KBH

September, 2018

Energy, Carbon, and Poverty

Is Compromise Possible

SWITCH ENERGY ALLIANCE

Scott W. Tinker

Bureau of Economic Geology

The Western Narrative

Renewables and batteries are "clean" and "good"…

Fossil energy and nuclear are "dirty" and "bad"…

SWITCH ENERGY ALLIANCE

BUREAU OF ECONOMIC GEOLOGY

The Dilemma

Most people do not know how electricity is made or where gasoline comes from.

But… they think they do!

SWITCH ENERGY ALLIANCE

BUREAU OF ECONOMIC GEOLOGY

Outline

- Energy
- Carbon
- Poverty
- Radical Middle

SWITCH
ENERGY ALLIANCE

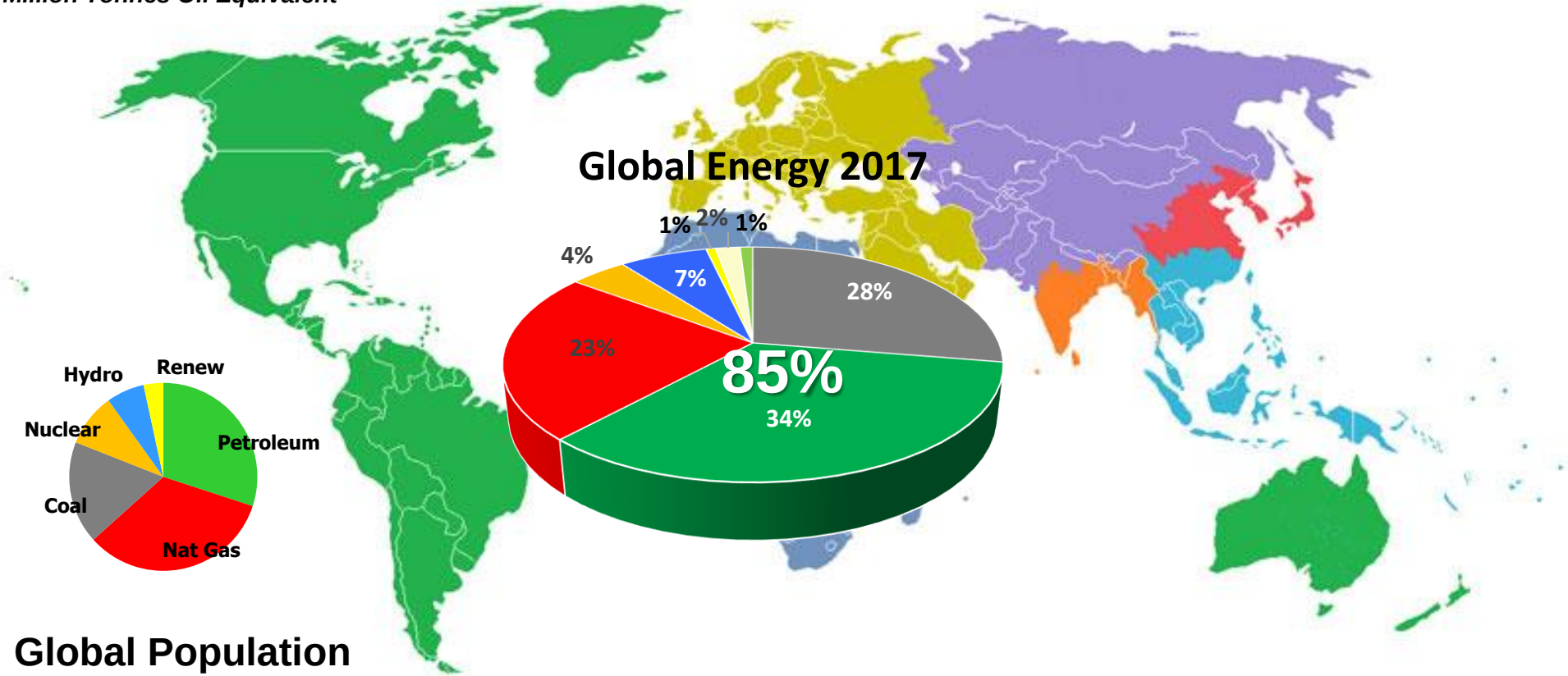
Bureau of Economic Geology

Energy Security

Affordable	Cost: per unit of energy
	Price Volatility: stable or fluctuating
	Infrastructure: cost to build the plant
Available	Access: substantial resources
Reliable	Intermittent: source consistent or variable
	Safe: natural/human causes
Sustainable	Clean: air and atmospheric emissions
	Dense: energy per area, weight and volume
	Dry: fresh water use/risk

The Global Energy Mix

Million Tonnes Oil Equivalent



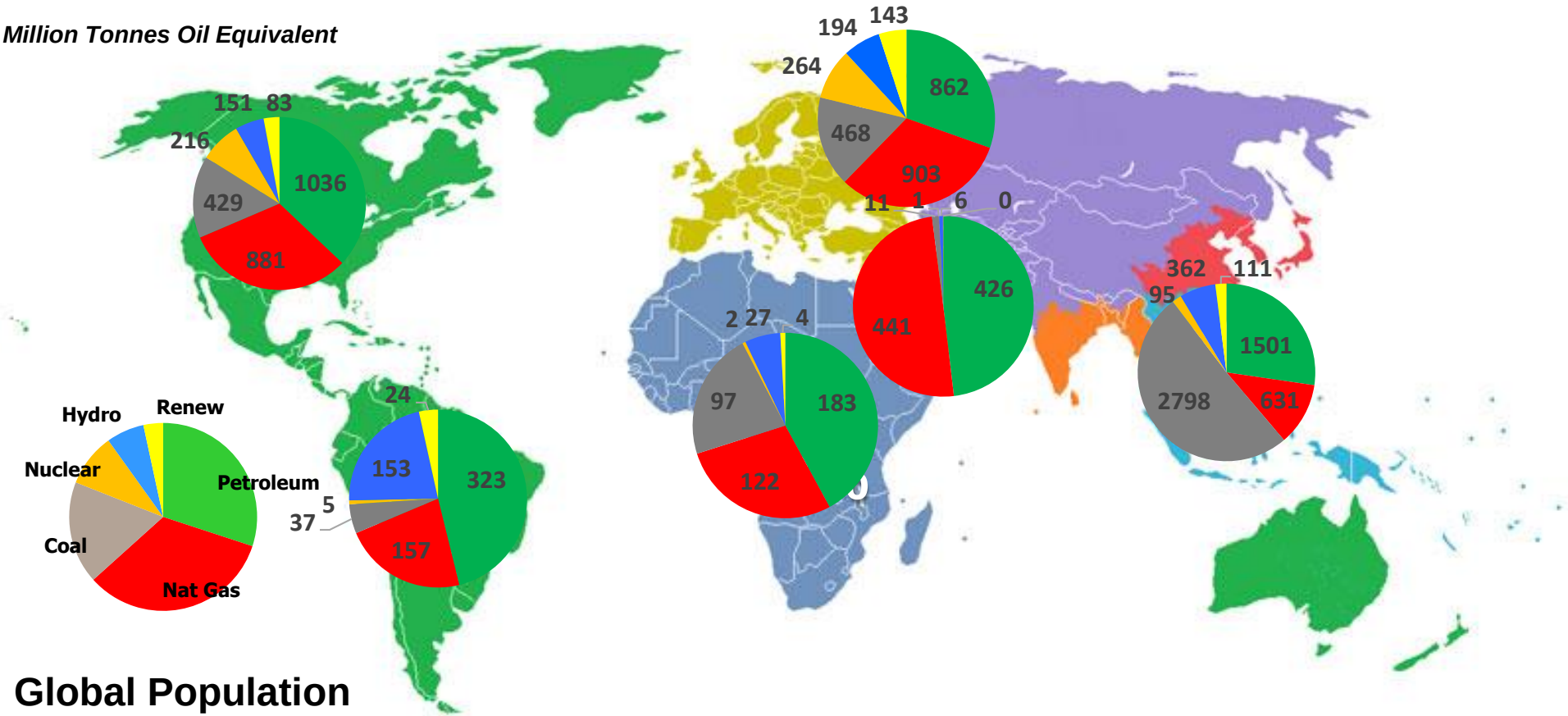
Global Population

Each color on the map represents ~ 1 billion people

Data: BP Statistical View of World Energy (2018)

The Global Energy Mix

Million Tonnes Oil Equivalent



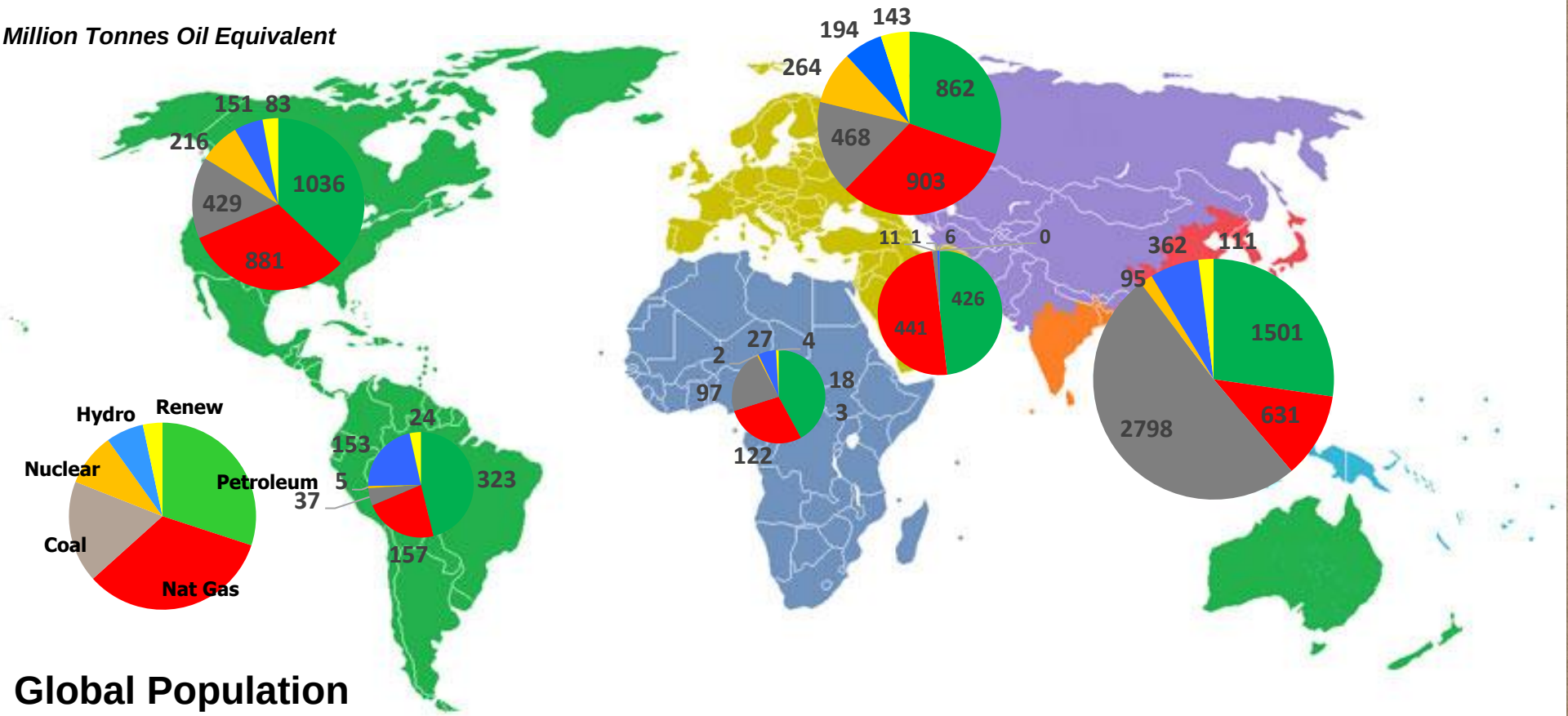
Global Population

Each color on the map represents ~ 1 billion people

Data: BP Statistical View of World Energy (2016)

Global Energy Demand

Million Tonnes Oil Equivalent

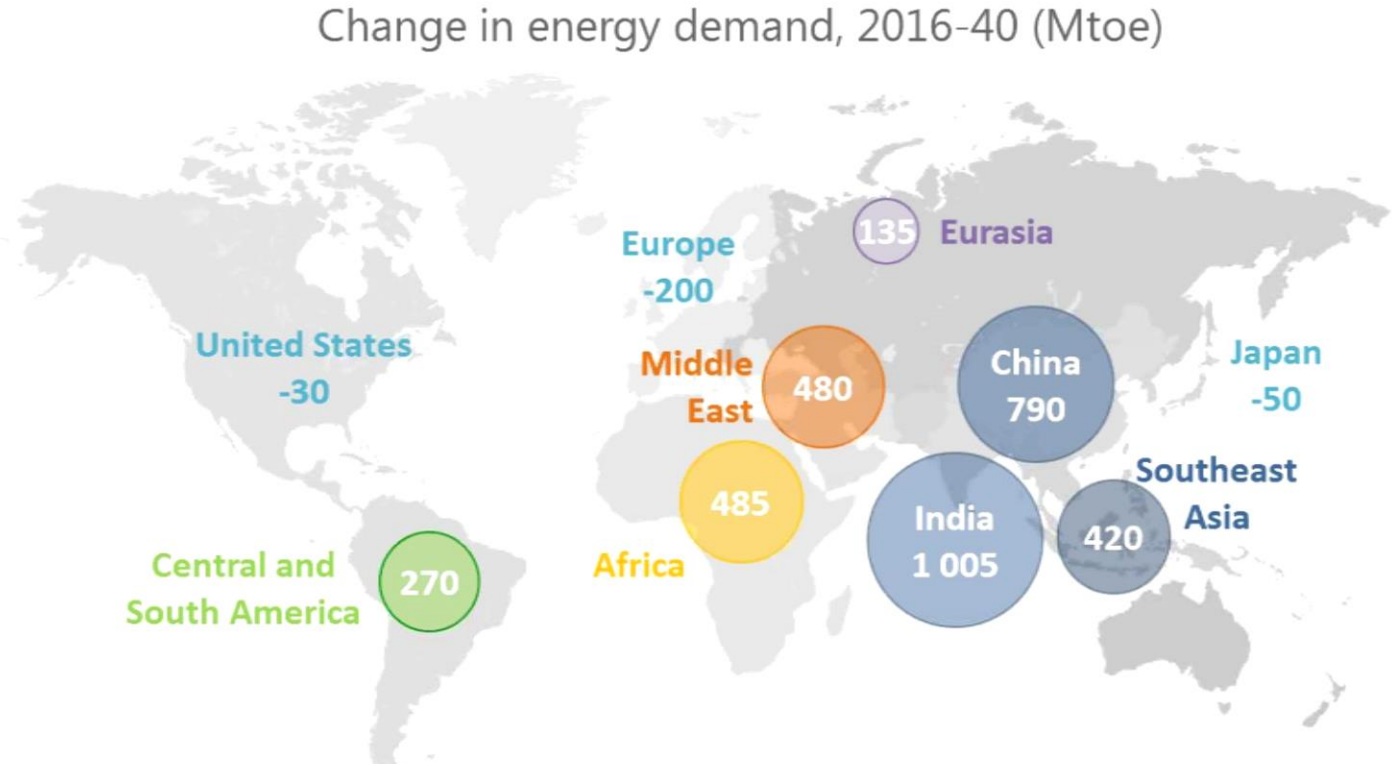


Global Population

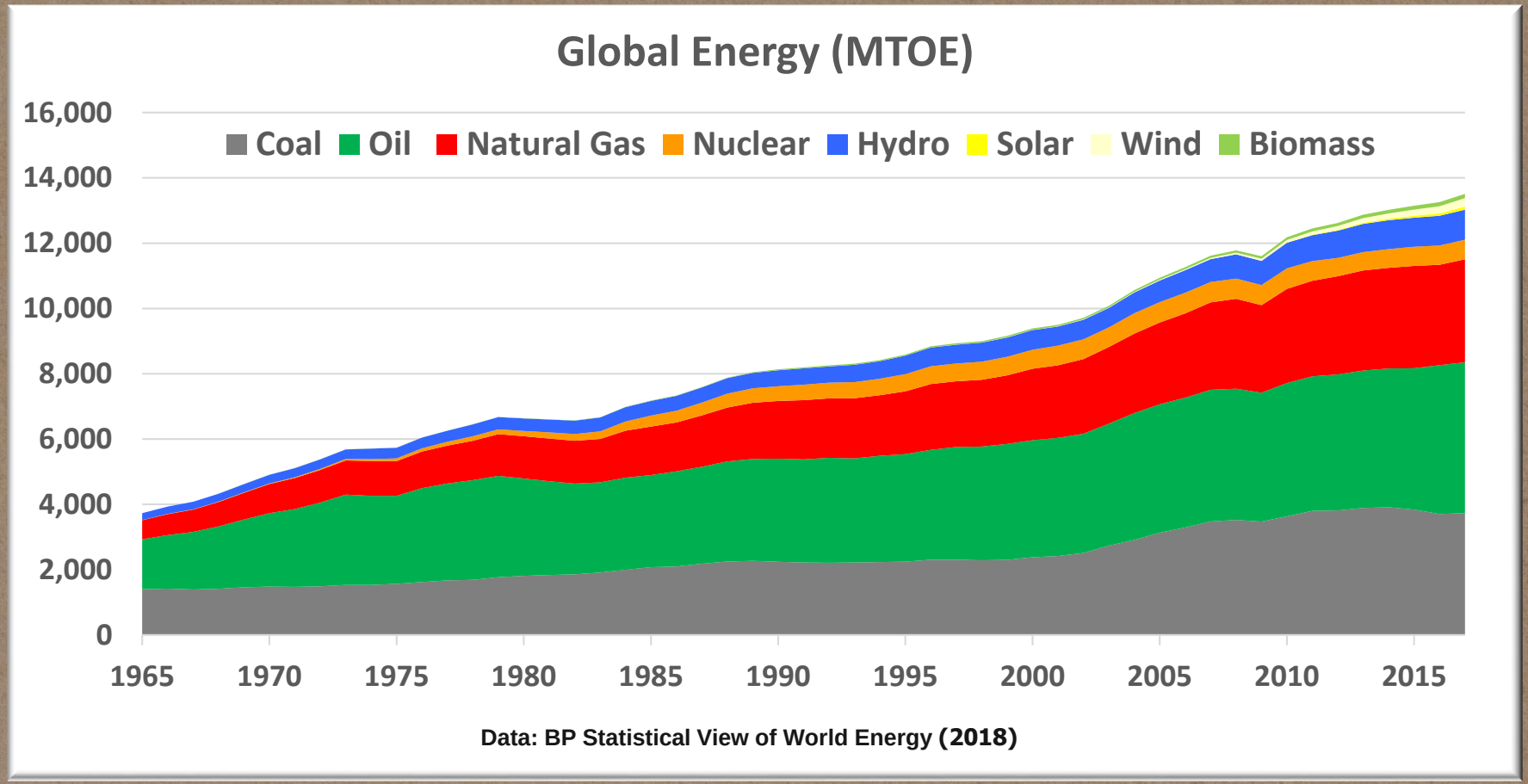
Each color on the map represents ~ 1 billion people

Data: BP Statistical View of World Energy (2016)

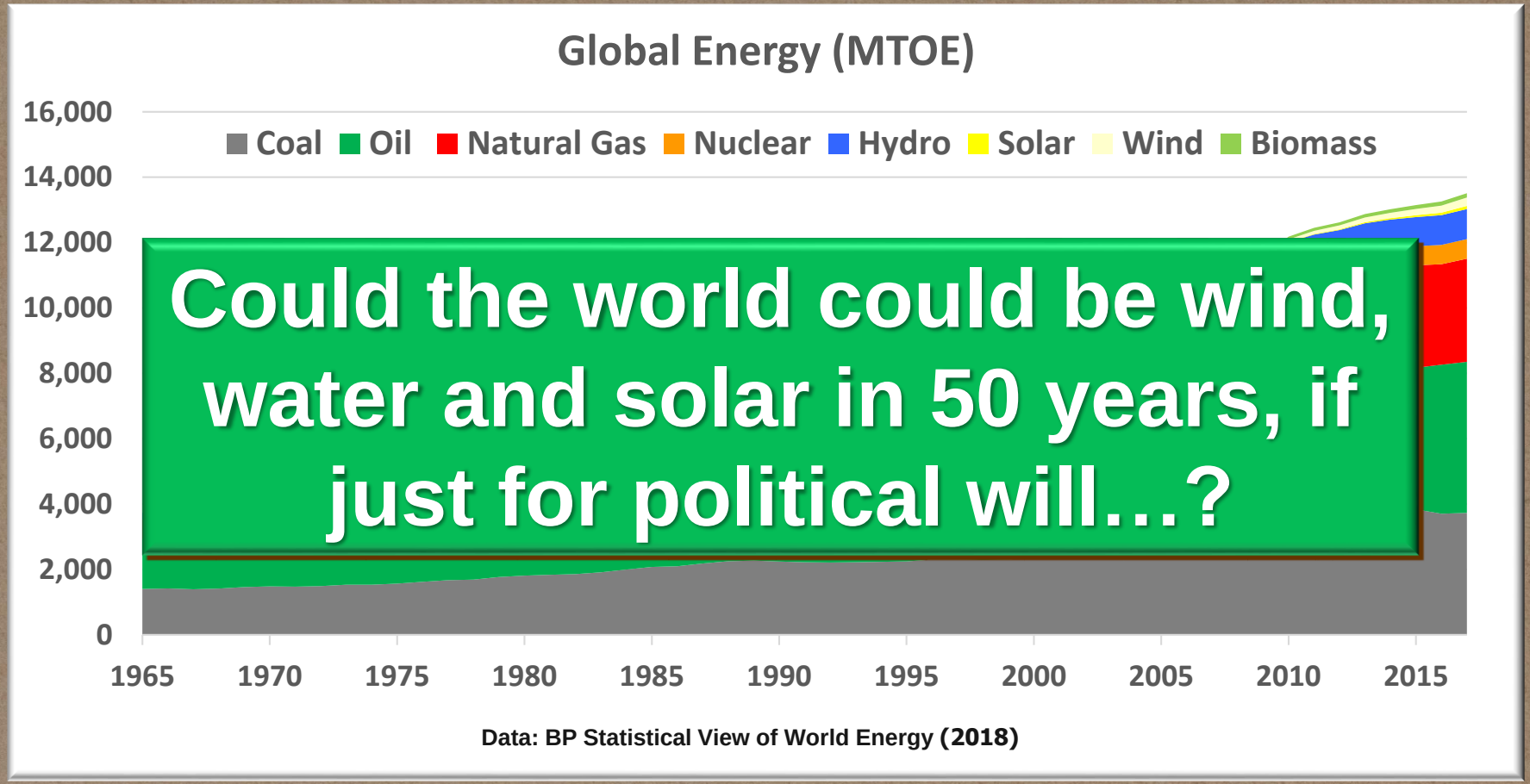
The Global Energy Mix



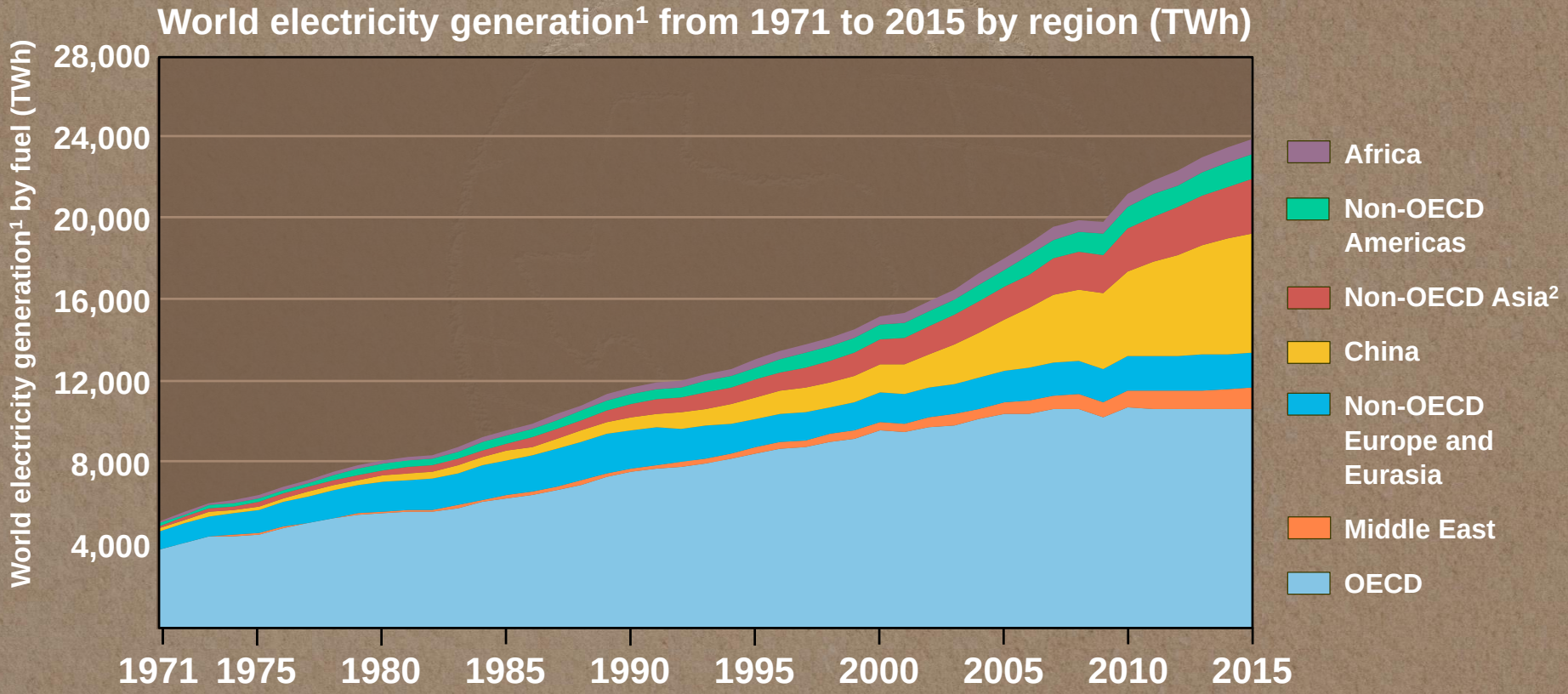
Global Energy



Global Energy

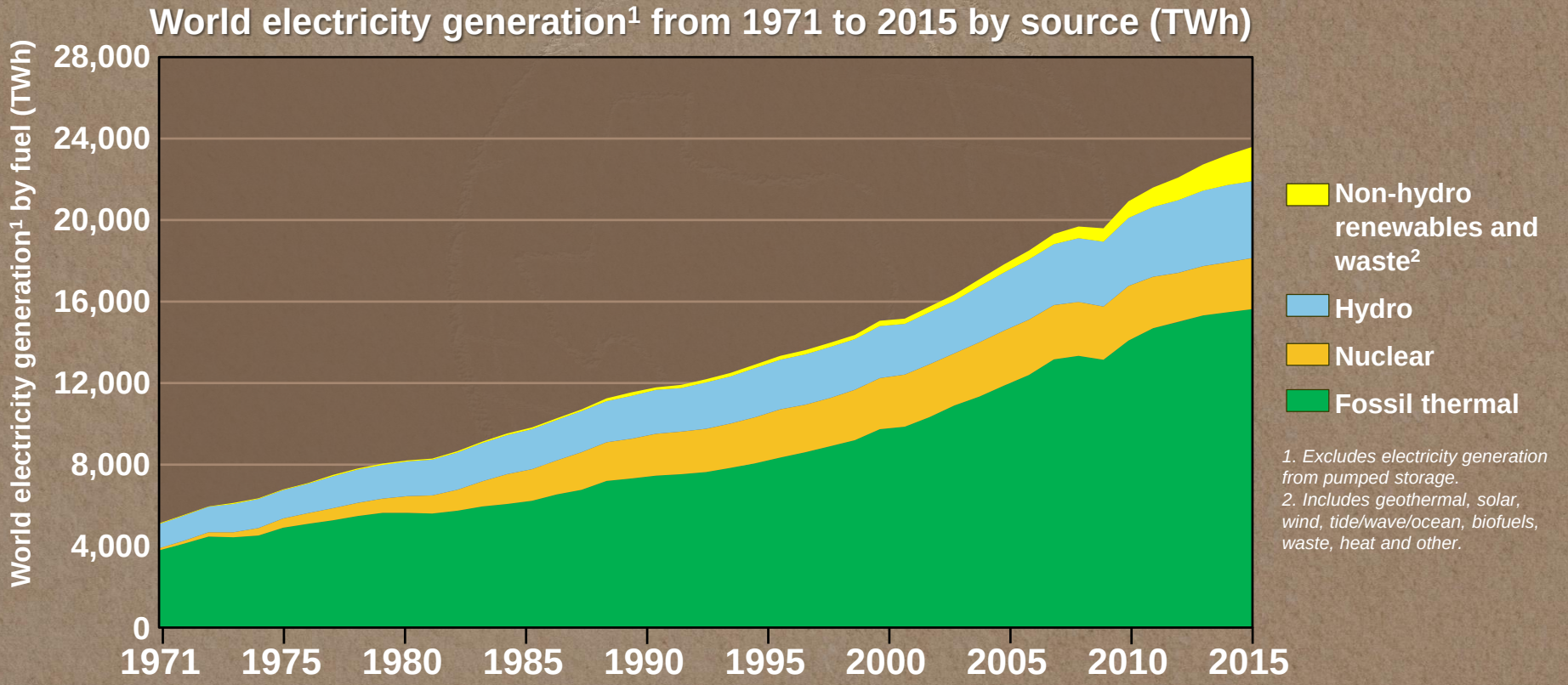


Electricity Generation
By Region



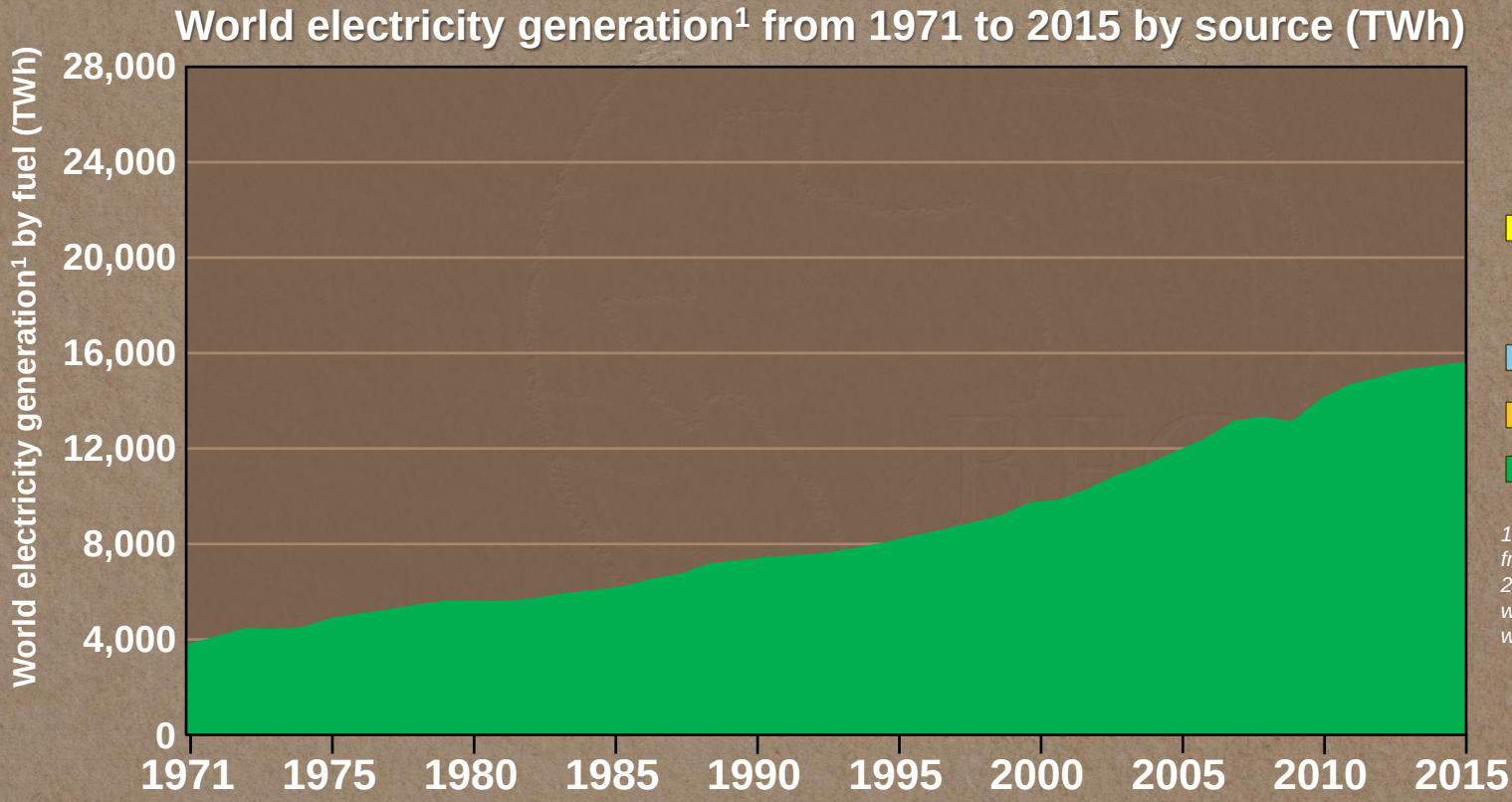
Source: **World Energy Outlook, 2017, EIA** *1. Excludes electricity generation from pumped storage. 2. Non-OECD Asia excludes China.*

Electricity Generation
by Source



Source: **World Energy Outlook, 2017, EIA**

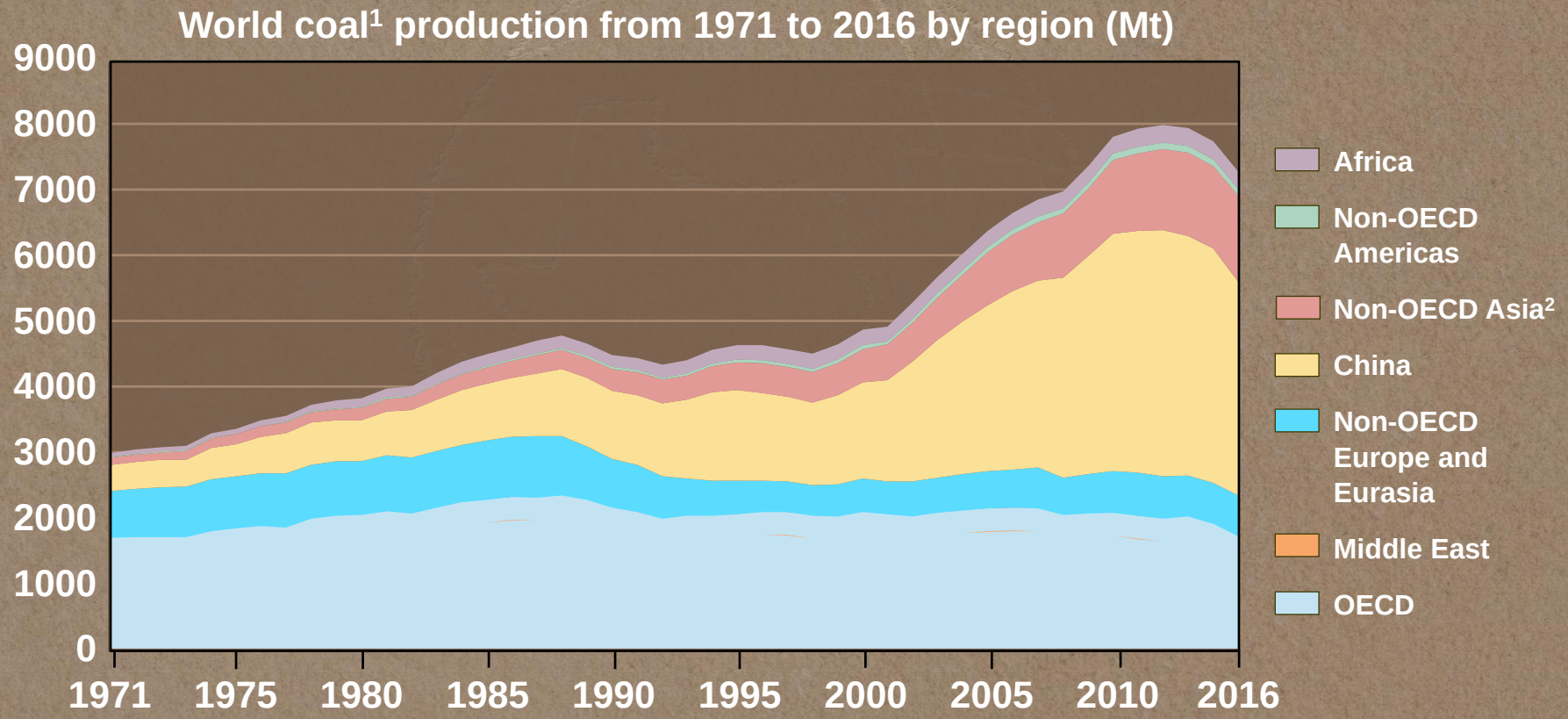
Electricity Generation
by Source



1. Excludes electricity generation from pumped storage.
2. Includes geothermal, solar, wind, tide/wave/ocean, biofuels, waste, heat and other.

