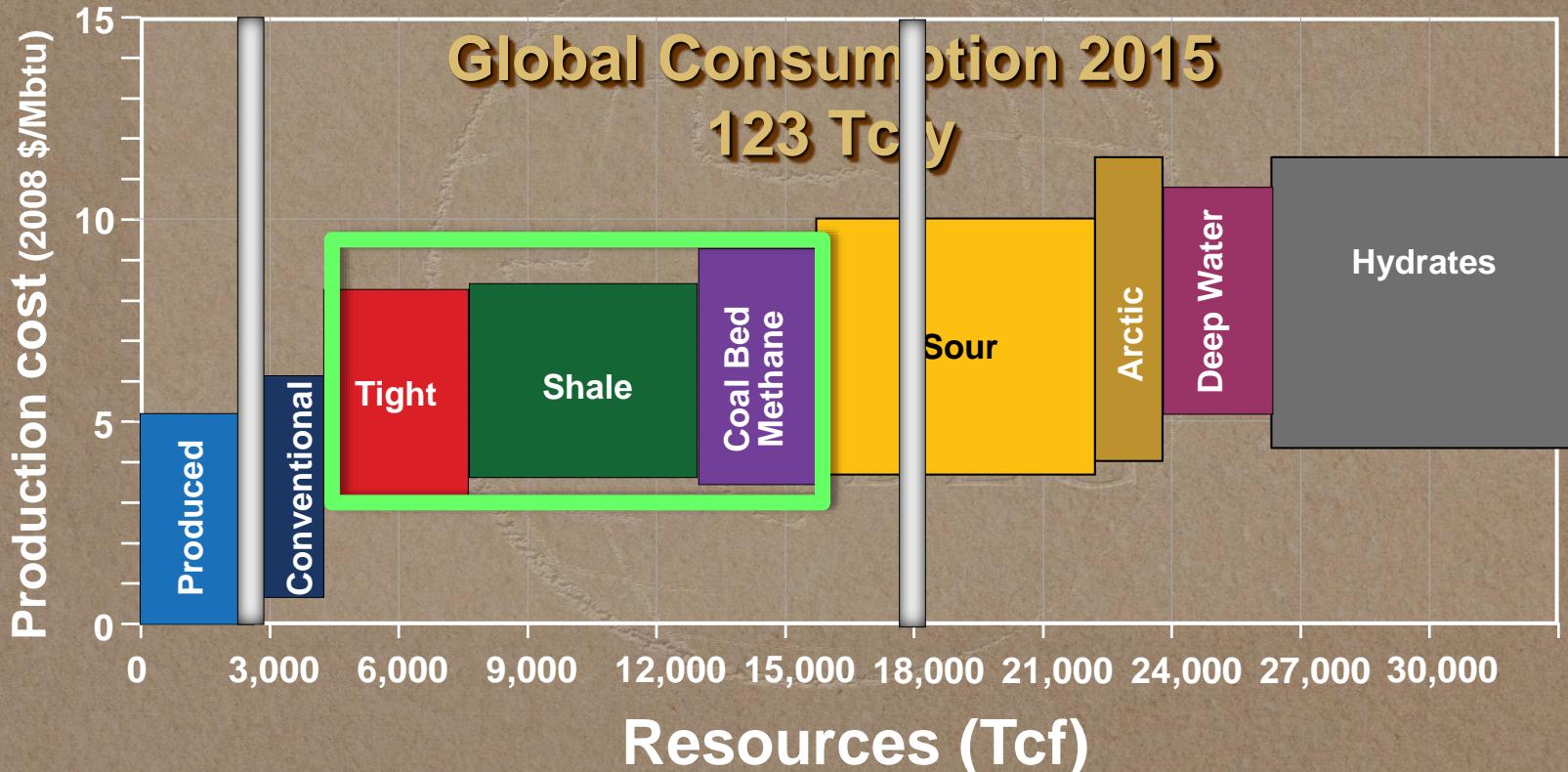
Are there affordable, available, reliable and sustainable:

- fossil energy and nuclear resources to meet this demand?
- renewable energy resources to meet this demand?



