From Shanghai to San Antonio:

The World's Impact on Fuel Prices In ERCOT

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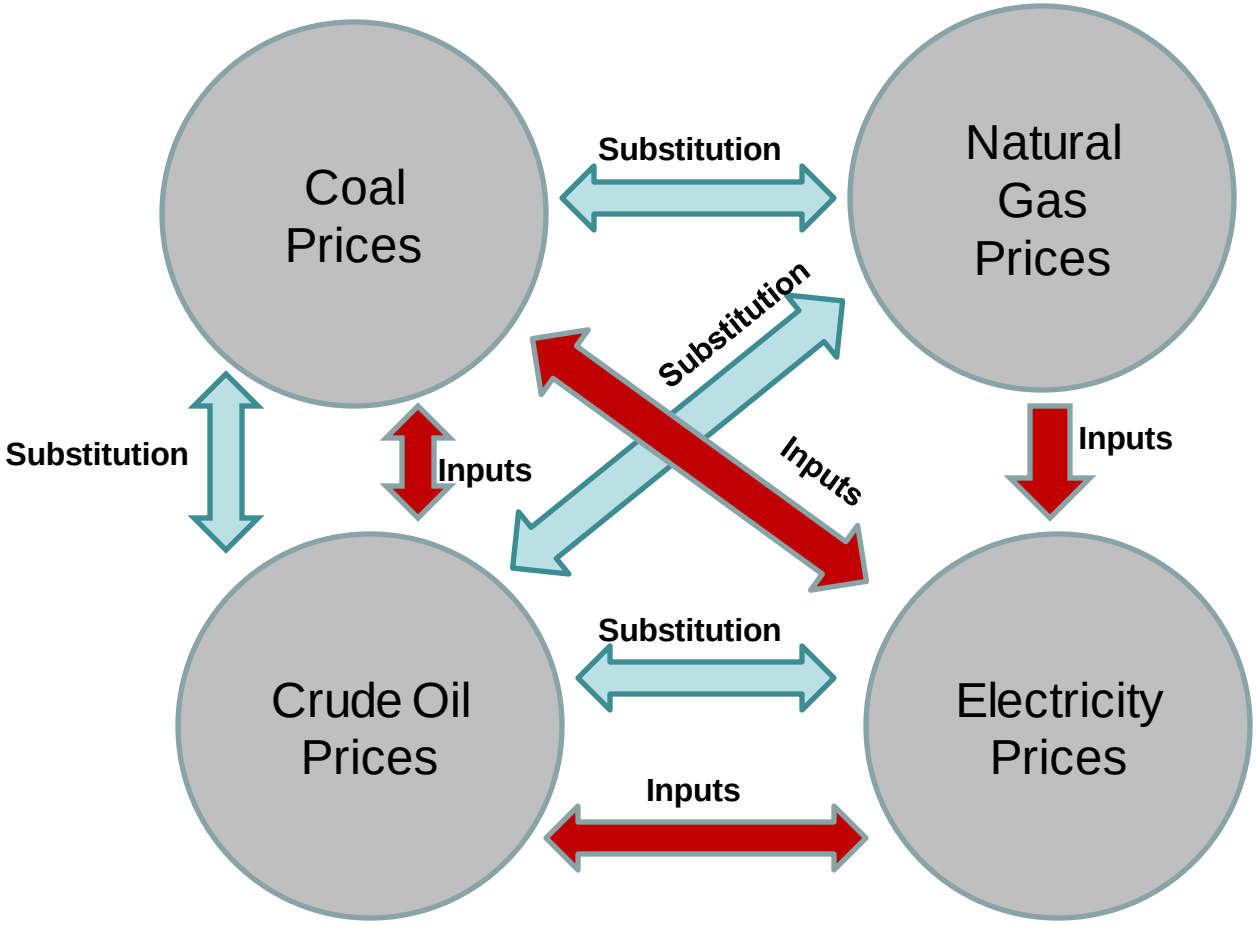
Summary

- **Baseline assumption: demand is strong worldwide for electricity and therefore the fuels needed to generate this electricity are in demand**
- **Additional uses for fuels add to the potential upward price pressure**
- **From this exercise we are not attempting to forecast fuel prices**
- **But we will show the impact of supply and demand on fuel prices**
  - Fuel prices in the future have potential extremes from historical norms
    - Future impacts
      - Demand for resources
      - Environmental issues
      - Political situations

Fuel Consumption Not Only Driven by Electricity Generation

	End Uses							
	Residential		Commercial		Industrial	Transportation	Agriculture	Electricity Production
Fuels	Water Heating	Space Heating	Water Heating	Space Heating	Multiple Uses		Fertilizer	
Nuclear								X
Coal		X		X	X		X	X
Natural Gas	X	X	X	X	X	X	X	X
Crude Oil	X	X	X	X	X	X	X	X
Wind								X
Solar	X							X
Geothermal	X	X	X	X	X			X
Biomass					X			X

Fuels are Intertwined



Overview

- **Crude Oil**
  - US Production and Reserves
  - International Reserves
  - Prices
- **Coal**
  - Impacts on Production
  - World Imports and Exports
  - International Reserves and Consumption
  - Impact on Texas
  - Additional Thoughts
  - Prices
- **Natural Gas**
  - International Reserves
  - Shale Gas Influence on US Reserves
  - Prices
- **Electricity**
- **Additional items**

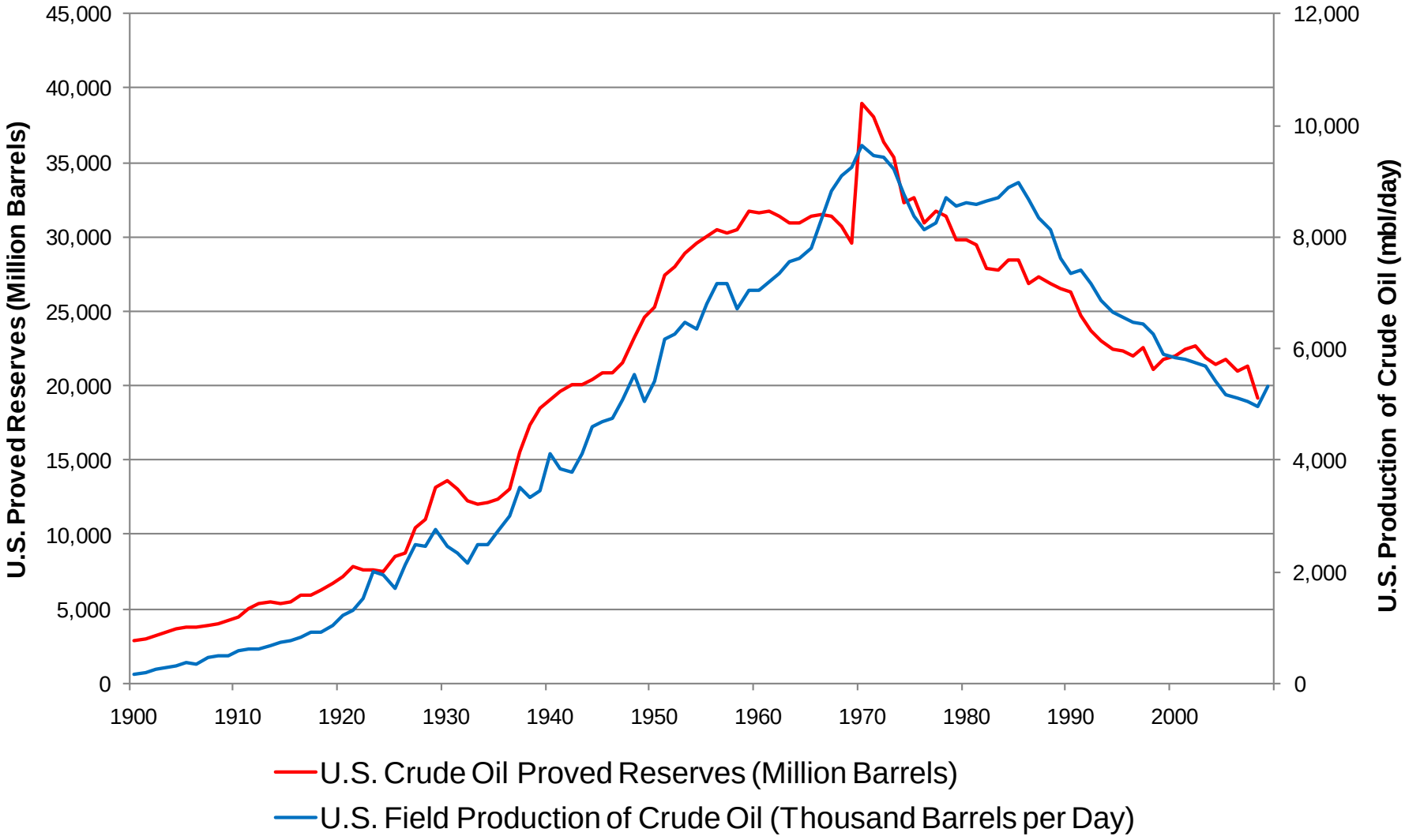
CRUDE OIL

Crude Oil: Does this actually impact ERCOT?

- **Q. Why are we concerned about oil prices in ERCOT?**

- **A. Oil prices impact coal prices (via production costs) and natural gas prices (via substitution option and production costs). Both issues are discussed later in the presentation.**