Source: **World Energy Outlook, 2017, EIA**

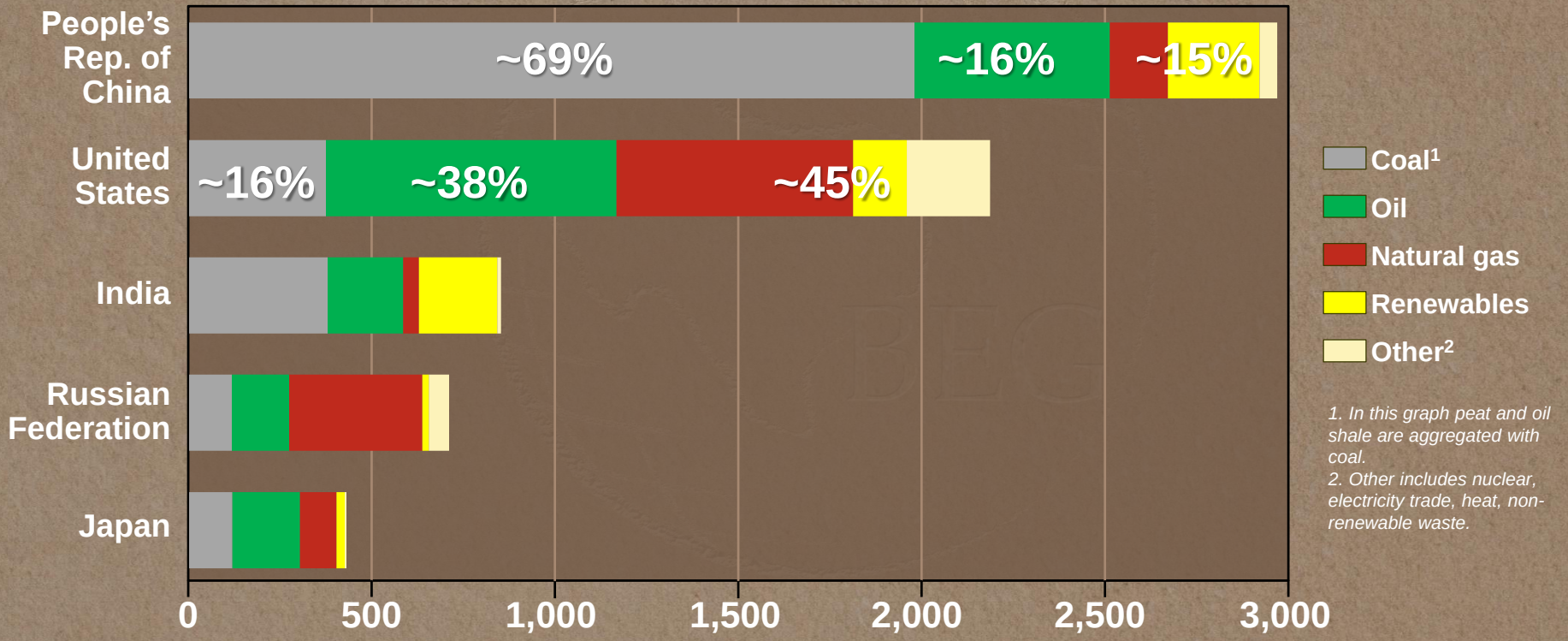
Global Coal Production



Source: **World Energy Outlook, 2017, EIA** *1. Includes steam coal, coking coal, lignite and recovered coal. 2. Non-OECD Asia excludes China.*

Total Primary Energy Supply (TPES)

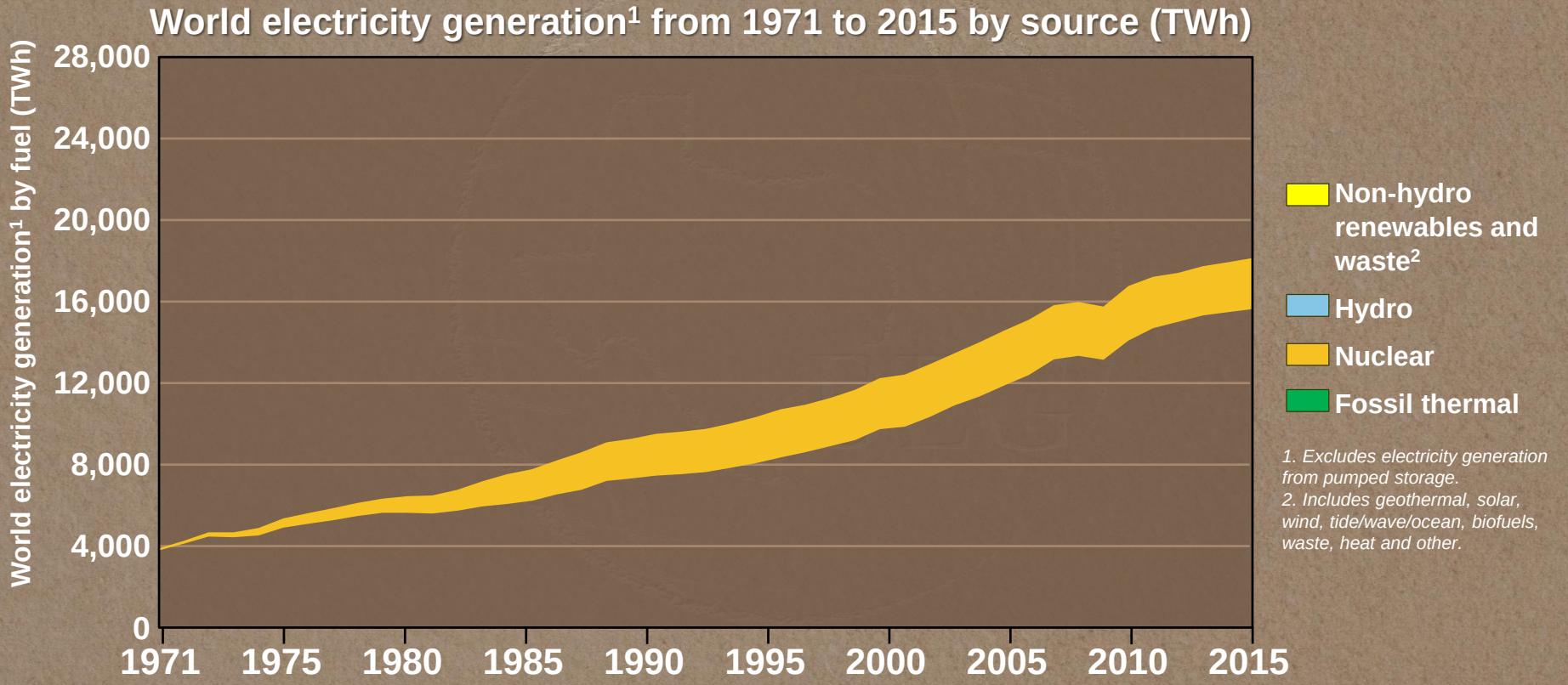
by Energy Source (Mtoe)



1. In this graph peat and oil shale are aggregated with coal.
2. Other includes nuclear, electricity trade, heat, non-renewable waste.

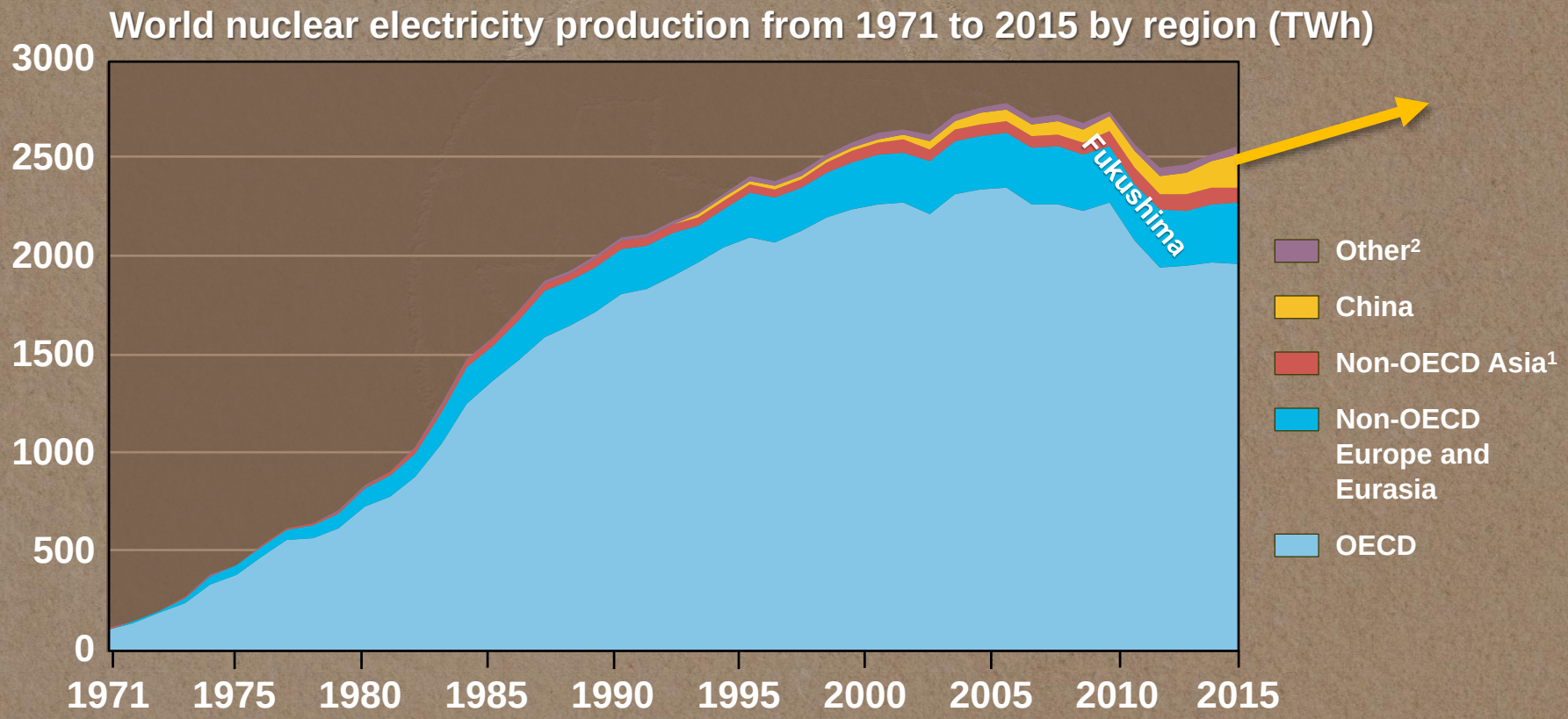
Source: **World Energy Outlook, 2017, EIA**

Electricity Generation
by Source



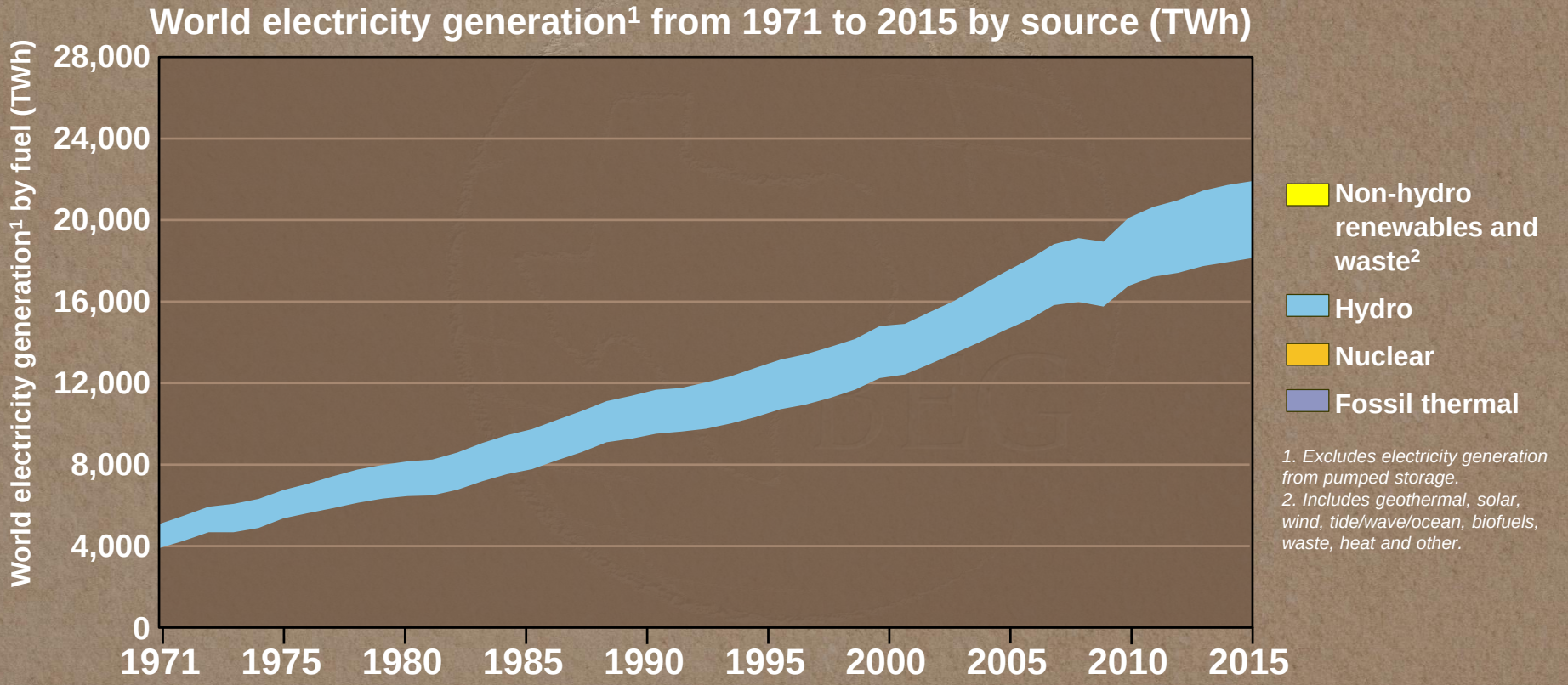
Source: **World Energy Outlook, 2017, EIA**

Nuclear Electricity
Production



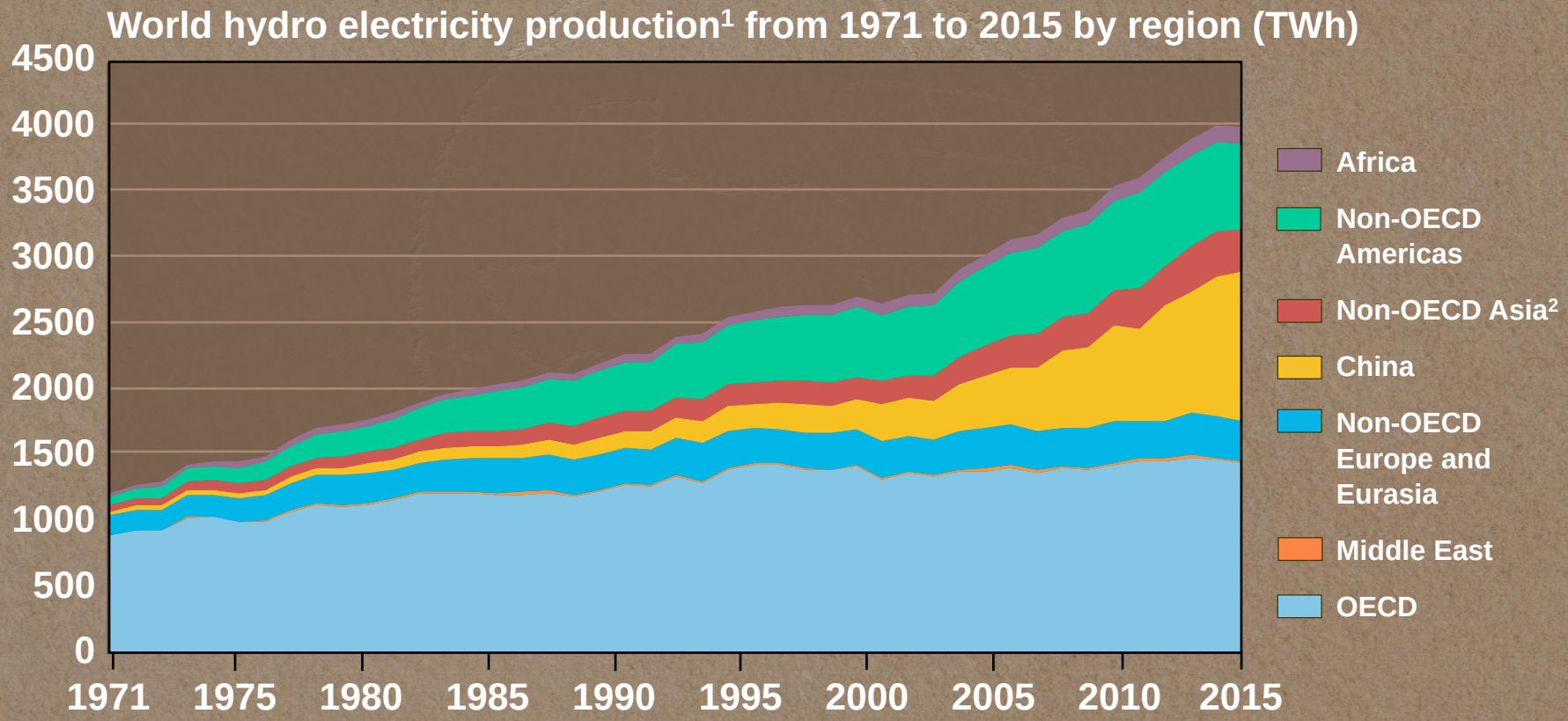
Source: **World Energy Outlook, 2017, EIA** *1. Non-OECD Asia excludes China. 2. Other includes Africa, Non-OECD Americas and the Middle East.*

Electricity Generation
by Source



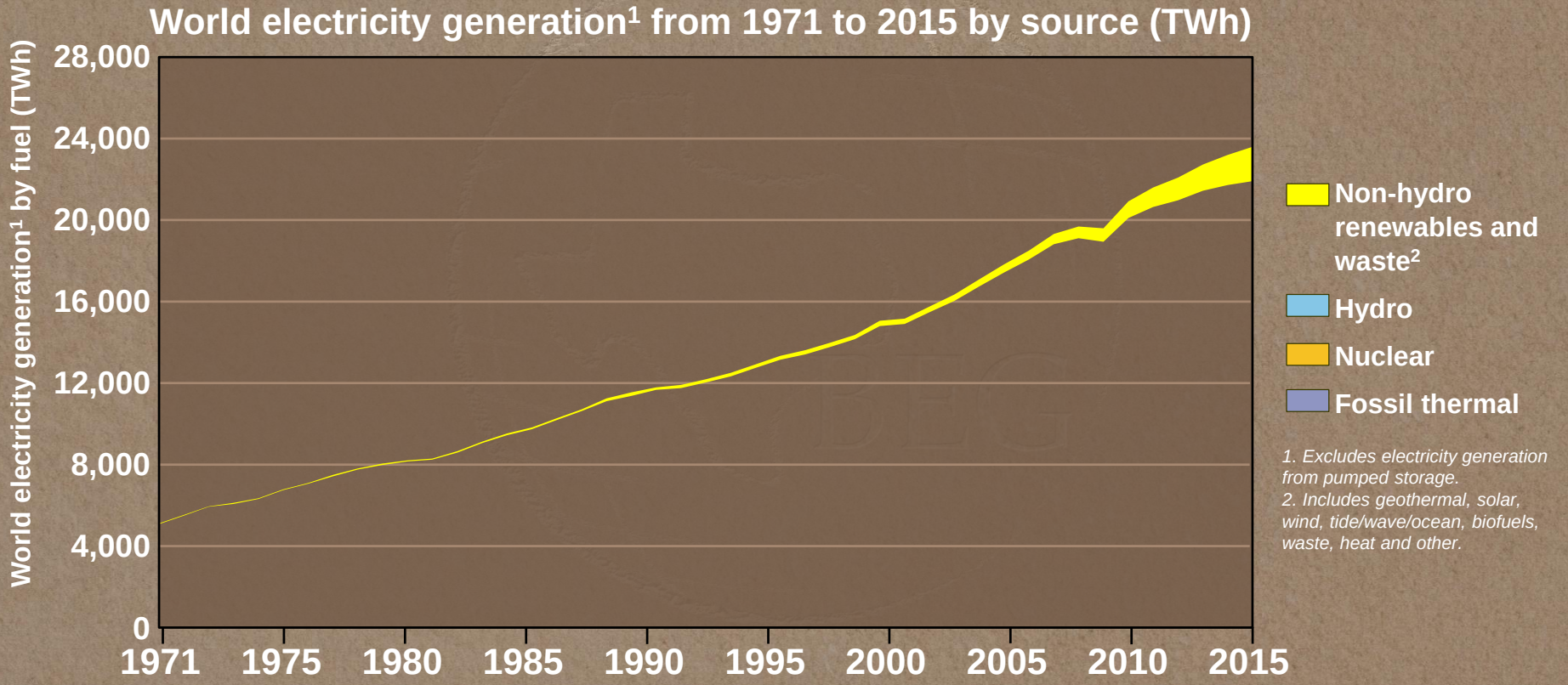
Source: **World Energy Outlook, 2017, EIA**

Hydro Electricity Production



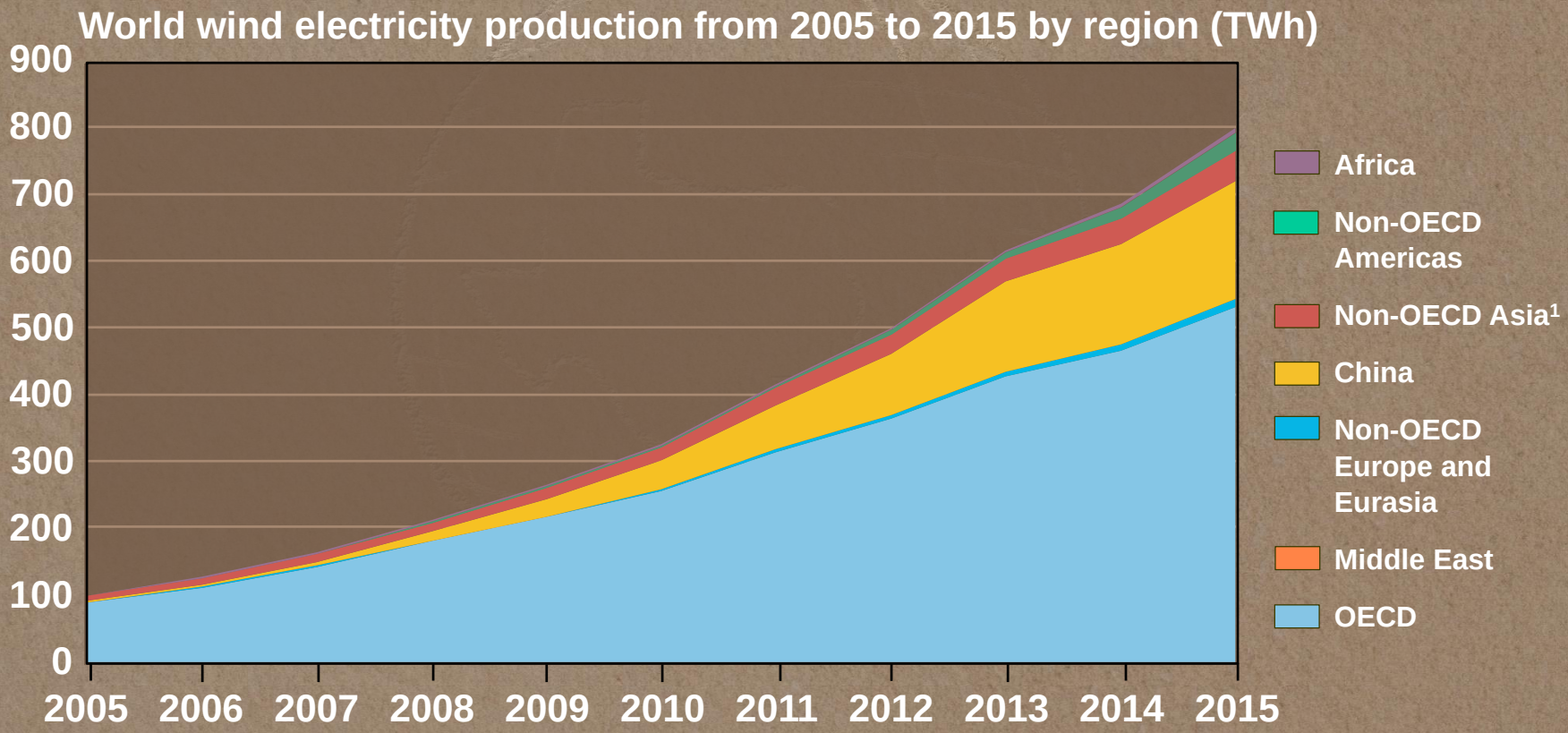
Source: **World Energy Outlook, 2017, EIA** *1. Includes electricity production from pumped storage. 2. Non-OECD Asia excludes China.*

Electricity Generation
by Source



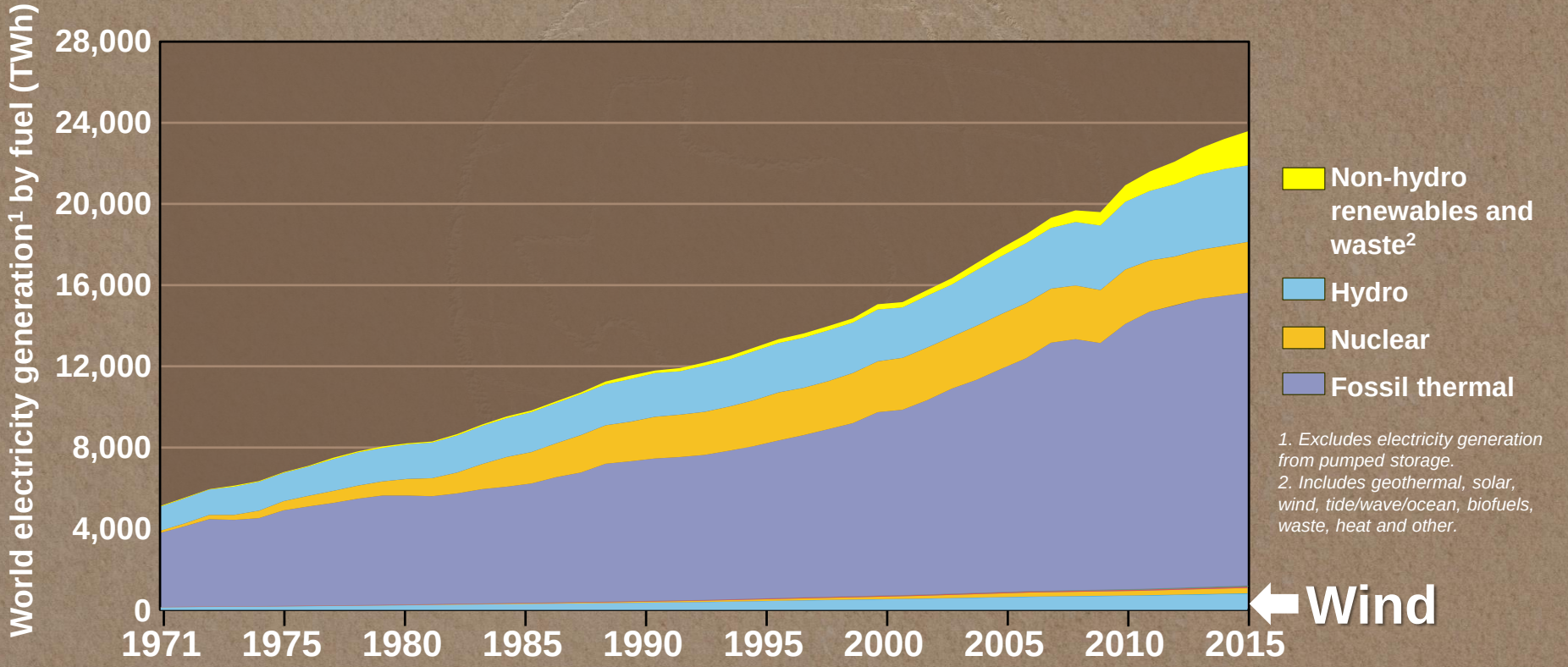
Source: **World Energy Outlook, 2017, EIA**

Wind Electricity Production



Source: **World Energy Outlook, 2017, EIA** *1. Non-OECD Asia excludes China.*

Electricity Generation by Source



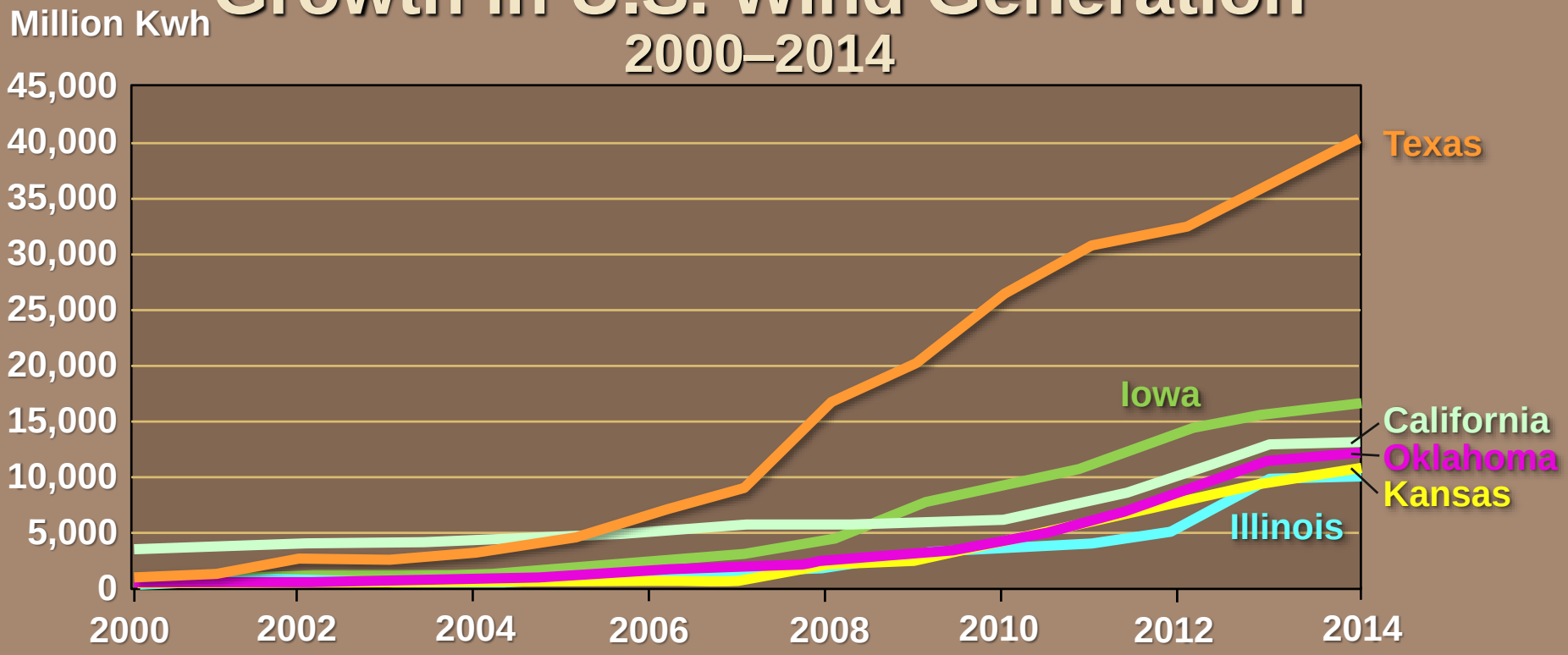
1. Excludes electricity generation from pumped storage.
2. Includes geothermal, solar, wind, tide/wave/ocean, biofuels, waste, heat and other.