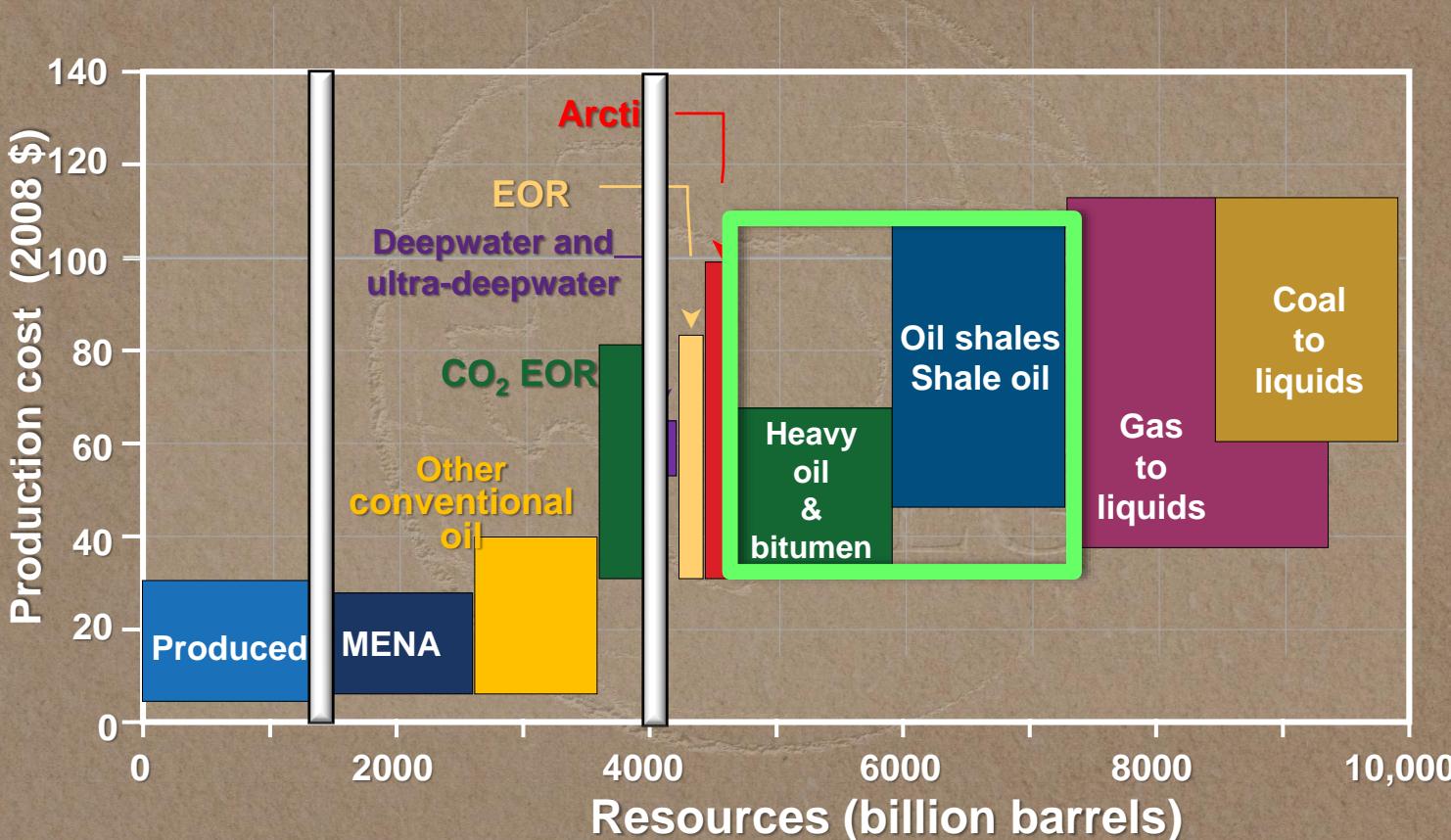
# Natural Gas Cost of Supply

## Resources v. Cost

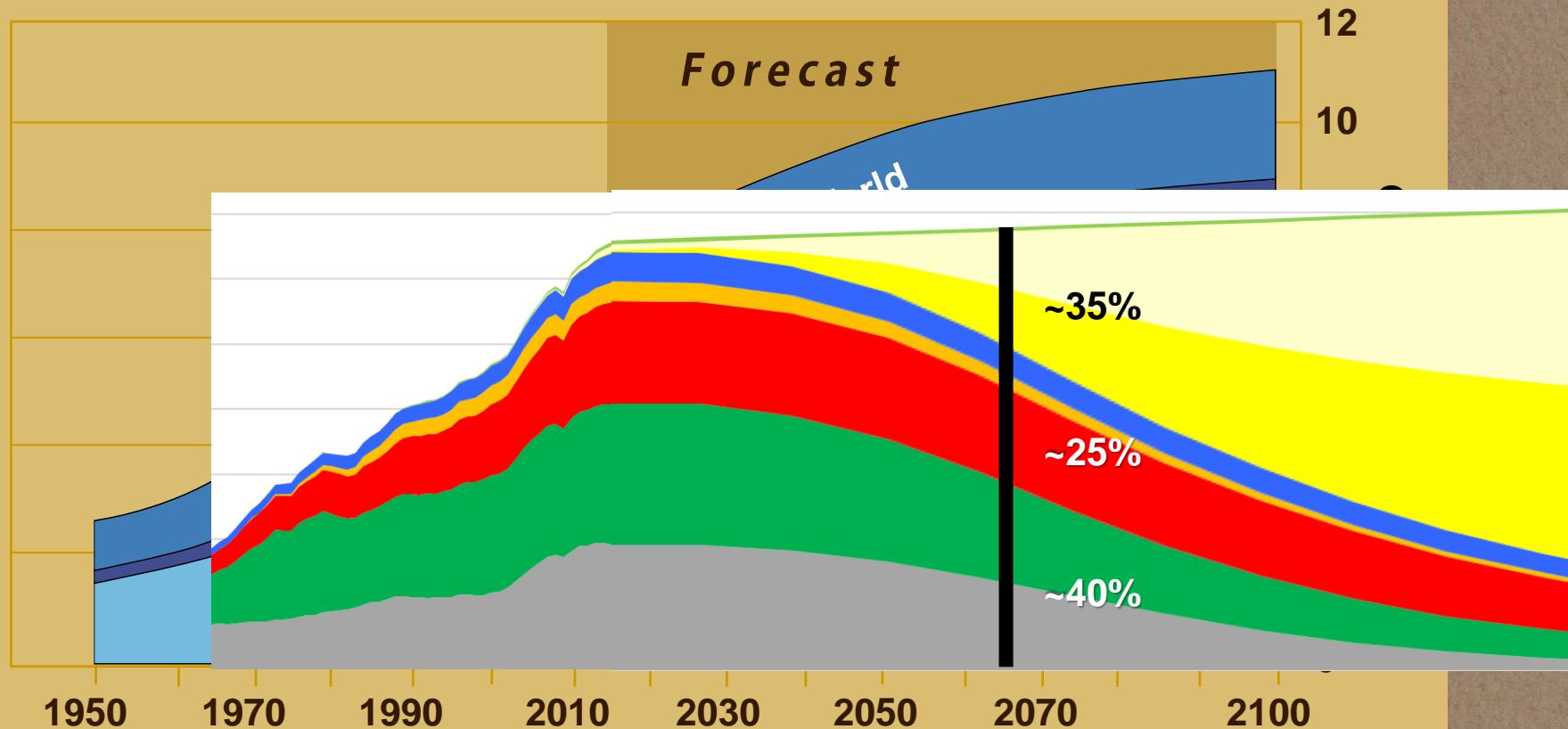


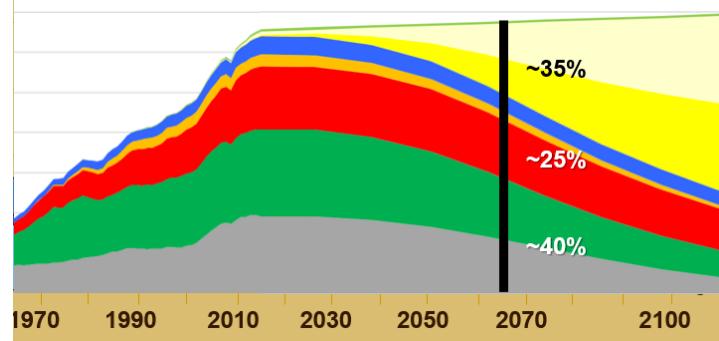
# Oil Cost of Supply

## Resources and Cost



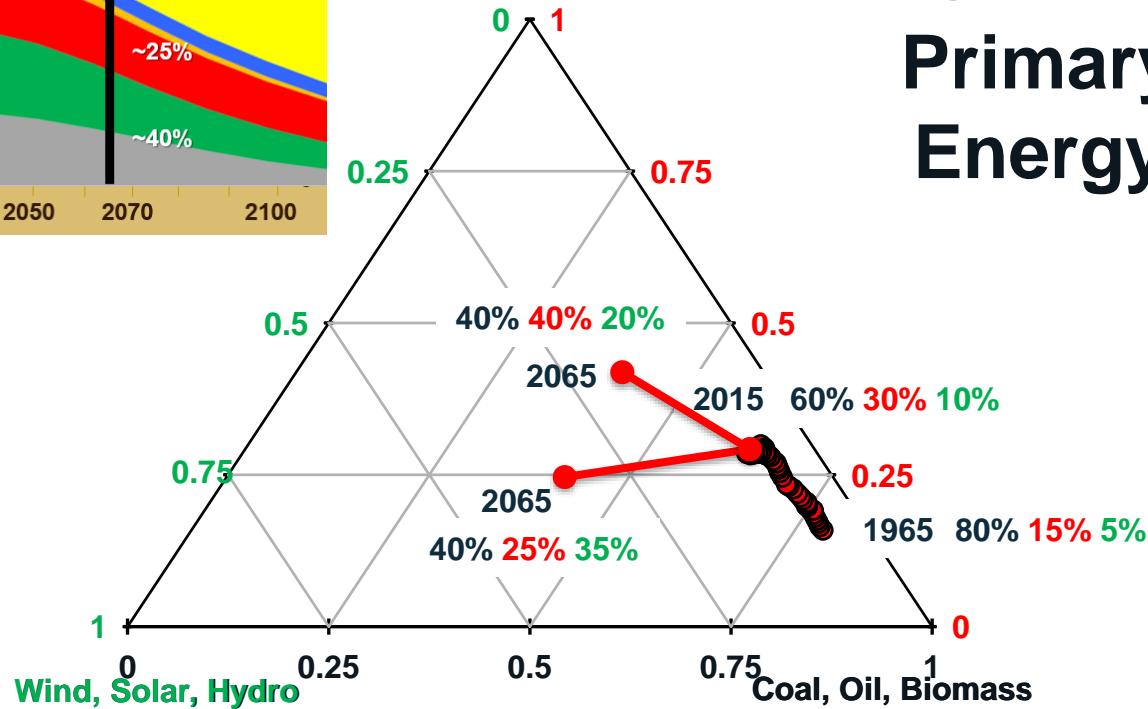
# Population and Energy





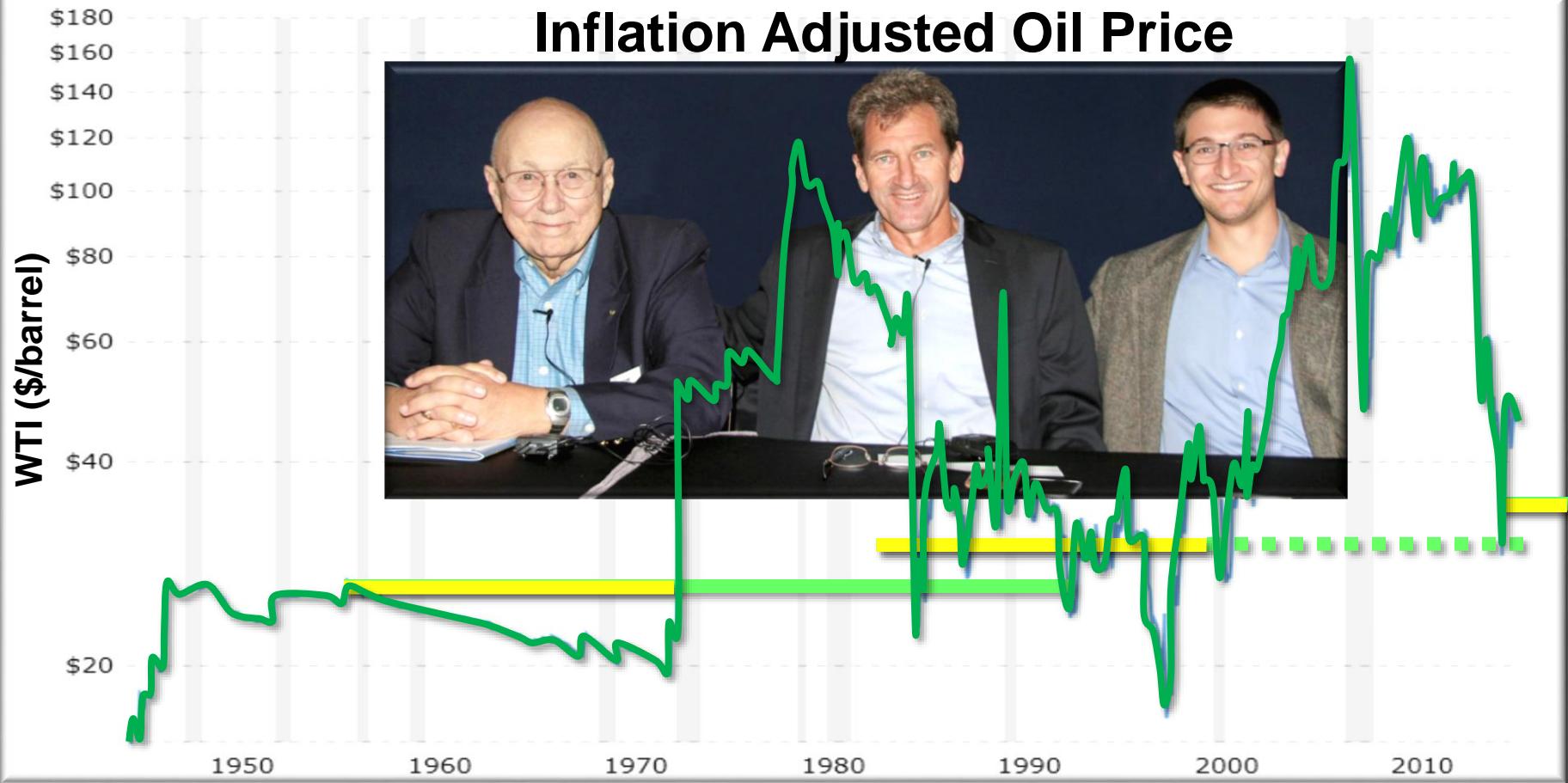
Natural Gas, Nuclear

# Global Primary Energy



# 60 Years and Counting

## Inflation Adjusted Oil Price

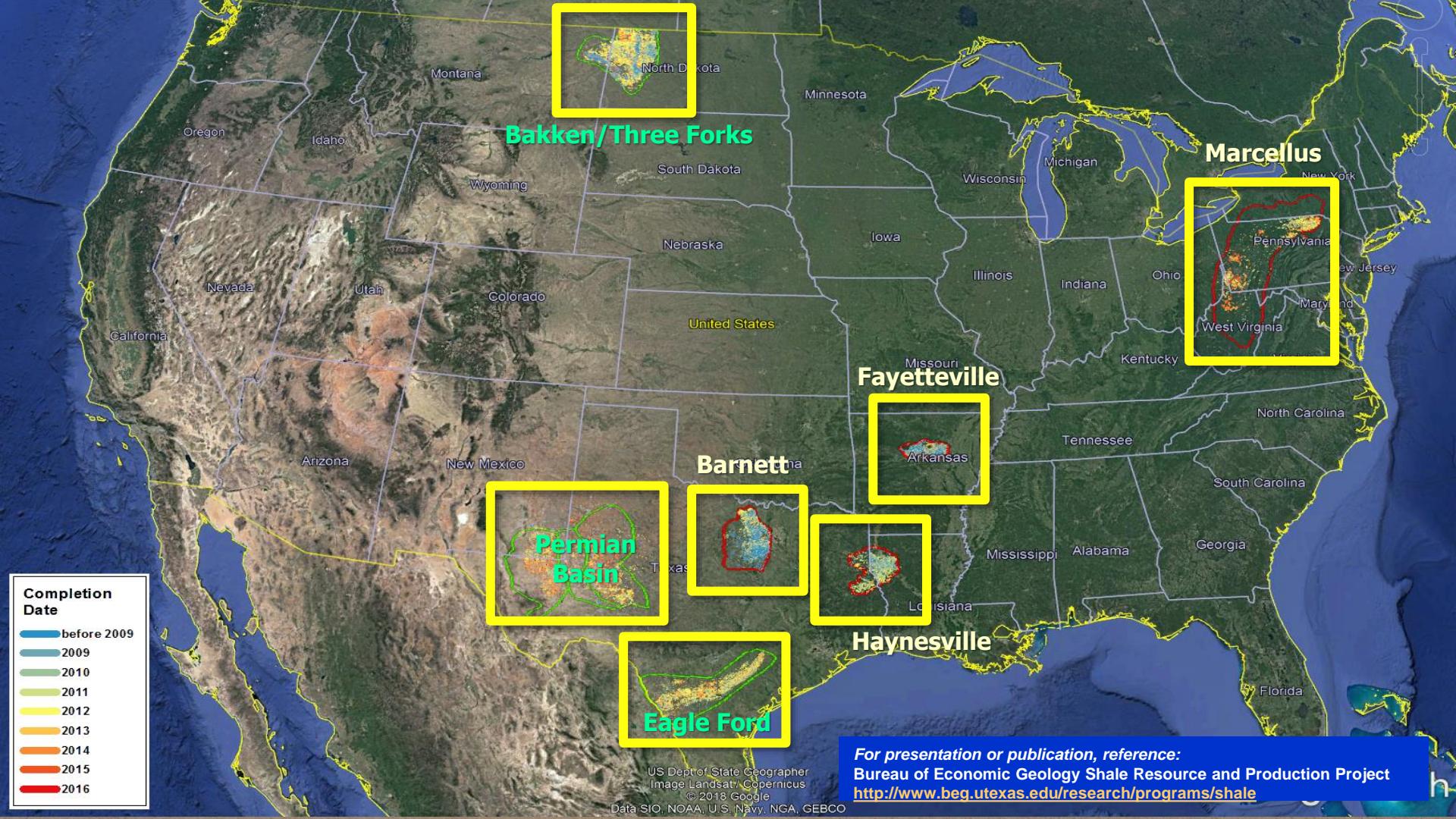


# Outline

- ❖ Global Energy Mix
- ❖ US Shale Super Basins
- ❖ Super Basin Sustainability

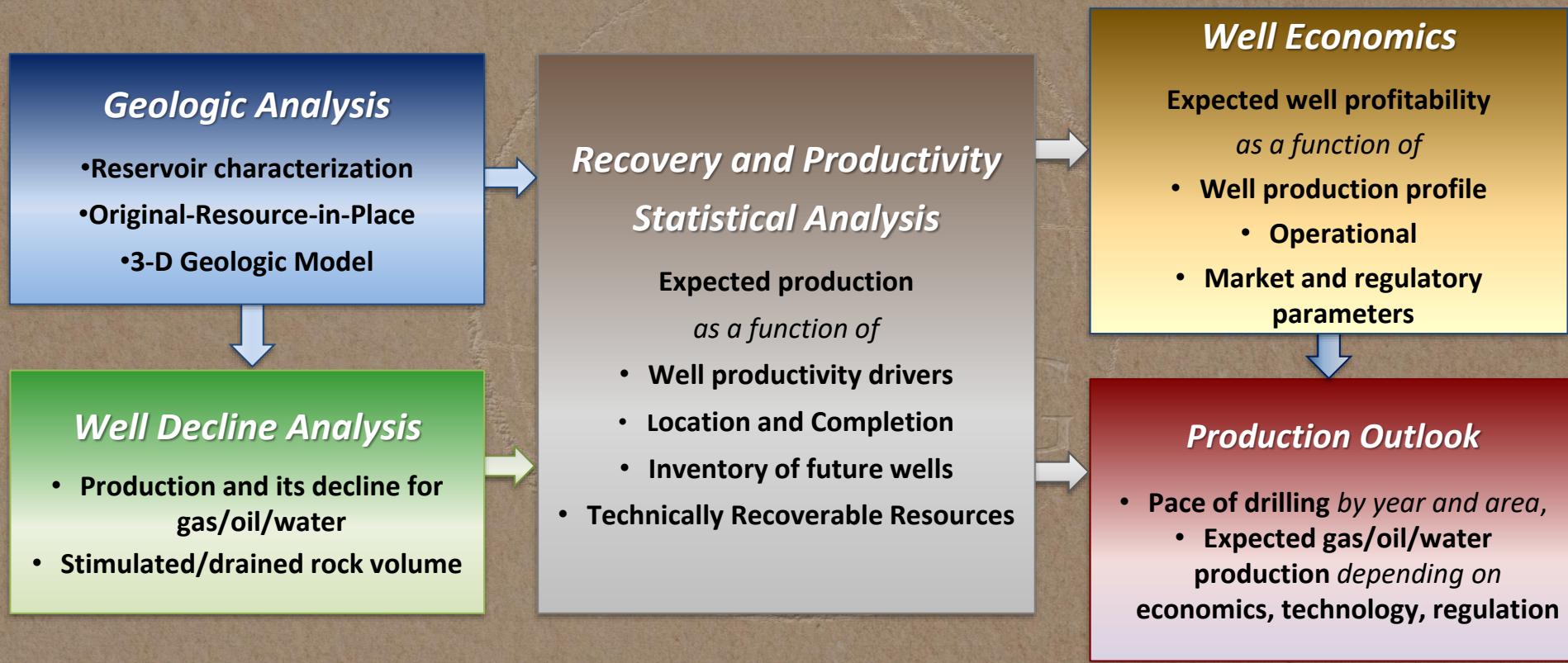


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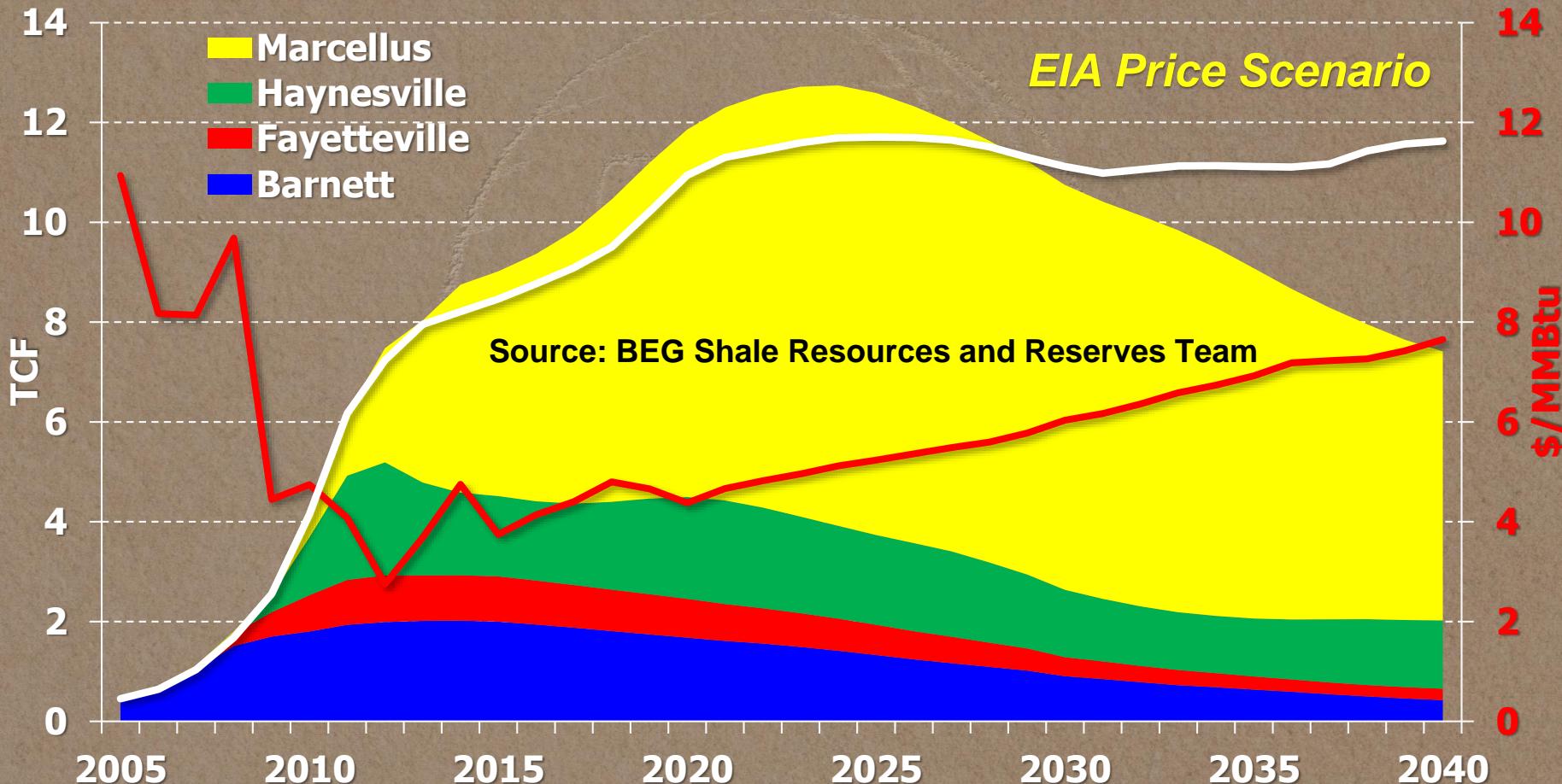


# BEG Tight Oil Resource Assessment (TORA)

## *Integrated Study Workflow*



# U.S. Shale Gas



# U.S. Shale Gas

14