Crude Oil Production and Reserves



Source: Energy Information Administration

International Trade of Crude Oil

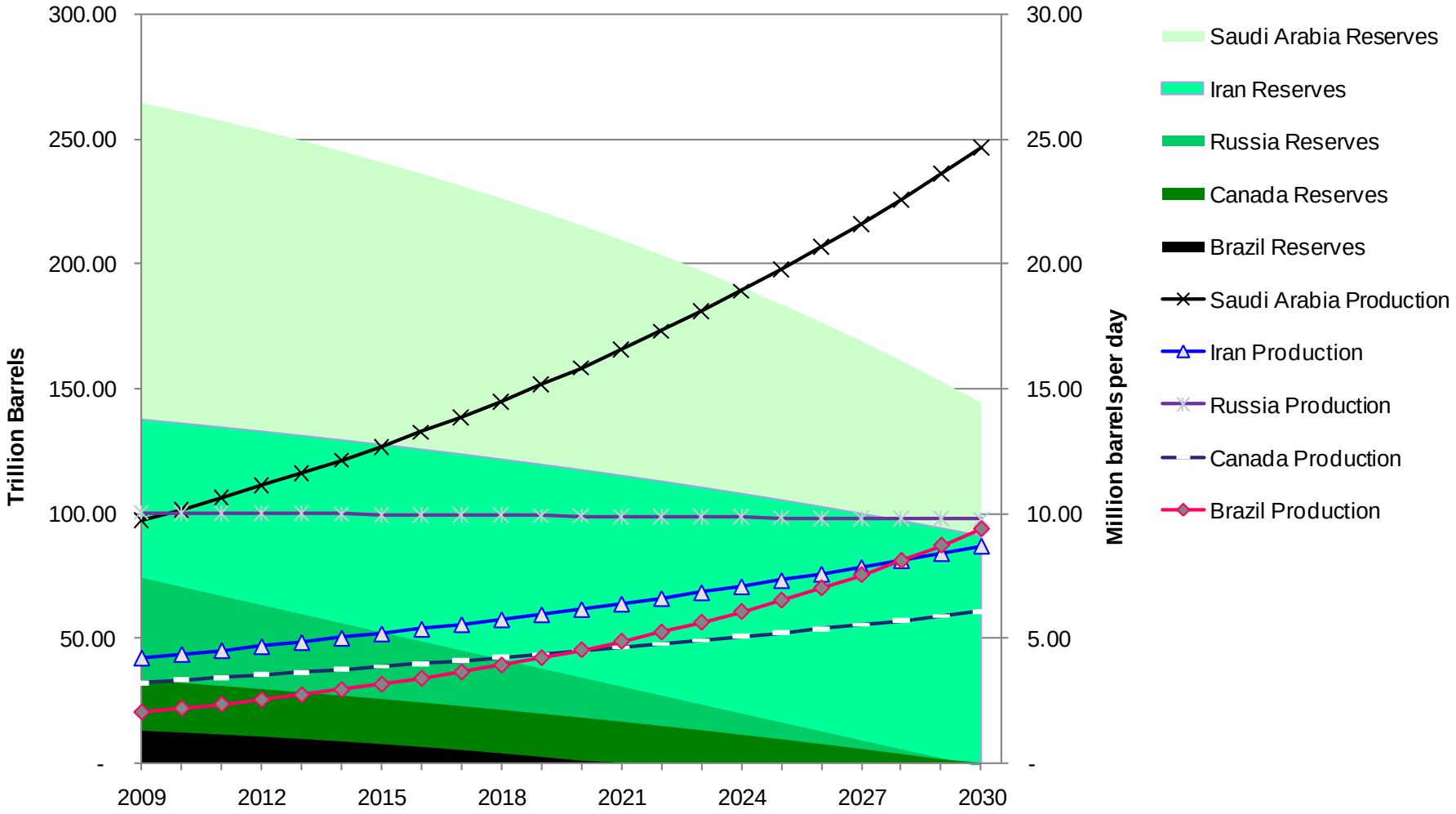
- Canada, Iran, Russia, and Saudi Arabia will continue to be largest exporters
- New exploration has begun in more countries
  - South Africa
  - Egypt
  - Columbia
  - Australia
  - Nigeria
- In 2009 the largest importers of crude oil from the world market:
  - US (22%)
  - European Union (26%)
- In 2009 the largest exporters of crude oil:
  - Middle East (35%)
  - Russia (17%)

Crude Oil Reserves

- Large exporting countries that will deplete their reserves (year they run out)
  - Brazil (2021)
  - Russia (2030)
  - Canada (2030)
  - Saudi Arabia (2042)
  - Iran (2051)

- These target dates are based on 2009 reserve levels and the following formula
  - $\text{Reserves}_{(t)} = \text{reserves}_{(t-1)} - \text{production}_{(t-1)}$

Reserves Decline as the World's Appetite Continues to Grow



CRUDE OIL

PRICES

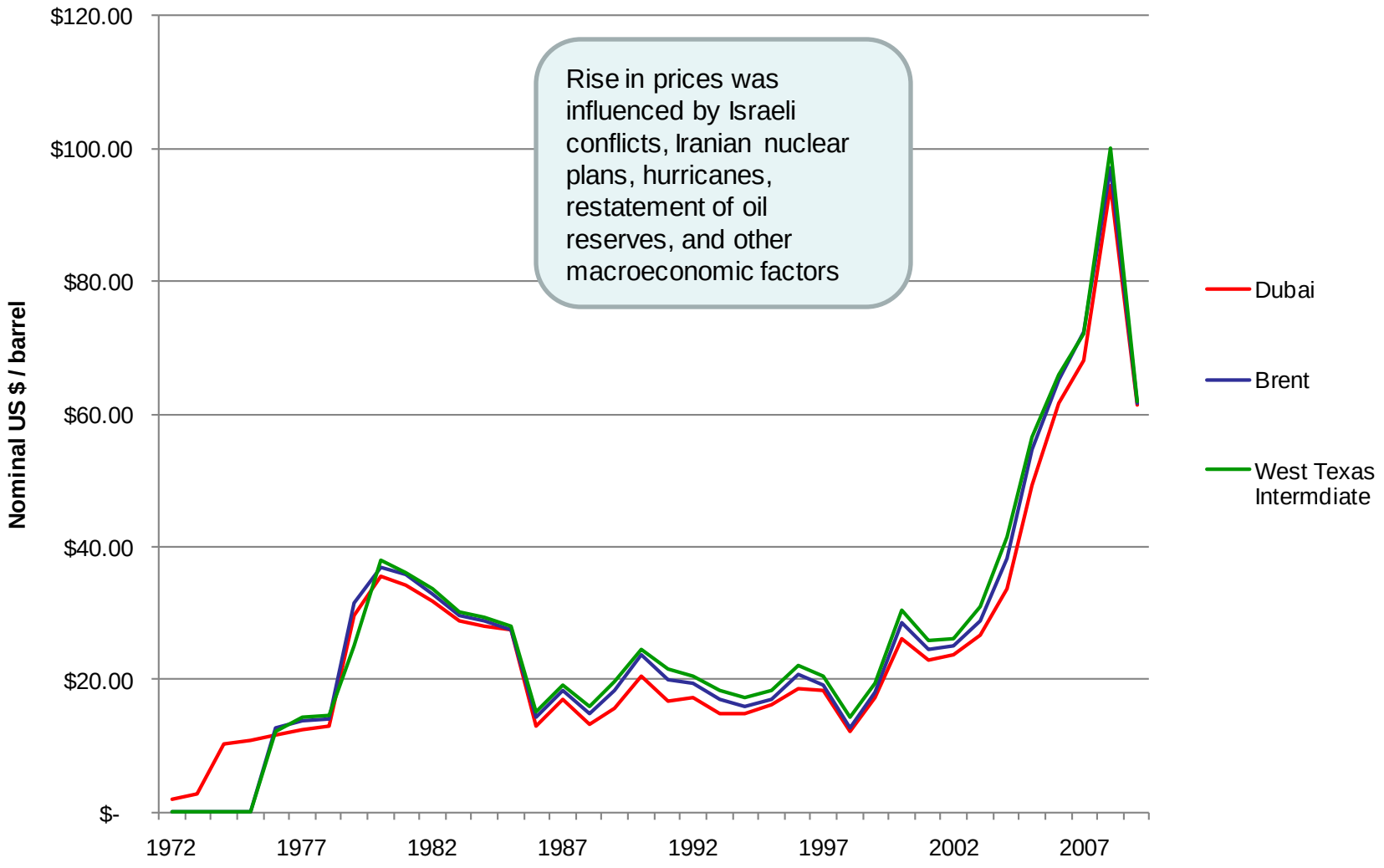
Impacts on Crude Oil Price

- Supply
  - Supply is impacted by availability of reserves
    - Market price determines economic availability
    - Environment and legal issues impact geographical availability
  - The interests of the member countries of OPEC may alter the supply levels
  - Forecasted reserves (*using previously mentioned formula)*
- Demand
  - Price of substitute fuel sources *(natural gas)*
  - Preferences
    - Environmental
    - Legislation
  - Increase in consumption
    - Fuel for electrical generation, manufacturing, production, etc.
- Net exports = production – consumption - imports
- US reserves and production peaked in the early 1970s *(as shown on previous slide)*

Impacts on Crude Oil Prices, cont.

- Oil prices have increased due to worldwide demand and increasing production costs
  - Leading up to 2008, Europe's demand for low sulfur diesel fuel was increasing
    - Diesel is refined more easily from light sweet crude which is in low supply
  - As a well becomes depleted it becomes less economical to produce after a certain point, unless of course oil prices increase
    - Higher production costs due to increasing difficulty in extraction
- Different trading hubs of crude oil
  - Dubai Crude stays domestically in the Middle East or is exported to Asia
  - Brent Crude is mostly refined in Europe
  - West Texas Intermediate is traded on the NYMEX here in the US
- Differences in market prices are impacted by increase in delivery costs and quality of oil
  - Transportation costs (also dependent on crude oil market prices)
  - Light sweet vs. heavy sour
    - Light sweet crude oil is most demanded due to its relatively low refining costs
      - Less impurities

Crude Oil Prices of Different Markers Have Similar Trends



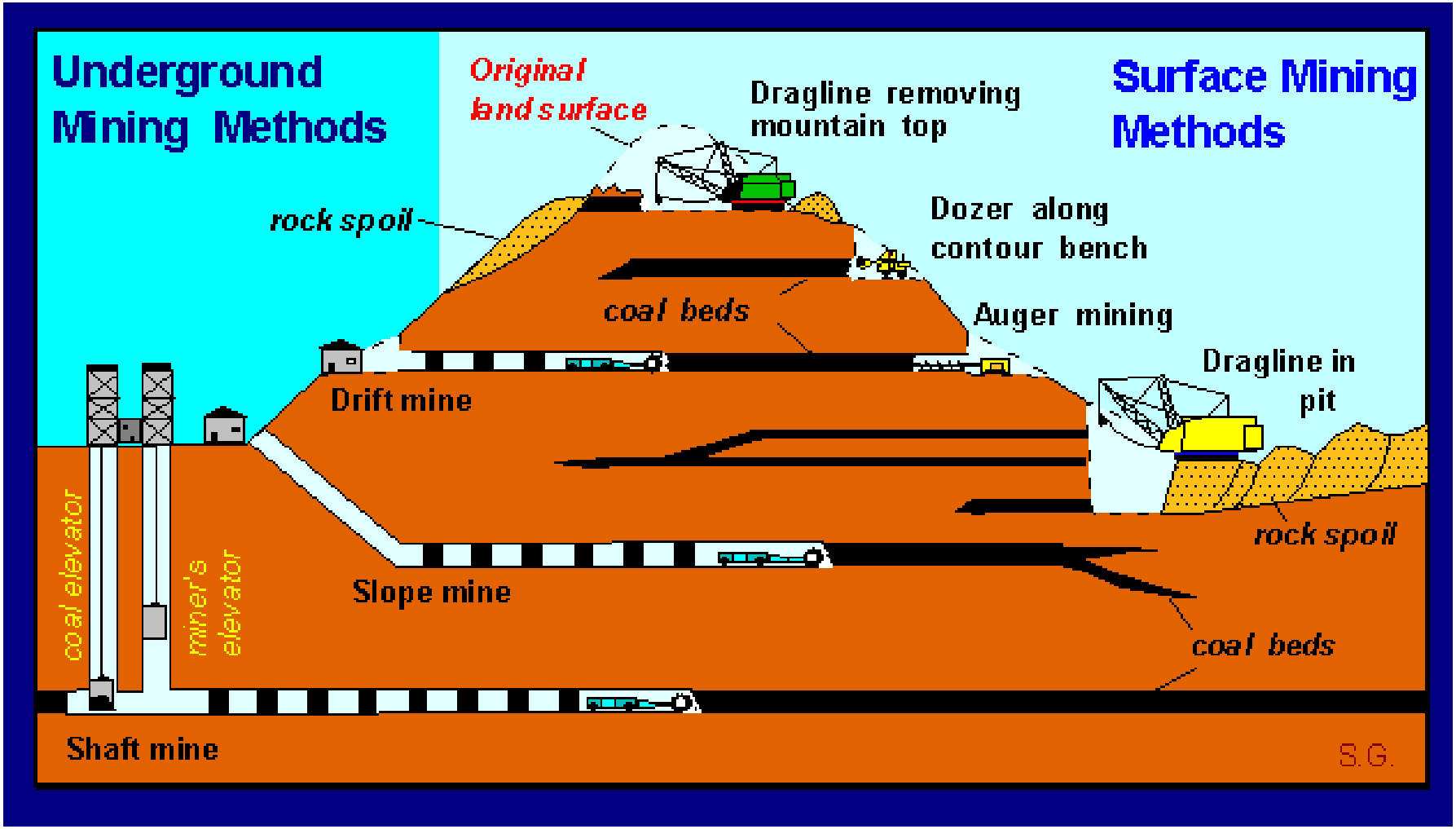
How do Crude Oil Prices Affect Other Fuels