Source: **World Energy Outlook, 2017, EIA**

Wind Electricity

Growth in U.S. Wind Generation

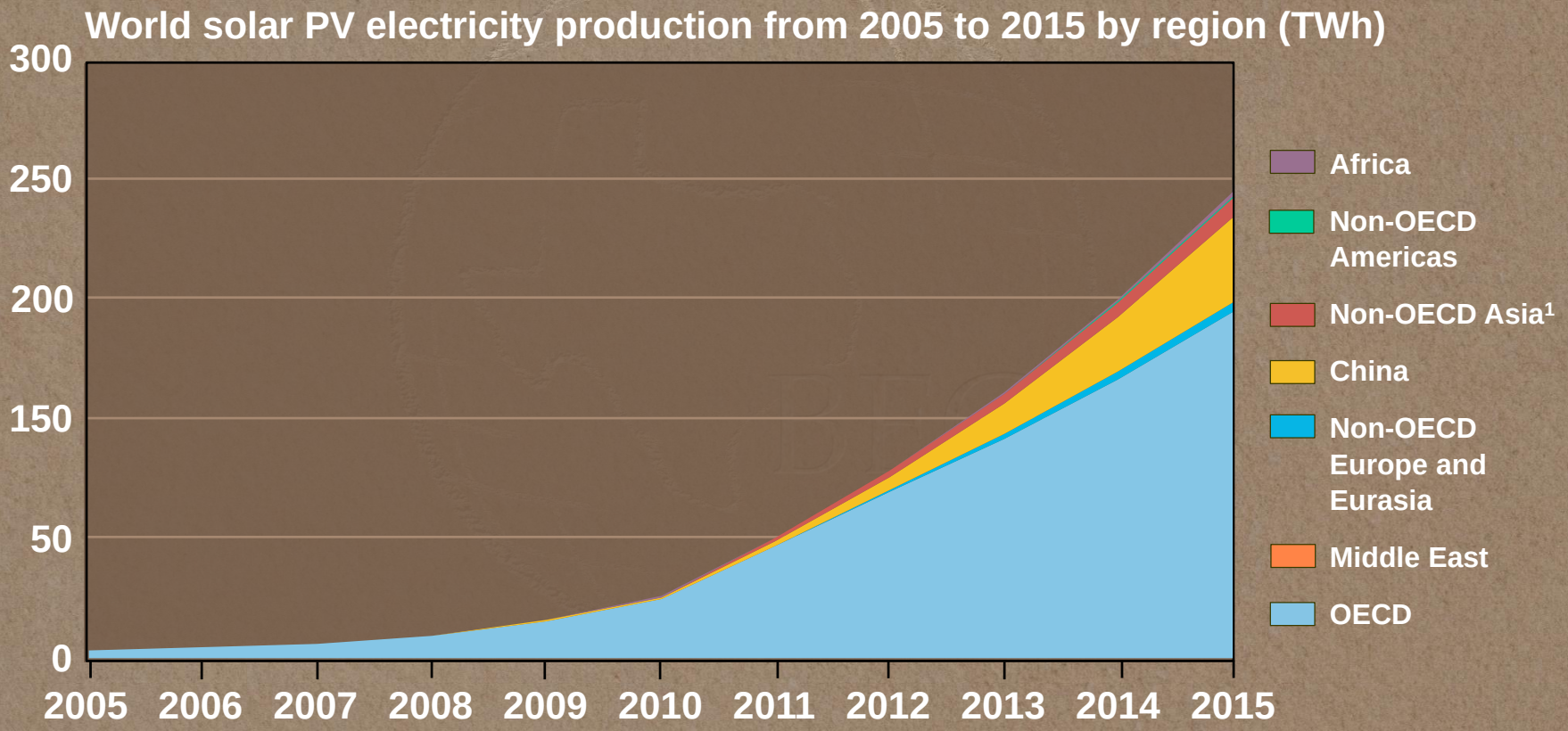
2000–2014



QAe5771

Source: **World Energy Outlook, 2017, EIA** *1. Non-OECD Asia excludes China.*

Solar Photovoltaic Electricity Production

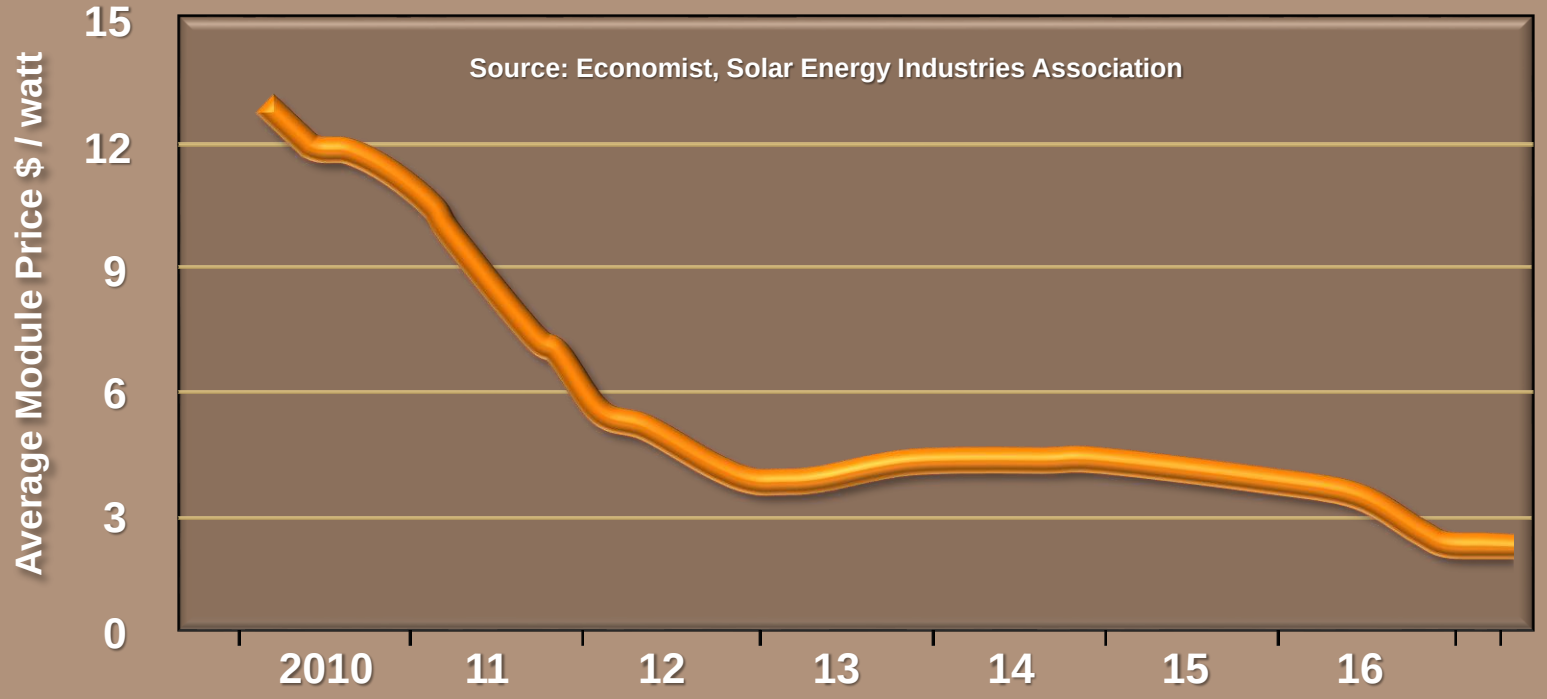


Source: **World Energy Outlook, 2017, EIA** *1. Non-OECD Asia excludes China.*

Solar Photovoltaic Electricity

United States

Solar photovoltaics

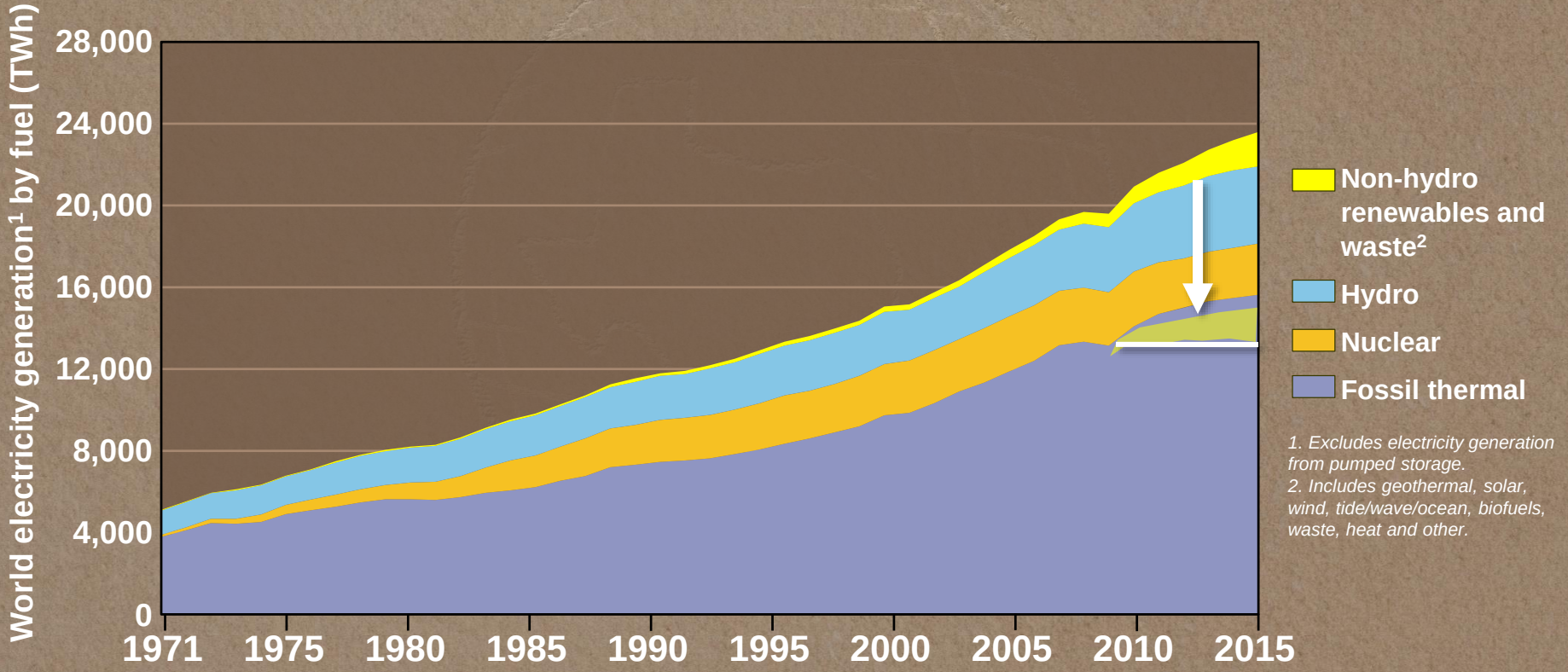


QAe5833

Source: **World Energy Outlook, 2017, EIA** *1. Non-OECD Asia excludes China.*

QAe6821

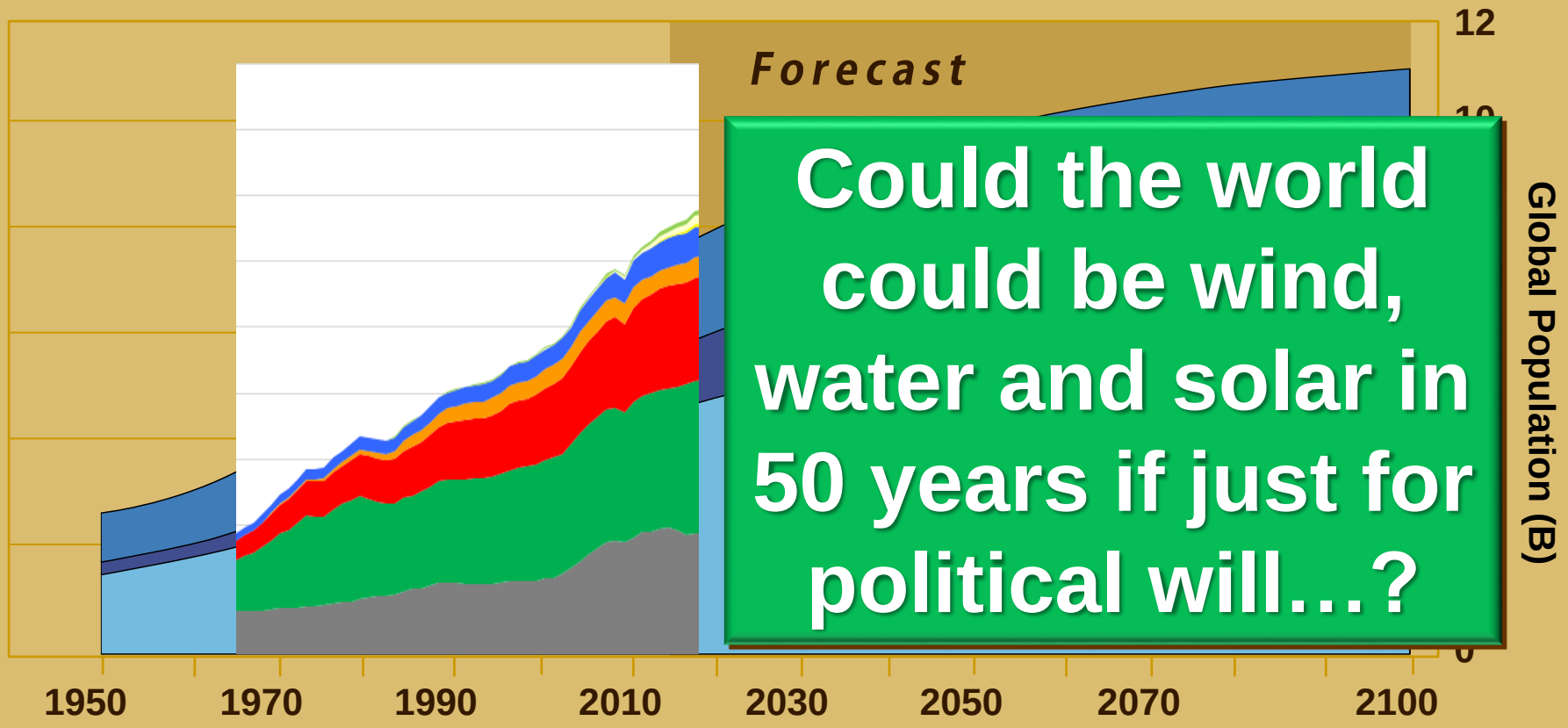
Electricity Generation by Source



1. Excludes electricity generation from pumped storage.
2. Includes geothermal, solar, wind, tide/wave/ocean, biofuels, waste, heat and other.

Source: **World Energy Outlook, 2017, EIA**

Population and Energy

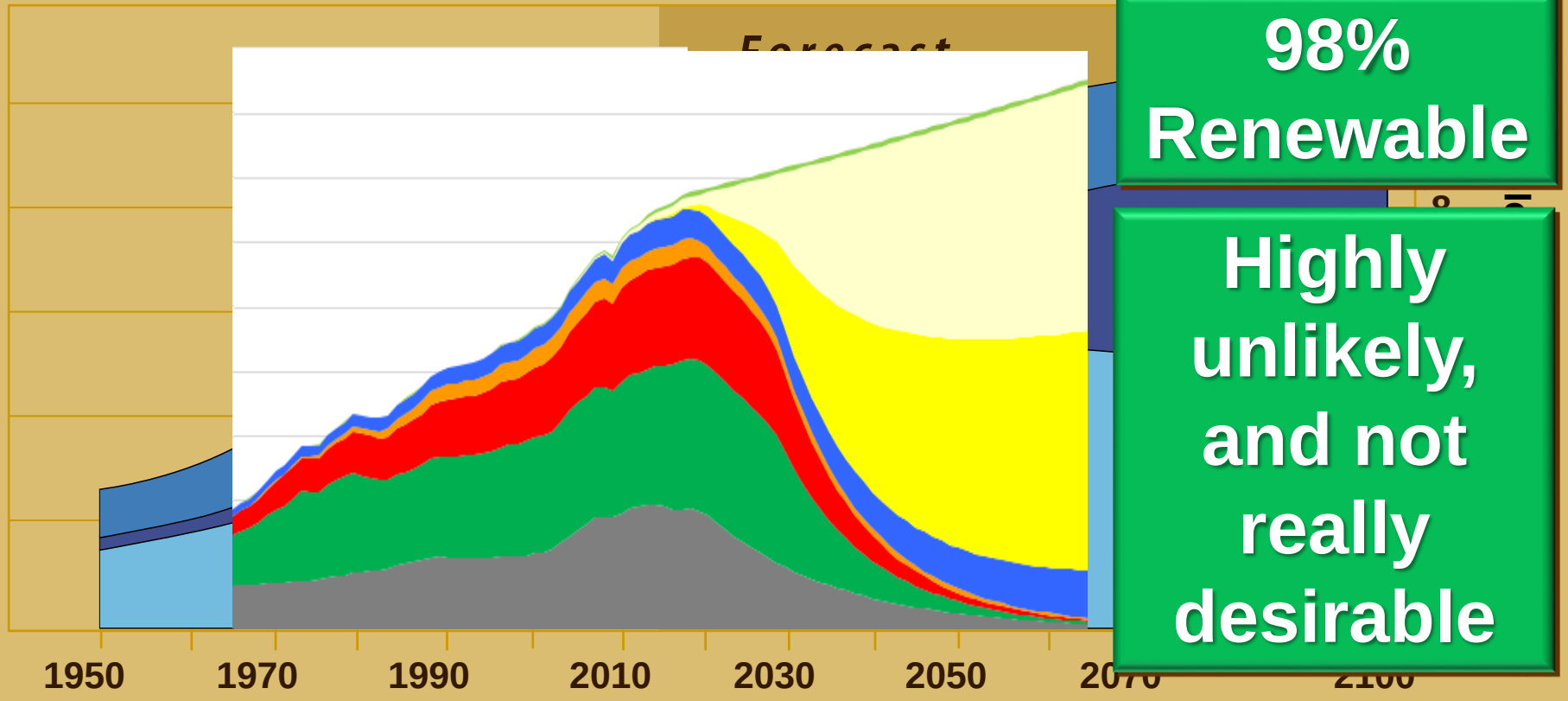


Could the world could be wind, water and solar in 50 years if just for political will…?

Data: BP Statistical View of World Energy (2016)

Source: From the UN, as appeared in *The Economist*, August 23, 2014

Population and Energy



98% Renewable

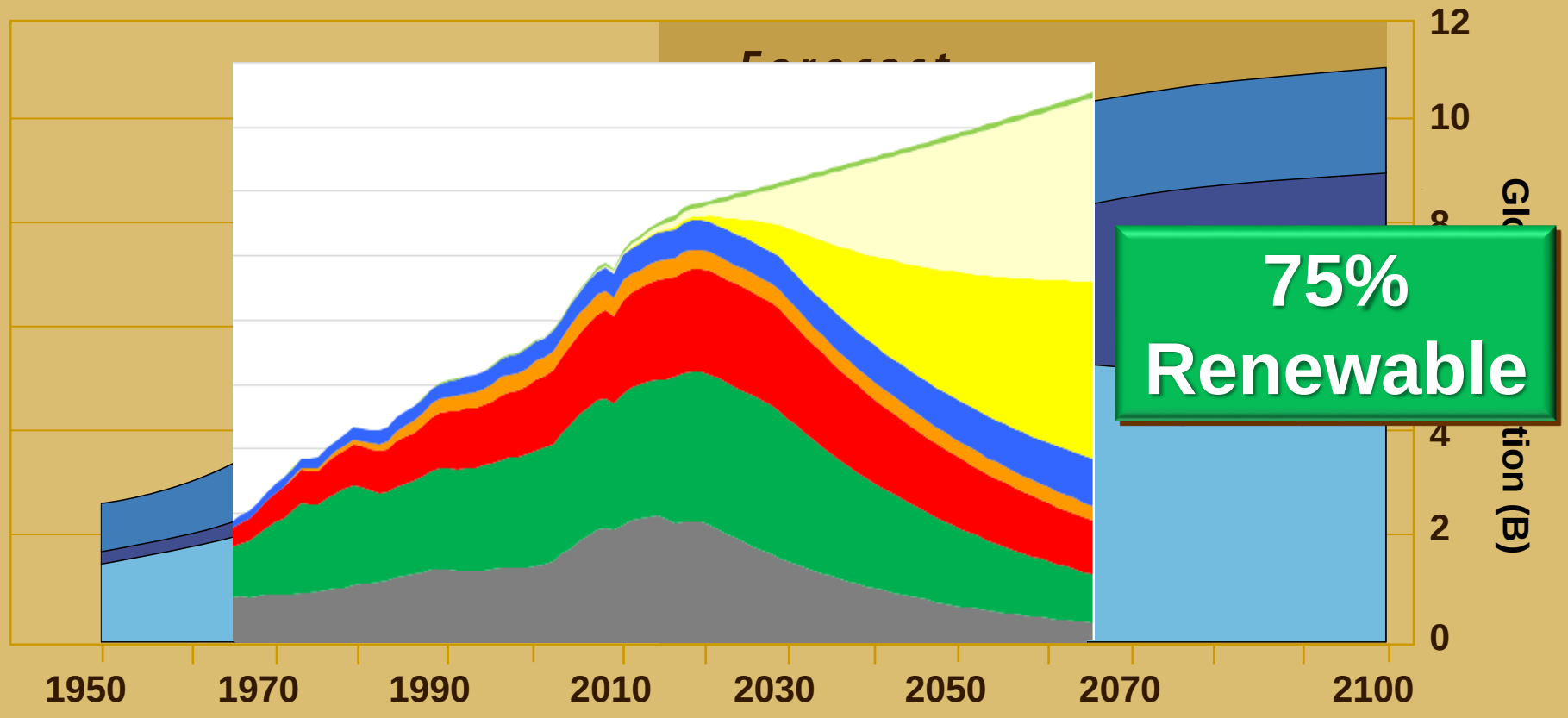
Highly unlikely, and not really desirable

Data: BP Statistical View of World Energy (2016)

Source: From the UN, as appeared in *The Economist*, August 23, 2014

Population and Energy

Tinker 2018

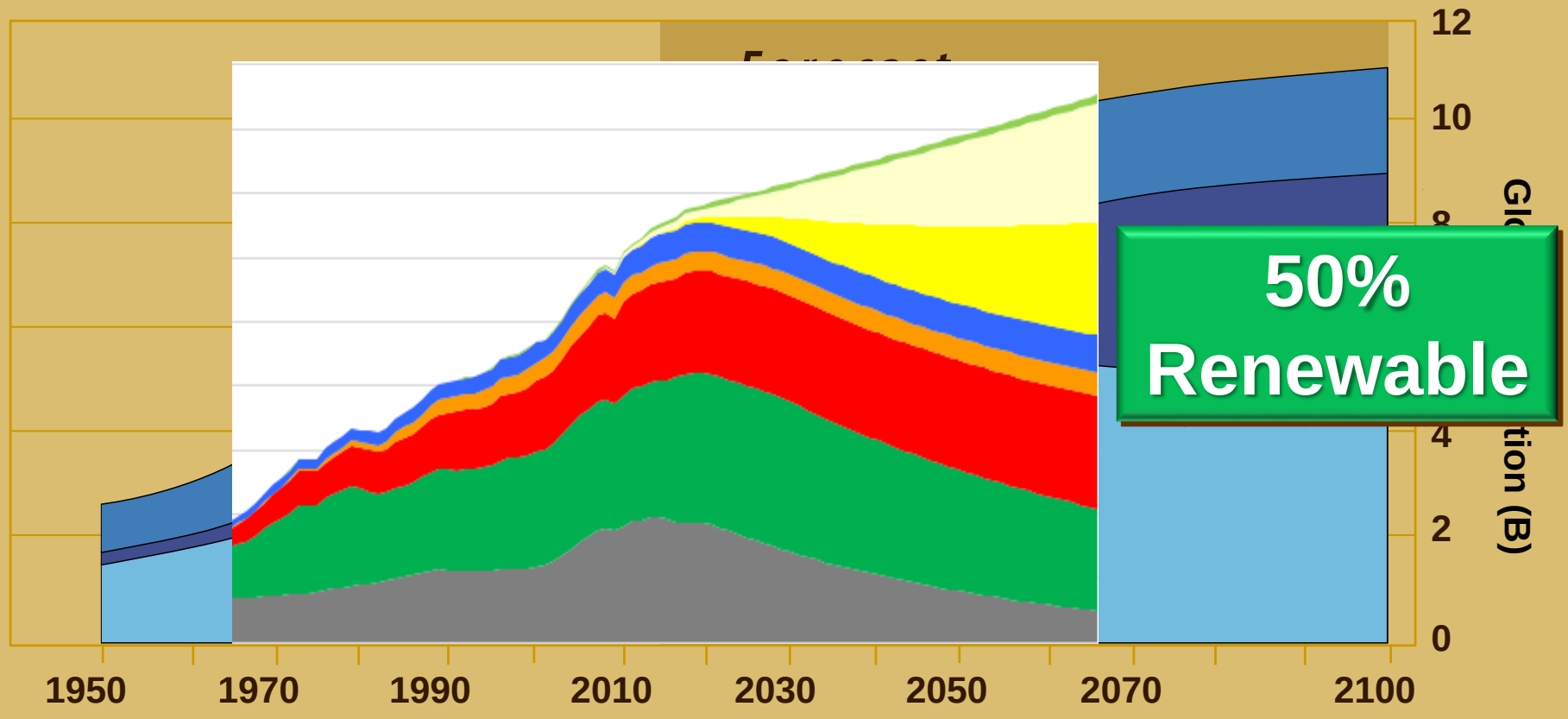


Data: BP Statistical View of World Energy (2016)

Source: From the UN, as appeared in *The Economist*, August 23, 2014

Population and Energy

Tinker 2018

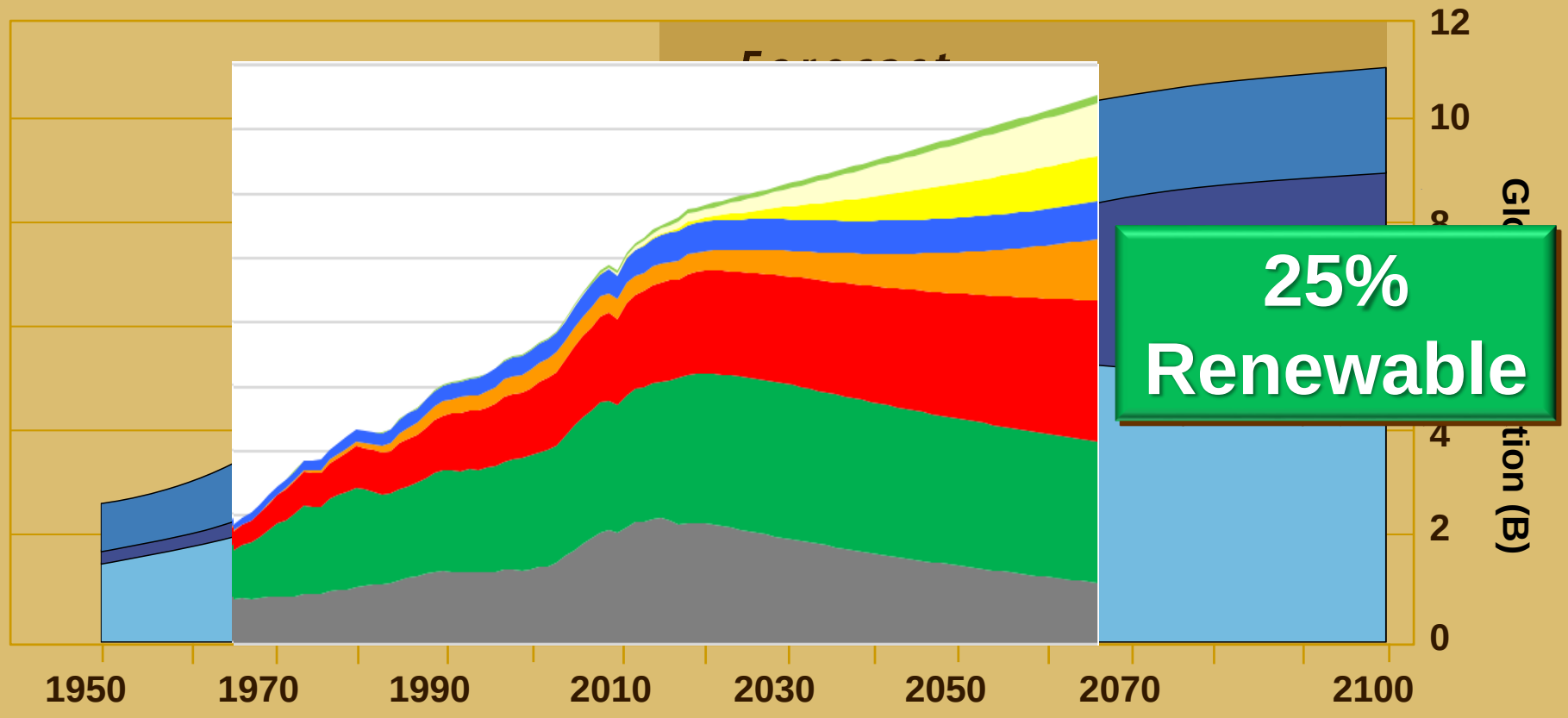


Data: BP Statistical View of World Energy (2016)

Source: From the UN, as appeared in *The Economist*, August 23, 2014

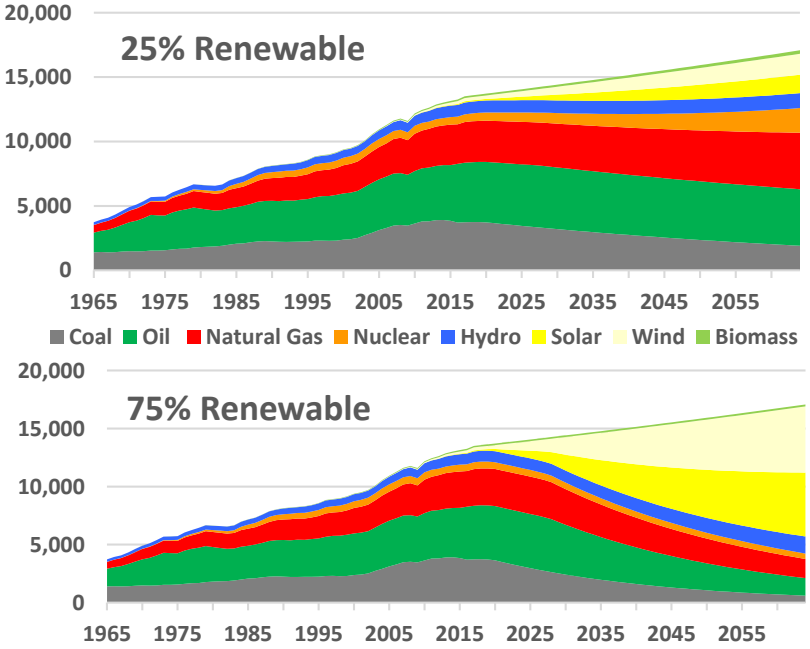
Population and Energy

Tinker 2018

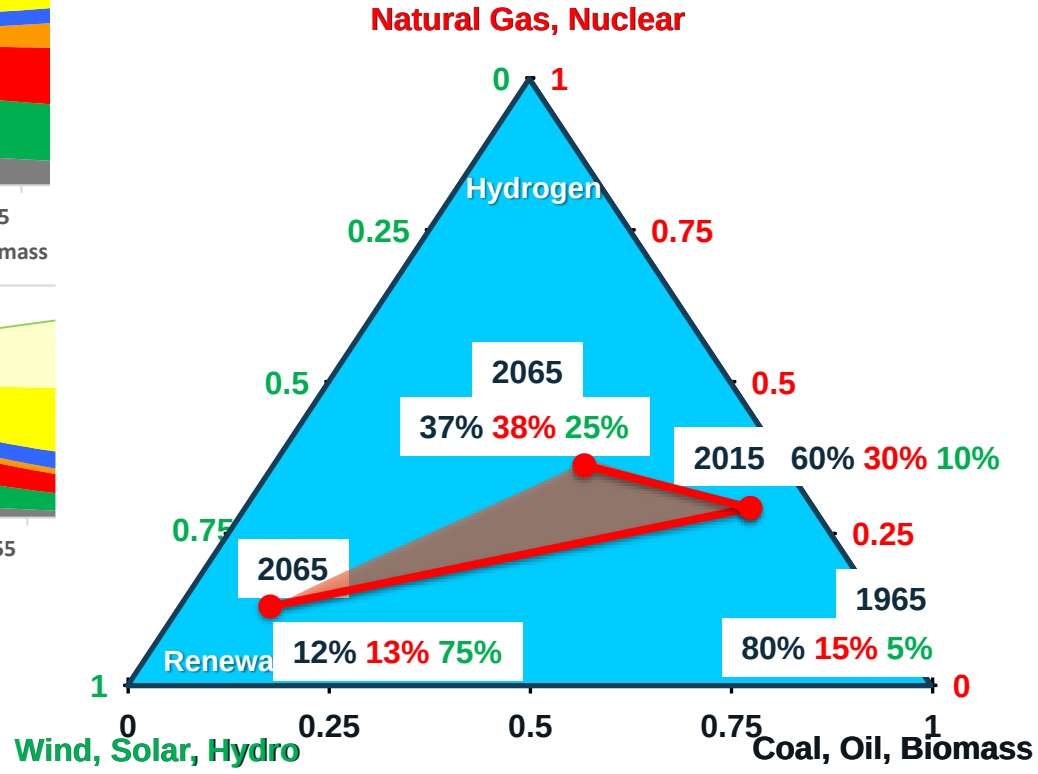


Data: BP Statistical View of World Energy (2016)