14

Formation	OGIP <sub>free</sub>	Prod. through 2045			RF (P50)
		P10	P50	P90	
Barnett	444	37	47	57	11%
Fayetteville	80	12	18	23	23%
Haynesville	489	33	52	72	11%
Marcellus	2071	-	183	-	9%
	3084		300		10%



0

2005

2010

2015

2020

2025

2030

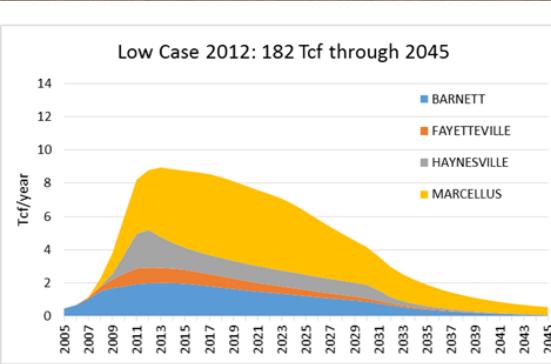
2035

2040

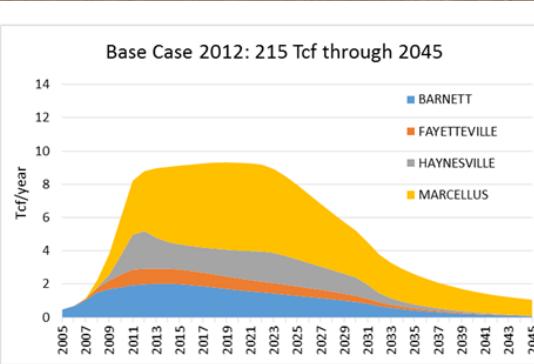
# U.S. Shale Gas

2012

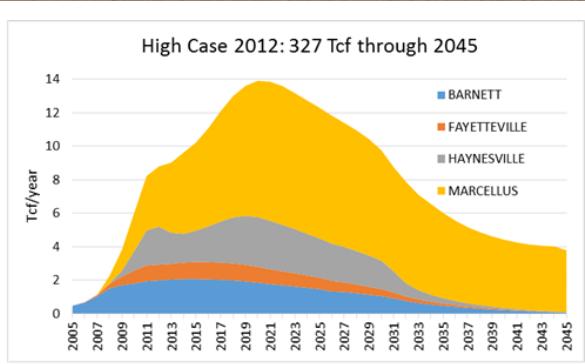
Low



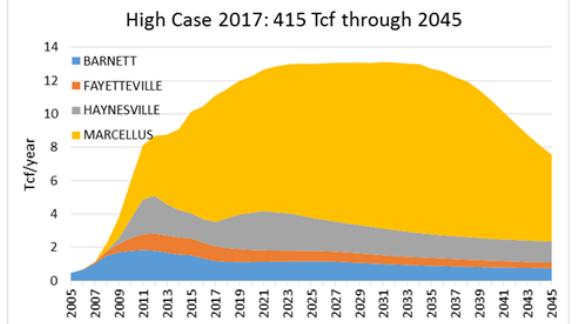
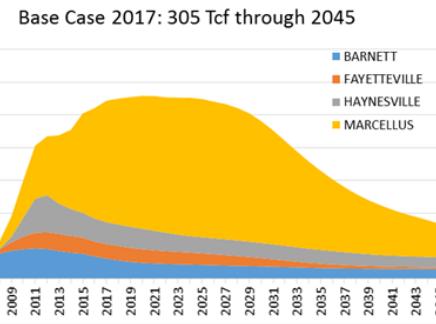
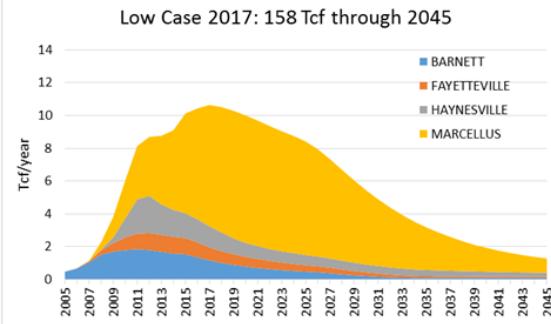
Base



High



2017

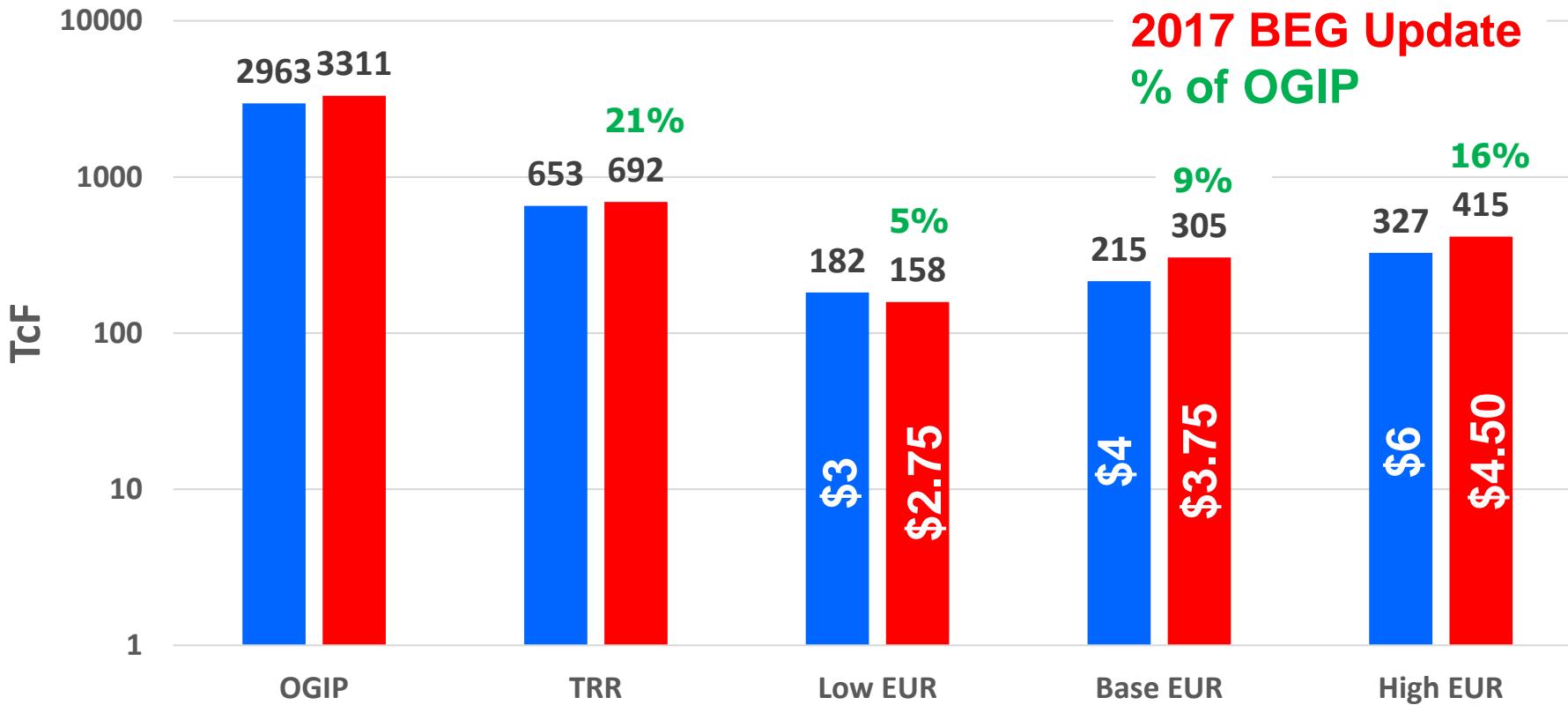


For presentation or publication, reference: Bureau of Economic Geology Shale Resource and Production Project  
<http://www.beg.utexas.edu/research/programs/shale>