- Coal production input
  - Fuel source for mining equipment
    - Hauling trucks
  - Transportation to destination
    - Power plant
    - Industrial manufacturer
- Coal demand could be increased by Coal to Oil/Gas technologies
- Steel prices are impacted by coal prices (metallurgical coal) which impacts wind turbine prices
- Substitute for natural gas in power production

COAL

(1 metric tonne = 1.1 short ton = 2200 lbs)

Coal Mine Seams



Source: University of Kentucky-Kentucky Geological Survey

Impacts on Coal Production

- Coal prices
  - Market price impact on recoverable reserves
- Crude oil prices
  - Gasoline used in hauling trucks
  - Tires
  - Freight (moving the coal from the mines to the end users)
- Infrastructure
  - Railways
  - Roads
  - Ports

Worldwide Coal Imports and Exports

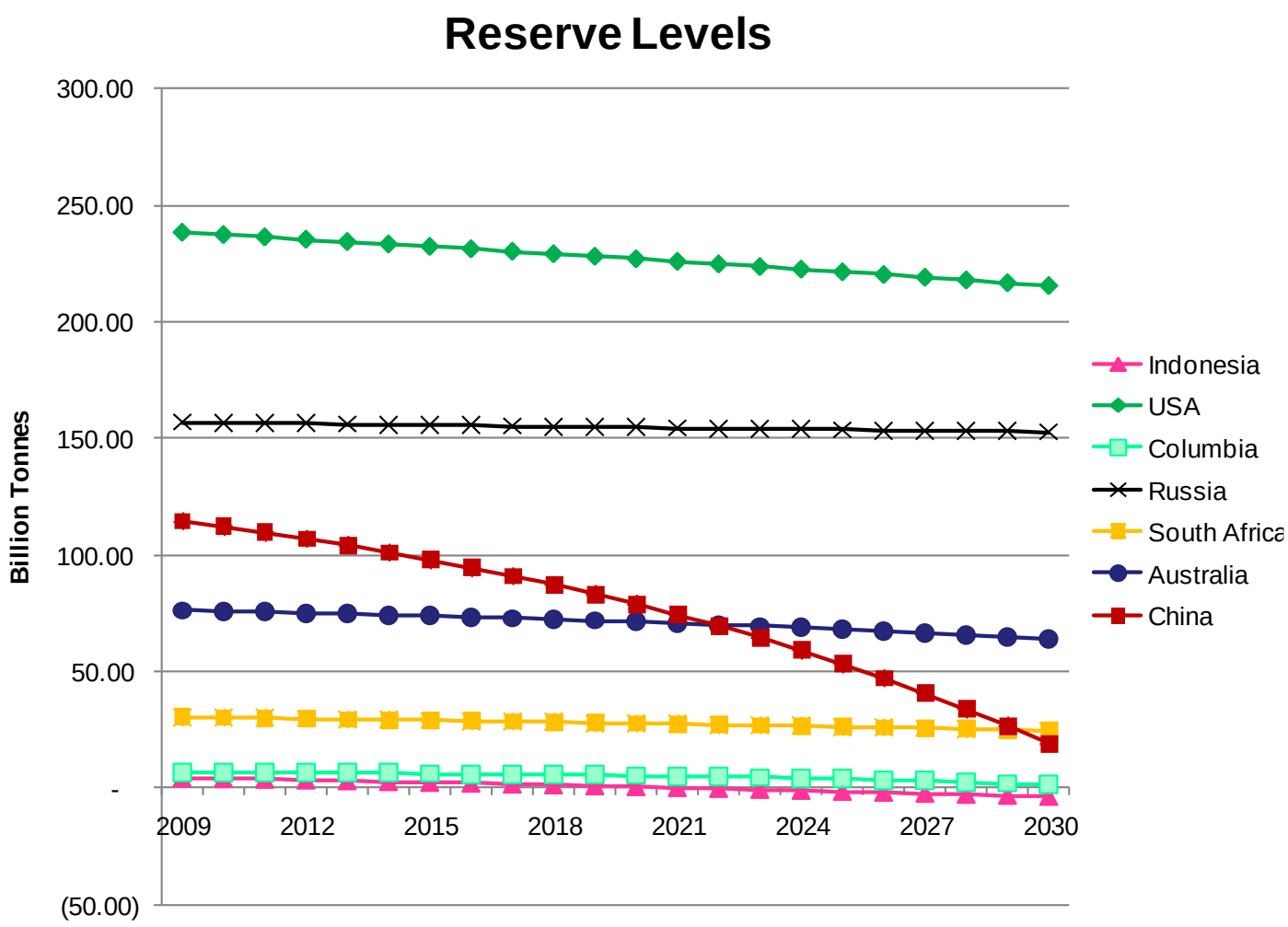
- China and India are the major wildcards in the imports market
- Australia and Indonesia are major wildcards in the exports markets
- U.S. potential for exports growth has not been tapped yet
  - It emerged during the last coal price run up in 2008

Imports (million tonnes)						
	2009	**2010**	**2011**		**2009 to 2010**	**2010 to 2011**
World	737.3	778.4	805.8		5.57%	3.52%
Asia	452.2	478.5	497.6		5.82%	3.99%
China	92.1	98.3	103.0		6.73%	4.78%
Taiwan	59.4	59.6	60.2		0.34%	1.01%
India	54.0	68.0	77.0		25.93%	13.24%
Japan	117.0	120.0	121.0		2.56%	0.83%
S. Korea	80.5	82.0	83.0		1.86%	1.22%
Malaysia	16.1	16.4	17.1		1.86%	4.27%
other Asia	33.1	34.2	36.3		3.32%	6.14%
Europe	211.4	220.2	225.8		4.16%	2.54%
Other	73.7	79.7	82.4		8.14%	3.39%
Exports (million tonnes)						
Indonesia	233.5	250.0	254.0		7.07%	1.60%
Australia	139.1	142.4	158.0		2.37%	10.96%
Russia	91.7	97.0	102.8		5.78%	5.98%
South Africa	66.9	67.0	71.0		0.15%	5.97%
Columbia	63.4	65.0	71.0		2.52%	9.23%
China	21.5	20.0	20.0		-6.98%	0.00%
United States	19.4	22.0	23.0		13.40%	4.55%
Others	101.8	115.0	105.9		12.97%	-7.91%

Source: ABARE http://www.forexyard.com/en/news/Asias-thermal-coal-imports-seen-hitting-record-in-2011-2010-06-22T034053Z

Coal Reserve Levels

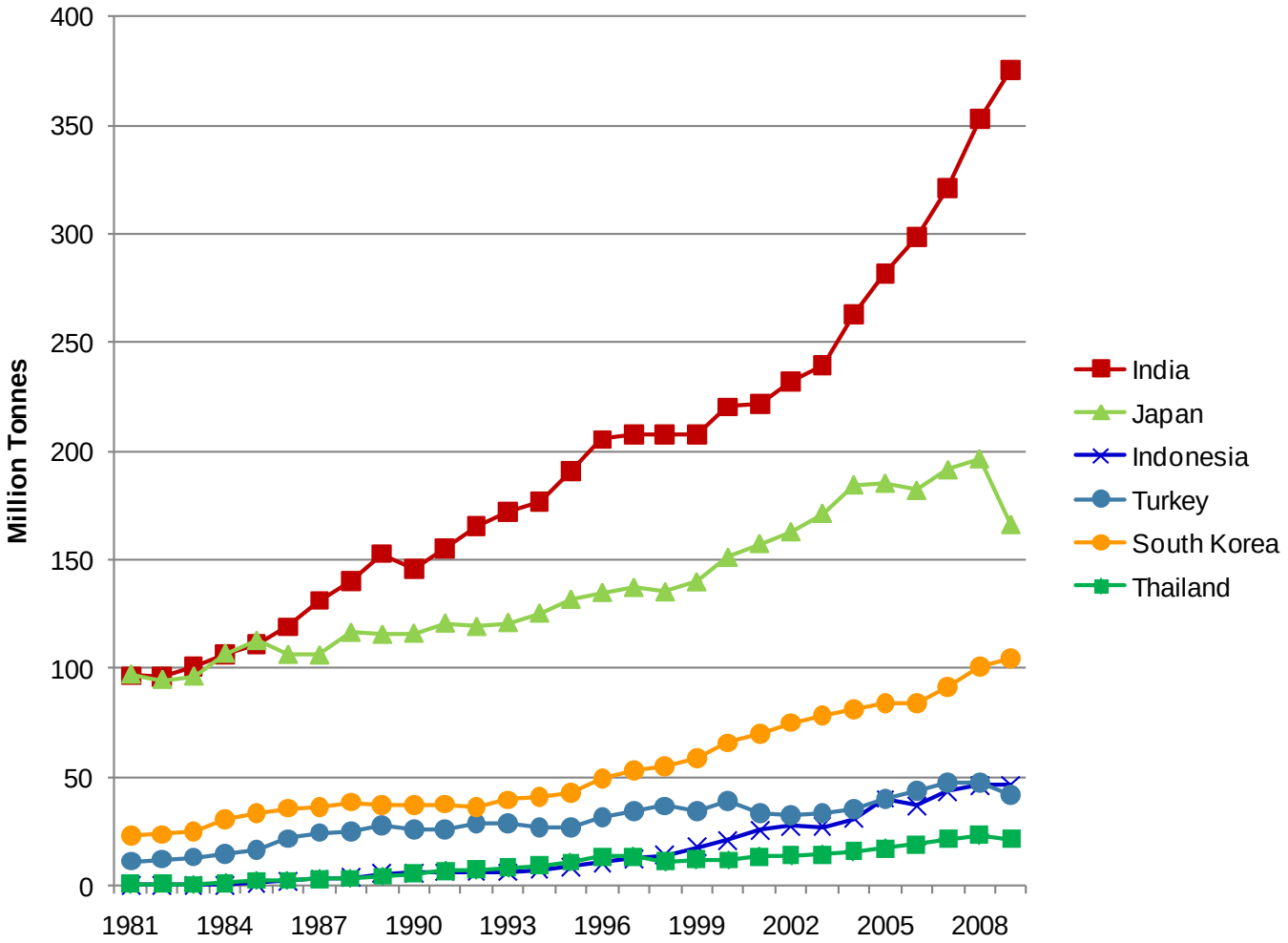
- 2008: Indonesia was the 2nd largest exporting country, to Australia
- 2022: Indonesia will be a net importer