Source: From the UN, as appeared in *The Economist*, August 23, 2014

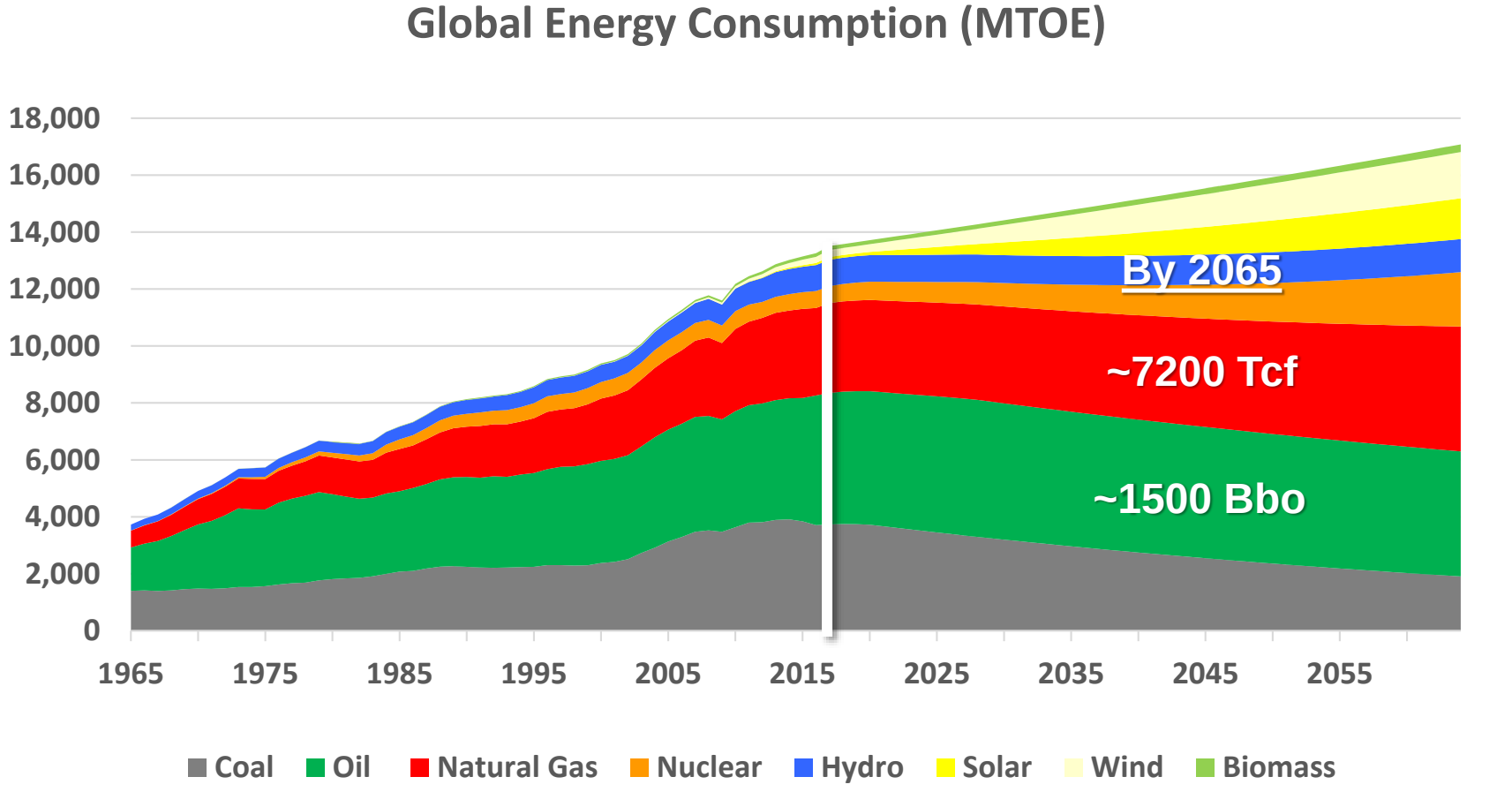


Global Primary Energy



Data: BP Statistical View of World Energy (2018)

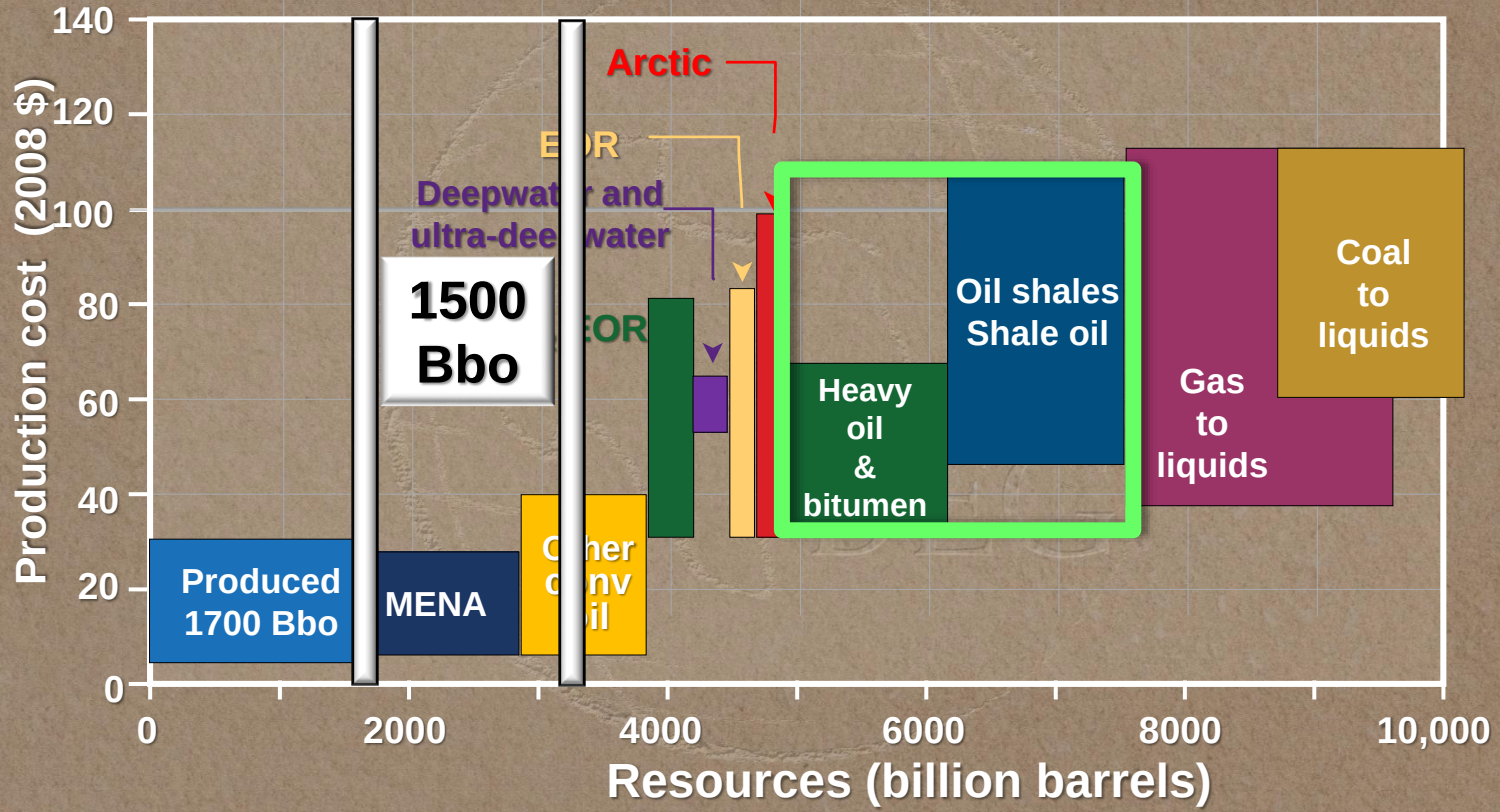
Global Energy 2065



Tinker 2018

Oil Cost of Supply

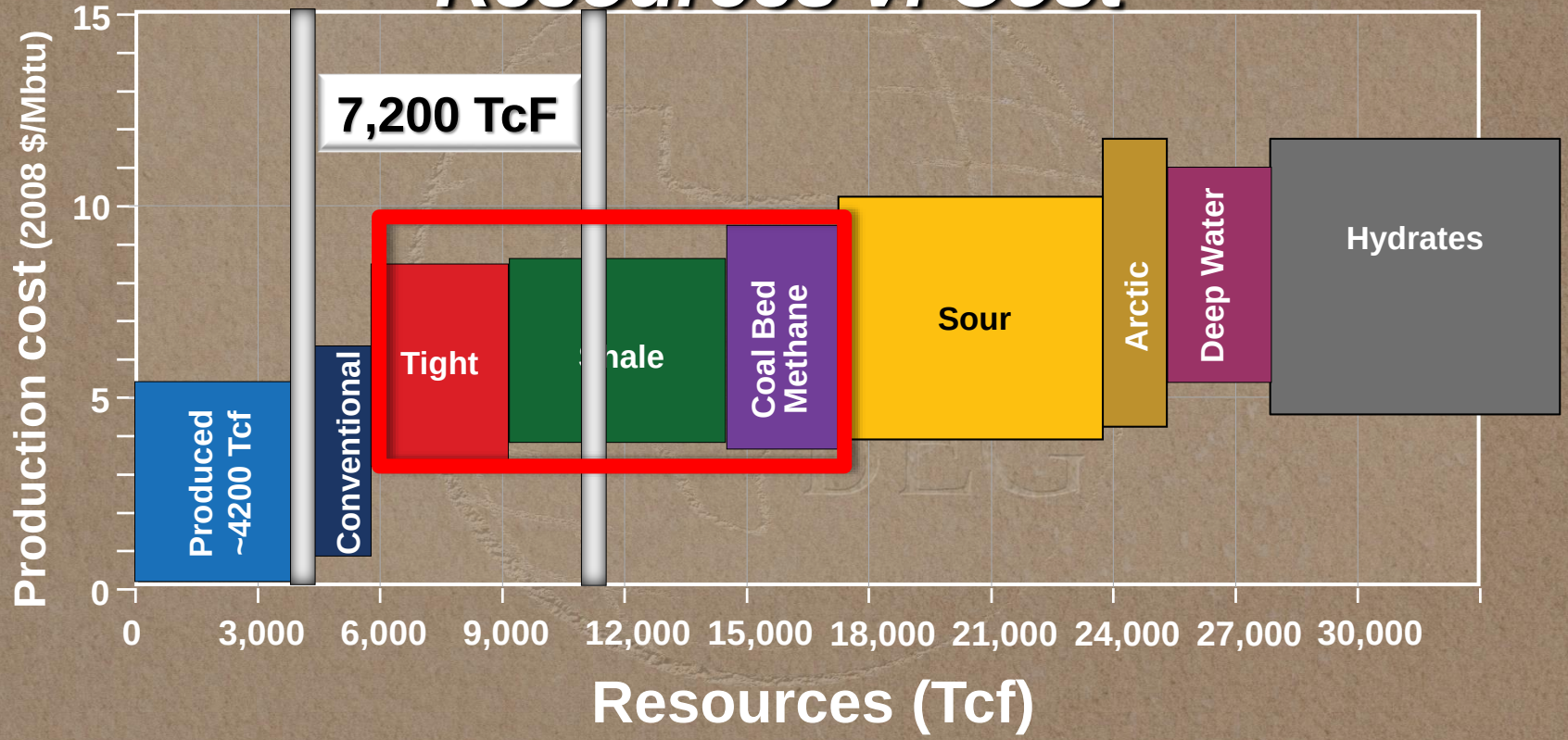
Resources and Cost



Modified 2018 from: IEA World Energy Outlook (2009) and BP Statistical View of World Energy 2018

Natural Gas Cost of Supply

Resources v. Cost

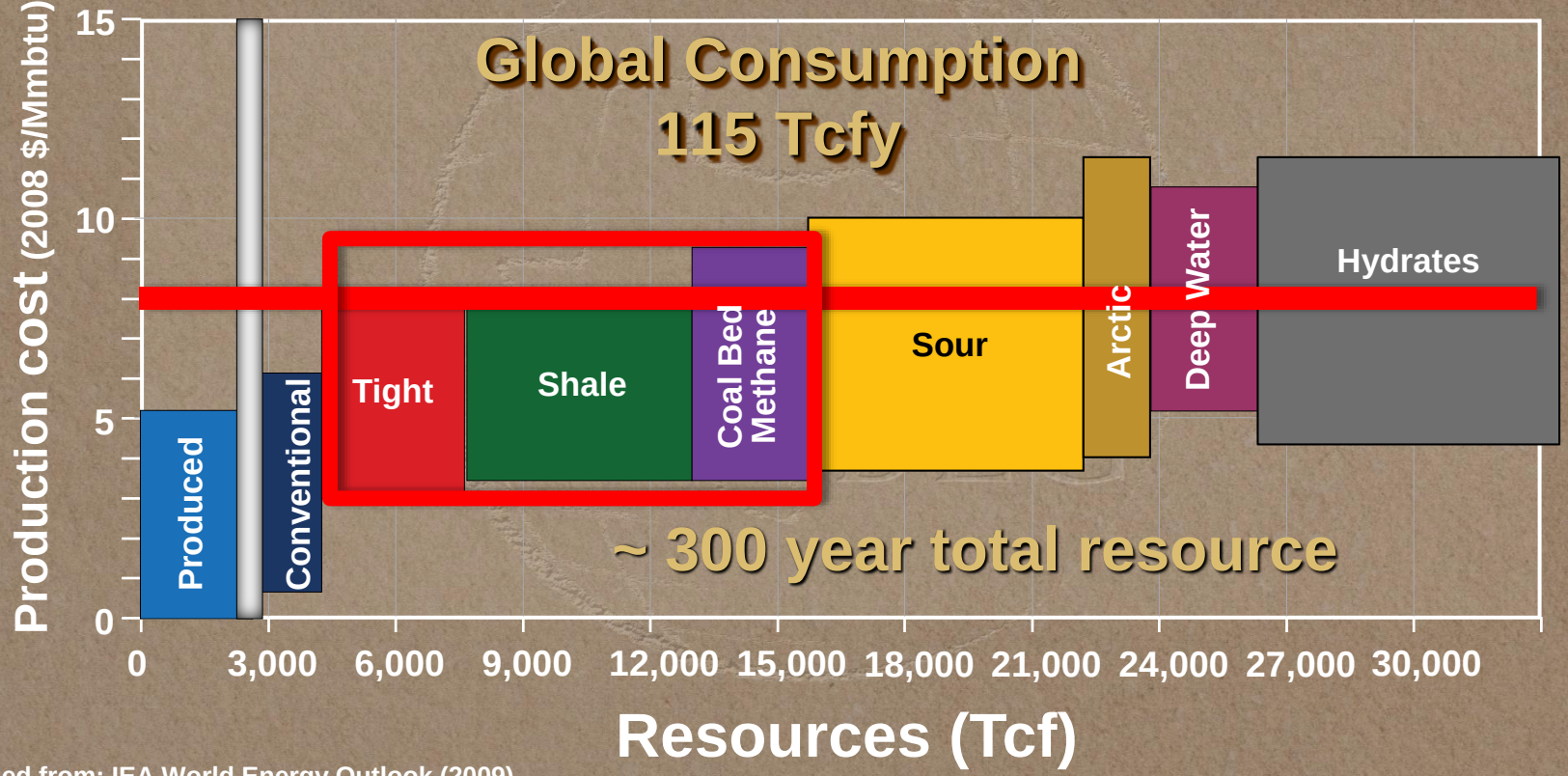


QAe980

Modified 2018 from: IEA World Energy Outlook (2009) and BP Statistical View of World Energy 2018

Natural Gas Cost of Supply

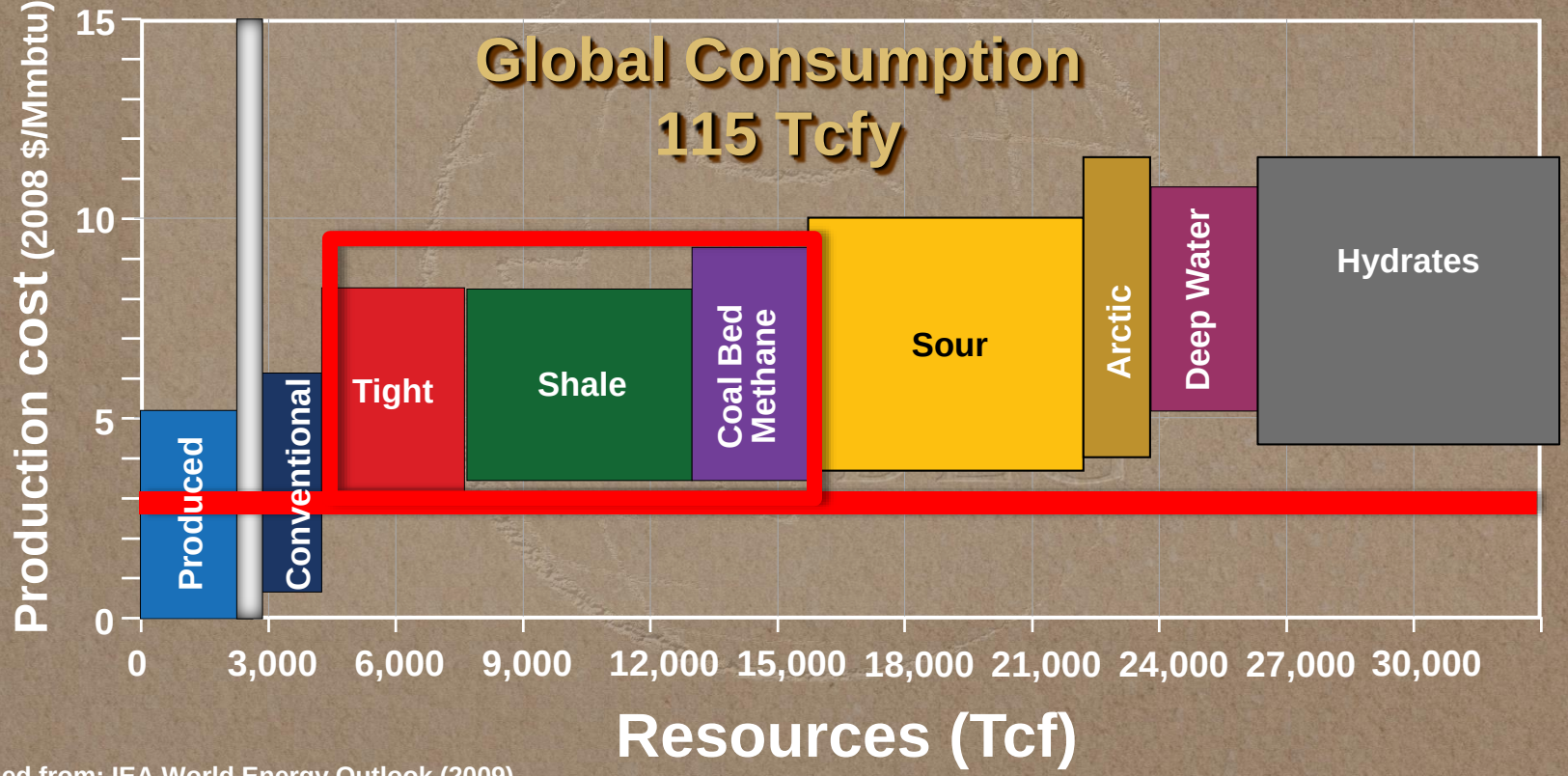
Resources v. Cost



Modified from: IEA World Energy Outlook (2009)

Natural Gas Cost of Supply

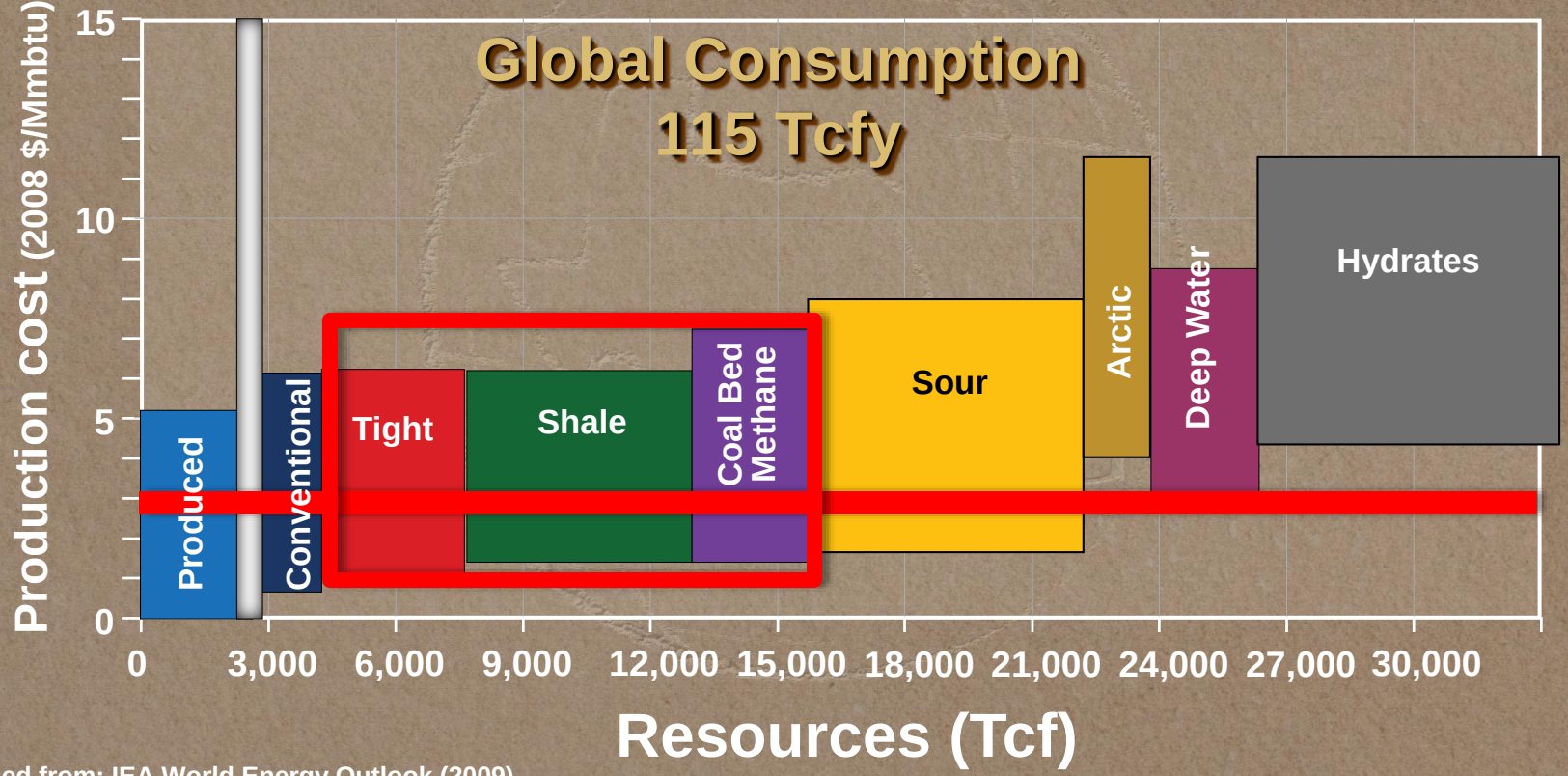
Resources v. Cost



Modified from: IEA World Energy Outlook (2009)

Natural Gas Cost of Supply

Resources v. Cost



Modified from: IEA World Energy Outlook (2009)

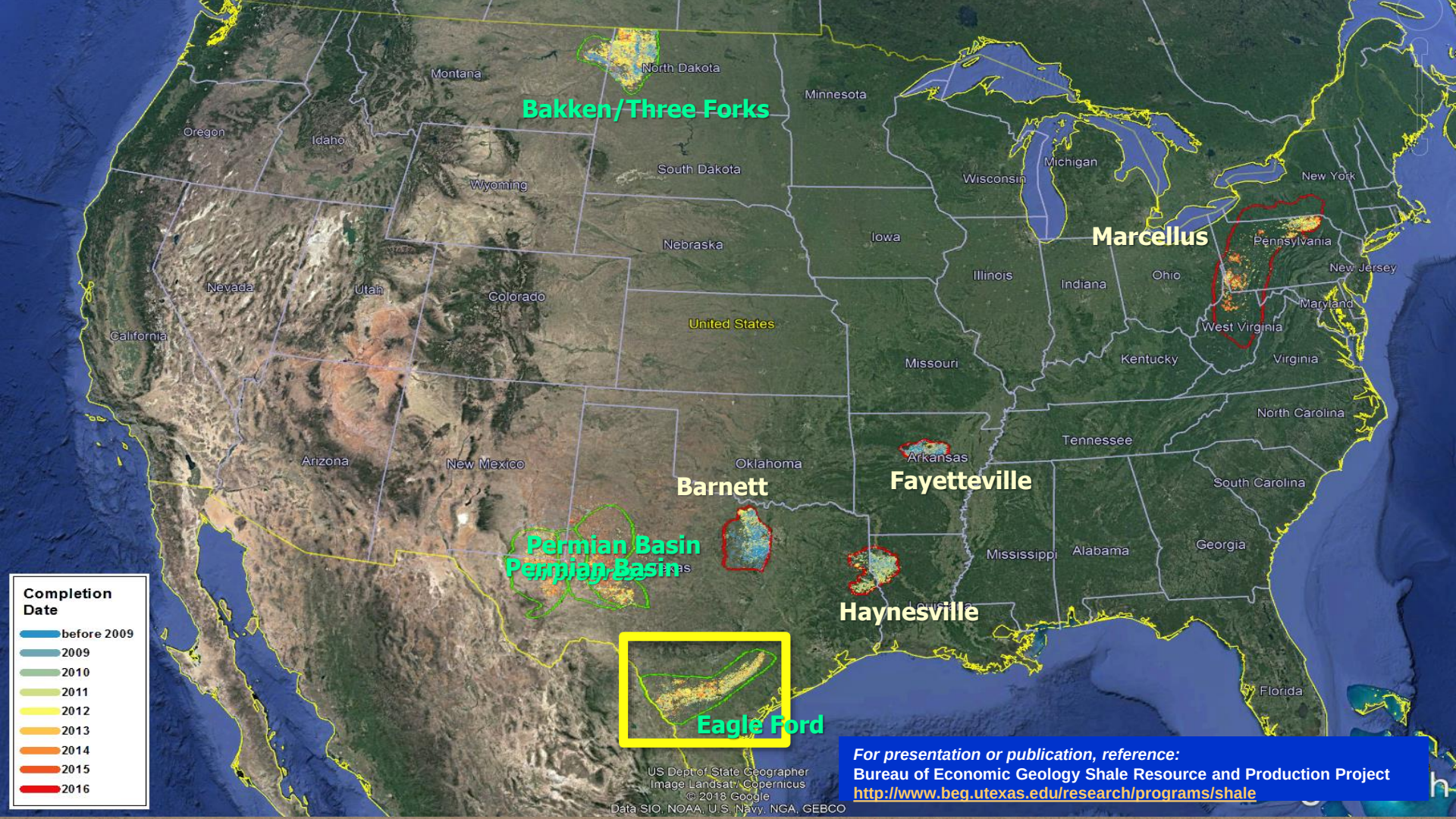
Natural Gas Cost of Supply

Resources v. Cost

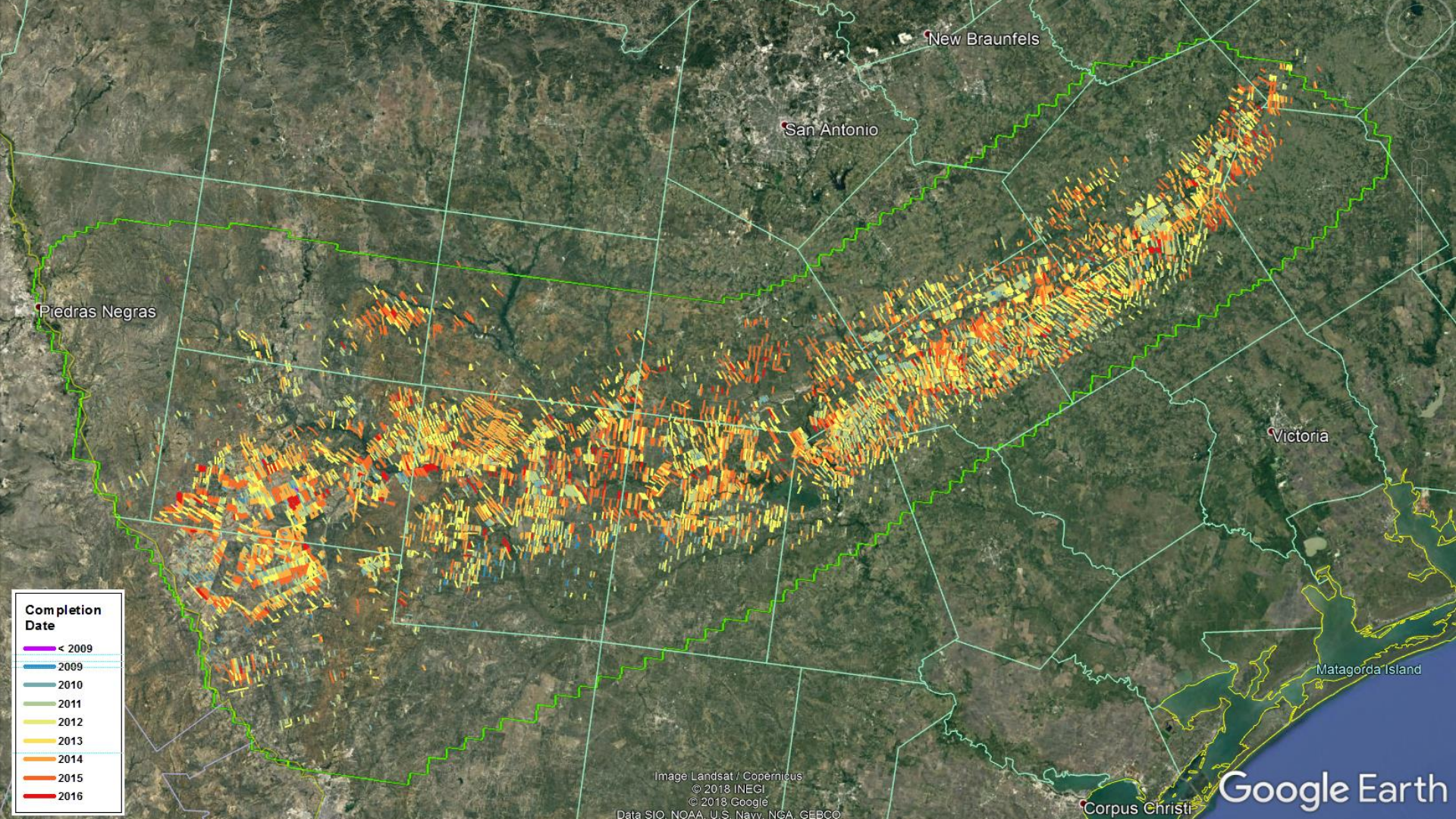
The Global Resource is Vast

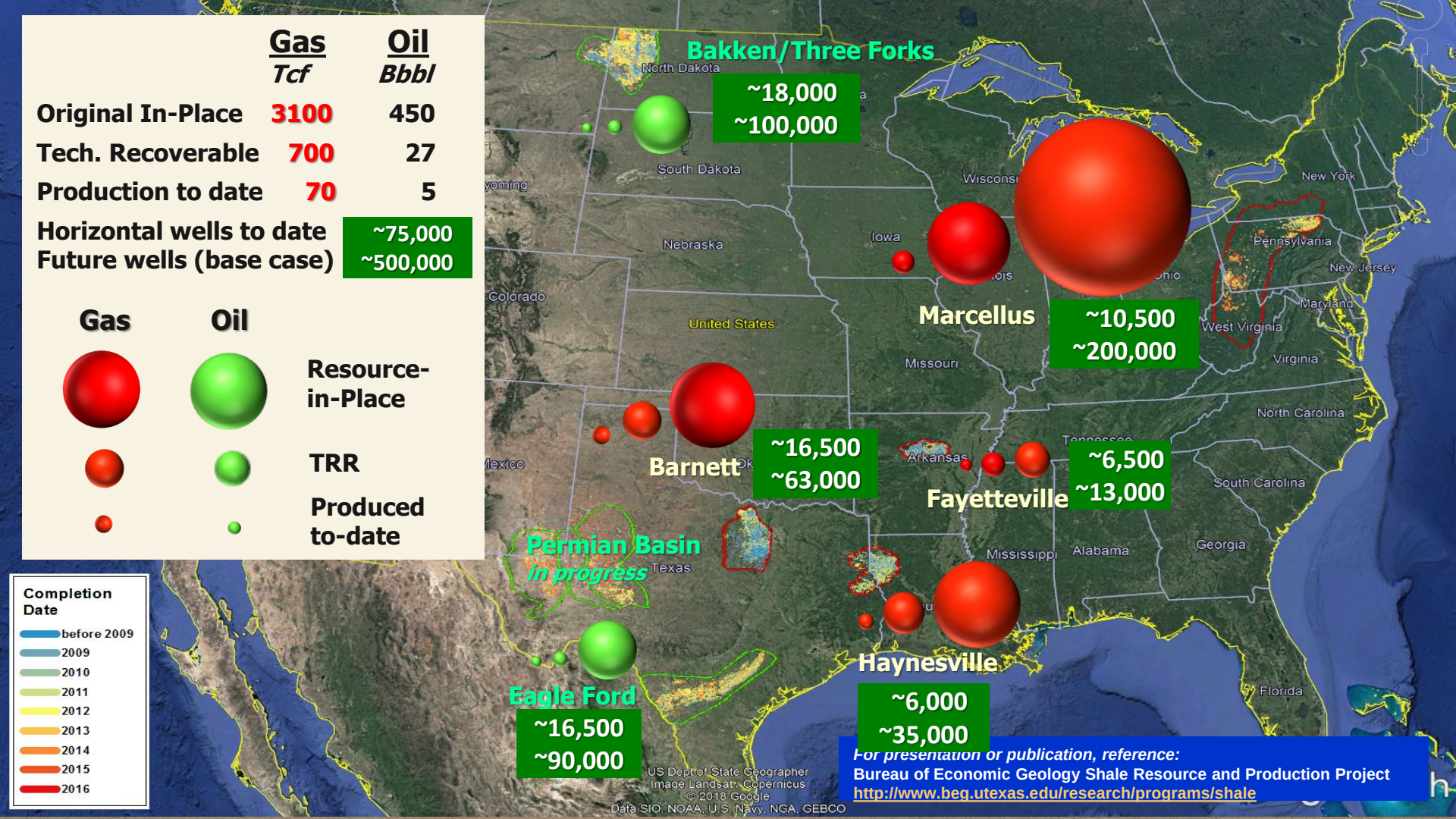
Reserves and production are a function of Price, Cost, Technology, Policy and Demand

Modified from: IEA World Energy Outlook (2009)



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


New Braunfels
San Antonio
Piedras Negras
Victoria
Matagorda Island
Corpus Christi
Completion Date
< 2009
2009
2010
2011
2012
2013
2014
2015
2016
Image Landsat / Copernicus
© 2018 INEGI
© 2018 Google
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Google Earth


Gas
Tcf
Oil
Bbbl
Original In-Place 3100 450
Tech. Recoverable 700 27
Production to date 70 5
Horizontal wells to date ~75,000
Future wells (base case) ~500,000
Gas
Oil
Resource-in-Place
TRR
Produced to-date
Completion Date
before 2009
2009
2010
2011
2012
2013
2014
2015
2016
Bakken/Three Forks
~18,000
~100,000
Marcellus
~10,500
~200,000
Barnett
~16,500
~63,000
Fayetteville
~6,500
~13,000
Permian Basin
in progress
Haynesville
~6,000
~35,000
Eagle Ford
~16,500
~90,000
North Dakota
South Dakota
Nebraska
Colorado
United States
Missouri
Arkansas
Texas
Mississippi
Alabama
Georgia
South Carolina
North Carolina
Virginia
West Virginia
Pennsylvania
New York
New Jersey
Maryland
Florida
US Dept of State Geographer
Image Landsat / Copernicus
© 2018 Google
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
For presentation or publication, reference:
Bureau of Economic Geology Shale Resource and Production Project
http://www.beg.utexas.edu/research/programs/shale

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

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

Gas Oil

Resource-in-Place

TRR

Produced to-date

Completion Date
- before 2009
- 2009
- 2010
- 2011
- 2012
- 2013
- 2014
- 2015
- 2016