# U.S. Shale Gas

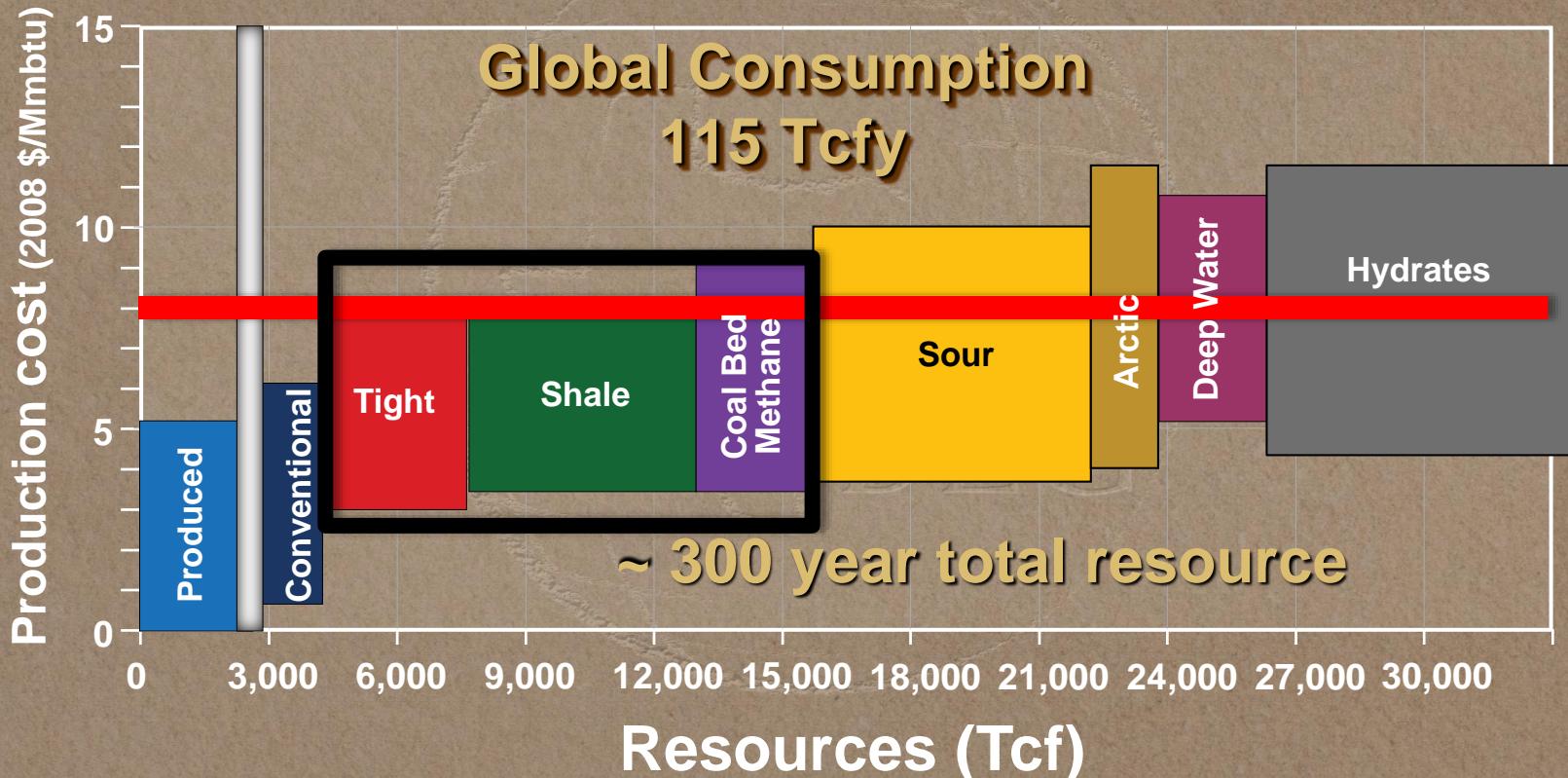
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## Barnett, FV, HV, Marcellus



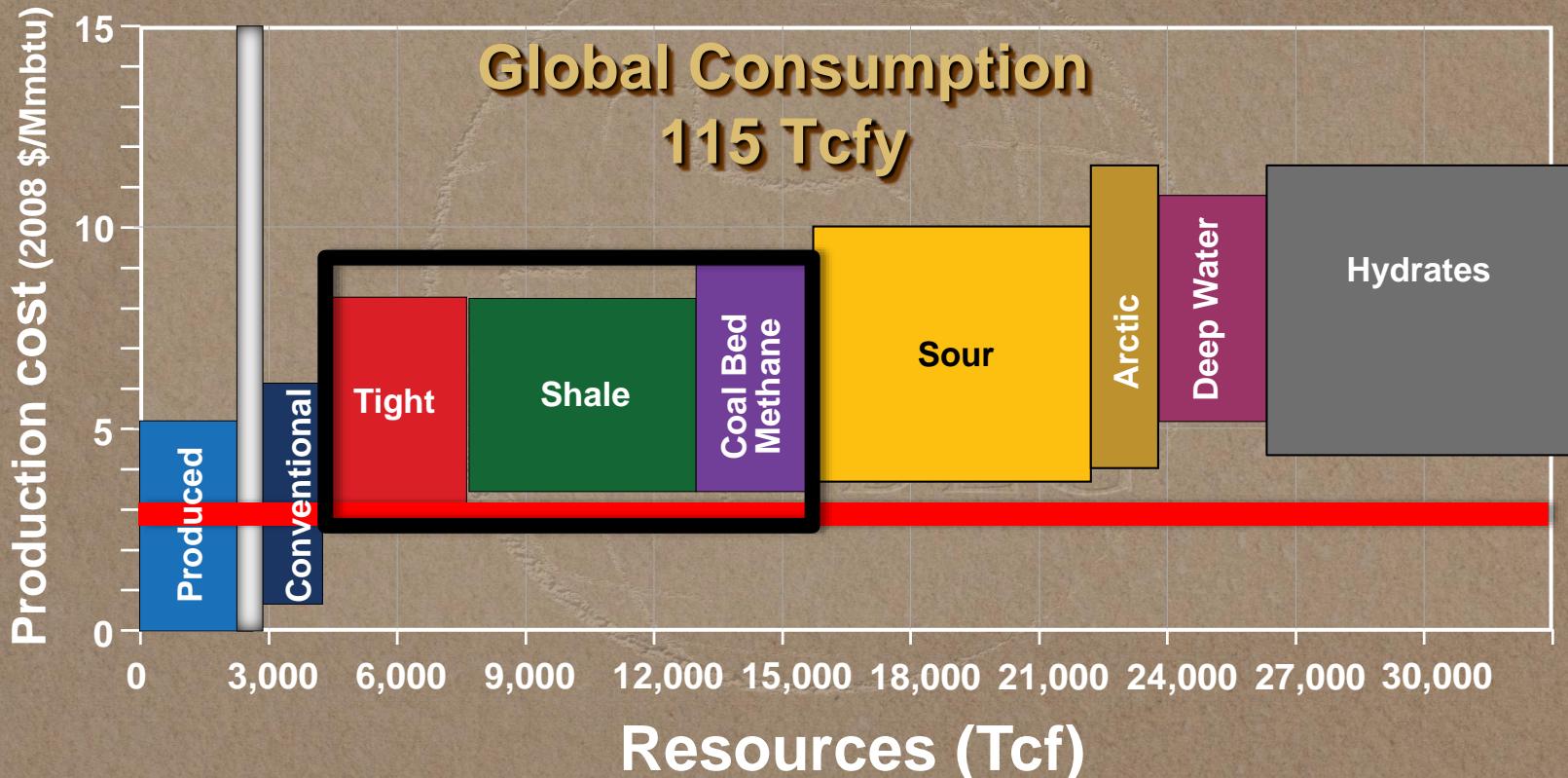
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## Resources v. Cost



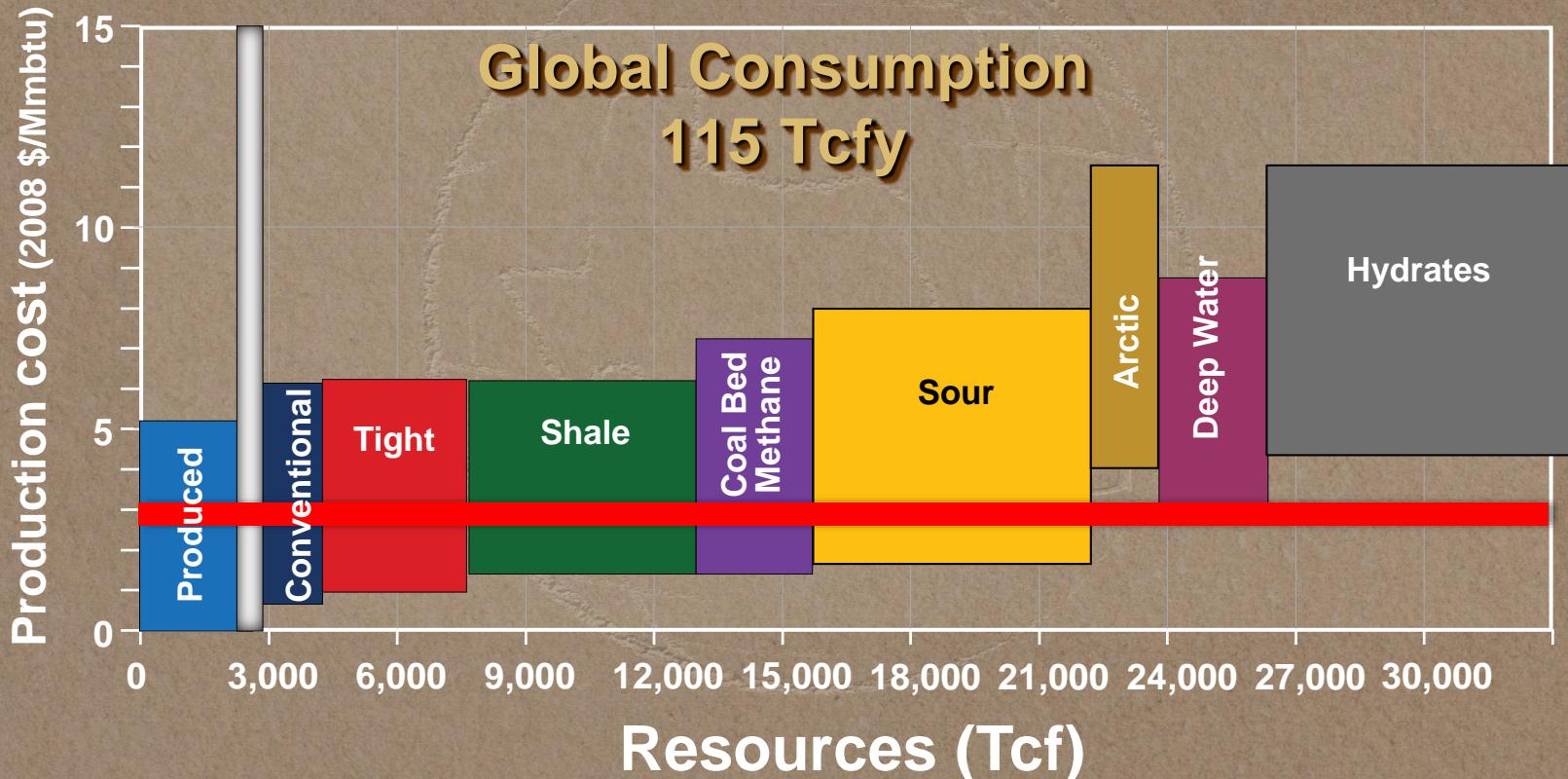
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## Resources v. Cost