Source: World Coal Institute

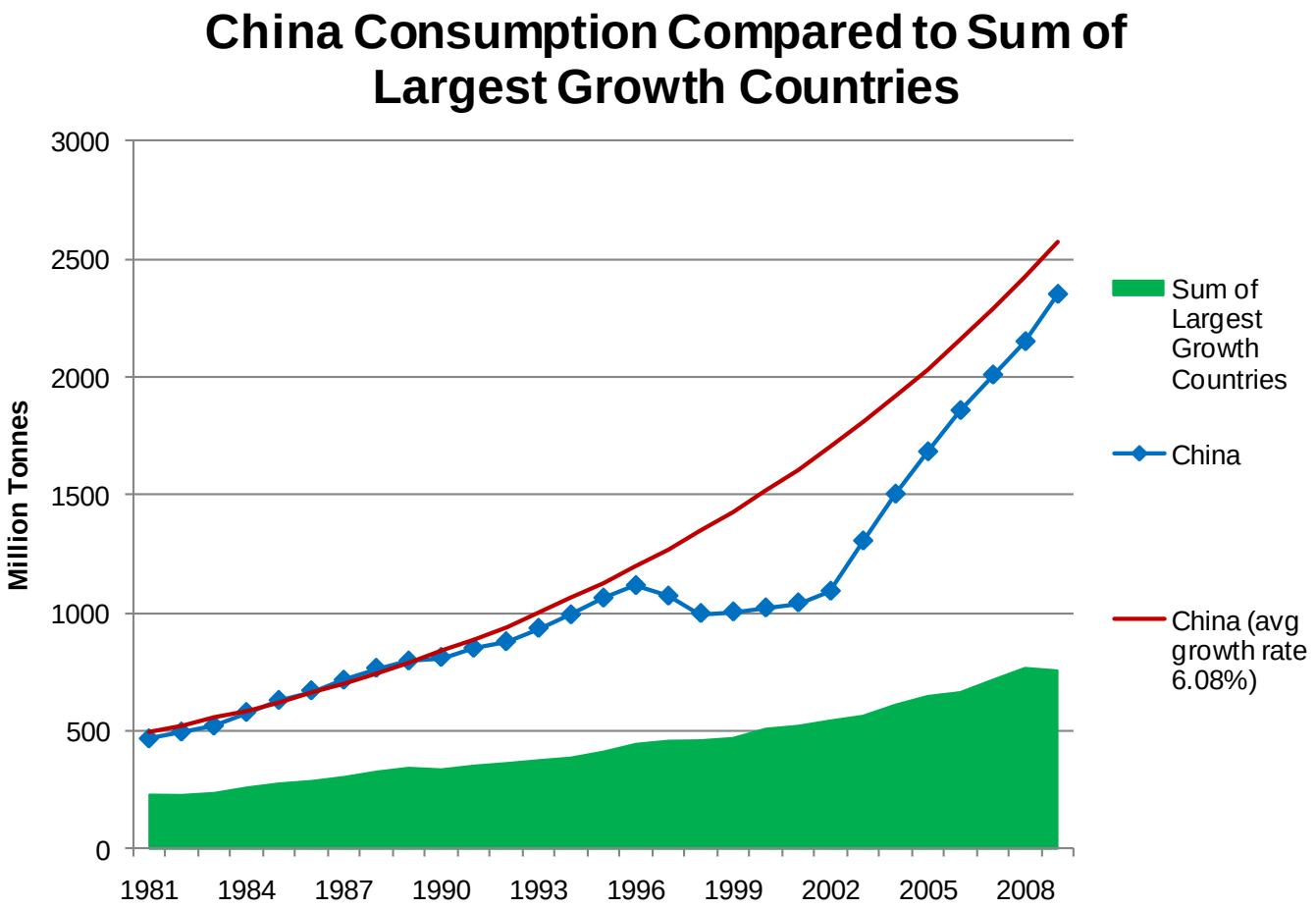
Countries with Annual Coal Demand Growth of 5% or Greater (excluding China)

- Each of these countries has experienced more than 5% growth on average from 1981-2009



Chinese Growth Leads to Largest Coal Consumer

- From 1981 to 2009, China's coal consumption has increased from 16.67% to 46.9% of the World's total consumption
- China's growth in consumption completely dwarfs the sum of the largest growth countries

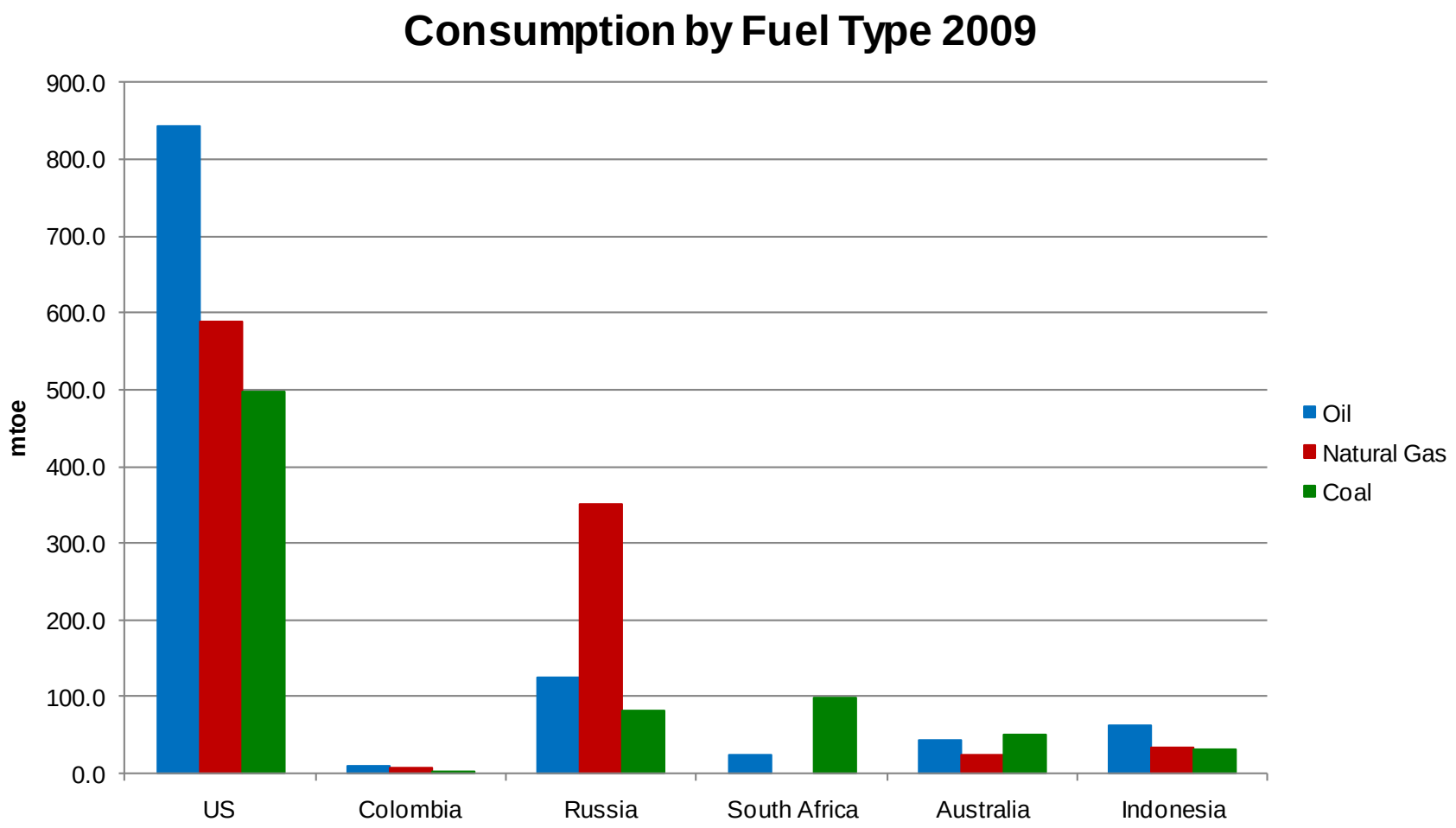


Australia and Indonesia are Current Swing Producers of Export Coal

- Australia
  - 2008: exported 26% of world's coal
  - Reserves will run out in 2063
    - Using average production growth rate from 1981-2009 = 4%
- Indonesia
  - 2008: exported 21% of world's coal
  - 1981-2009: average production growth rate = 24%
    - Consumption growth rate = 12%
    - These growth rates are probably not sustainable
  - Negative reserves in 2021
    - 7 million tonnes/year cap from 2009 to 2030 on production
    - Indonesian Coal Mining Association
      - Reserves at 17 billion tonnes
      - R/P ratio = 42 years