Bakken/Three Forks
~18,000
~100,000

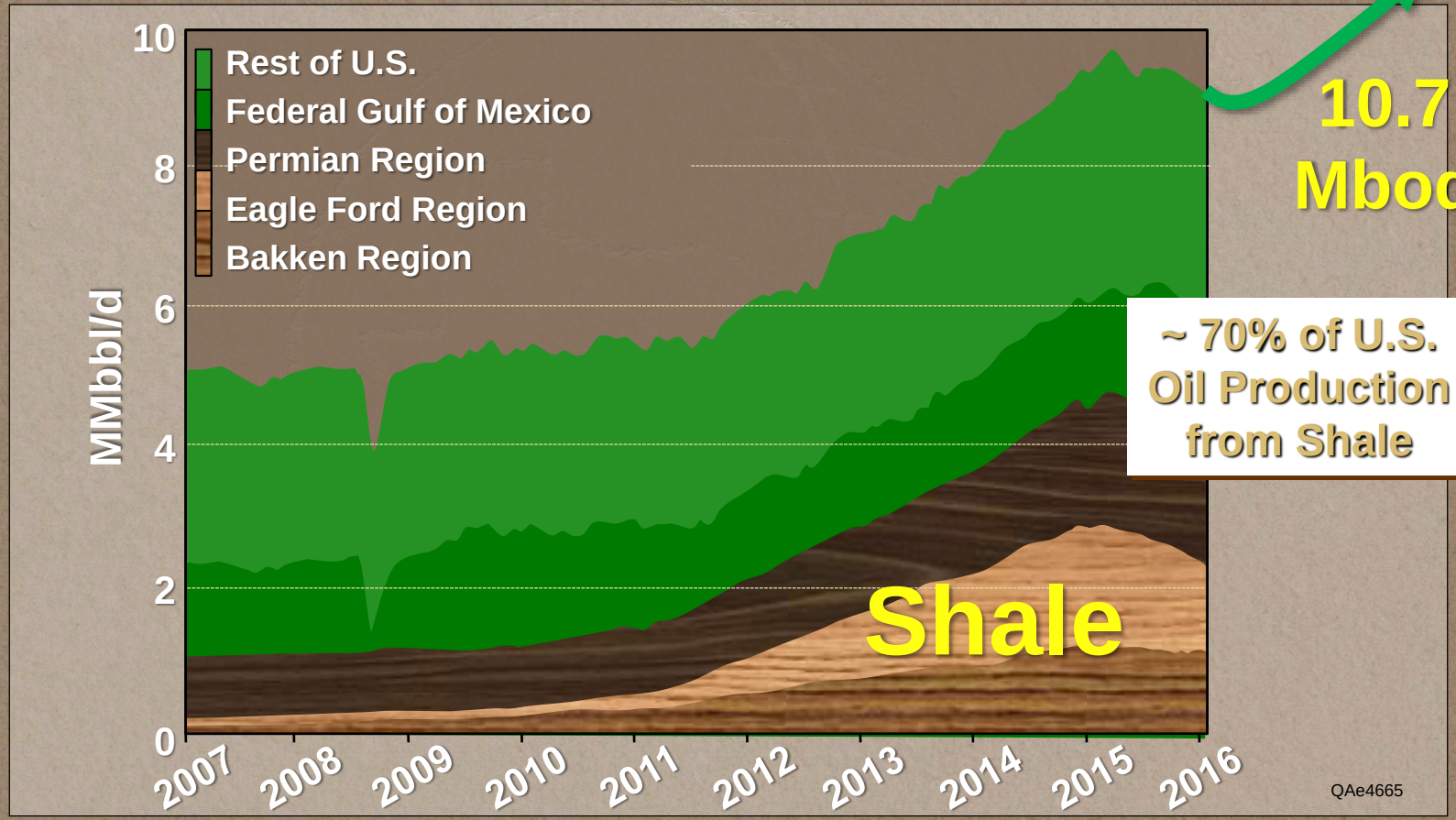
Recovery to Date

2% of the natural gas
1% of the oil

Haynesville
~6,000
~35,000

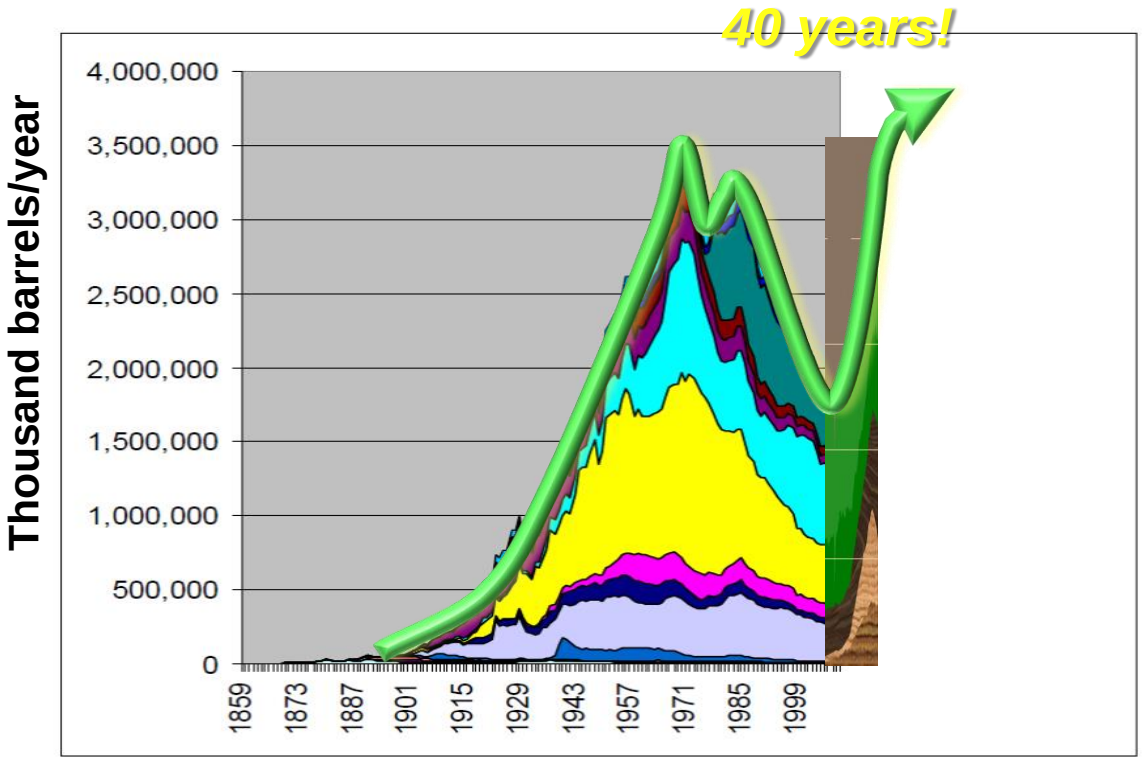
Eagle Ford
~16,500
~90,000

U.S. Crude Oil Production



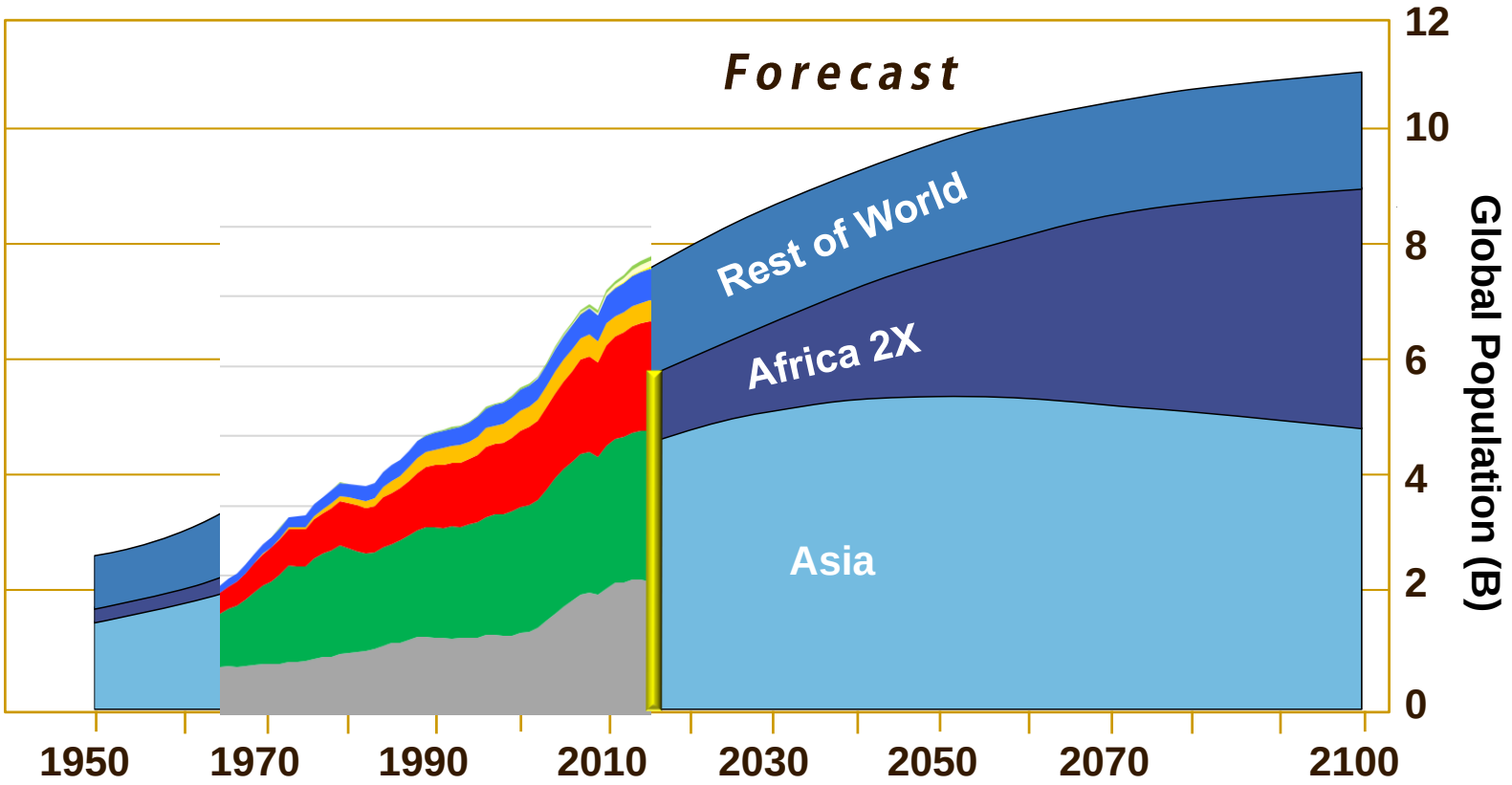
Source:
U.S. Energy Information Administration
Drilling Productivity Report regions, *Petroleum Supply Monthly*, *Natural Gas Monthly*

Annual US Oil Production



From: James D. Hamilton, Working Paper 17759, NATIONAL BUREAU OF ECONOMIC RESEARCH, 2012

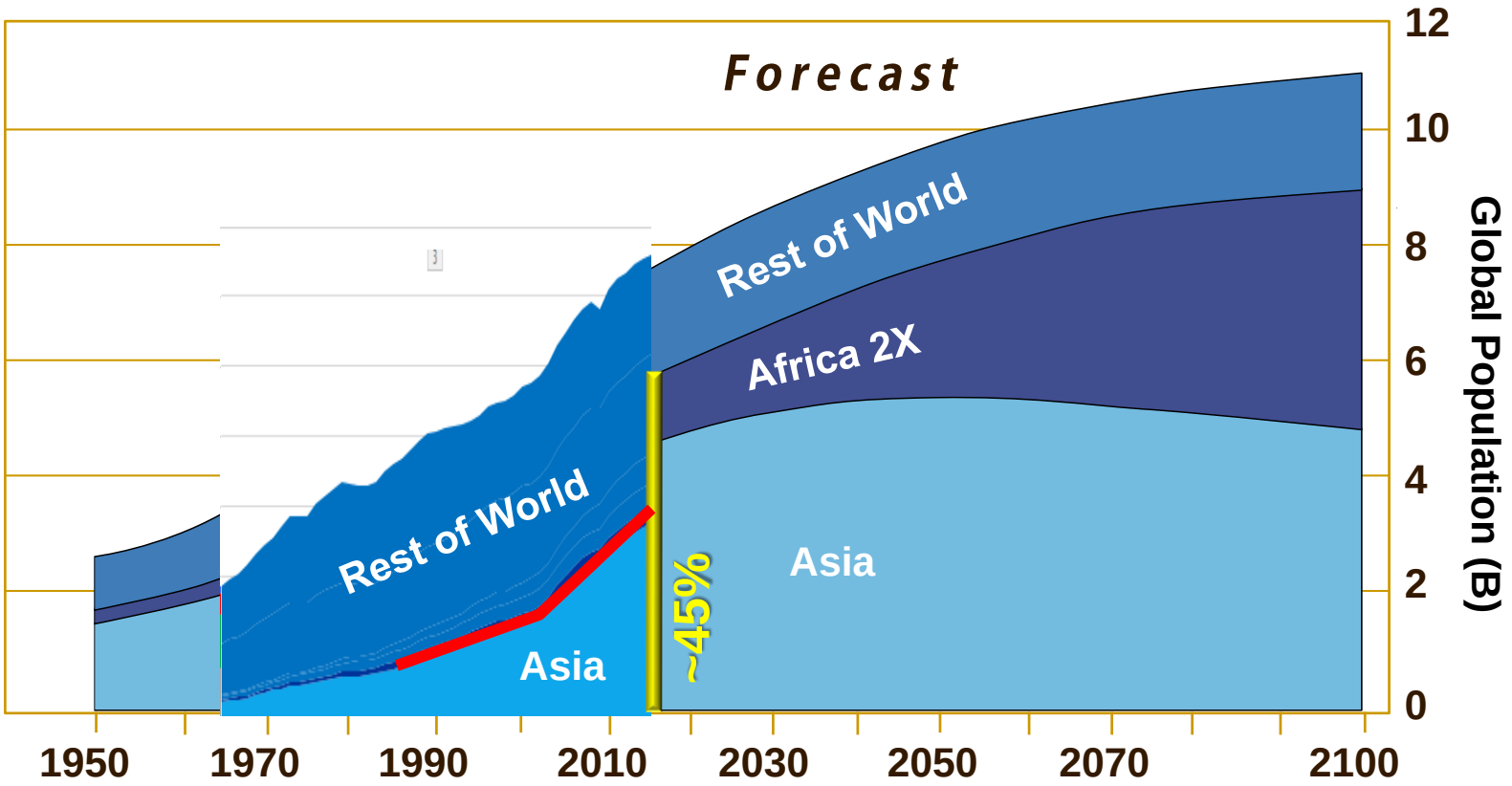
Population and Energy



Data: BP Statistical View of World Energy (2016)

Source: From the UN, as appeared in *The Economist*, August 23, 2014

Population and Energy



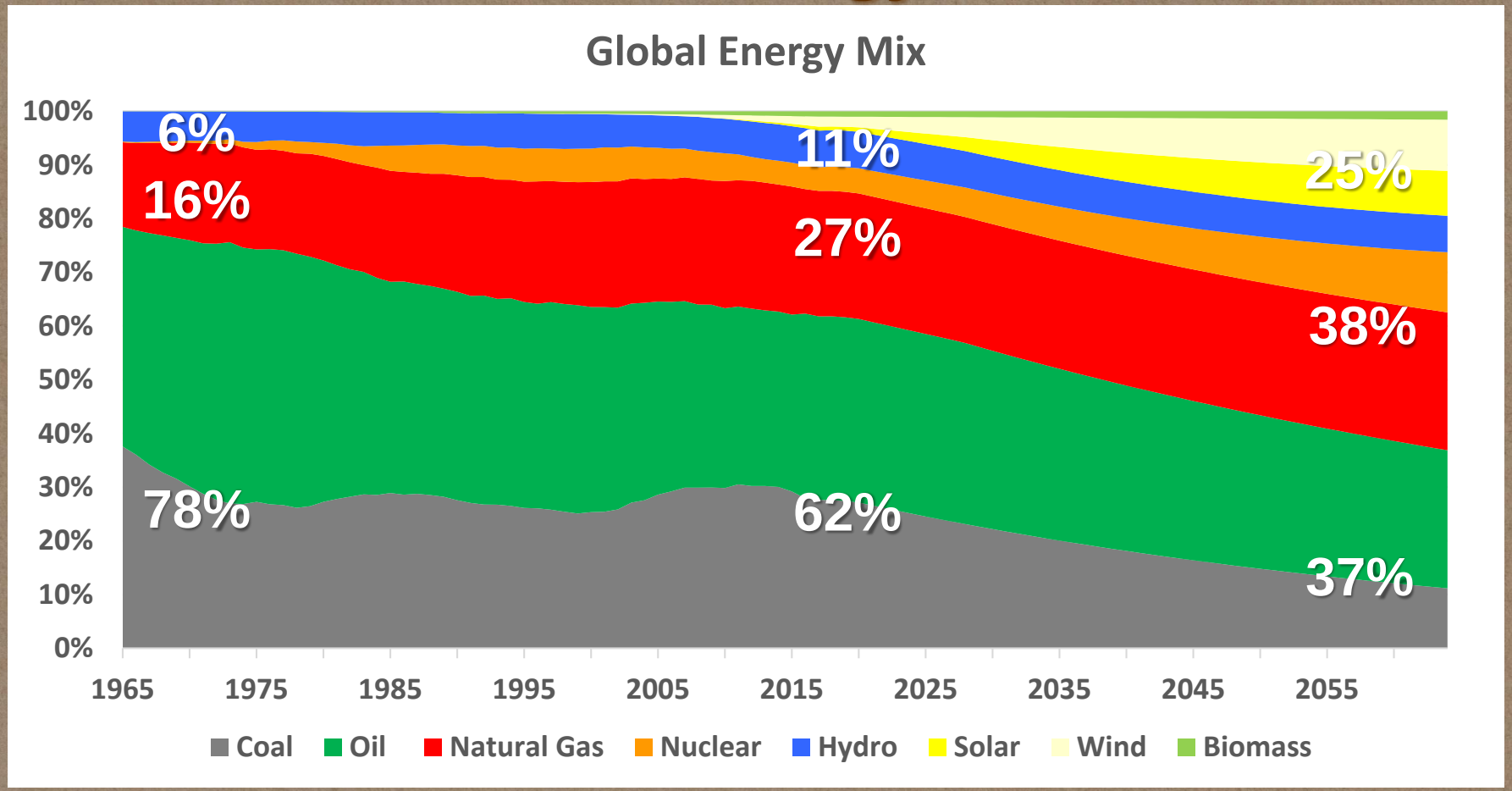
Data: BP Statistical View of World Energy (2016)

Source: From the UN, as appeared in *The Economist*, August 23, 2014

Tinker 2018

Data: BP Statistical View of World Energy (2018)

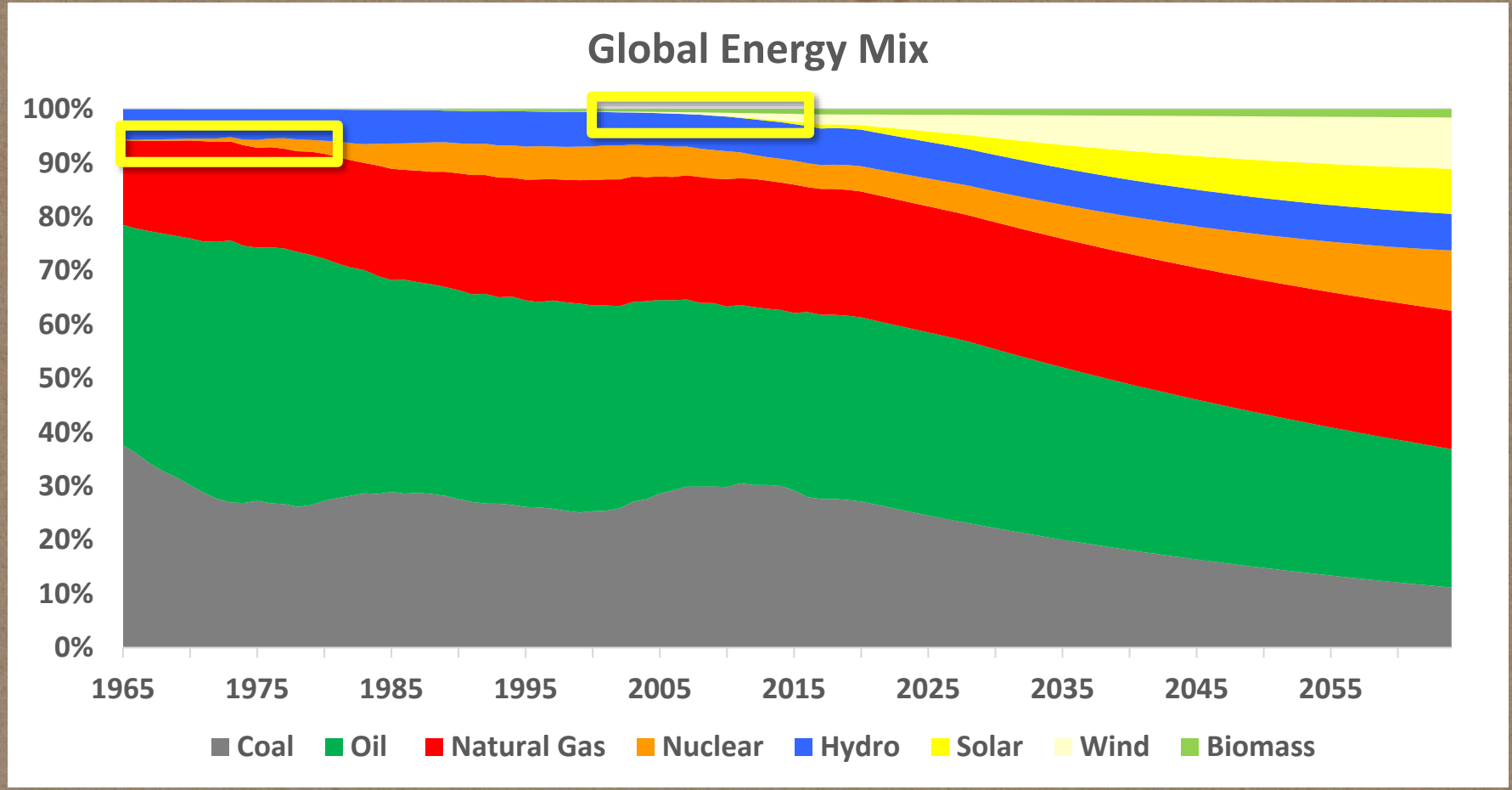
Global Energy 2065



Tinker 2018

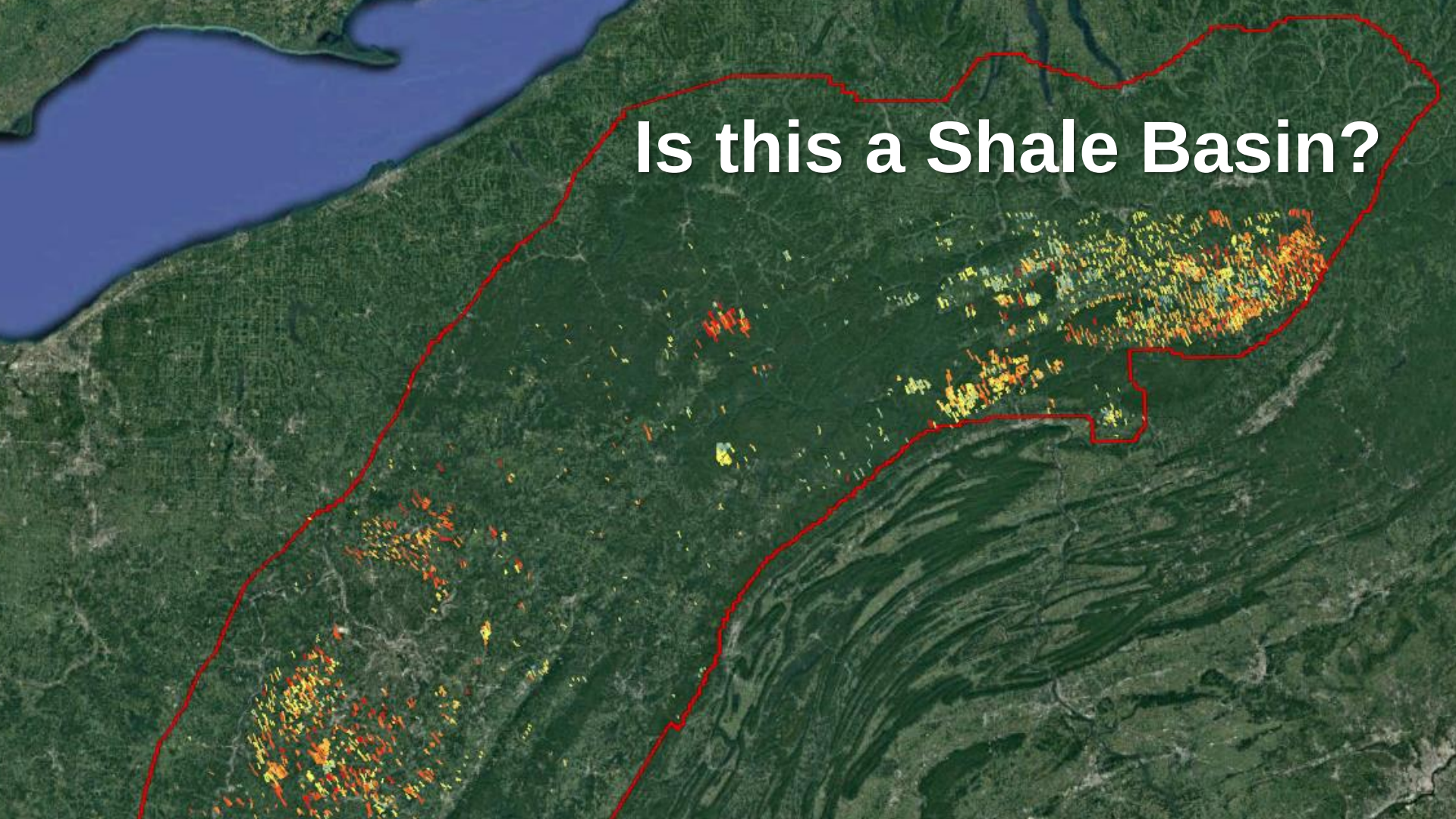
Data: BP Statistical View of World Energy (2018)

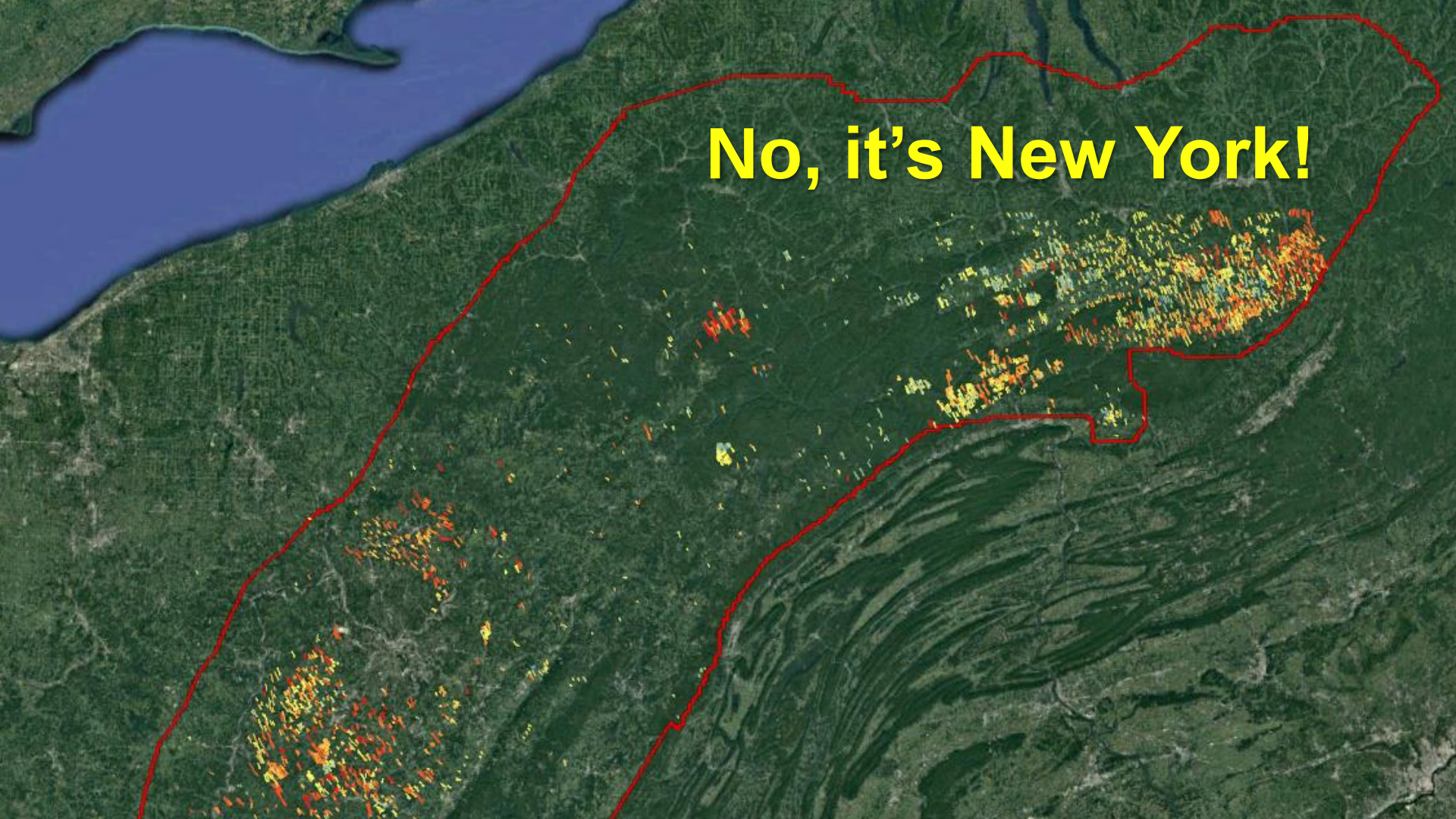
Global Energy 2065



Environmental Impact
Coal, Oil, Natural Gas

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


Is this a Shale Basin?


No, it’s New York!