# Natural Gas Cost of Supply

## *Resources v. Cost*

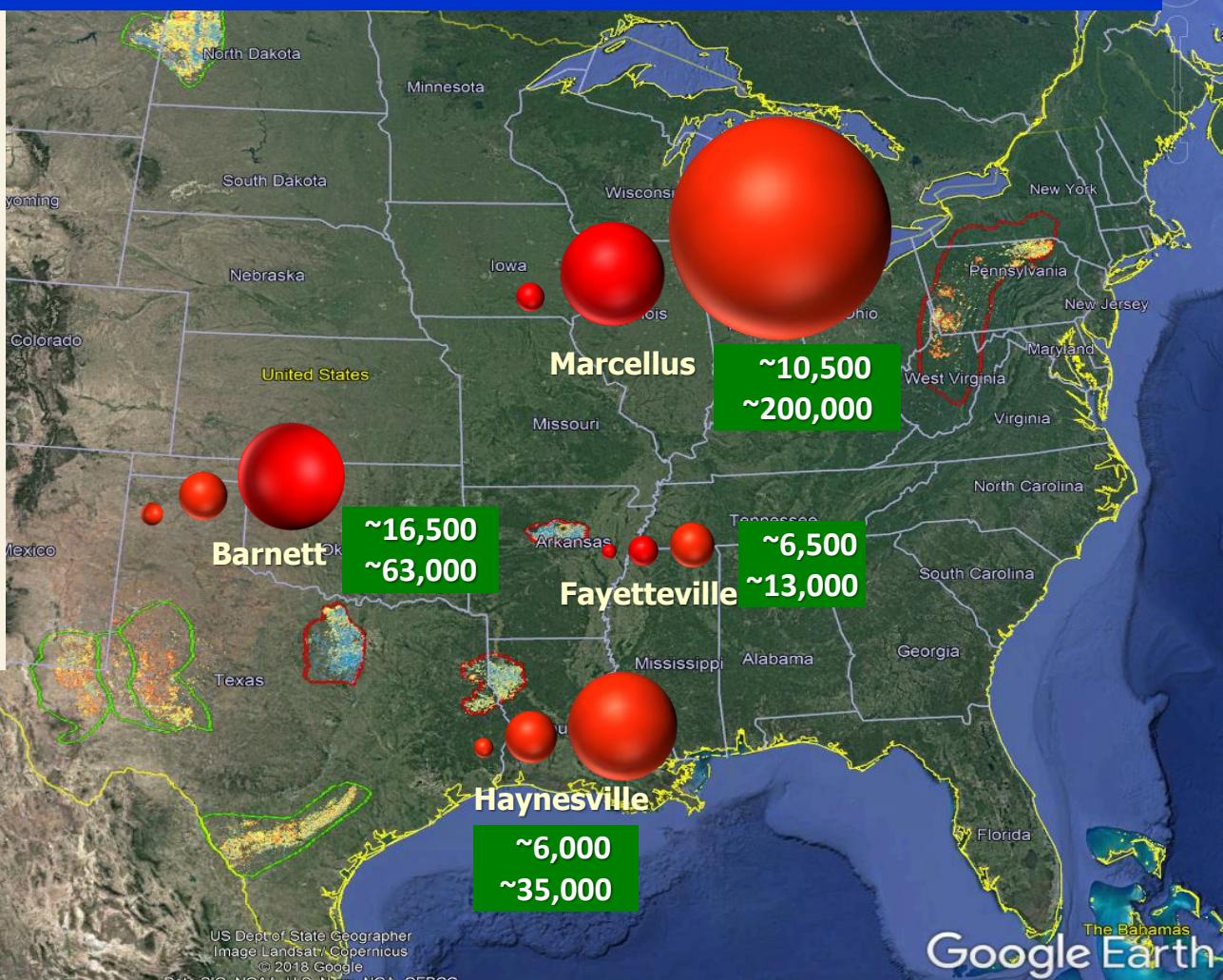
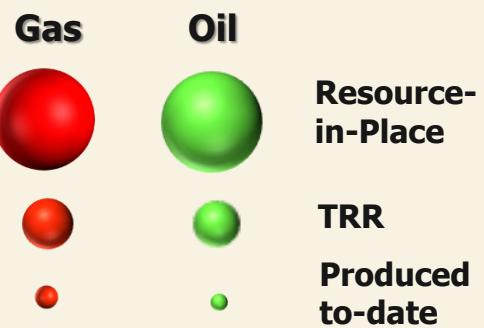


# Natural Gas Cost of Supply

## *Resources v. Cost*

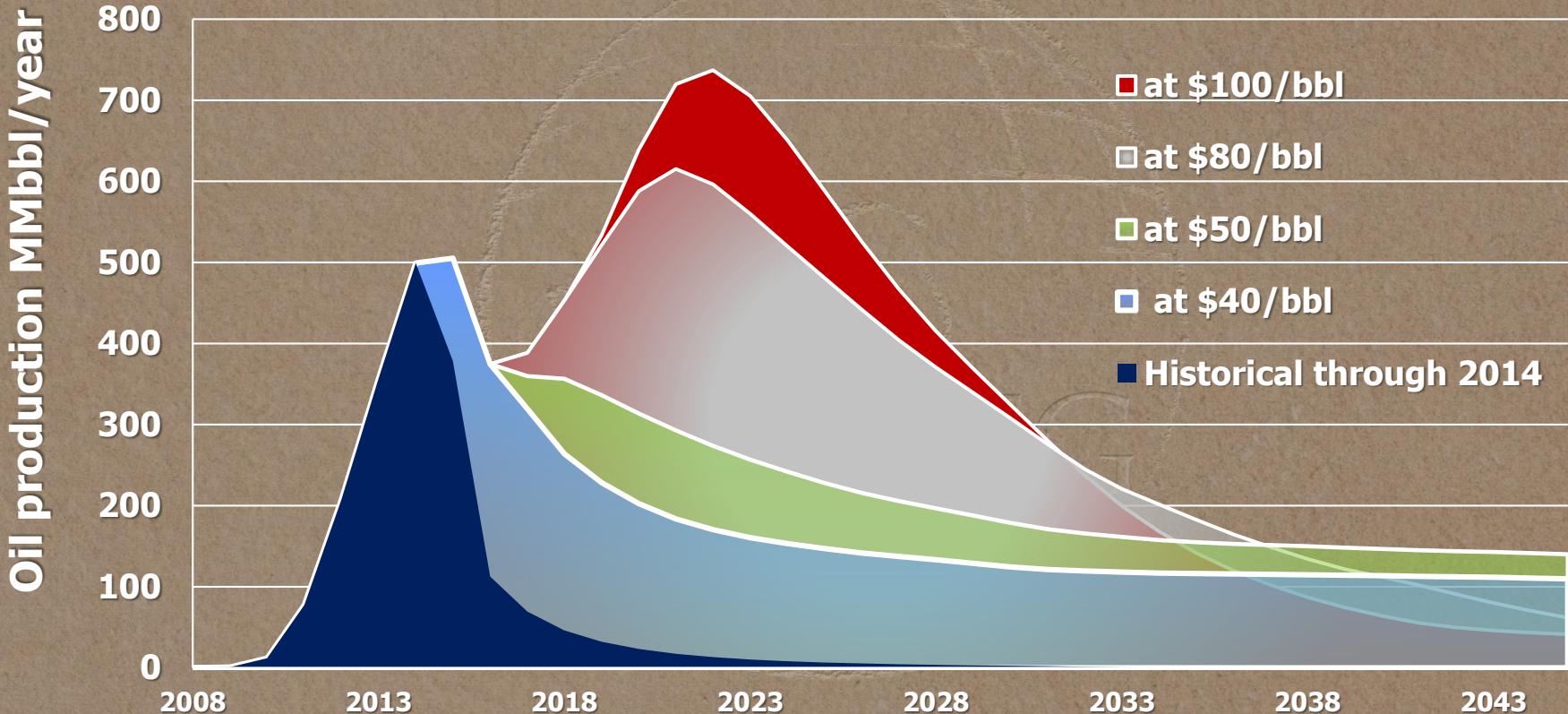
Reserves are a function of  
Price, Cost, Technology,  
Policy and Demand

	<b>Gas Tcf</b>	<b>Oil Bbb/</b>
Original In-Place	<b>3100</b>	450
Tech. Recoverable	<b>700</b>	27
Production to date	<b>70</b>	5
Horizontal wells to date		~75,000
Future wells (base case)		~500,000