Source: World Coal Institute

Consumption by Fuel Type of Top 6 Largest Coal Exporting Countries

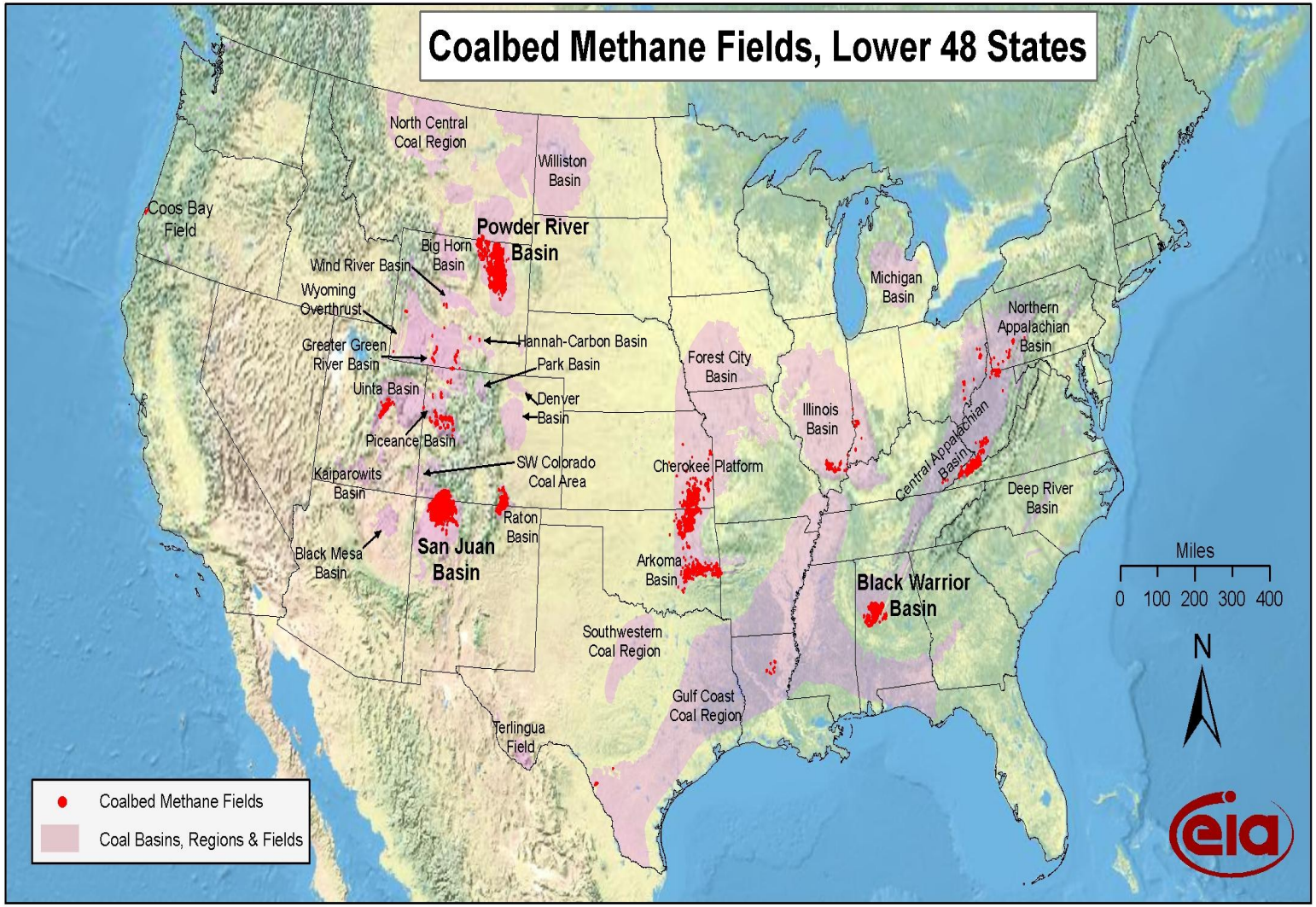


Source: World Coal Institute liststop 6 largest coal exporting countriesfrom 2008

Reserve to Production Life at Year End 2009

- BP lists the world's coal reserve life around 119 years
- Countries with limited life span of reserves (years)
  - Vietnam (3)
  - United Kingdom (9)
  - Romania (14)
  - North Korea (16)
  - Indonesia (17)
  - Germany (37)
  - China (38)
- These values assume current production rates (i.e. 0% growth) and only take into account proved reserves, not total resources
- Using historical growth rates for production (6%)
  - China runs out of reserves in 2033

US Coal Mine Map



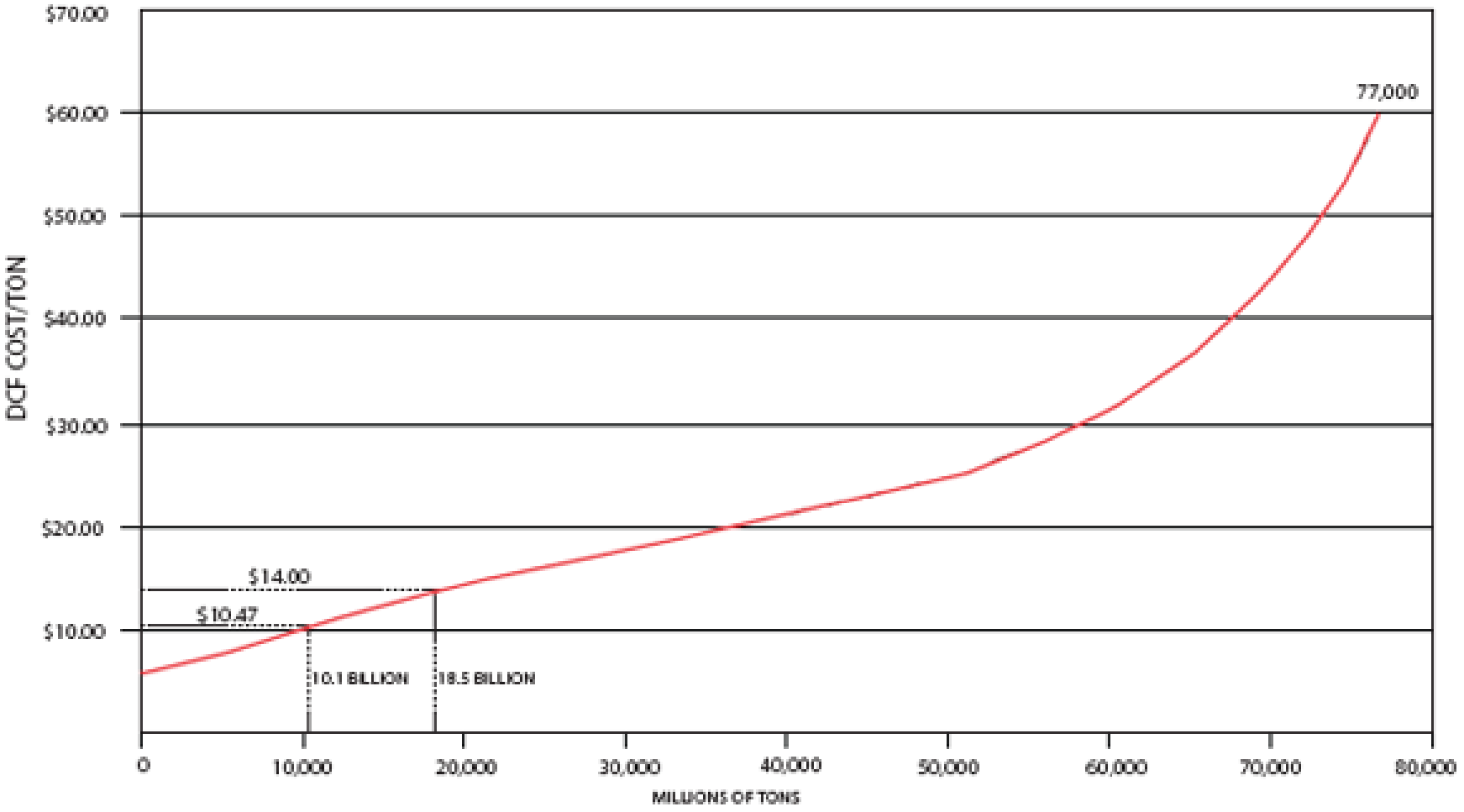
Source: Energy Information Administration based on data from USGS and various published studies
Updated: April 8, 2009

Coal's Impact on Texas

- Majority of Texas coal consumption is for electricity generation
- Approximately 60% of Texas coal comes from the Powder River Basin (PRB)
  - PRB consists of Wyoming and Montana
  - PRB has an estimated life of 25 years (based on current reserves and expected growth in demand) at $10/short ton
    - At current market prices, reserve recovery is around 6%
      - Approximately 10 billion short tons
        - » Wyoming
          - » 7 billion short tons of recoverable reserves
          - » Recovery rate of 92%
        - » Montana
          - » 3 billion short tons of recoverable reserves
          - » Recovery rate of 91%
    - However, if the market price increases to $60/short ton
      - Reserve Recovery estimated at 48%
        - » Approximately 80 billion short tons

Source: EIA and USGS

PRB Coal Recoverable Reserves Increase as Market Price Increases



Source: USGS Assessment of Coal Geology, Resources, and Reserves in the Gillette Coalfield, Powder River Basin, Wyoming

Coals Impact on Texas, cont.

- Another 38 % of Texas coal consumption comes from Texas lignite mines
  - Recoverable reserves are listed at 752 million short tons with a recovery of 91%
  - RP ratio for lignite is roughly 20 years
    - Currently producing 40 million short tons a year

Source: EIA-Texas State Profile

Additional Thoughts: International Coal

- Russia, South Africa, Australia, Indonesia, and Columbia have been key players in exporting coal
- Top World Coal Producers
  - China: 46%
  - US: 15%
  - Australia: 7%
  - Indonesia: 6%
  - Russia: 4%
  - South Africa: 4%
- The percentage of coal required for electricity generation in these countries is a major concern
- *Will the individual countries above be able to meet their domestic demand and provide enough exports for those countries who cannot?*

Additional Thoughts: Various Coal Uses & Greenhouse Gasses

- Coal has many uses
  - Power generation
  - Steel production (metallurgical coal)
  - Oil production
  - Fertilizer
    - Specifically the production of ammonia
      - Large industry for China and India
        - » Largest grain and fertilizer producers
        - » Each uses approximately 6% of total coal consumption
- Green House Gas (GHG) Legislation and/or Regulation
  - Cap and Trade
    - Banking possibilities
  - Taxes above specified levels