Environmental Impact
Renewables and Batteries

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

Energy
Key Points

- **Fossil energy demand remains strong, and resources are vast**
- **Wind and solar are a small component of the mix, but growing quickly in some regions**
- **No form of energy, at scale, is without environmental impact**

SWITCH ENERGY ALLIANCE

BUREAU OF ECONOMIC GEOLOGY

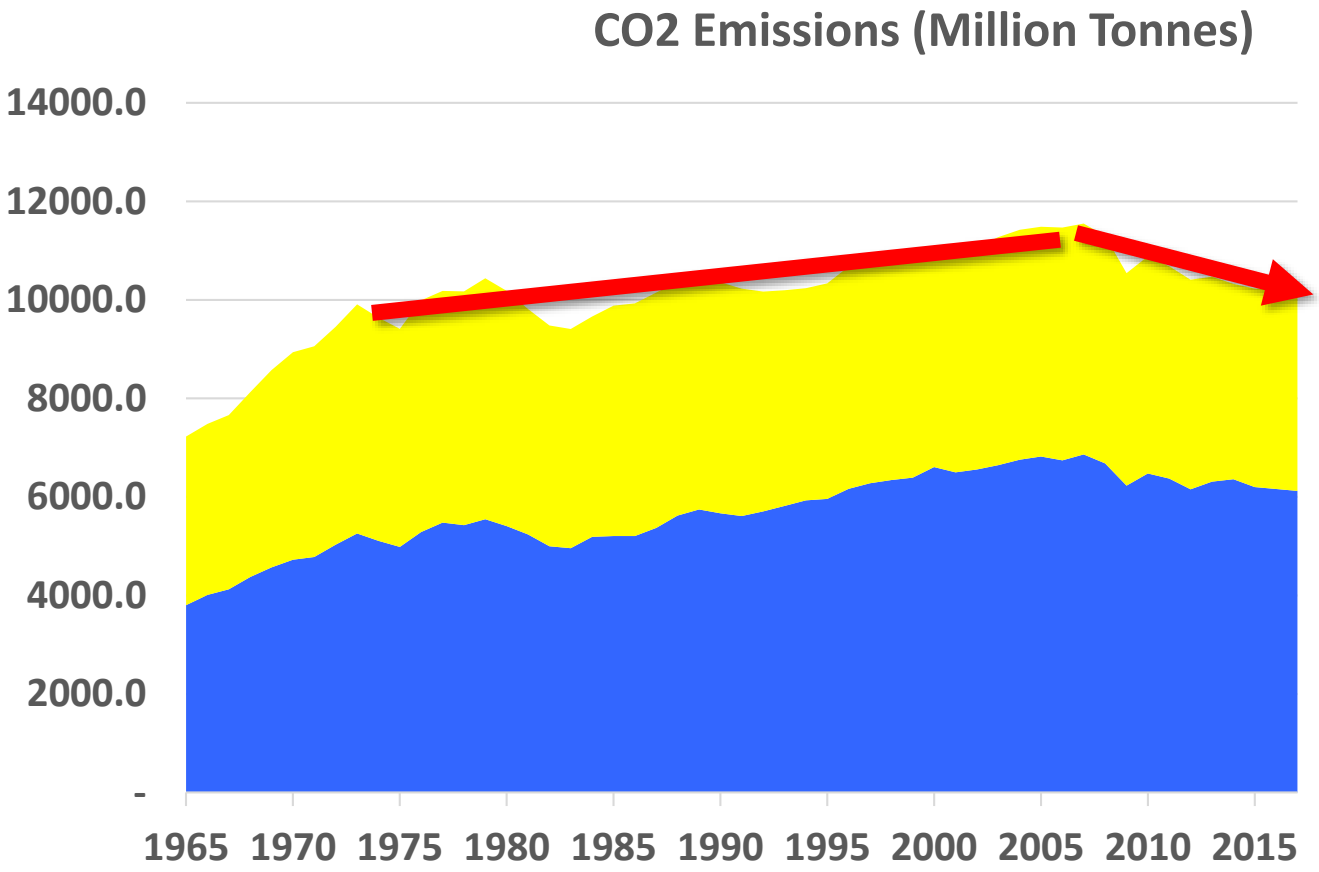
Outline

- Energy
- Carbon
- Poverty
- Radical Middle

SWITCH
ENERGY ALLIANCE

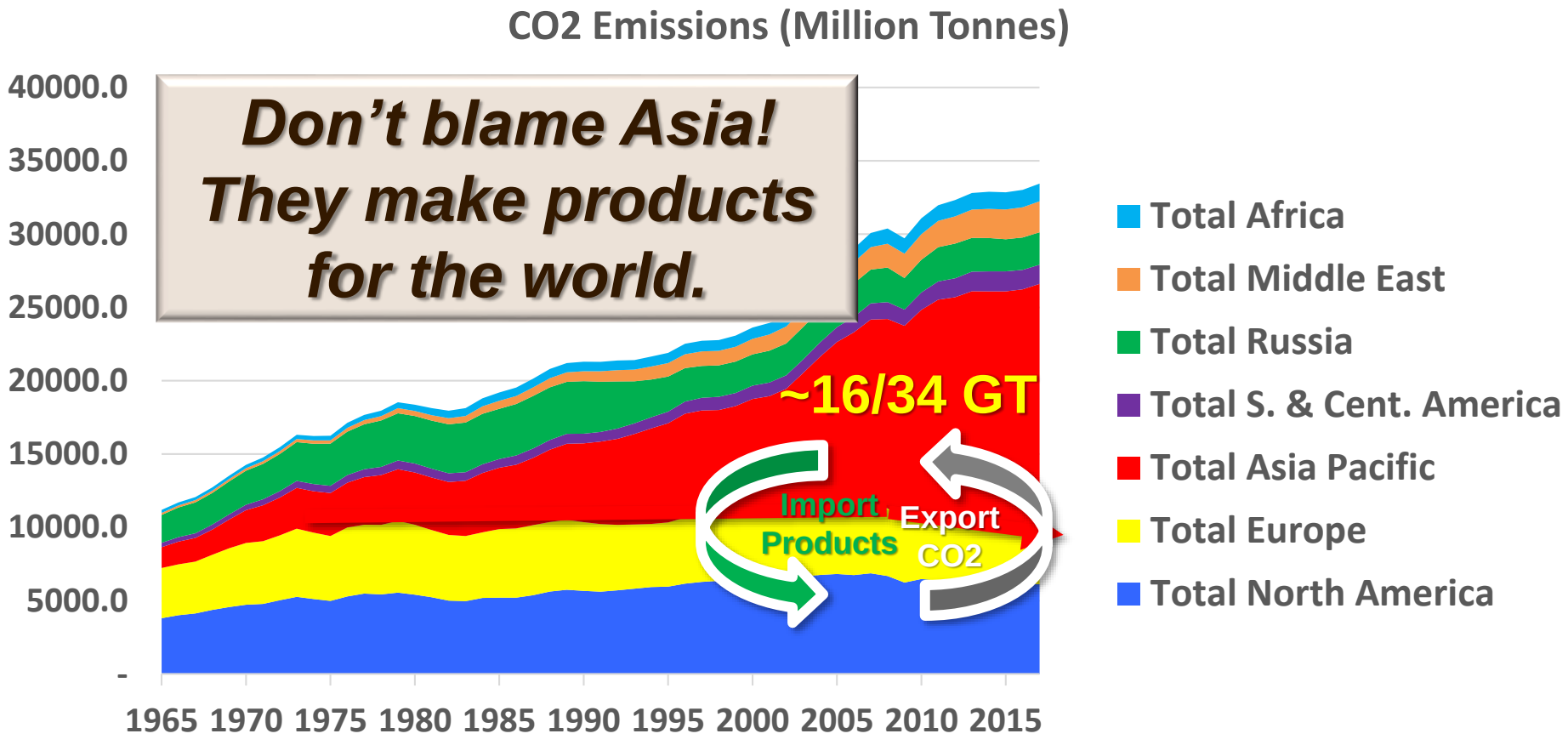
Bureau of Economic Geology

CO_2 Emissions



Data: BP Statistical View of World Energy (2016)

CO_2 Emissions

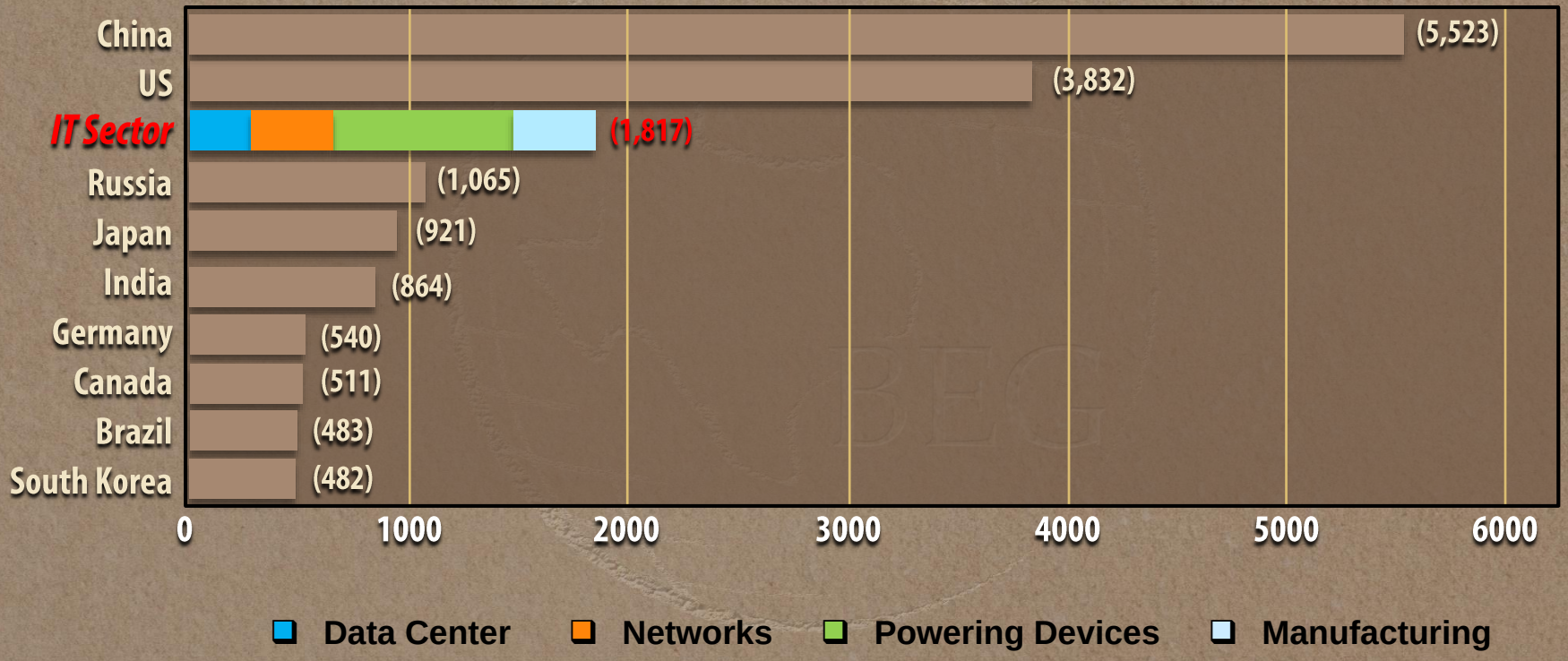


Data: BP Statistical View of World Energy (2016)

Tinker 2017

Electricity Use, 2012

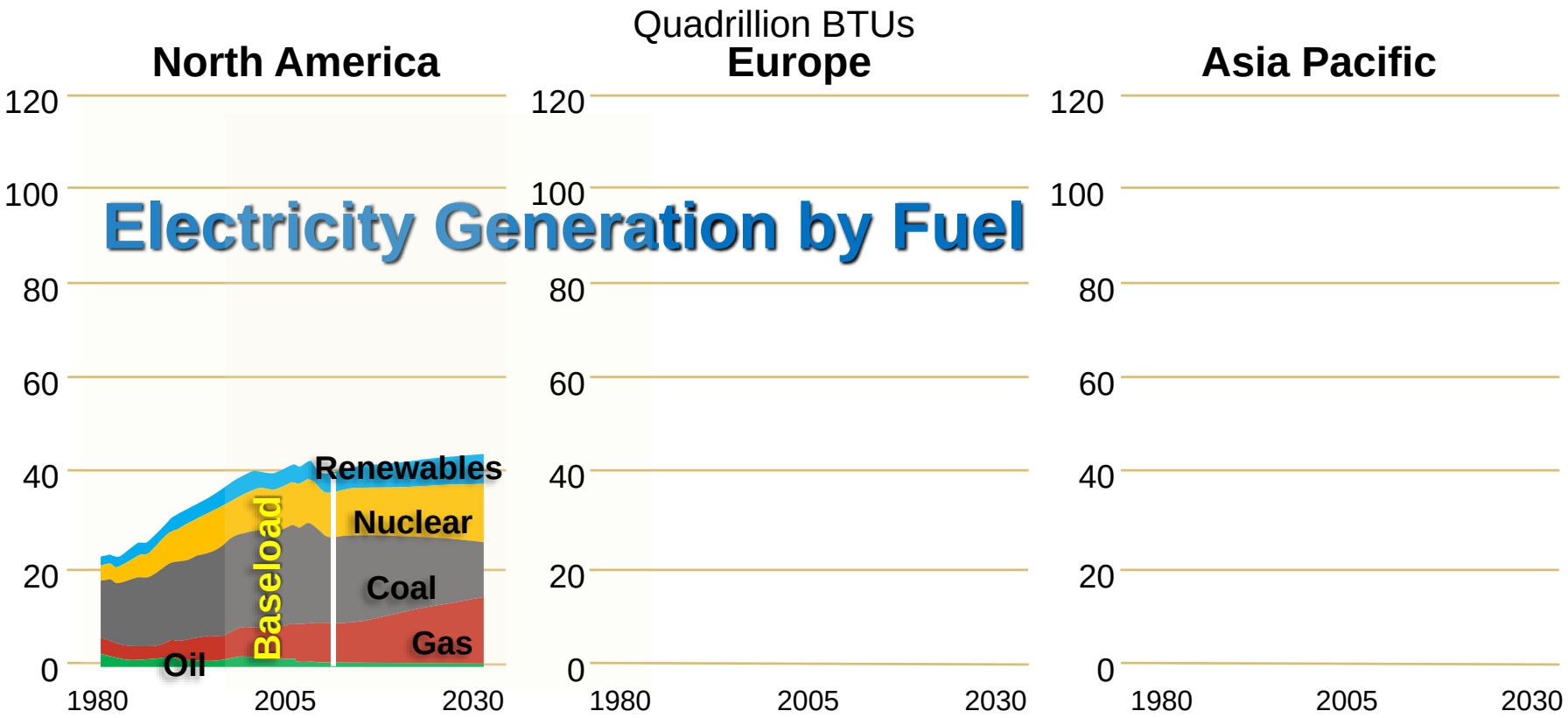
(Billion KwH)



Source: Emerging Trends in Electricity Consumption for Consumer ICT, Peter Corcoran and Andres Andrae (2013) and CIA World Factbook. China/Russia/Canada figures are from 2014.

QAe5585

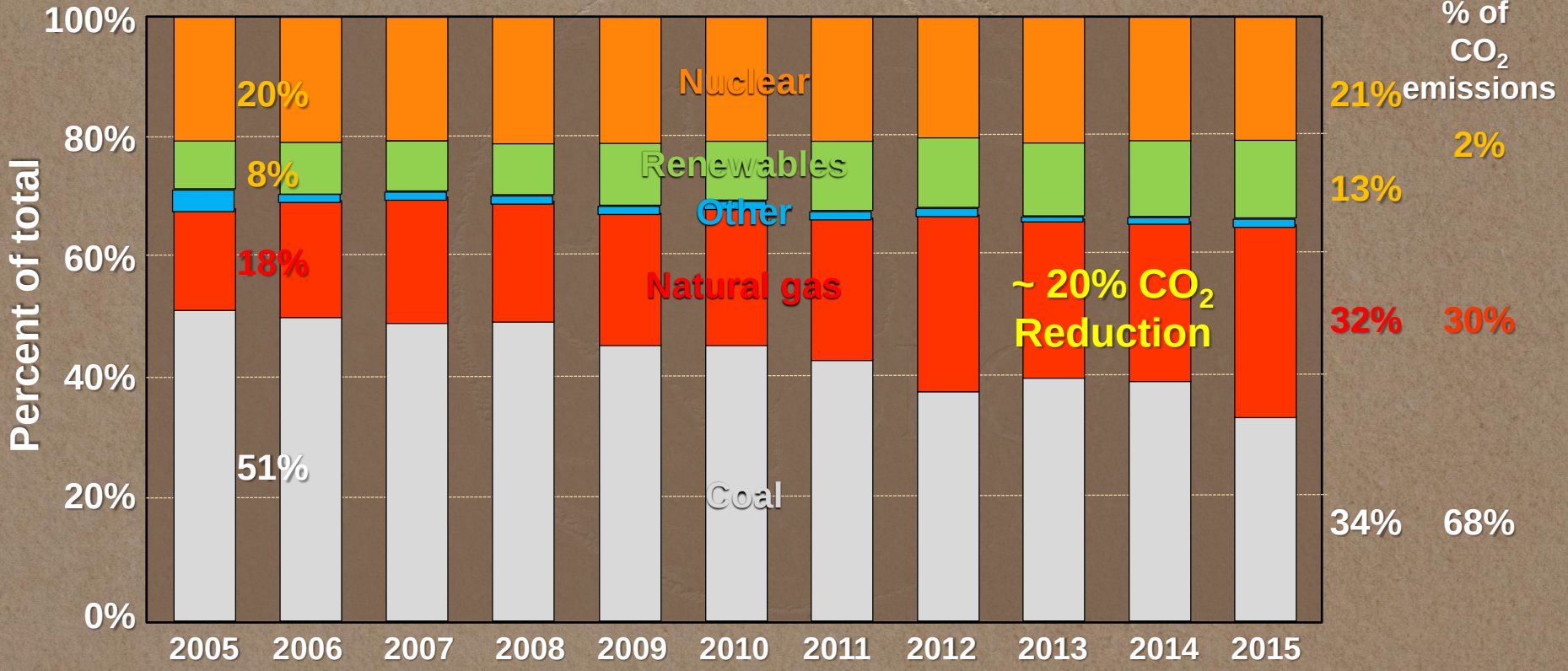
The Future Electricity Mix



ExxonMobil Corporation, 2010, The outlook for energy: a view to 2030: ExxonMobil report, 53 p.

Tinker 2018

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

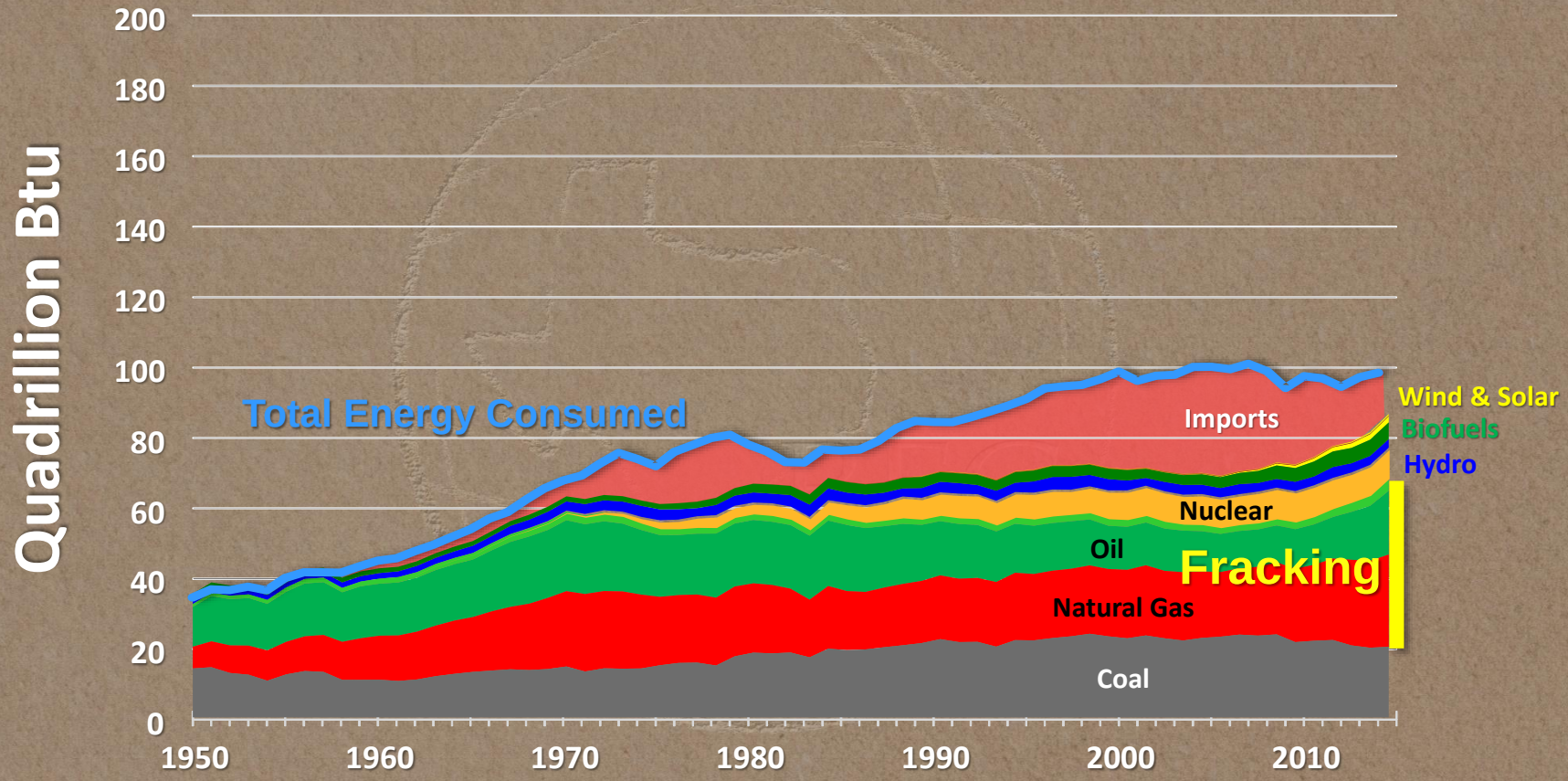


Source: EIA

QAe4744

Tinker 2016

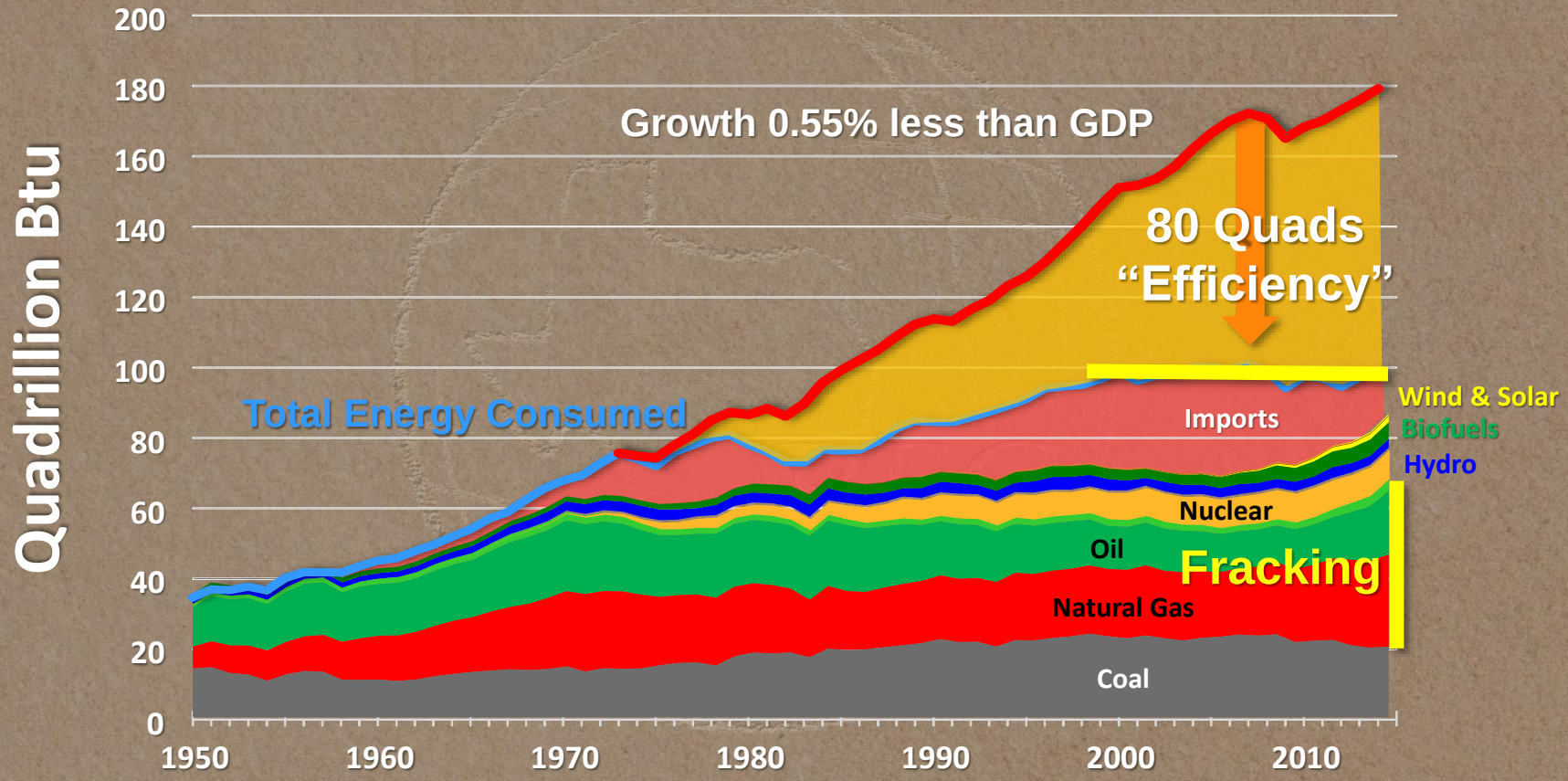
US Energy Mix



After Jim Sweeney, 2015. Data: EIA, Monthly Energy Review

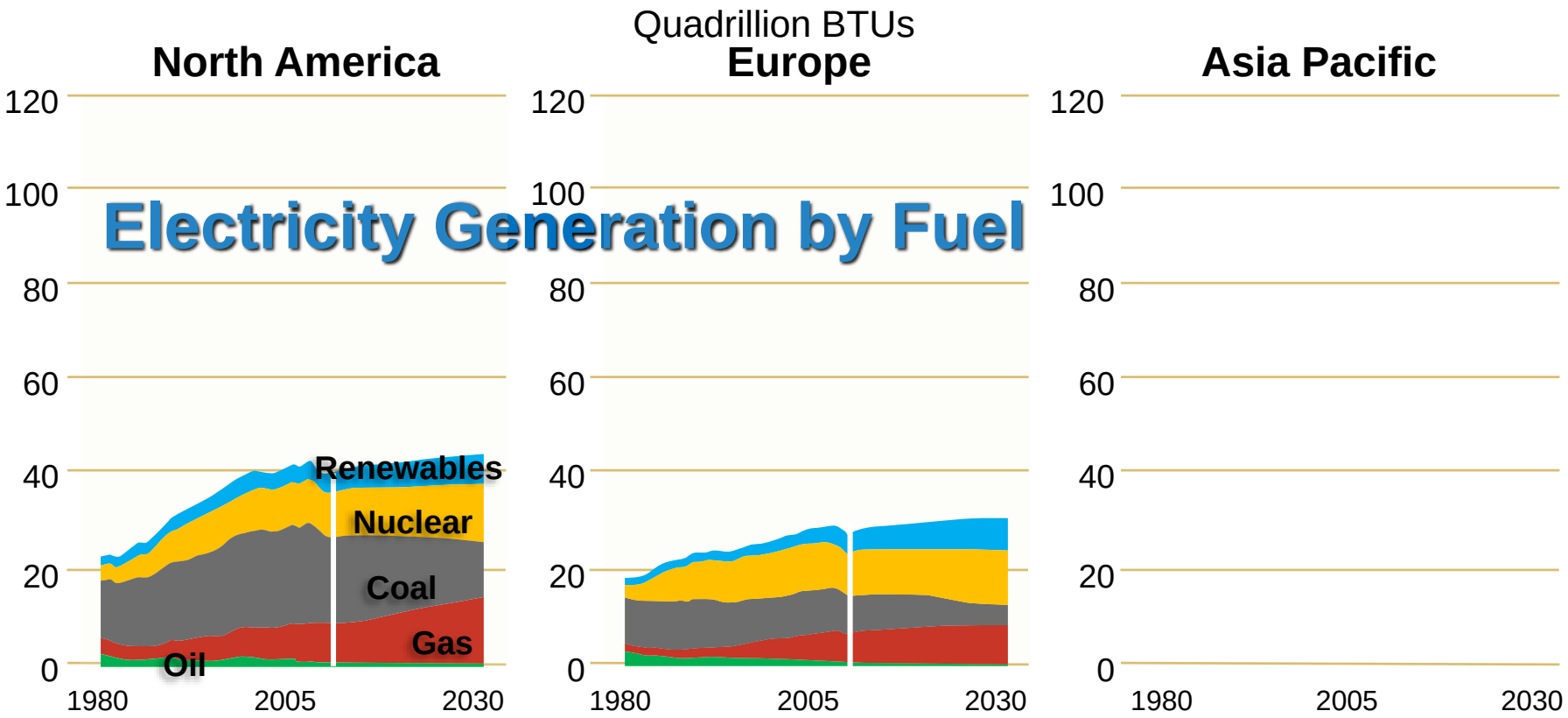
Tinker 2016

US Energy Mix



After Jim Sweeney, 2015. Data: EIA, Monthly Energy Review

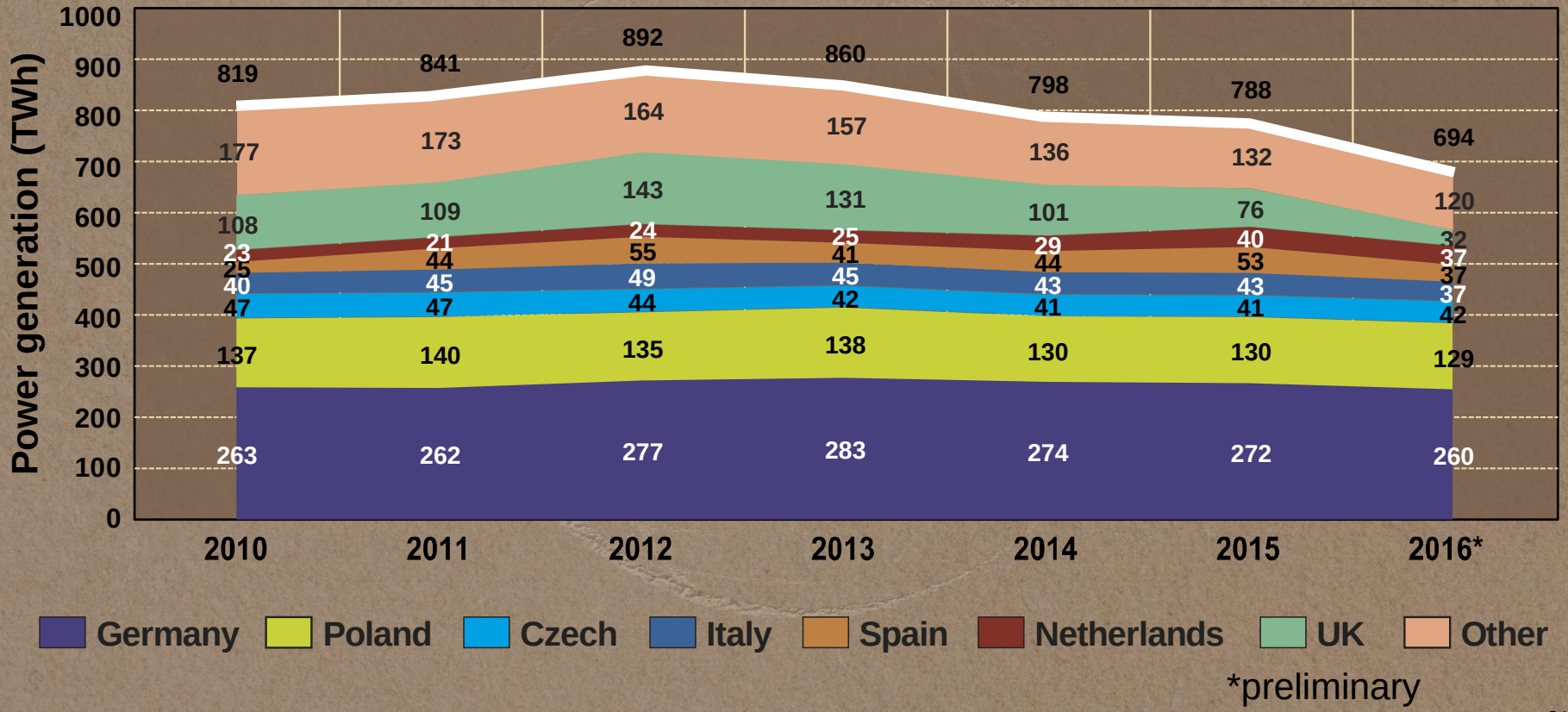
The Future Electricity Mix



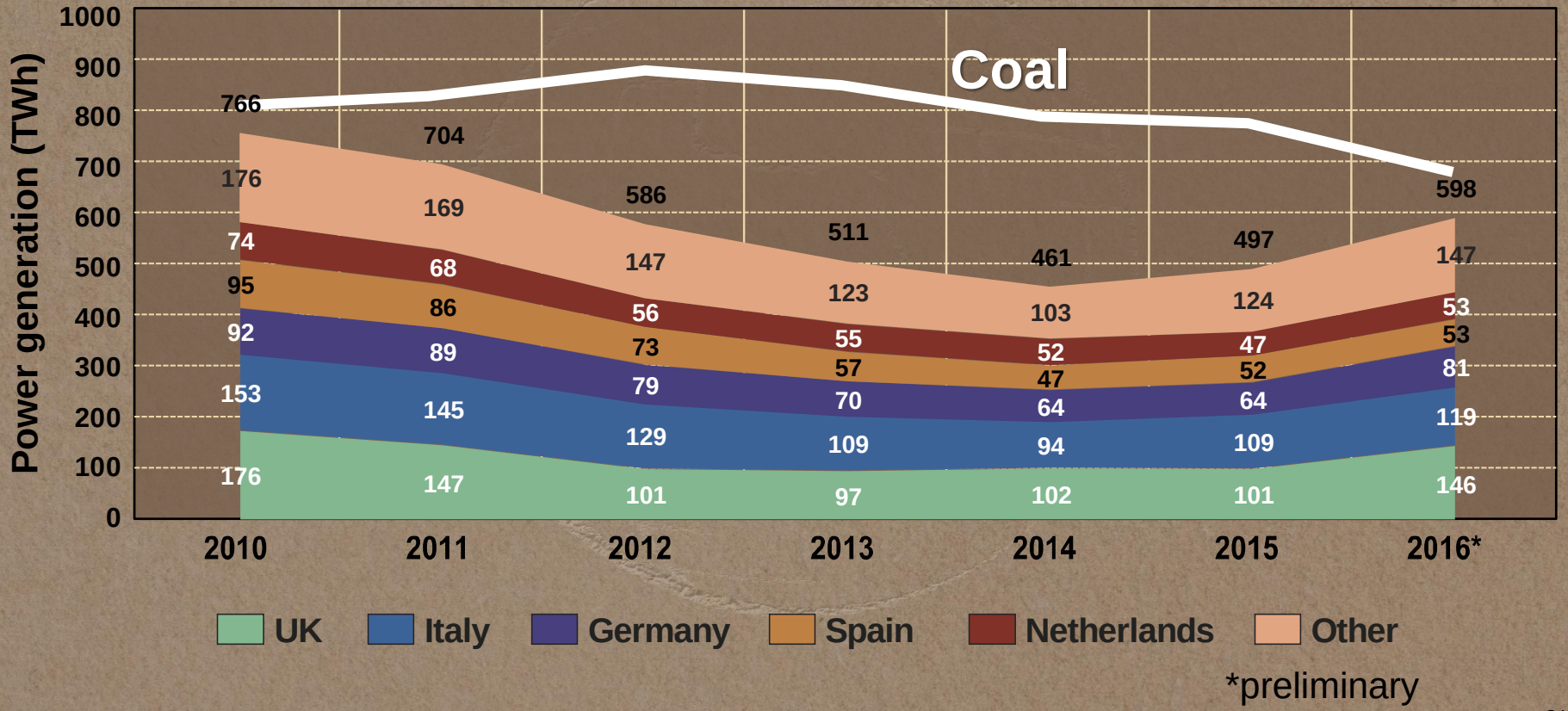
Electricity Generation by Fuel

ExxonMobil Corporation, 2010, The outlook for energy: a view to 2030: ExxonMobil report, 53 p.