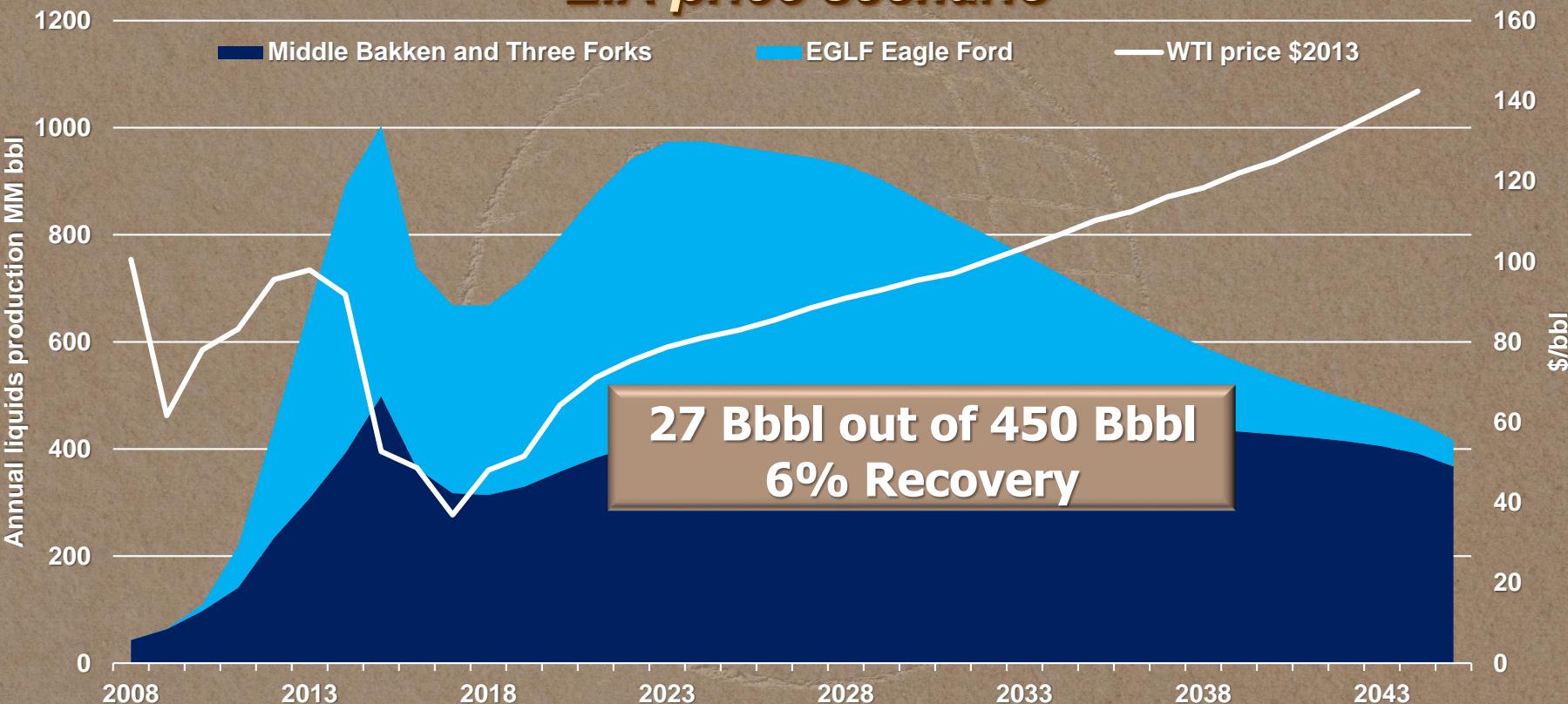


# Eagle Ford

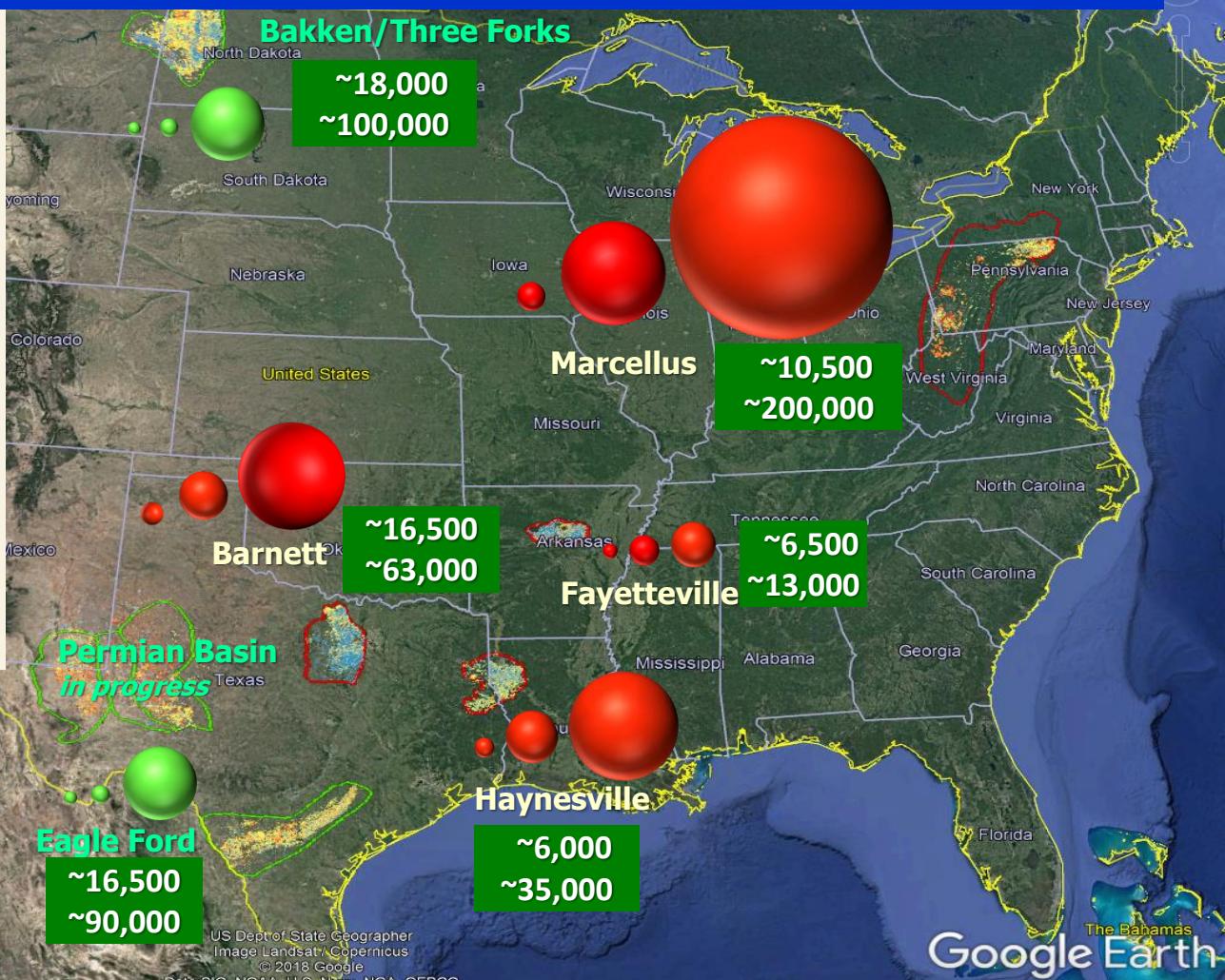
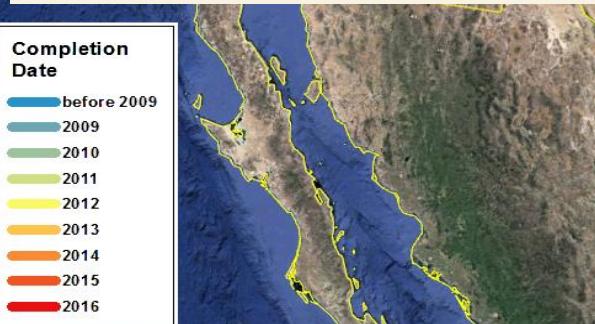
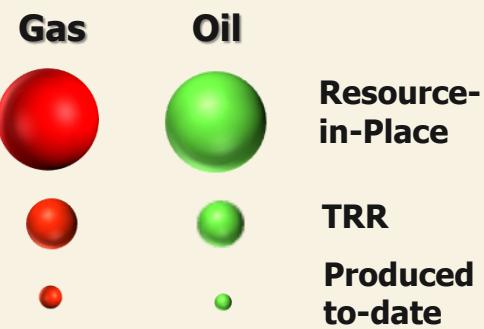
## *Oil Production Scenarios*



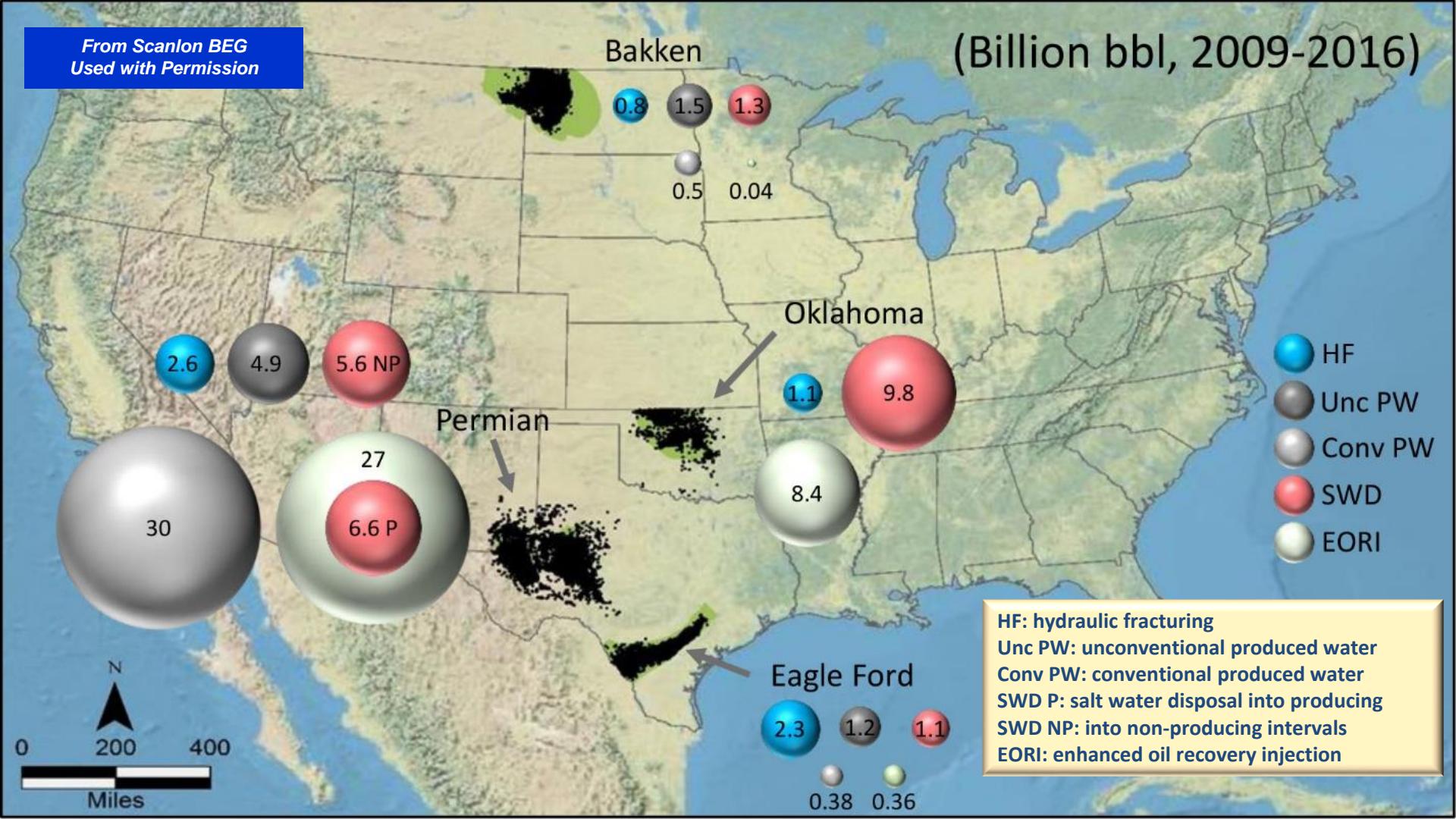
# Shale Oil Supply EIA price scenario



	<u>Gas</u> <i>Tcf</i>	<u>Oil</u> <i>Bbb/</i>
Original In-Place	<b>3100</b>	450
Tech. Recoverable	<b>700</b>	27
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(Billion bbl, 2009-2016)