Source: International Fertilizer Association

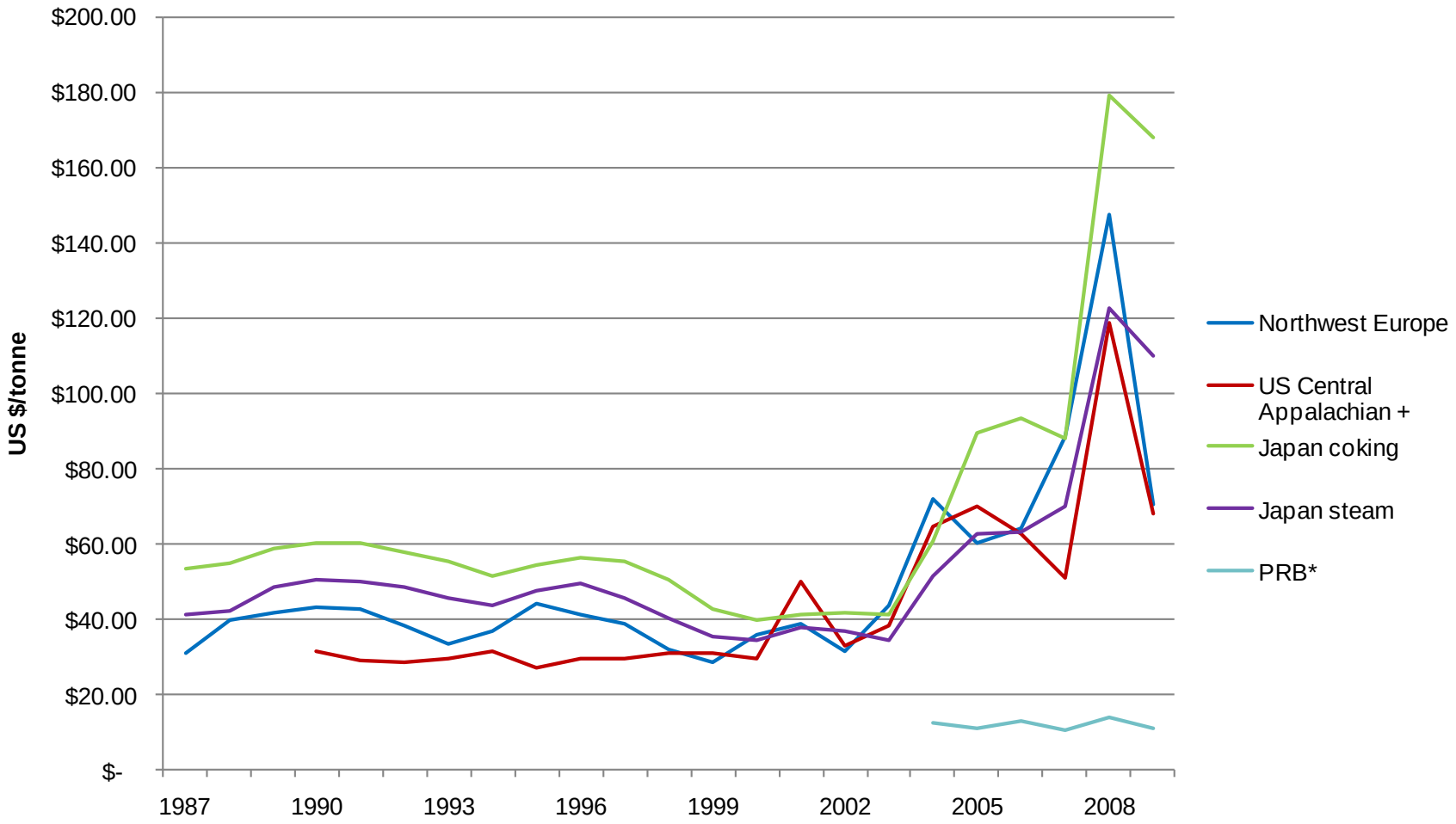
Additional Thoughts: Global Macroeconomics

- If Indonesia's net exports don't increase, the U.S. could potentially become a large player in the export coal market
  - Coal prices will increase domestically *(specifically PRB prices because of its low sulfur content)*
- If international demand for coal increases, the increase in international market prices will influence U.S. coal prices
  - Increasing US exports
  - US possible switch to alternative sources
- China and the US are heavily researching and developing coal-to-oil/gas technologies
  - coal may be in even higher demand if successful

COAL

PRICES

Coal Prices from 1987 – 2009

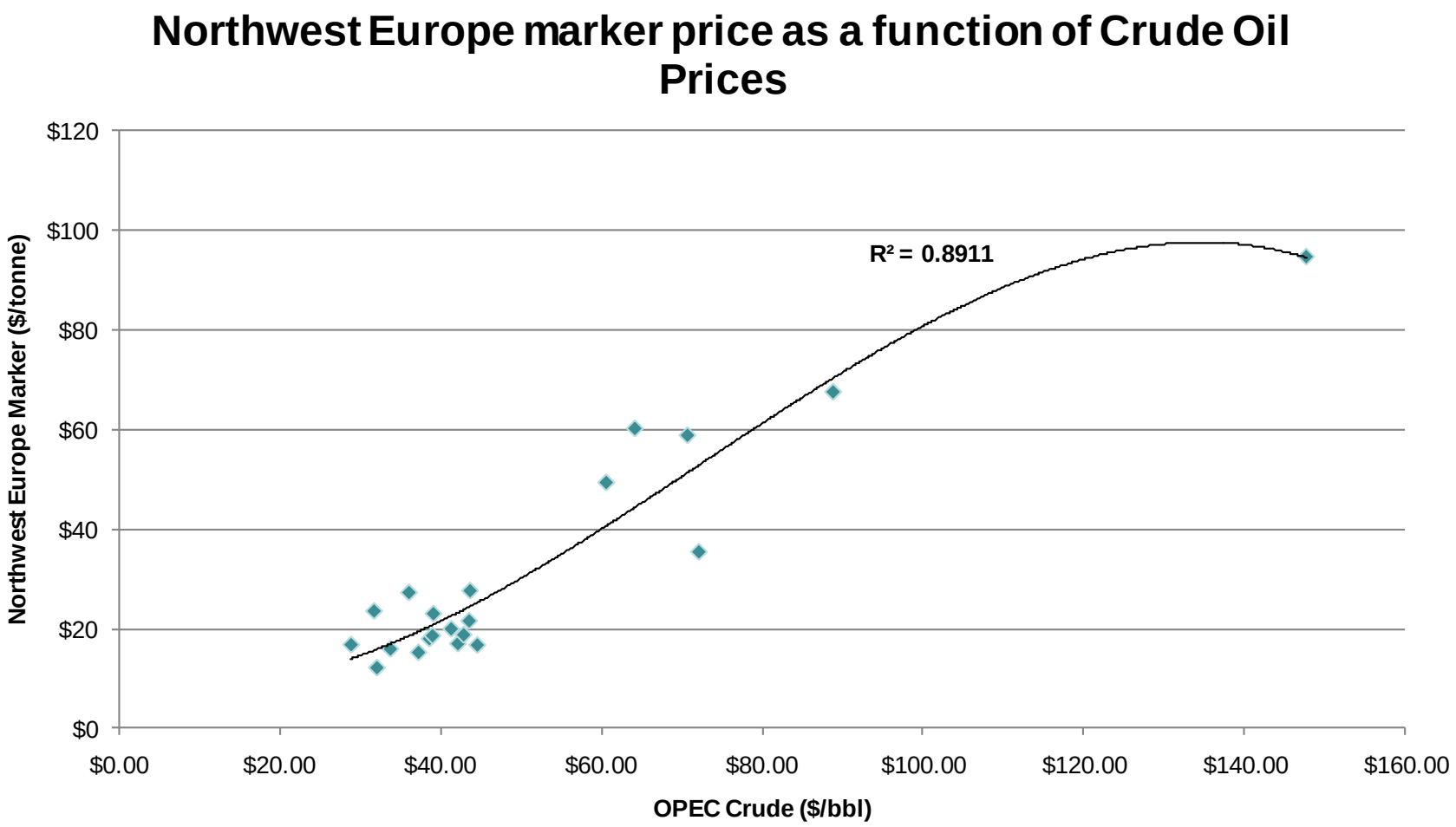


Source: BP Statistical Review of World Energy 2010
Energy Information Administration Weekly Coal Reports