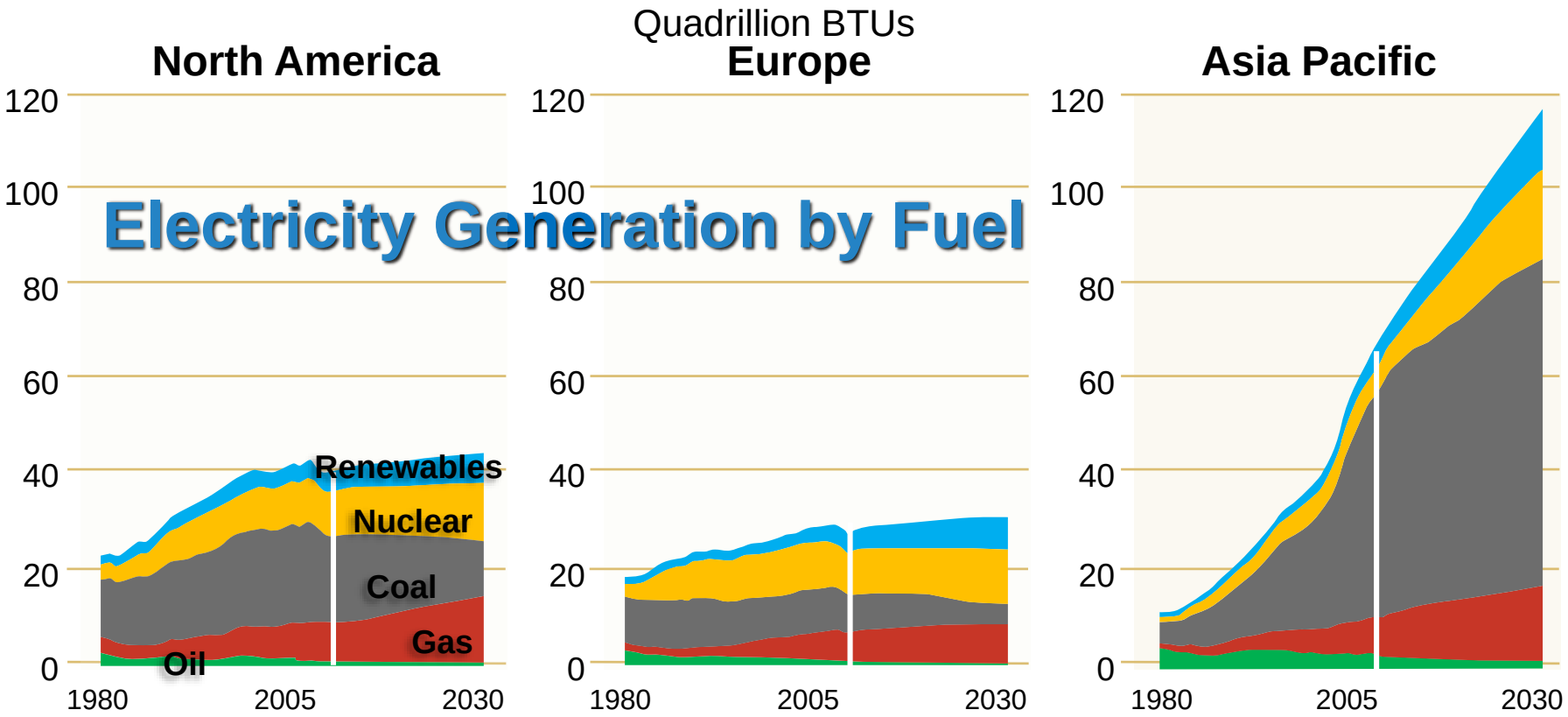
European Coal Generation



European Natural Gas Power Generation



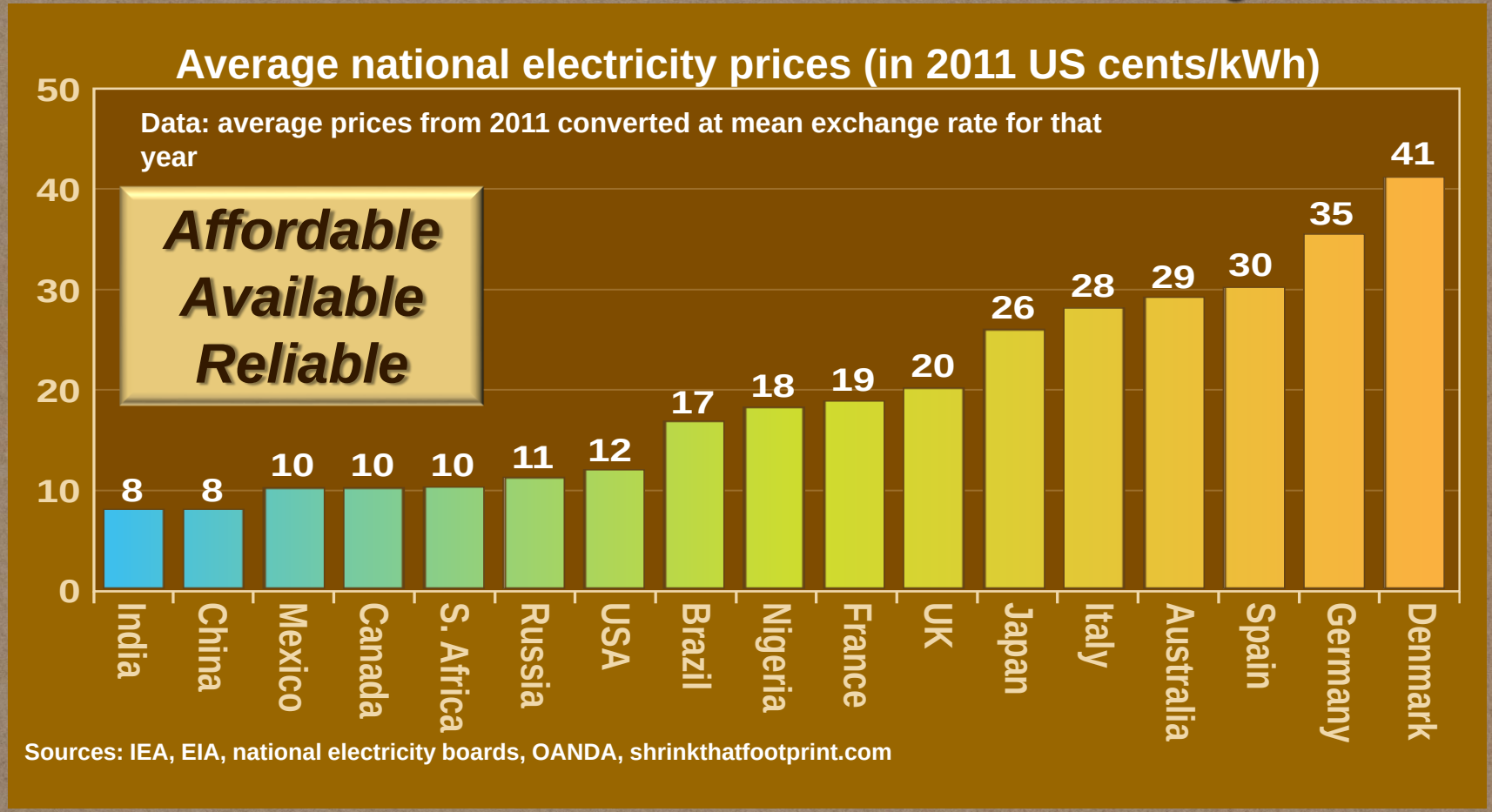
The Future Electricity Mix



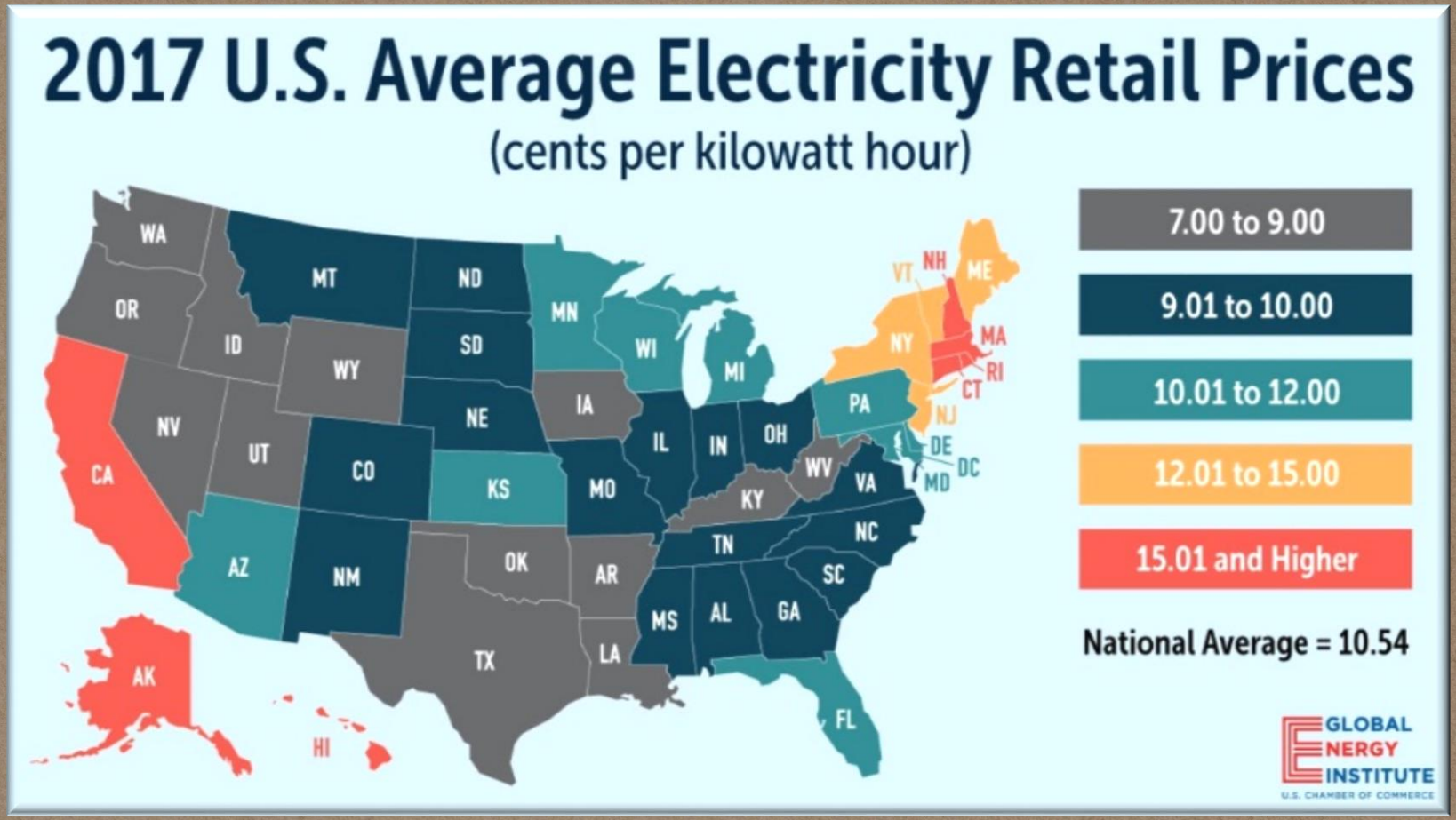
ExxonMobil Corporation, 2010, The outlook for energy: a view to 2030: ExxonMobil report, 53 p.

Tinker 2018

Actual Cost of Electricity

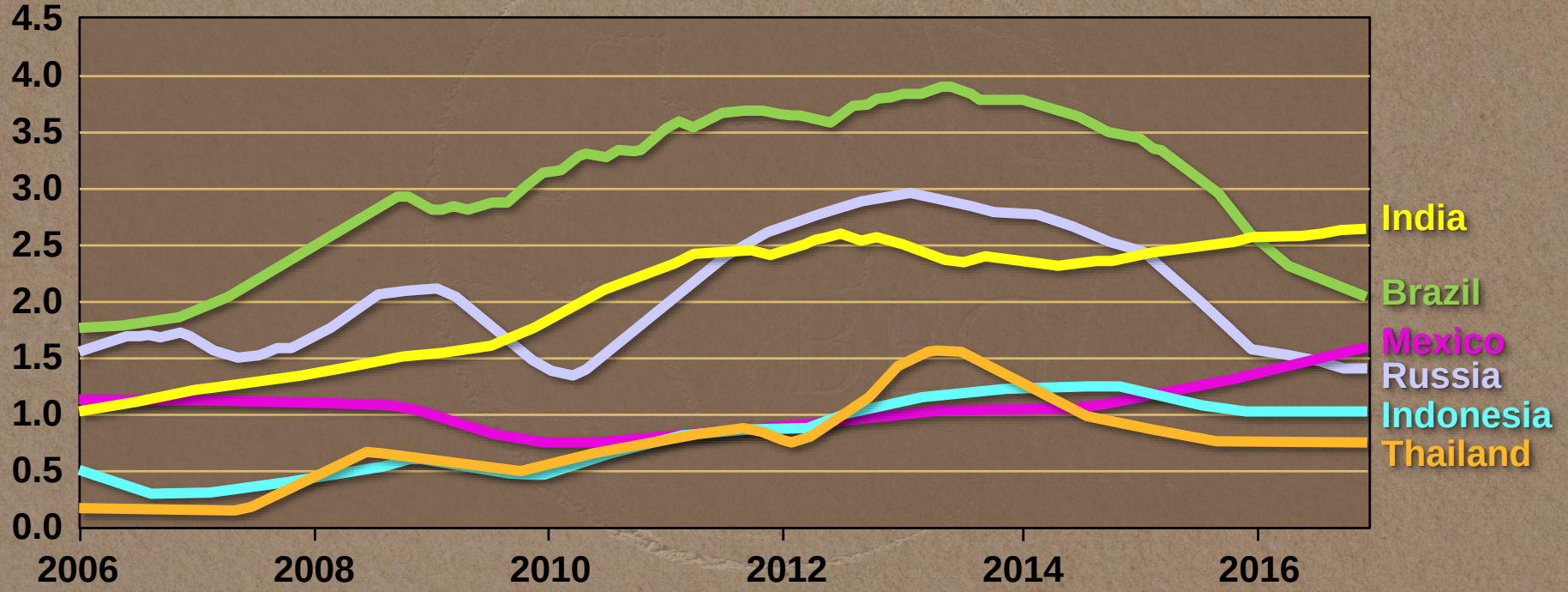


Actual Cost of Electricity



Auto Sales Developing Nations

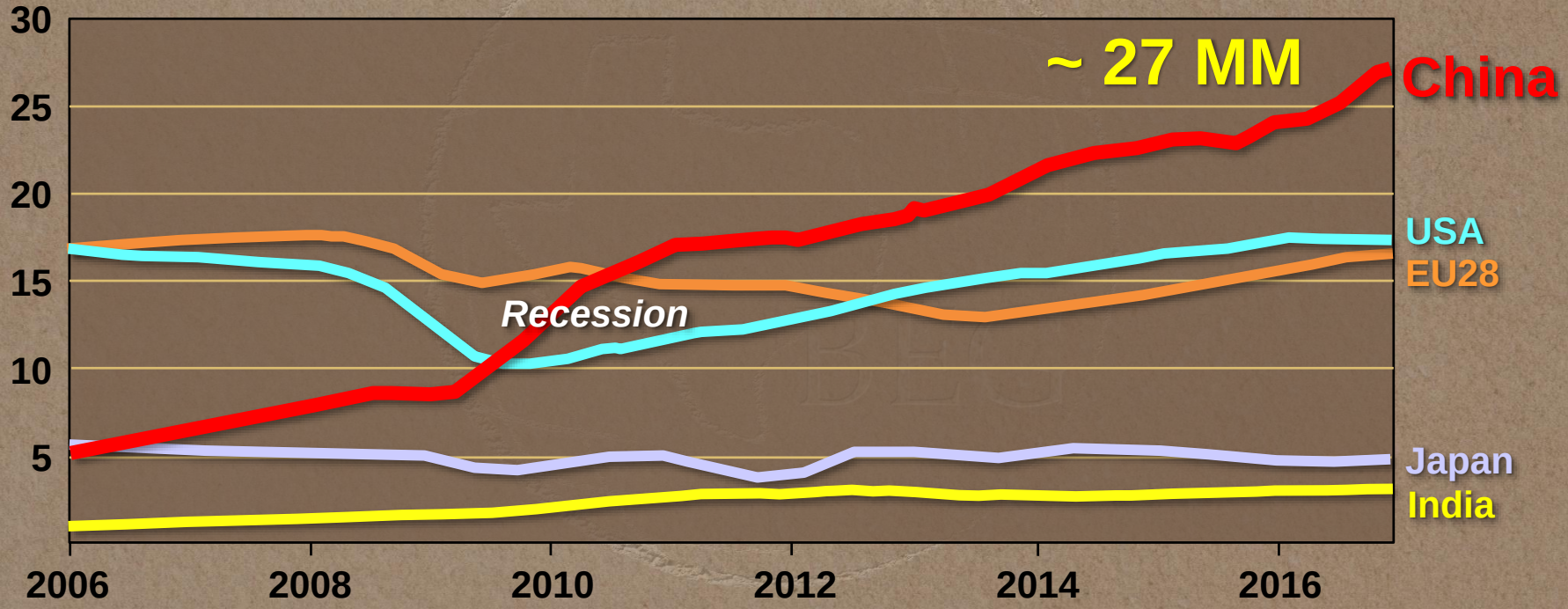
Rolling 12-month (million)



Source: National car data, Macquarie Research, January 2017

Auto Sales Developed Nations

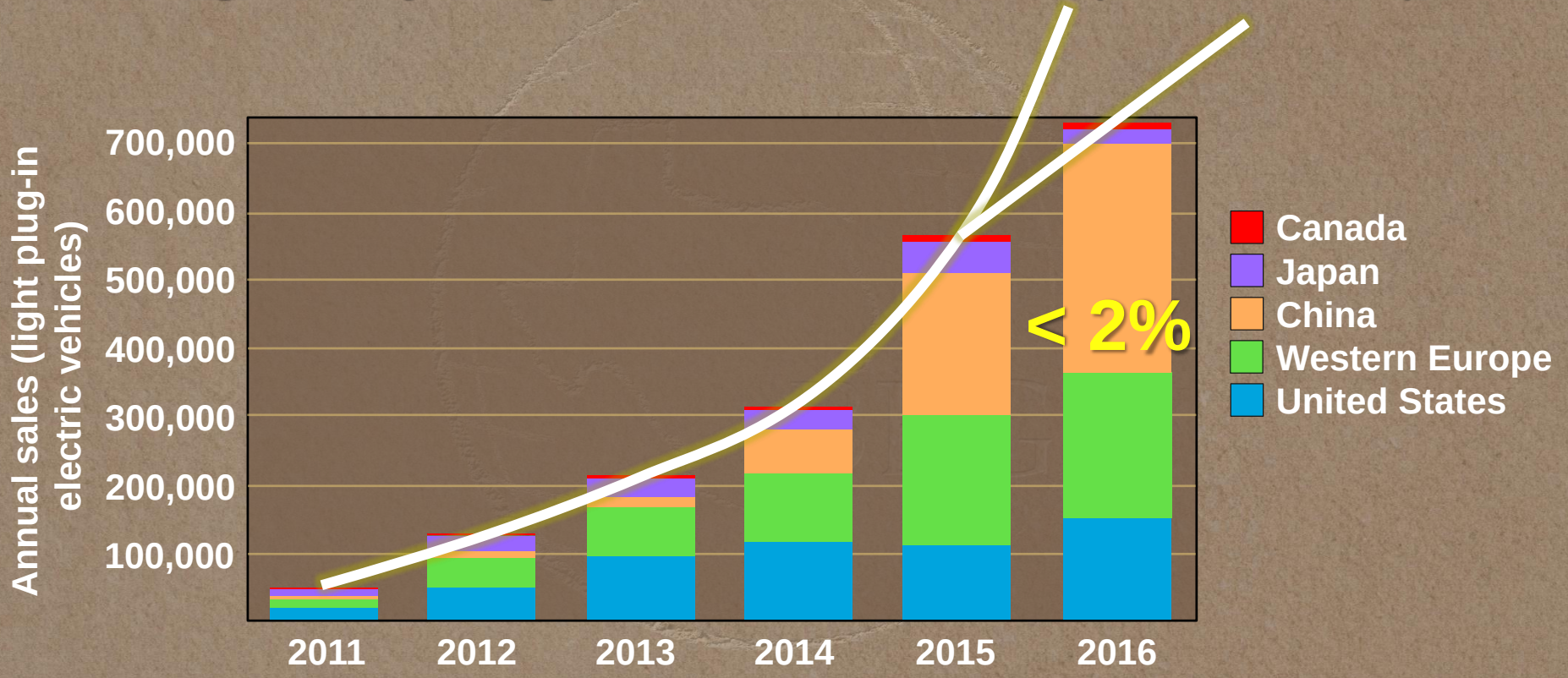
Rolling 12-month (million)



Source: National car data, Macquarie Research, January 2017

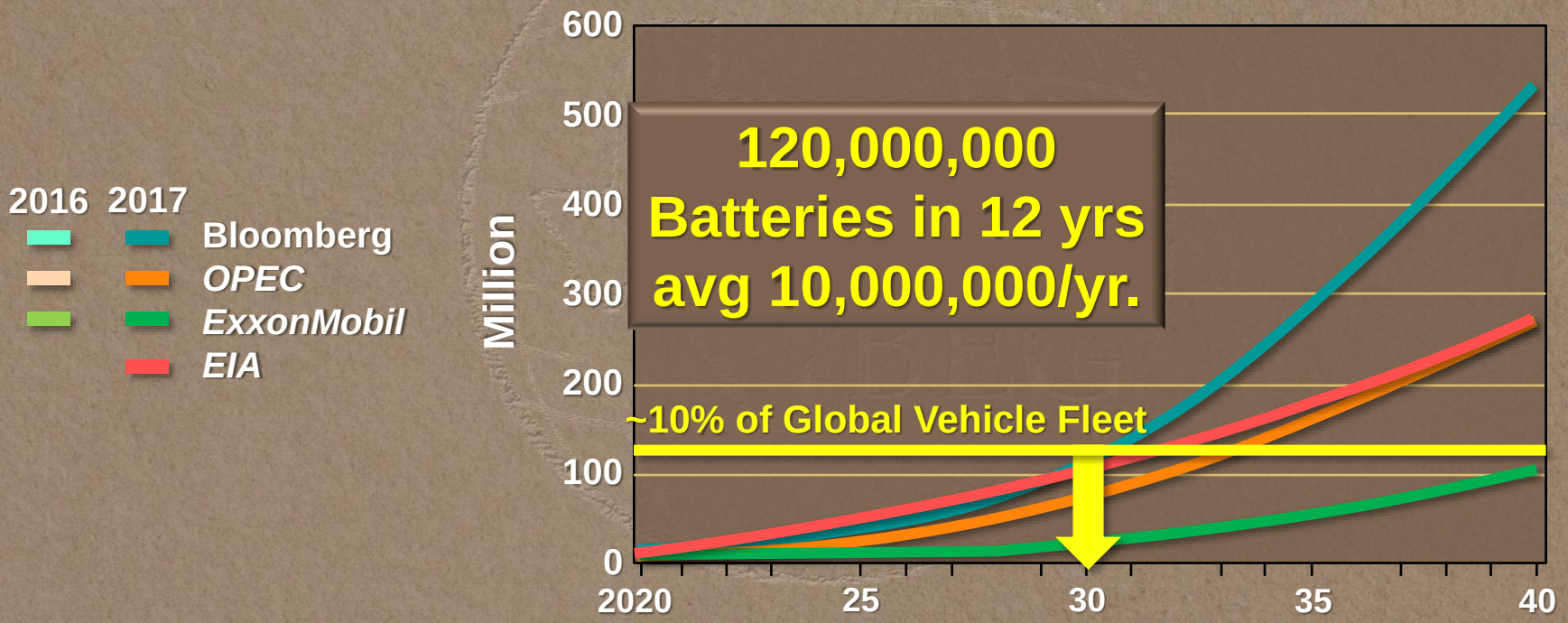
Global Annual Sales

Light-Duty Plug-In Electric Vehicles (2011 – 2016)



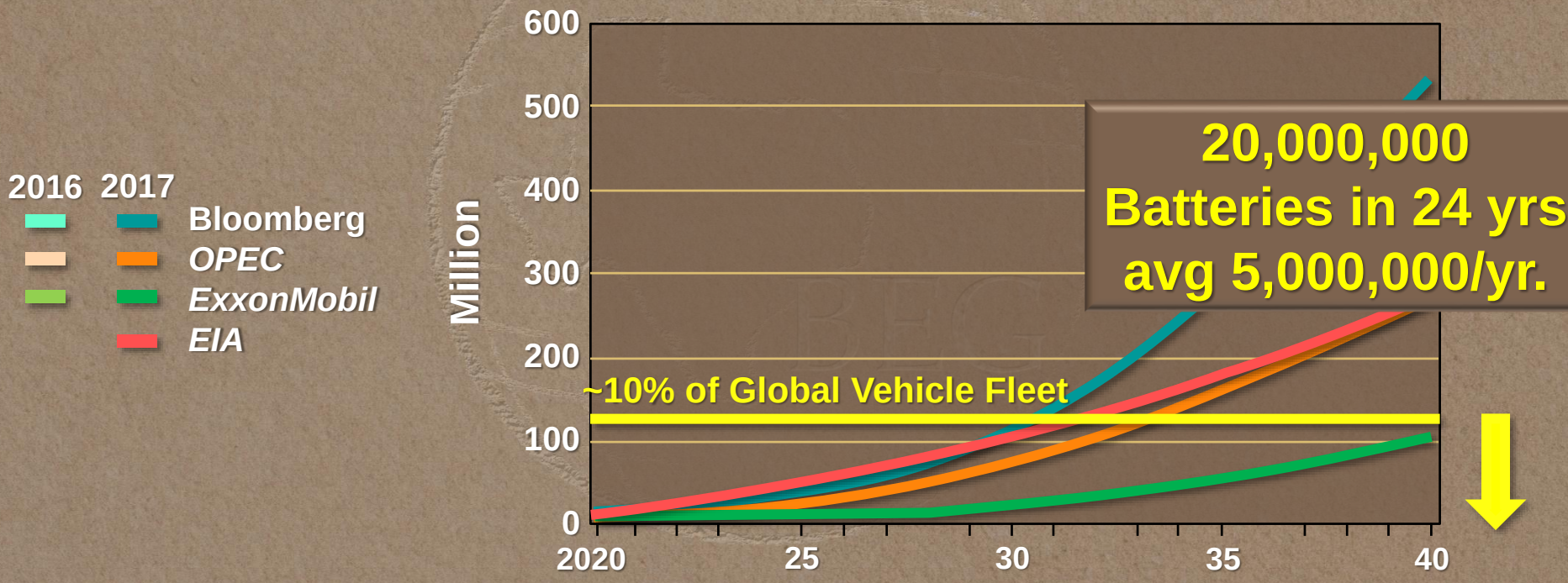
Source: Argonne National Laboratory, United States Department of Energy

Cumulative Electric-Vehicle Forecasts



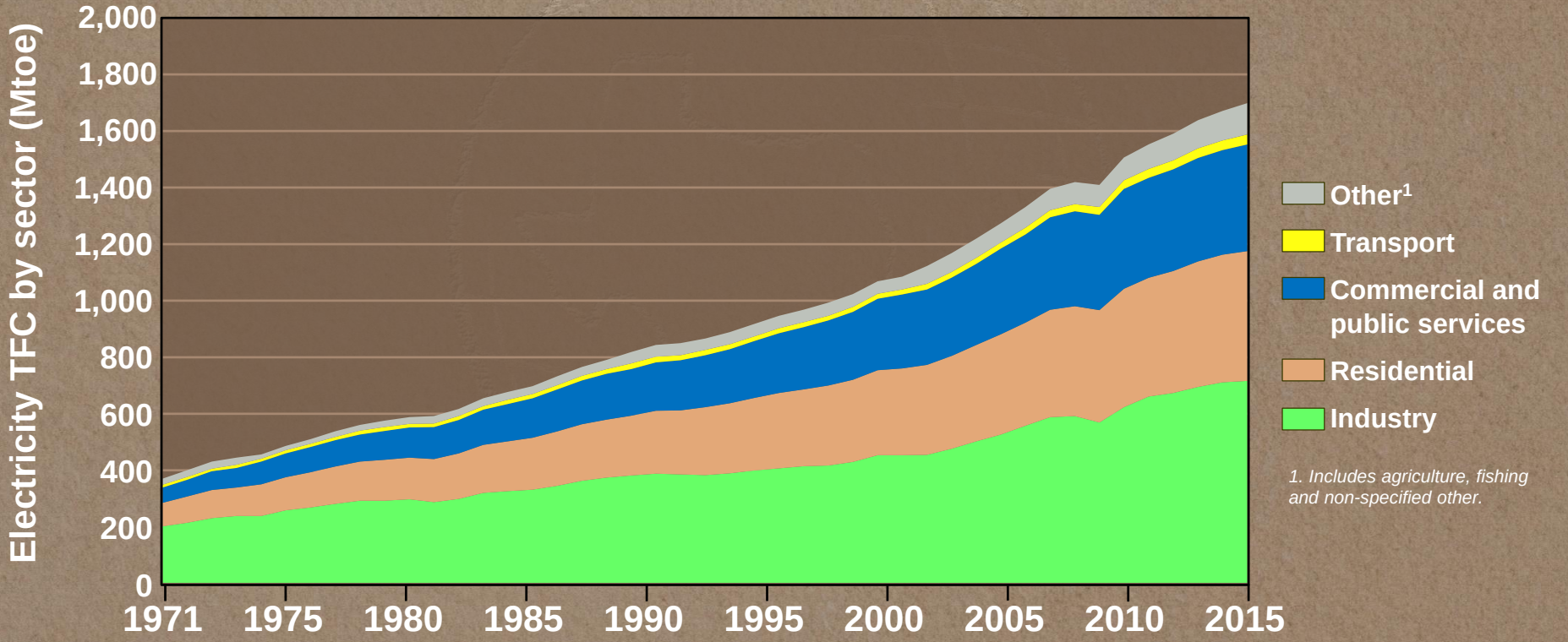
Source: Bloomberg New Energy Finance, Economist.com; EIA, WEO, 2017

Cumulative Electric-Vehicle Forecasts



Source: Bloomberg New Energy Finance, Economist.com; EIA, WEO, 2017

Total Final Consumption by Sector
Electricity



Source: **World Energy Outlook, 2017, EIA**

CO_2 Reduction Strategies

- **Efficiency**
- **Fuel Substitution**
  - ✓ **Nuclear, Nat Gas, Renewables**
- **Carbon Capture and Sequestration**

Carbon
Key Points

- **Renewables will grow, but not soon enough or large enough to reduce CO_2 emissions at scale**
- **Natural gas and nuclear can reduce CO_2 emissions at scale and in needed time frames**
  - ✓ **Reduce methane emissions!**
- **Electric Vehicle growth will not mitigate the demand for liquid petroleum fuels**

SWITCH ENERGY ALLIANCE

BUREAU OF ECONOMIC GEOLOGY

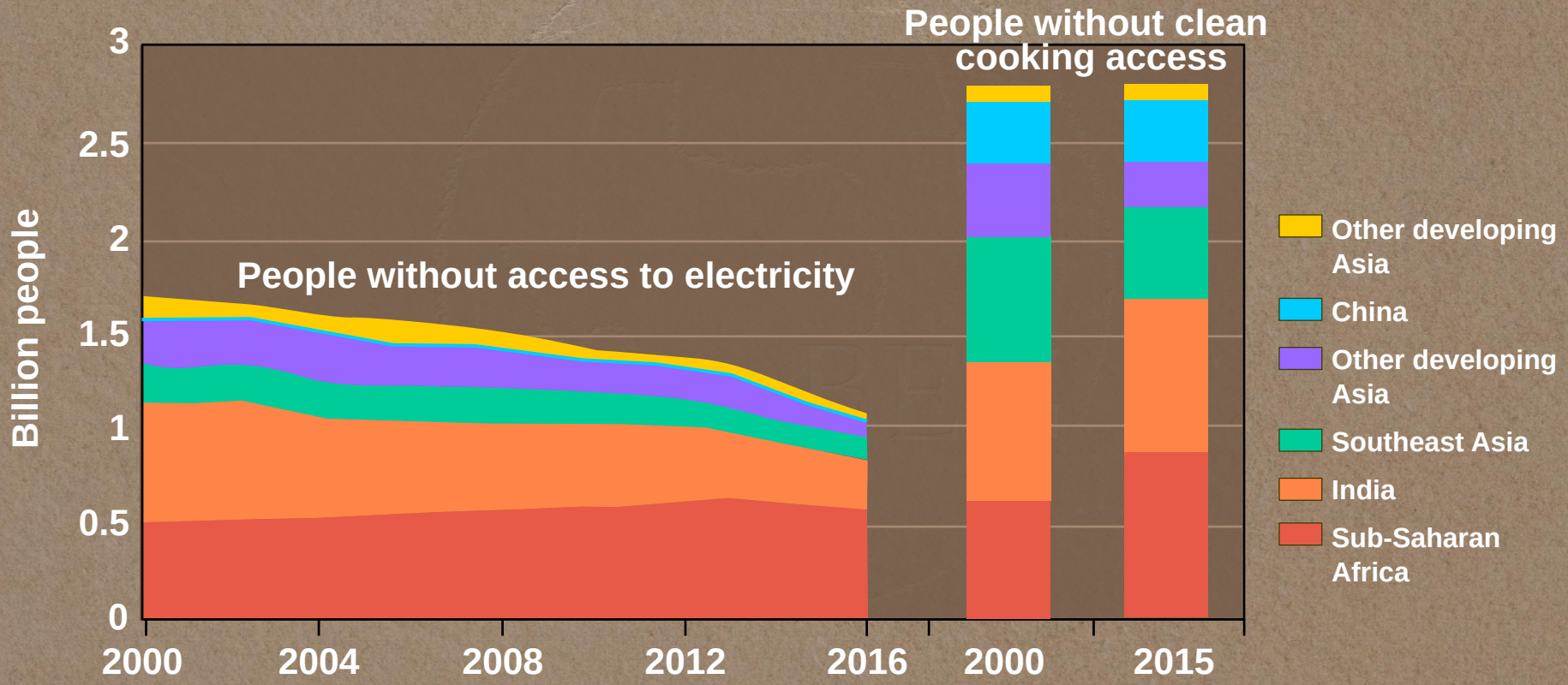
Outline

- Energy
- Carbon
- Poverty
- Radical Middle

SWITCH ENERGY ALLIANCE

Bureau of Economic Geology

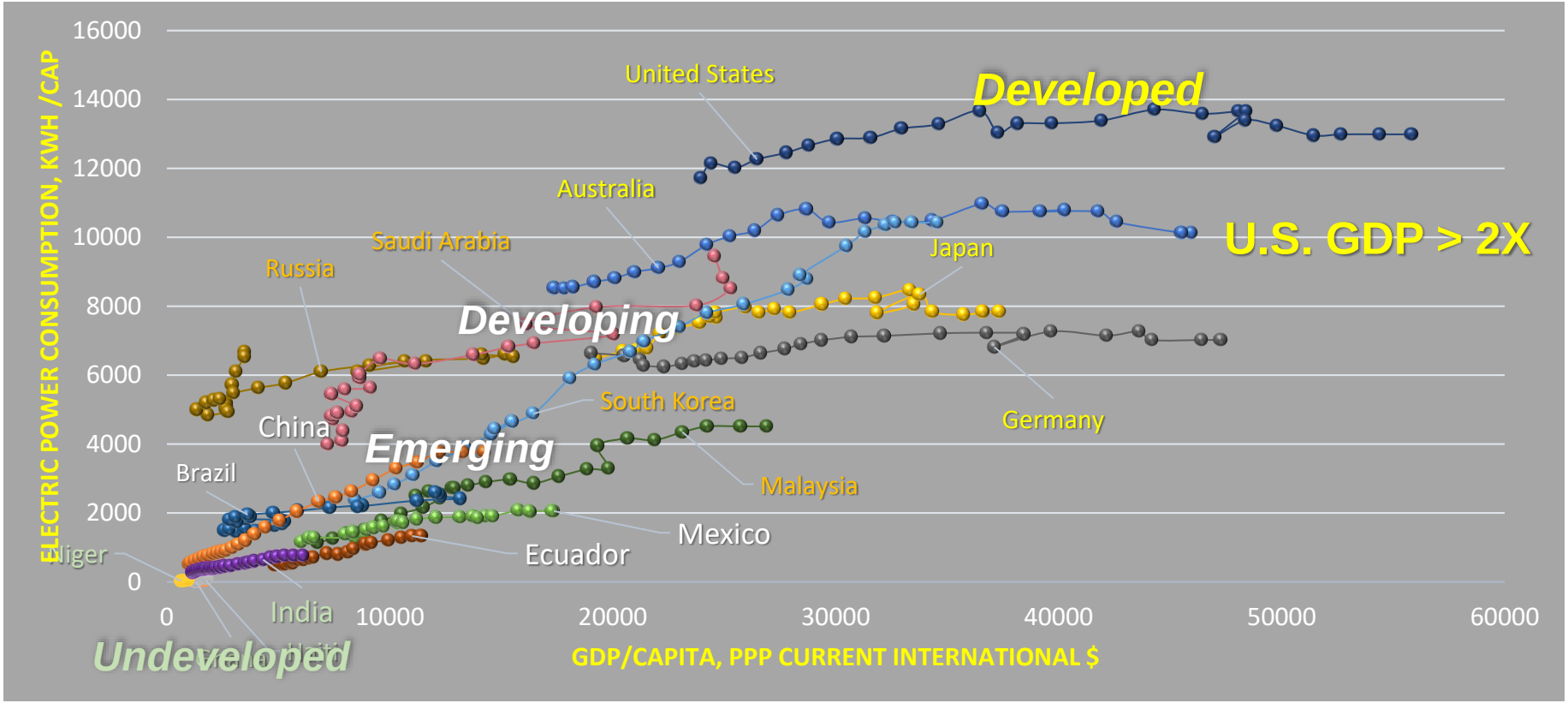
People Without Access to Electricity and Clean Cooking Facilities