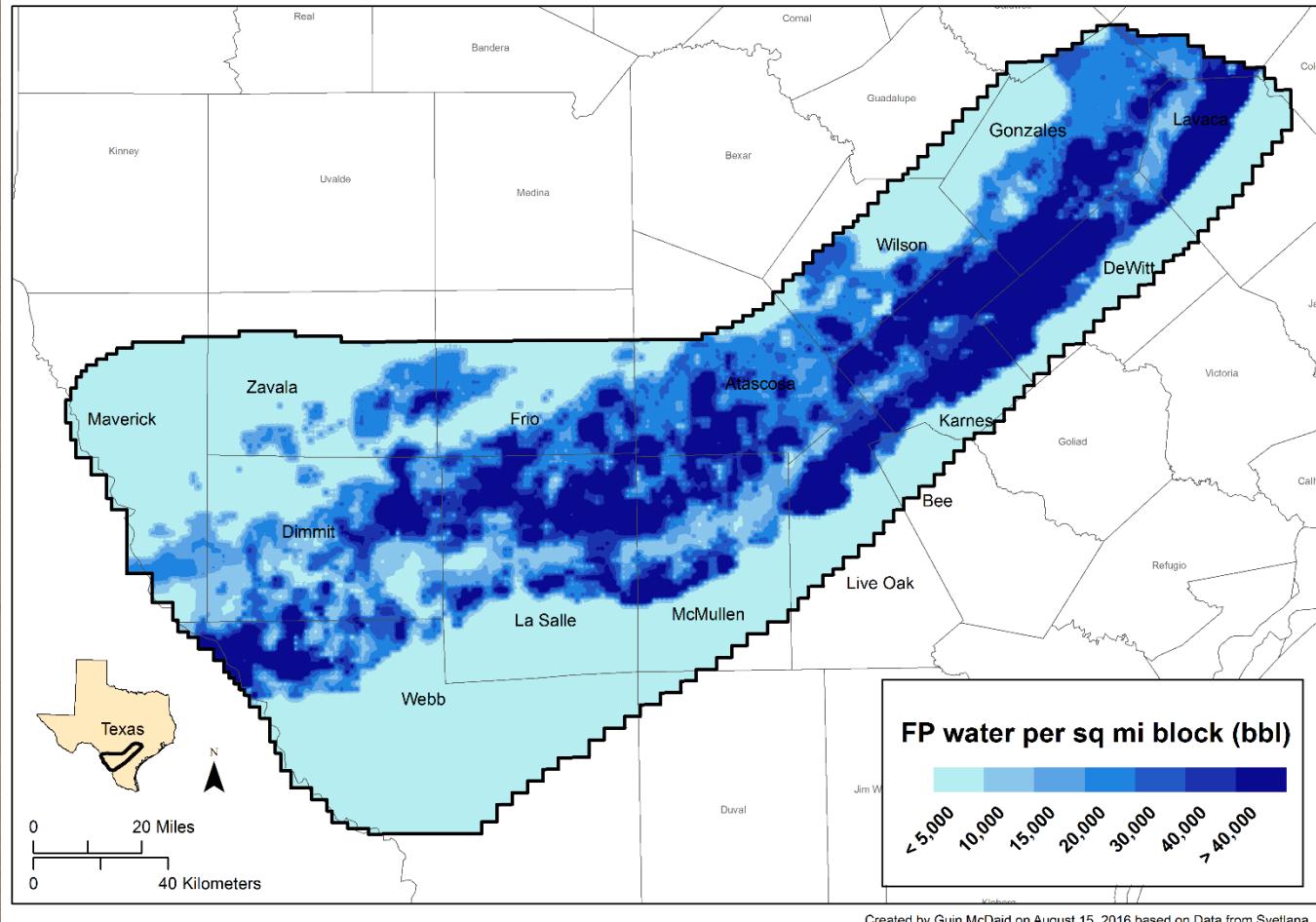


HF: hydraulic fracturing  
Unc PW: unconventional produced water  
Conv PW: conventional produced water  
SWD P: salt water disposal into producing  
SWD NP: into non-producing intervals  
EORI: enhanced oil recovery injection

# Eagle Ford Flowback and Produced Water at \$100 / Barrel - 2020

# Flowback and Produced Water Outlook

For presentation or publication,  
reference: Bureau of Economic  
Geology Shale Resource and  
Production Project  
<http://www.beg.utexas.edu/research/programs/shale>



# Super Basins

## *Environmental Impact*

- Mining and Manufacturing
- Drilling and Completion: *Land and Water*
- Transportation: *Pipelines, Trucks, Ships, Rail*
- Refining and Petrochemicals: *Emissions*
- Combustion: *Vehicle and Power Plant Emission*
- Social and Political

# Environmental Impact *Renewables and Batteries*

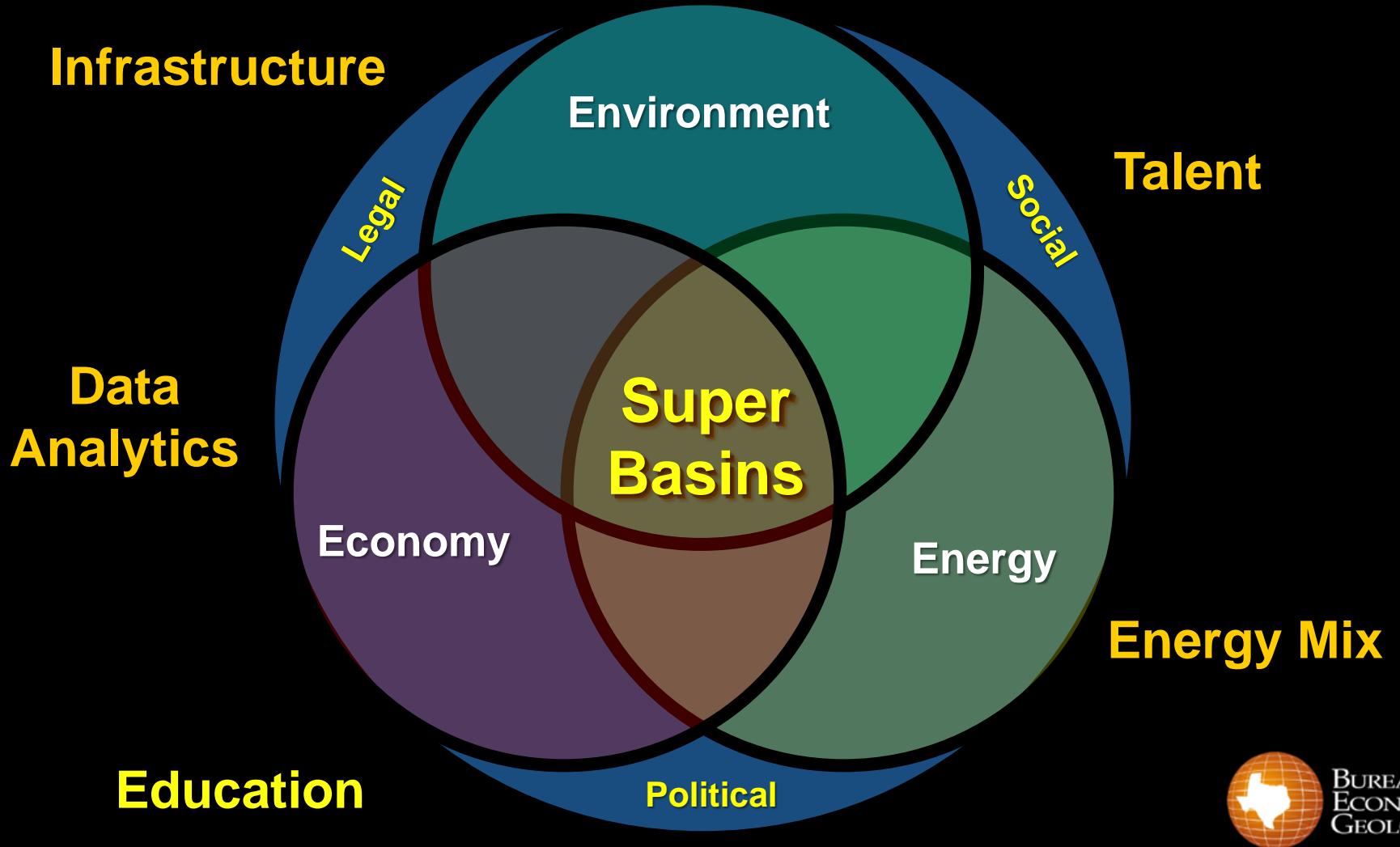
- Mining and Processing *Land, Water, Emissions*
- Manufacturing: *Turbines, Panels, Batteries*
- Production: *Land for “Farms”*
- Transmission: *Electricity*
- Disposal: *Landfill*

# Outline

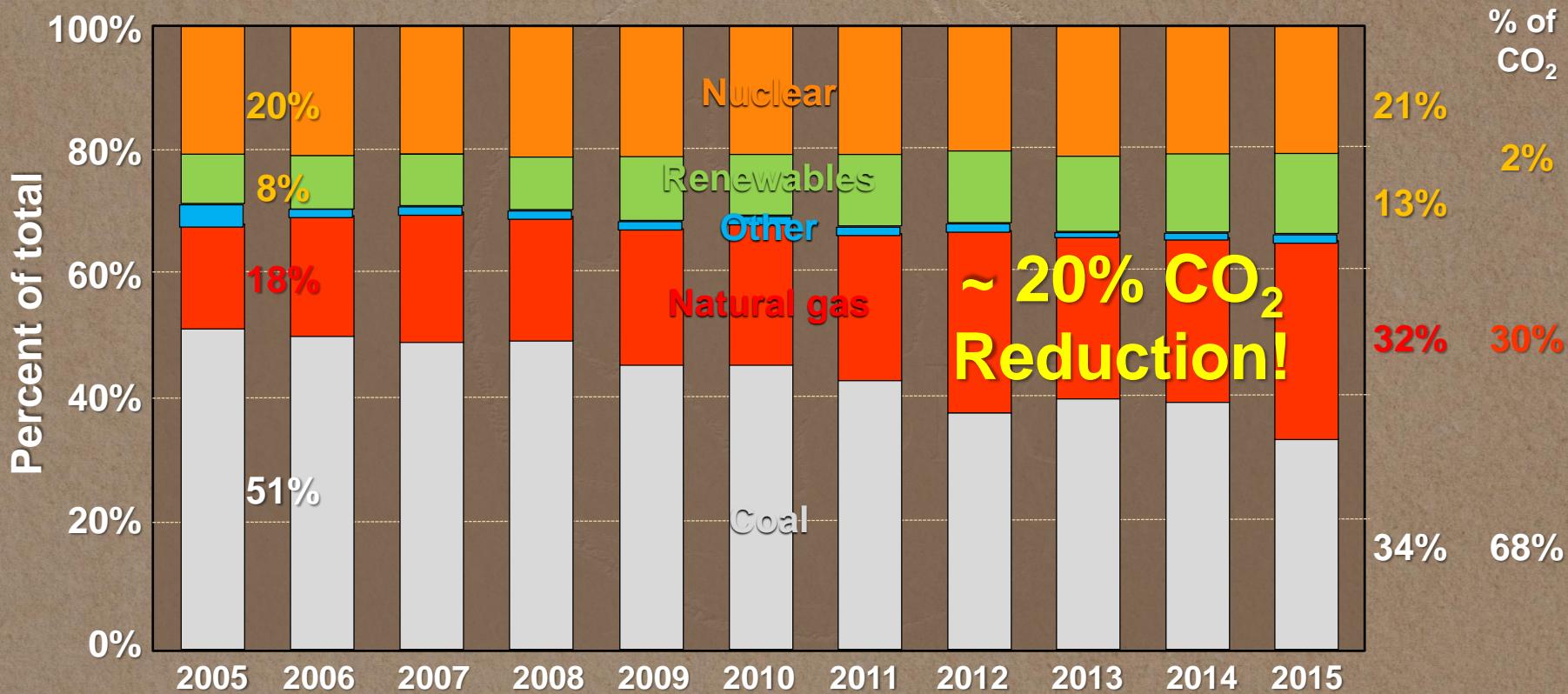
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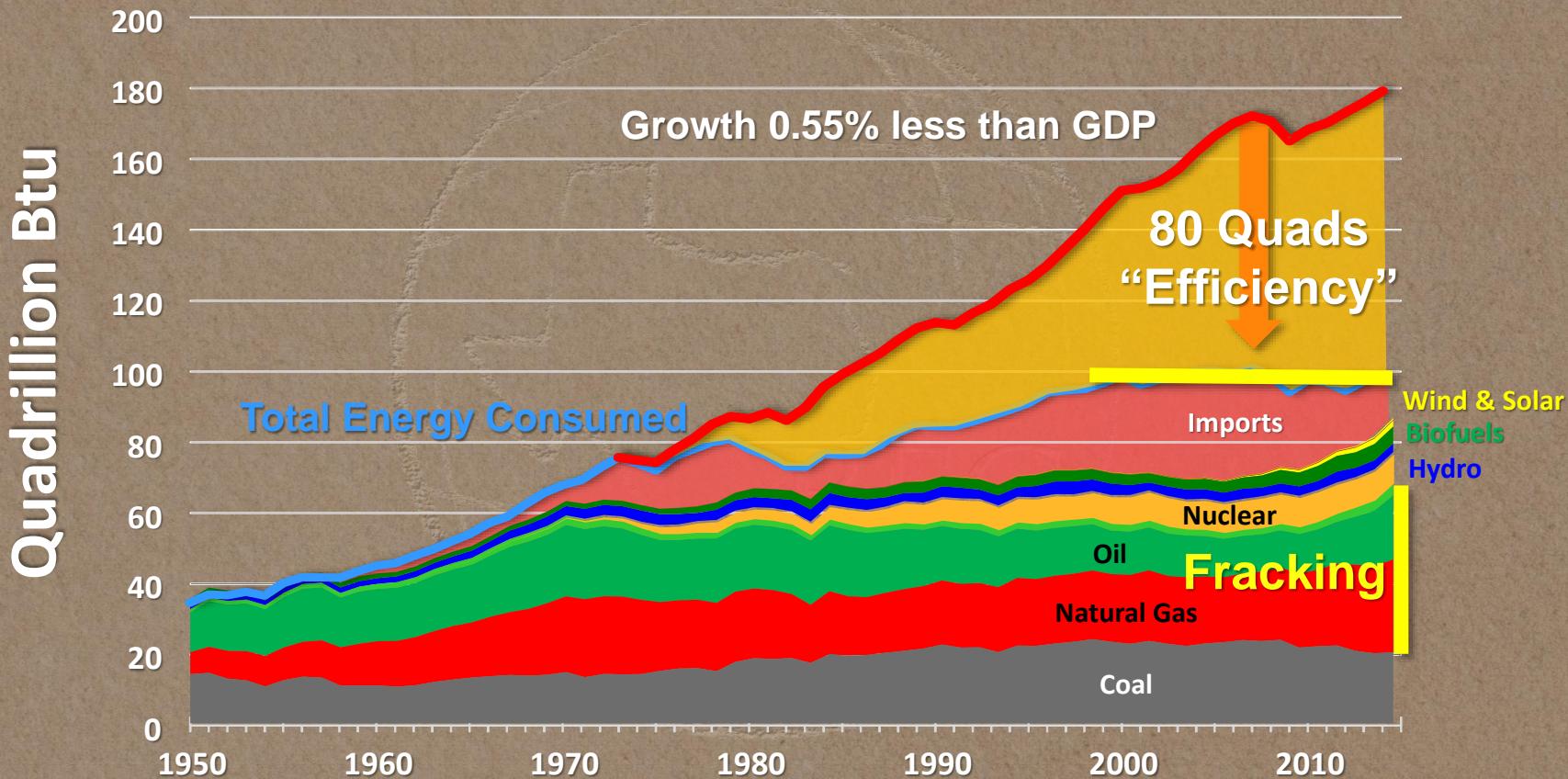
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# U.S. Electric Generation Shares (2005-15)