+BP only had price data for US Central App. Back to 1990

*EIA only publishes weekly coal reports for PRB back to 2004

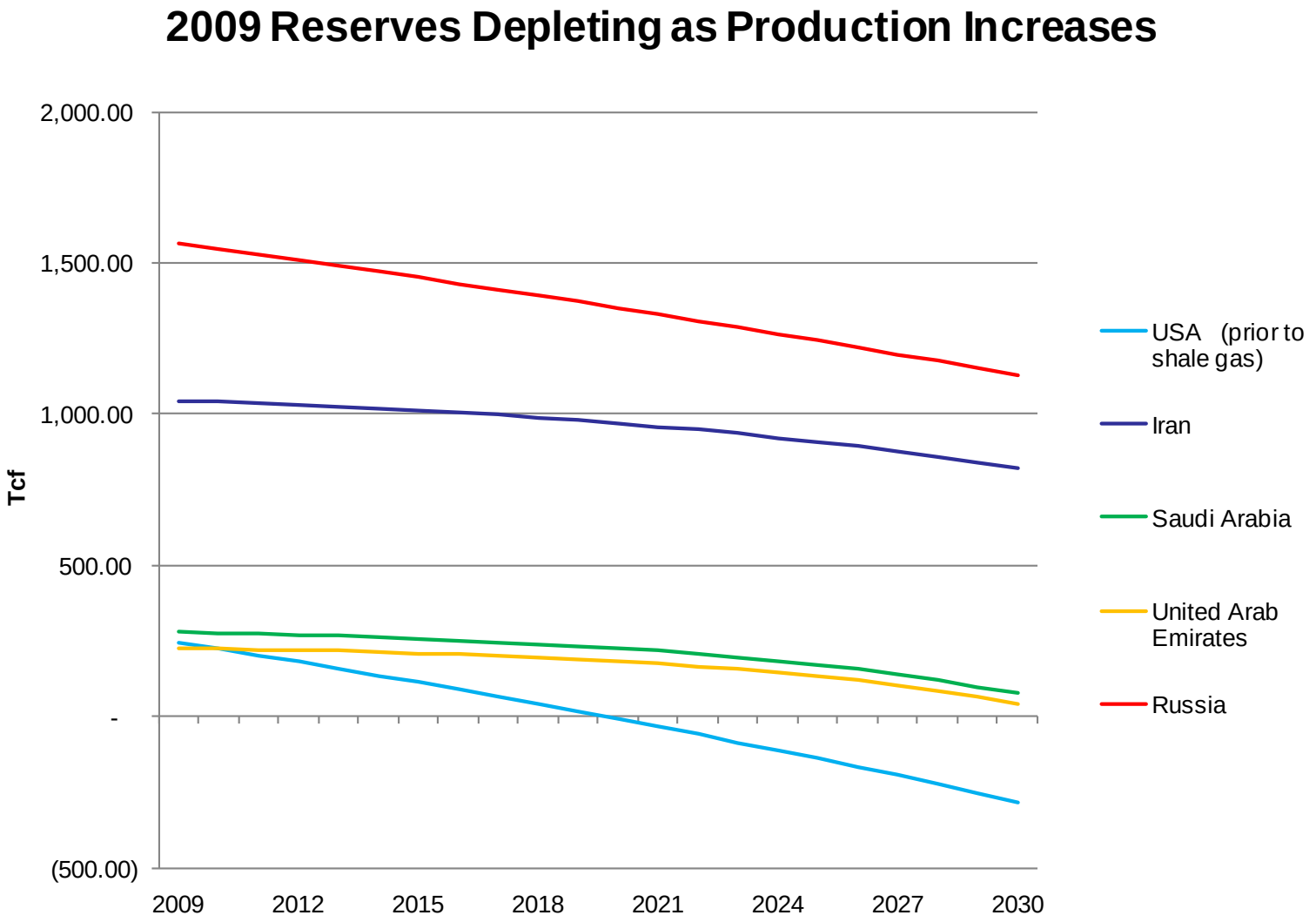
Oil Prices Impact Coal Prices



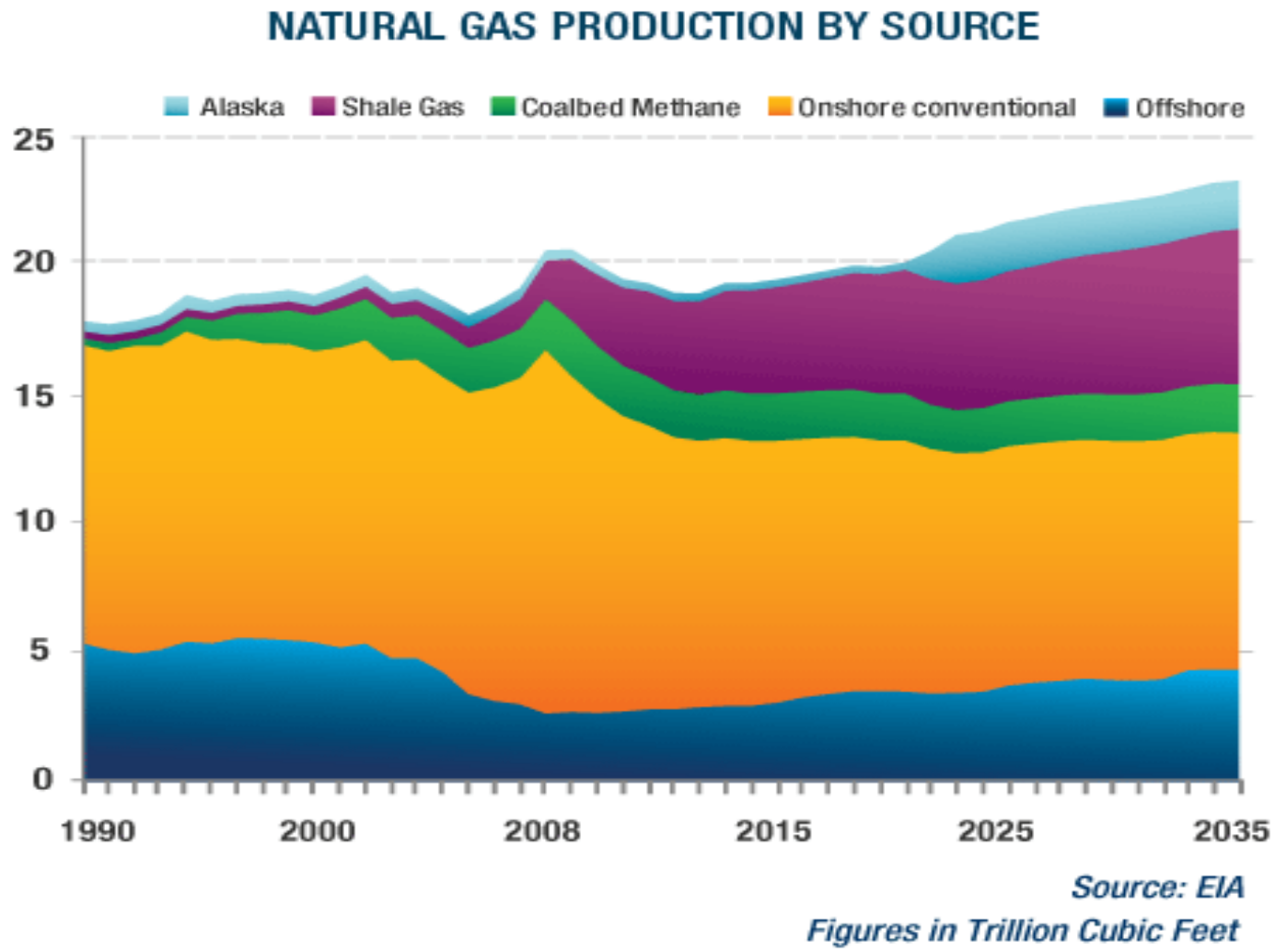
NATURAL GAS

Top 5 Countries With Largest Natural Gas Reserves

- BP World Energy Report shows that the US will completely deplete their proved reserves in 2020

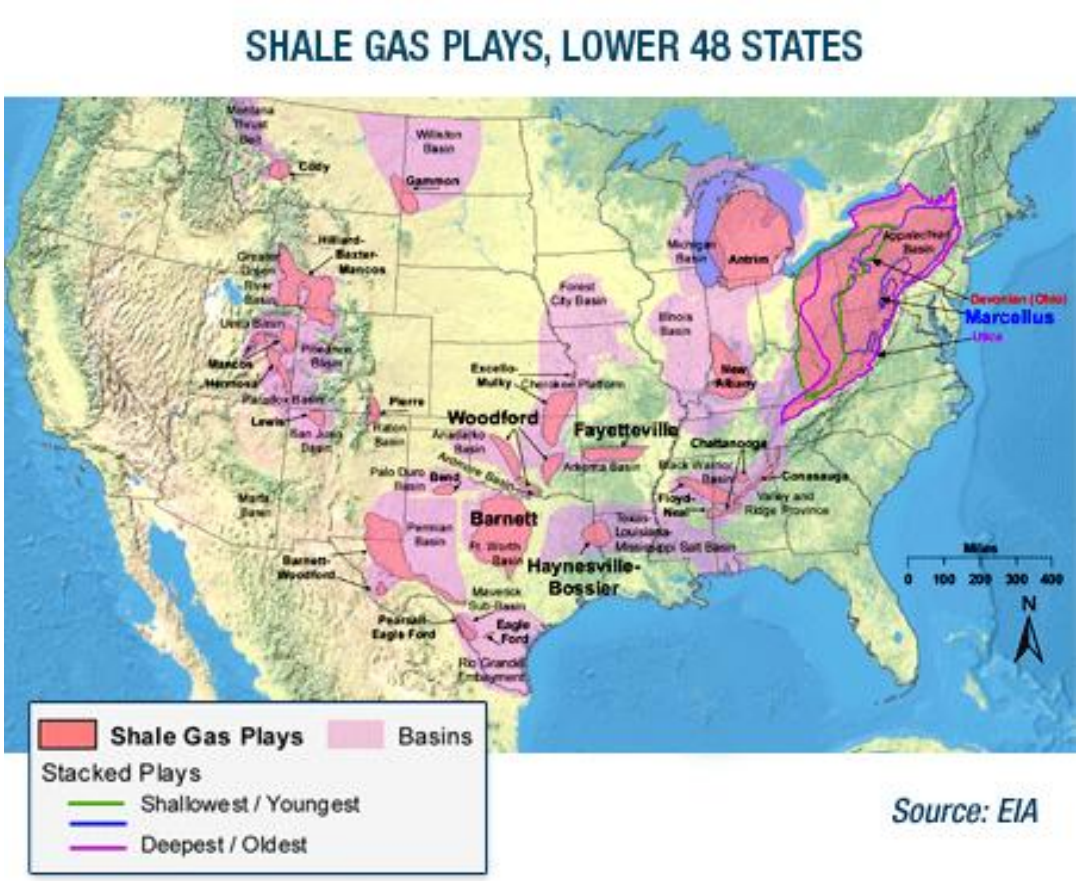


Shale Gas Has Been a Game Changer in Natural Gas Supply in the U.S.



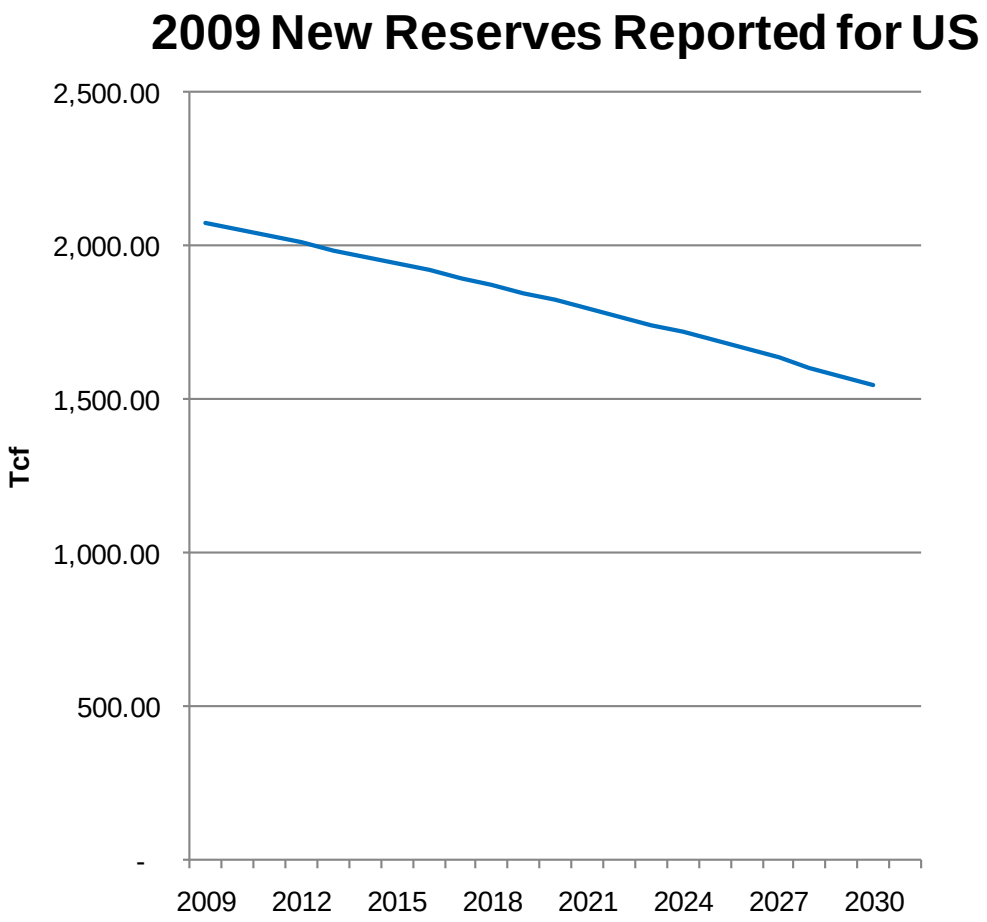
Shale Gas Plays in U.S. Lower 48 States

- **Shale Gas Plays are:**
  - Antrim
  - Barnett
  - Devonian
  - Fayetteville
  - Woodford
  - Haynesville
  - Marcellus
- **2008 Total Shale Gas Proved Reserves was 32.8 TCF**
- **1.5 years of US demand**