Source: **World Energy Outlook, 2017, EIA**

SWITCH
ENERGY ALLIANCE

Limited Access to Electricity Restricts Standard of Living

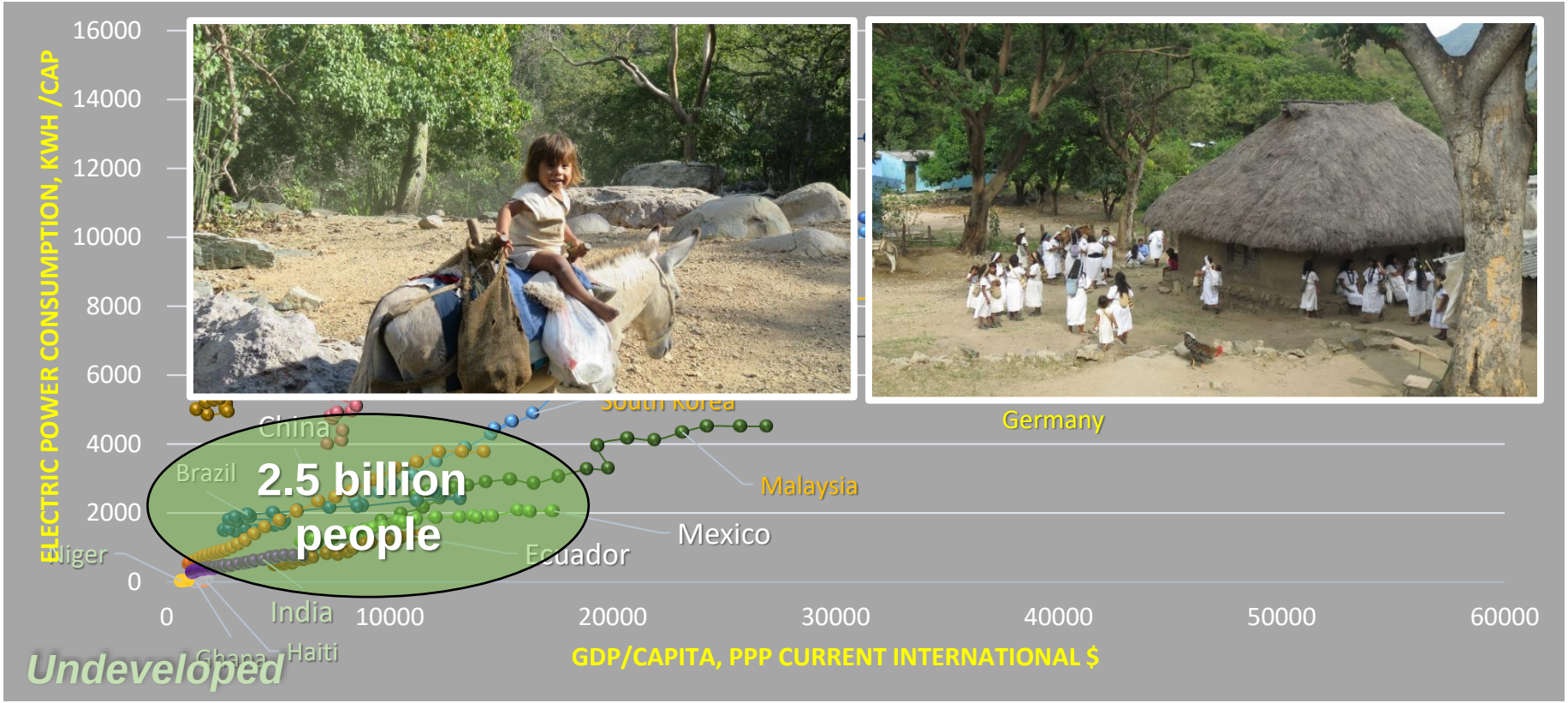


Source: World Bank Databank

1990 '92 '93 '94 '95 '96 '97 '98 '99 2000 '01 '02 '03 '04 '05 '06 '07 '08 '09 2010 '11 '12 '13 '14 '15

SWITCH ENERGY ALLIANCE

Limited Access to Electricity Restricts Standard of Living

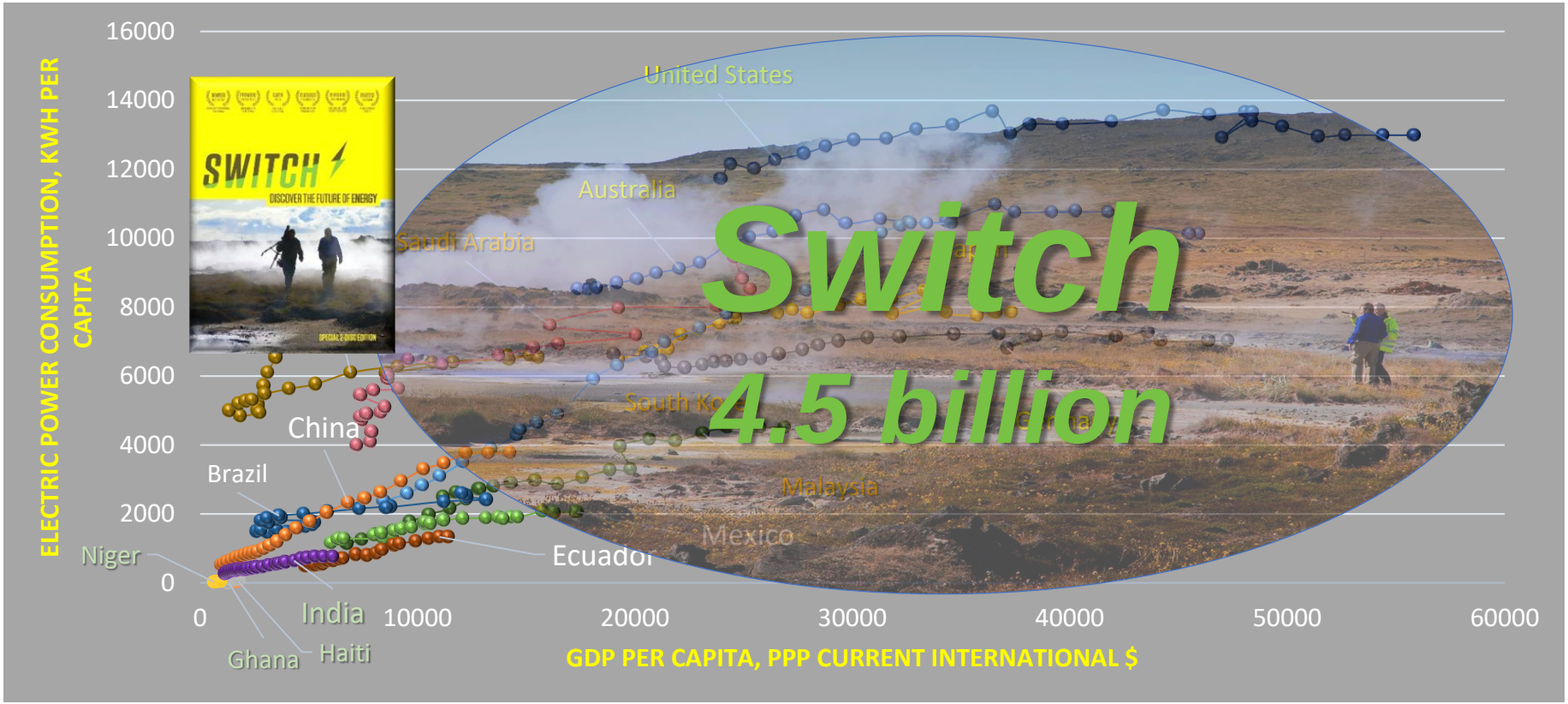


Source: World Bank Databank

1990 '92 '93 '94 '95 '96 '97 '98 '99 2000 '01 '02 '03 '04 '05 '06 '07 '08 '09 2010 '11 '12 '13 '14 '15

SWITCH
ENERGY ALLIANCE

Limited Access to Electricity Propagates Inequality



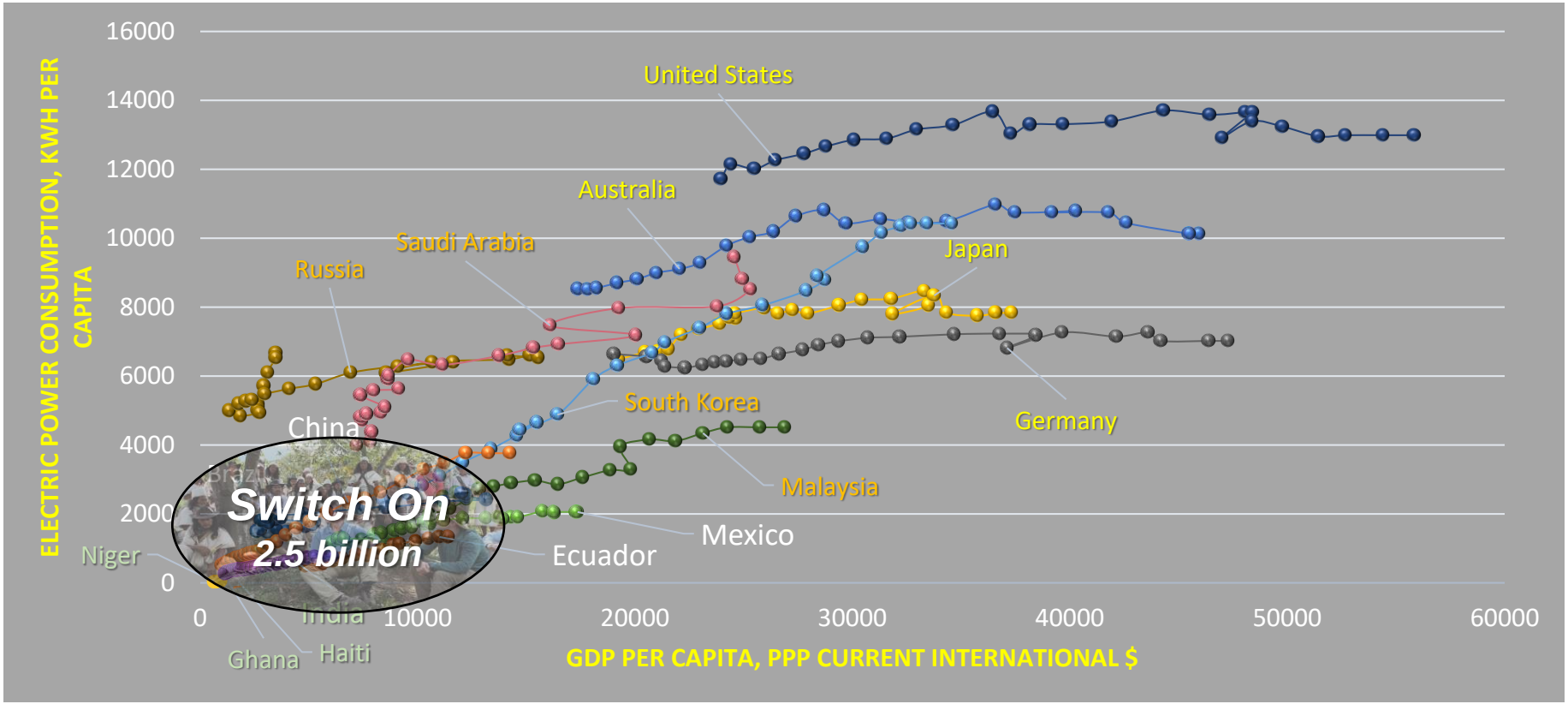
Source: World Bank Databank

Photo: Tinker, Ecuador, 2017

1990 '91 '92 '93 '94 '95 '96 '97 '98 '99 2000 '01 '02 '03 '04 '05 '06 '07 '08 '09 2010 '11 '12 '13 '14 '15 '16

SWITCH
ENERGY ALLIANCE

Limited Access to Electricity Propagates Inequality



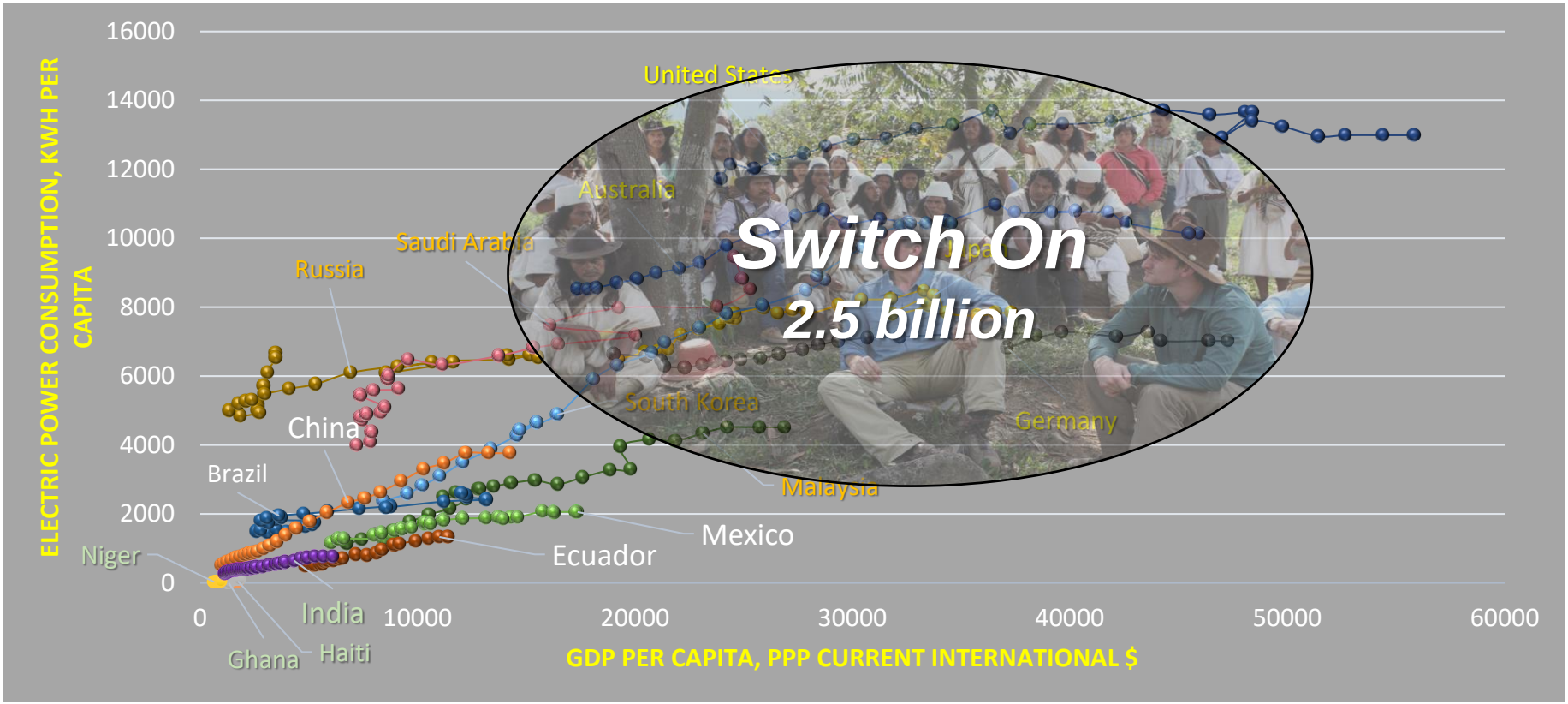
Source: World Bank Databank

Photo: Tinker, Ecuador, 2017

1990 91 92 93 94 95 96 '97 '98 '99 2000 '01 '02 '03 '04 '05 '06 '07 '08 '09 2010 '11 '12 '13 '14 '15 '16

SWITCH
ENERGY ALLIANCE

Limited Access to Electricity Propagates Inequality

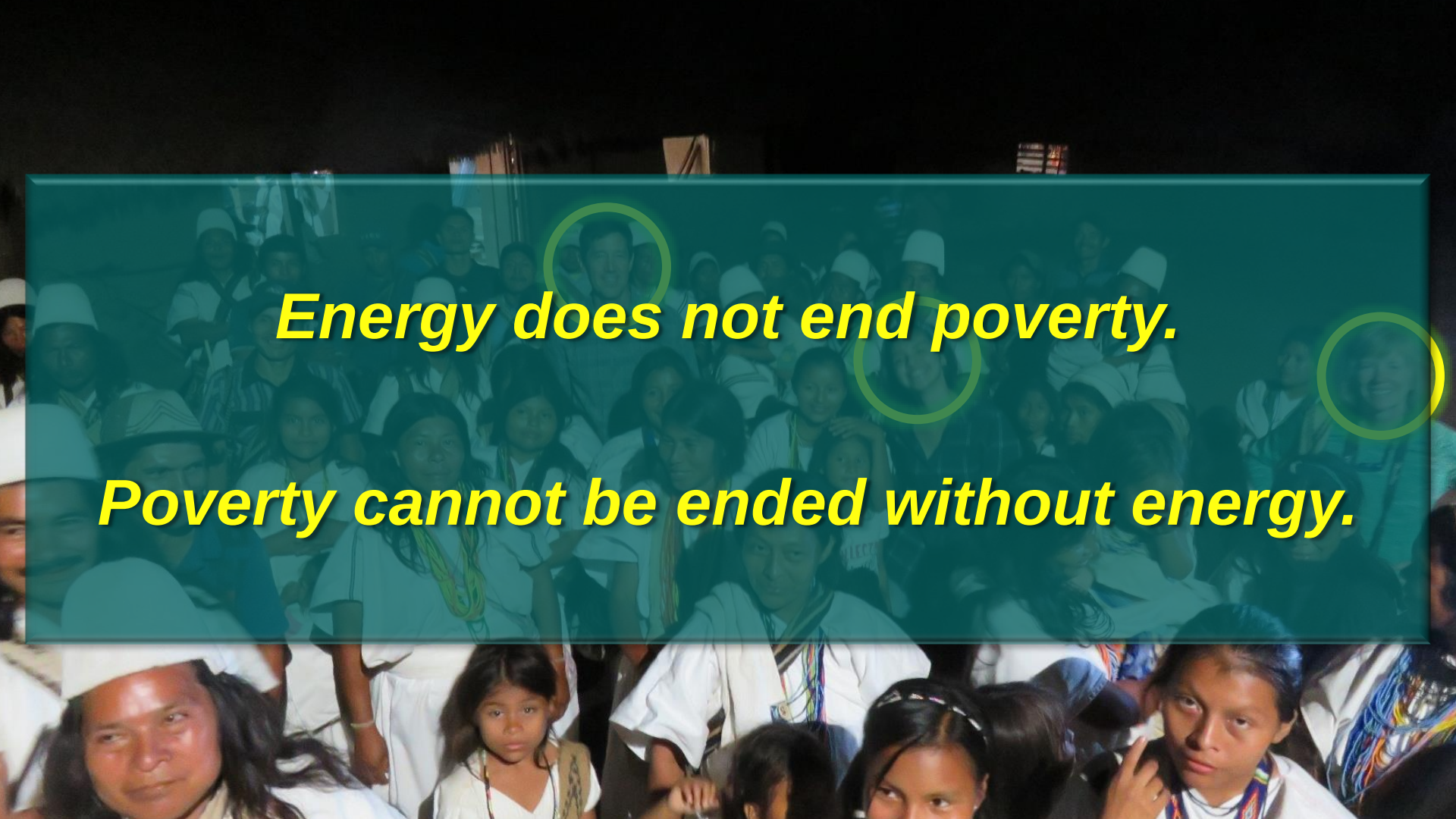


Source: World Bank Databank

Photo: Tinker, Ecuador, 2017

1990 91 92 93 94 95 96 '97 '98 '99 2000 '01 '02 '03 '04 '05 '06 '07 '08 '09 2010 '11 '12 '13 '14 '15 '16

It's Time to Educate & Power the People


Energy does not end poverty.
Poverty cannot be ended without energy.

Poverty
Key Points

- **Energy underpins modern economies and helps lift the world from poverty**
- **Energy resources vary by region and nations will use the energy resources that they have to reduce energy poverty**

SWITCH ENERGY ALLIANCE

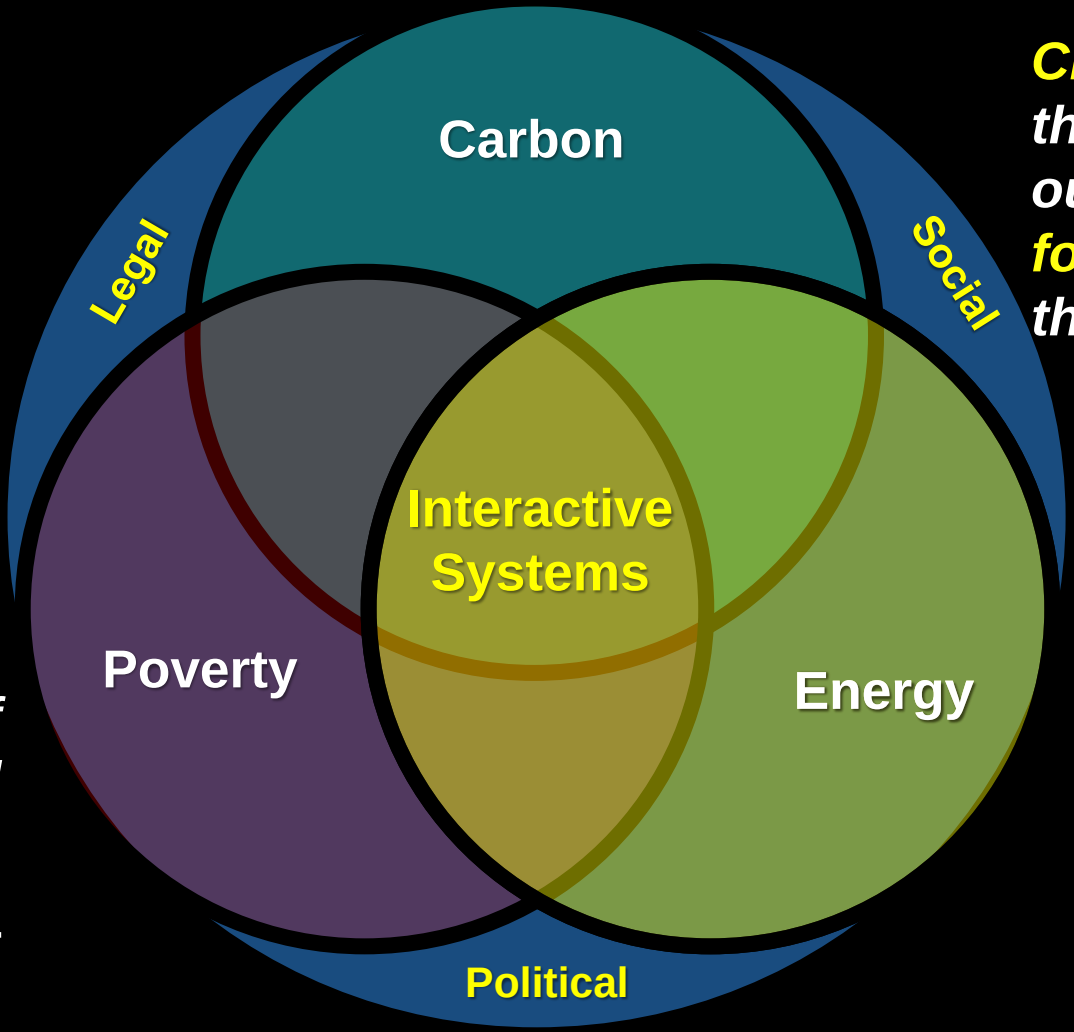
BUREAU OF ECONOMIC GEOLOGY

Outline

- Energy
- Carbon
- Poverty
- Radical Middle

SWITCH ENERGY ALLIANCE

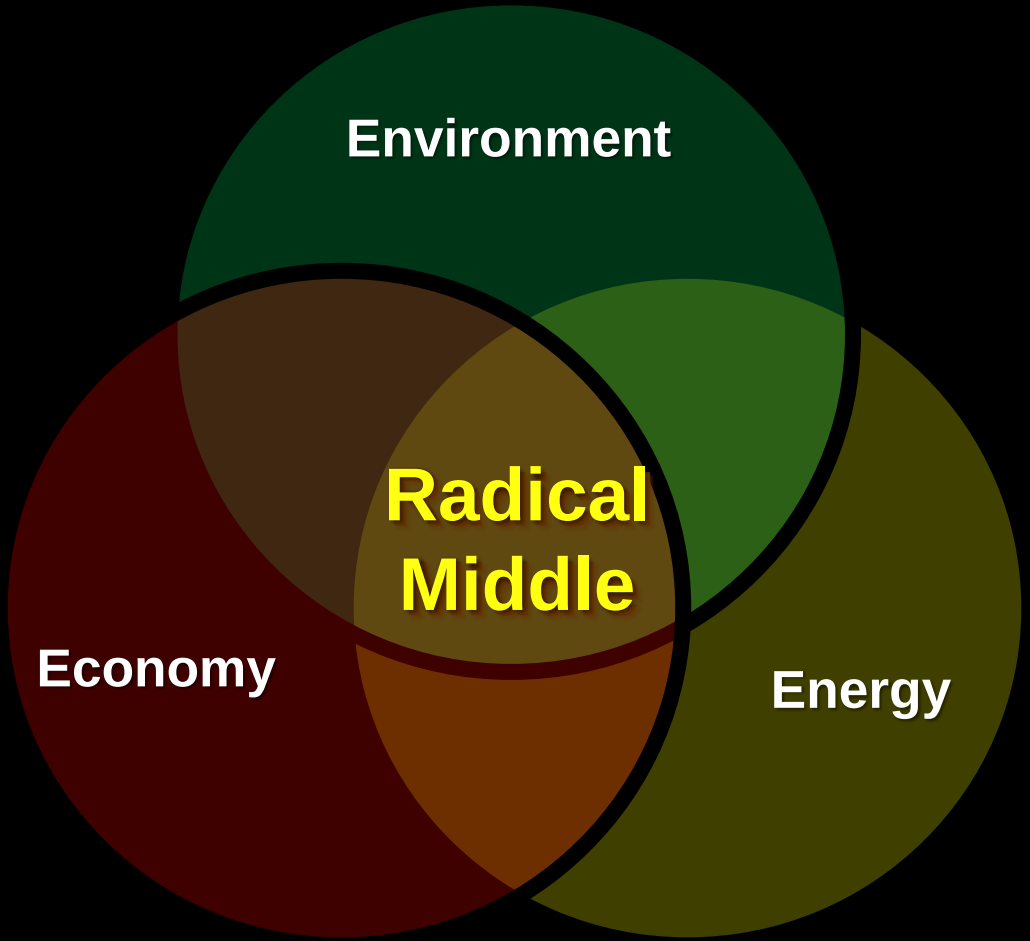
BUREAU OF ECONOMIC GEOLOGY



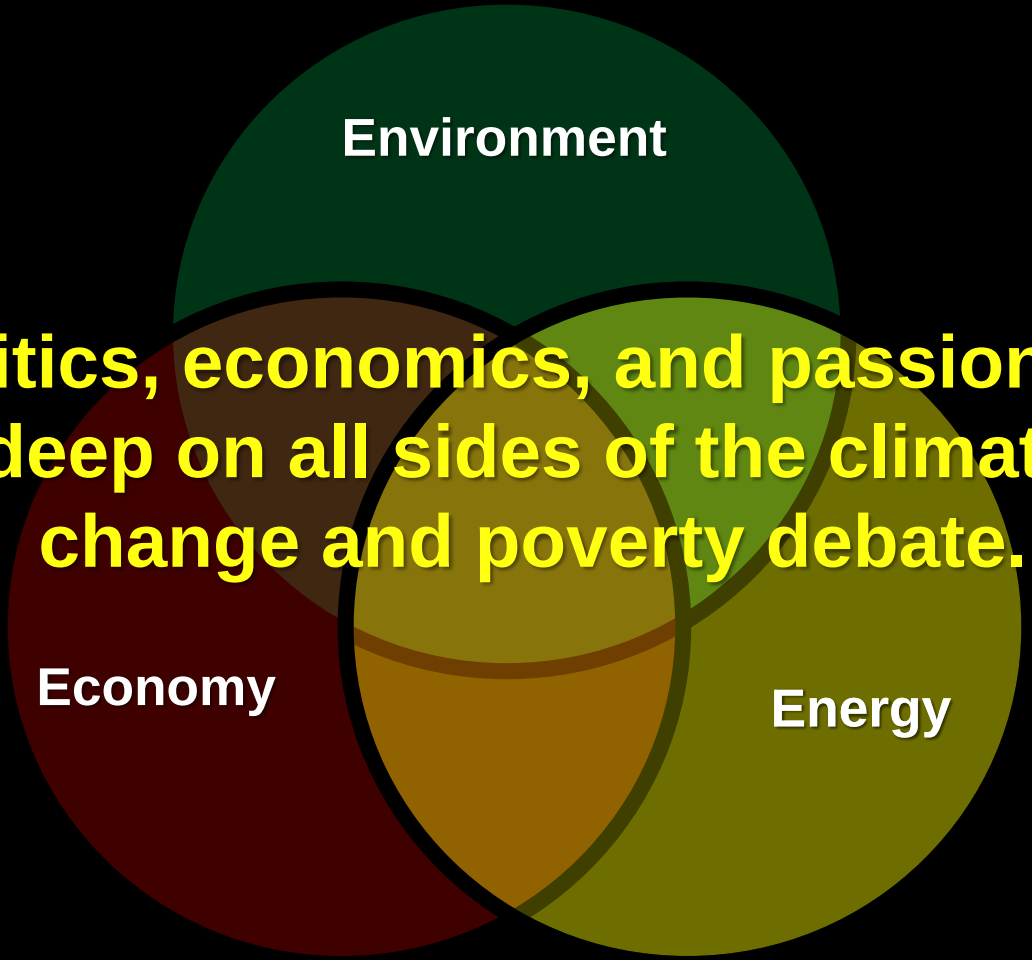
Climate Change *is the major issue of our time, and* ***fossil fuels*** *are the* ***problem***

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

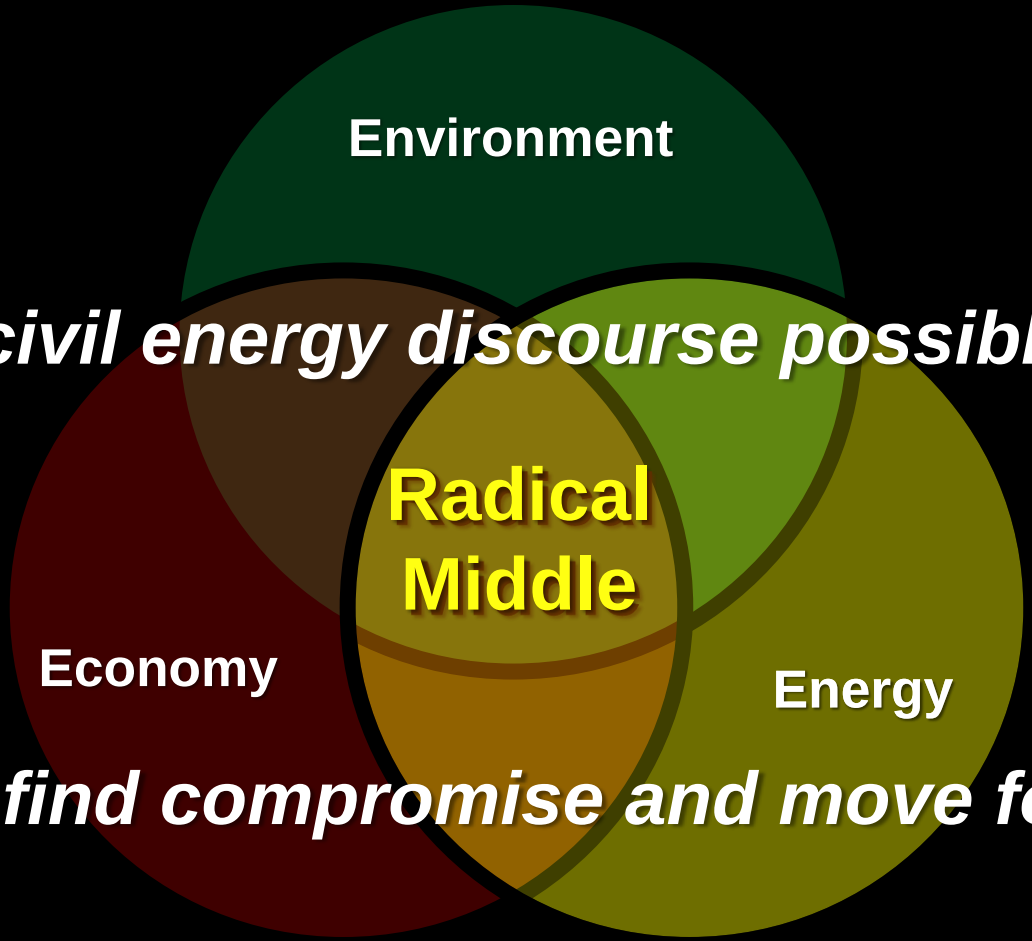
Bureau of Economic Geology



Bureau of Economic Geology



Politics, economics, and passion run deep on all sides of the climate change and poverty debate.



Is civil energy discourse possible?

Can we find compromise and move forward?

Bureau of Economic Geology

Towards Compromise

- Recognize that no form of energy is good or bad
- Assess the environmental impact of *all* energy
- Focus energy policy on energy security
- Make energy efficiency and energy storage tactical
- Recognize energy poverty as a critical challenge

Engage in Energy Education!

SWITCH ENERGY ALLIANCE

BUREAU OF ECONOMIC GEOLOGY


...keep it in the Ground.


Keep them in Poverty.

Lift *them* from Poverty!


SWITCH
ENERGY ALLIANCE


Bureau of Economic Geology
Thanks!
Join the Switch Energy Alliance
SwitchOn.org
SWITCH
ENERGY ALLIANCE
Inspire an Energy Educated Future