# US Energy Mix



# Electricity and Poverty

Poverty and electricity access in selected developing countries, circles sized by total population

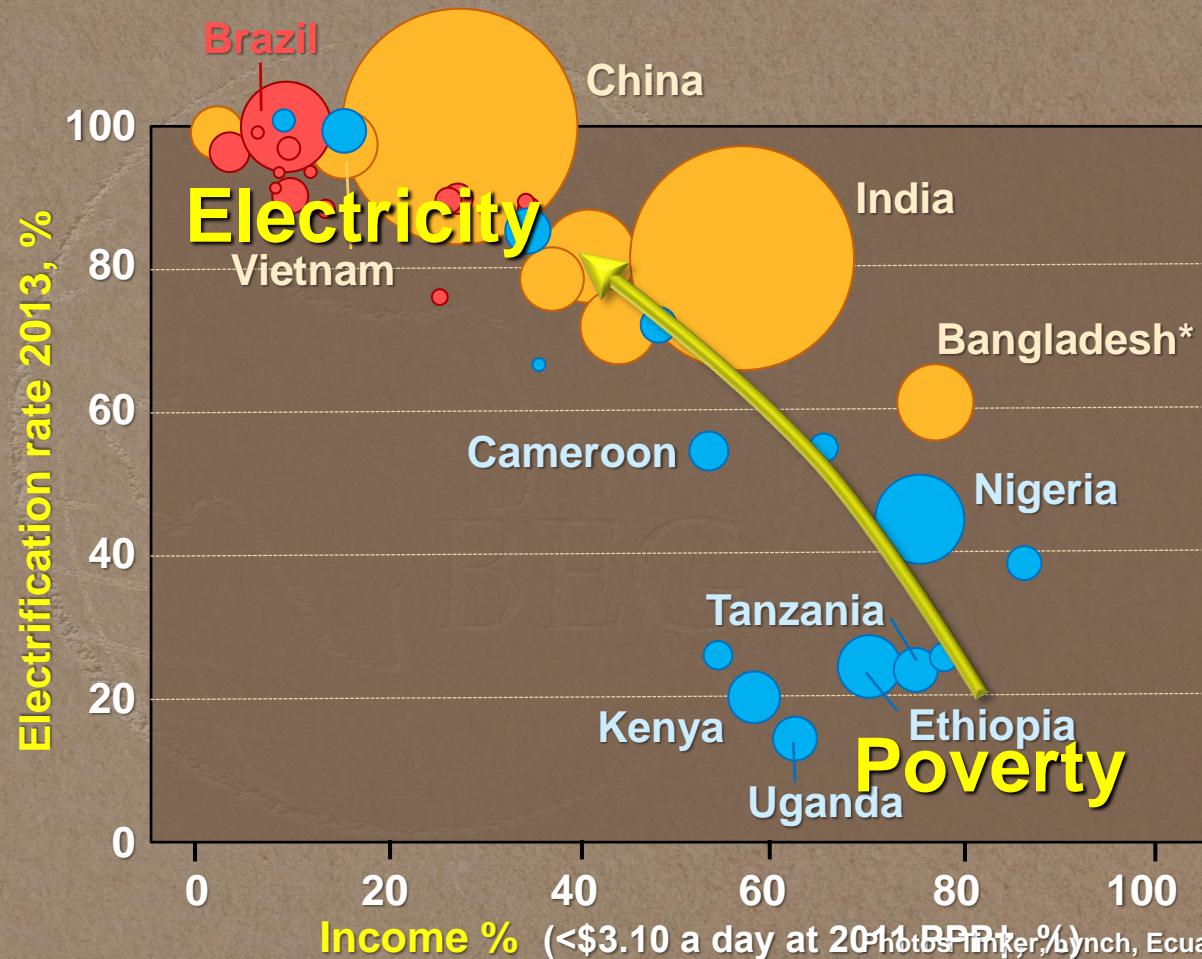
Africa

Asia

Latin America

\* Bangladesh uses 2005 PPP and \$2 a day poverty line

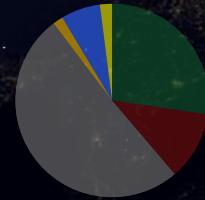
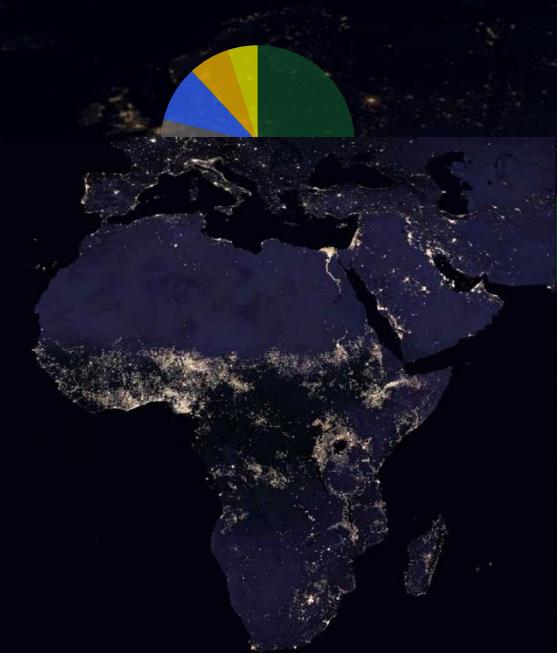
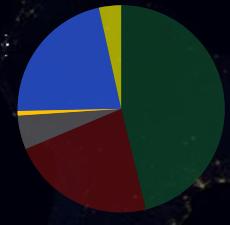
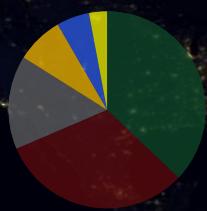
† Purchasing power parity



# *What do the “Educators” Communicate*

There is “good” energy and  
“bad” energy...

Renewables and batteries are “good”  
Fossils and nuclear are “bad”...



Keep **IT** in the Ground. Keep **THEM** in Poverty.

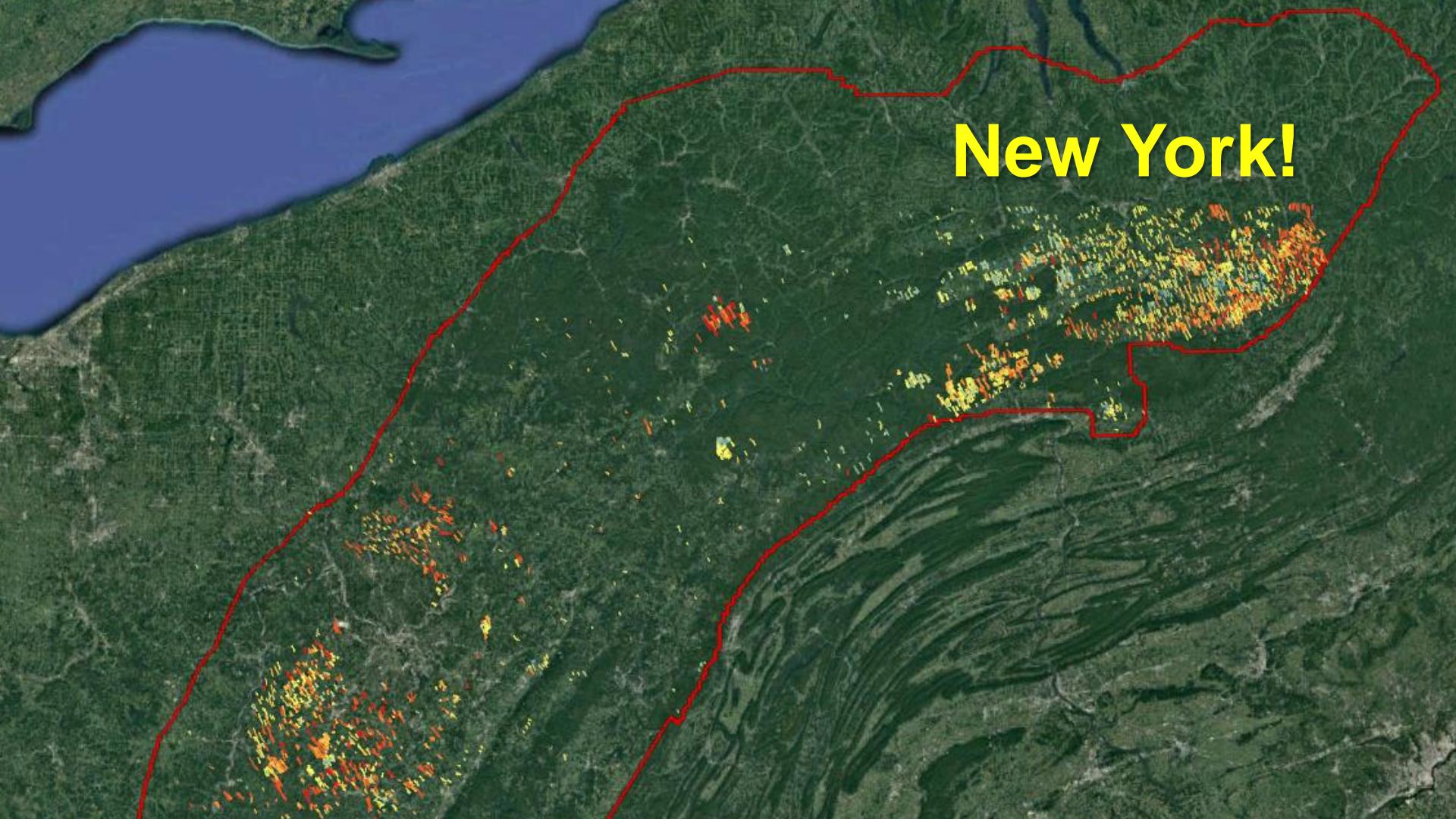
# Super Basin Key Issues

## ➤ Manage Complexity

- Oil & Gas supply and demand dynamics
- Power sector
- Human infrastructure
- Agriculture
- Regulators, policy makers, public perception

## ➤ Cooperate and Coordinate

- Across states and stakeholders
- Availability of water, land, energy
- Conflicts of interest
- Planning and Financing
- Law and politics



New York!

# Sustainability of Super Basins

- ❖ Energy: Scale and Diversity Matter
- ❖ Public Engagement: Vital
- ❖ Education: A Contact Sport

A silhouette of a large, gnarled acacia tree stands prominently against a vibrant orange and yellow sunset sky. The foreground is dark, creating a strong contrast with the bright background.

# Thank You...

...for what you do!