New Evidence Provides Optimistic Outlook on Natural Gas

- 2009 EIA reported
  - US Total Reserves = 2,074 tcf
  - Provides a 118 year life using 2007 production levels
  - Includes
    - 238 tcf proved
    - 1,836 tcf probable, possible, & speculative
- Hydraulic fracturing (fracking) allows for shale gas production
  - Shale gas makes up one-third of the 1,836 tcf of potential resources



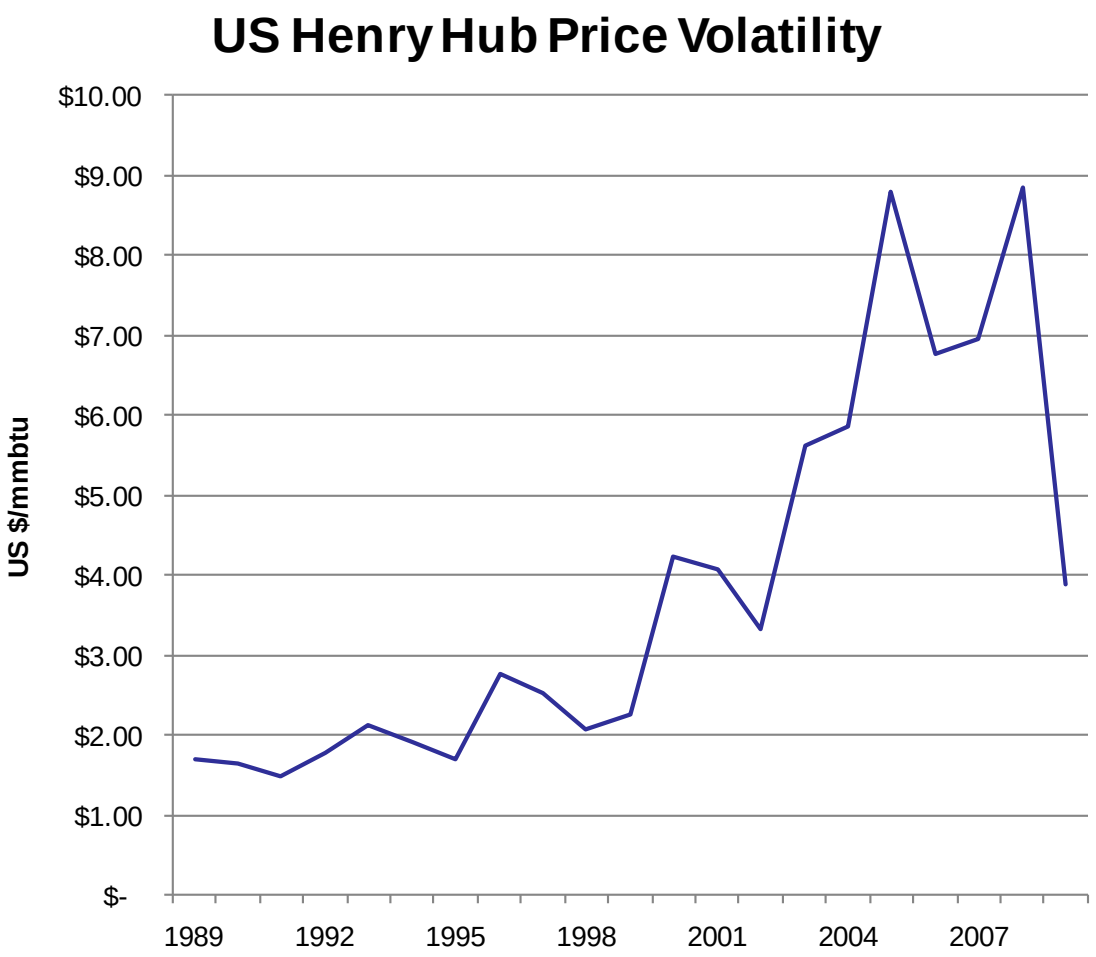
Source: EIA via the Potential Gas Committee

NATURAL GAS

PRICES

Natural Gas Prices

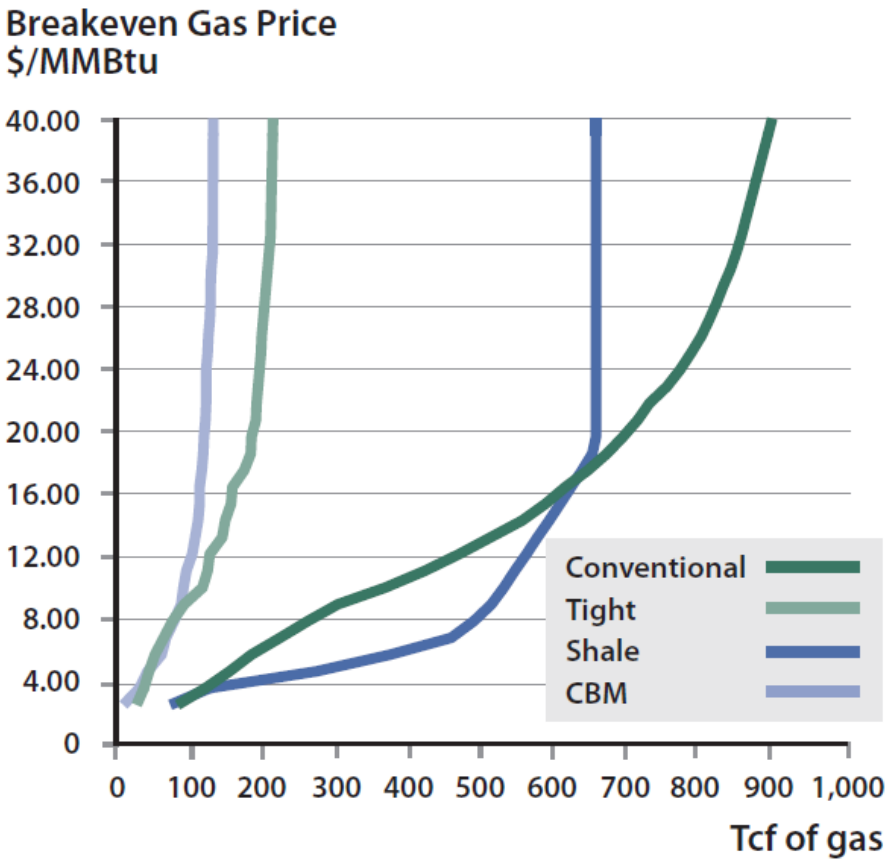
- Volatility in Natural Gas Market
  - 1989-1999: abundant reserves
  - 2000-2008: running low on reserves
  - 2008-present: shale gas economic availability was quantified
- Concerns for Production Slow Down
  - Water contamination
  - Safety issues
  - US liquefaction potential



U.S. Supply Curve for Natural Gas

- The marginal unit historically has set the market price
- Shale gas has reduced the marginal unit cost significantly
- If shale gas availability is reduced because of environmental issues from production, the marginal unit would be shifted back to the conventional production curve
- Current demand for natural gas is approximately 23 tcf per year
- With this demand and no slowdown in shale gas production, the marginal unit could stay below $8/mmbtu for at least 20 years

Figure 2.4b Breakdown of Mean U.S. Gas Supply Curve by Type; 2007 Cost Base

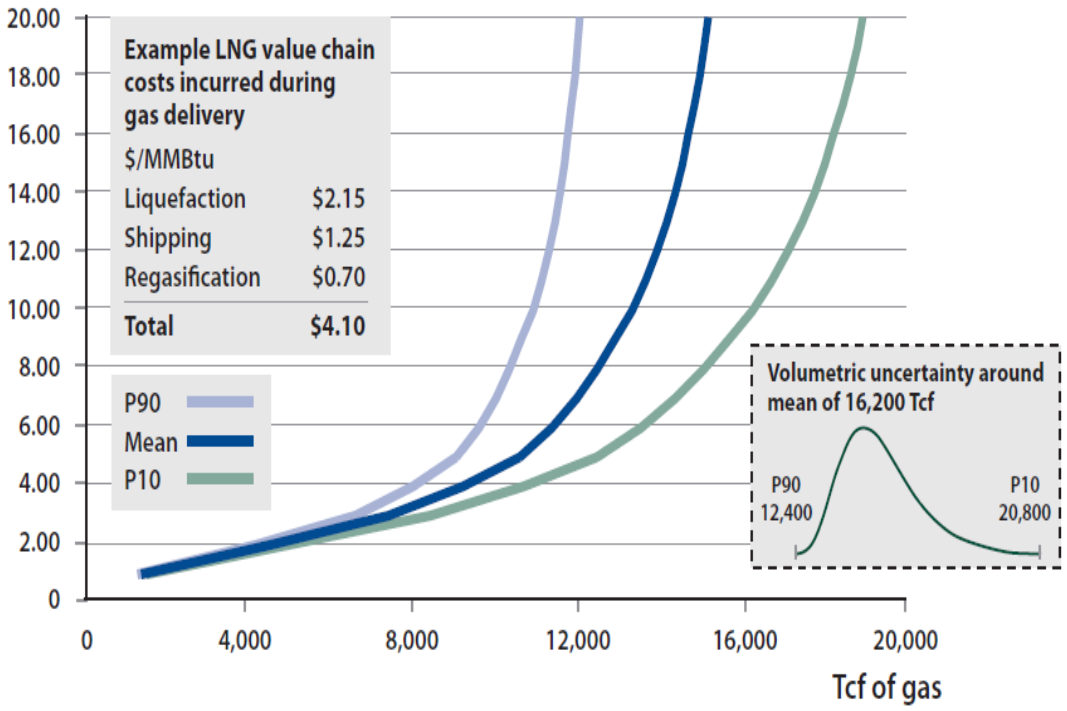


Source: "The Future of Natural Gas: An Interdisciplinary MIT Study", 2010, http://web.mit.edu/mitei/research/studies/naturalgas.html

Global Supply Curve for Natural Gas

- International supply and demand for natural gas will probably impact the price for natural gas in the U.S
- Producers/marketers may decide to develop liquefaction in the U.S. if the U.S. to international natural gas price supports it
- If China decides to comply with Kyoto and uses natural gas in place of coal for electricity generation, the market could see a substantial increase in natural gas prices

Figure 2.3 Global Gas Supply Cost Curve, with Uncertainty; 2007 Cost Base (excludes unconventional gas outside North America)

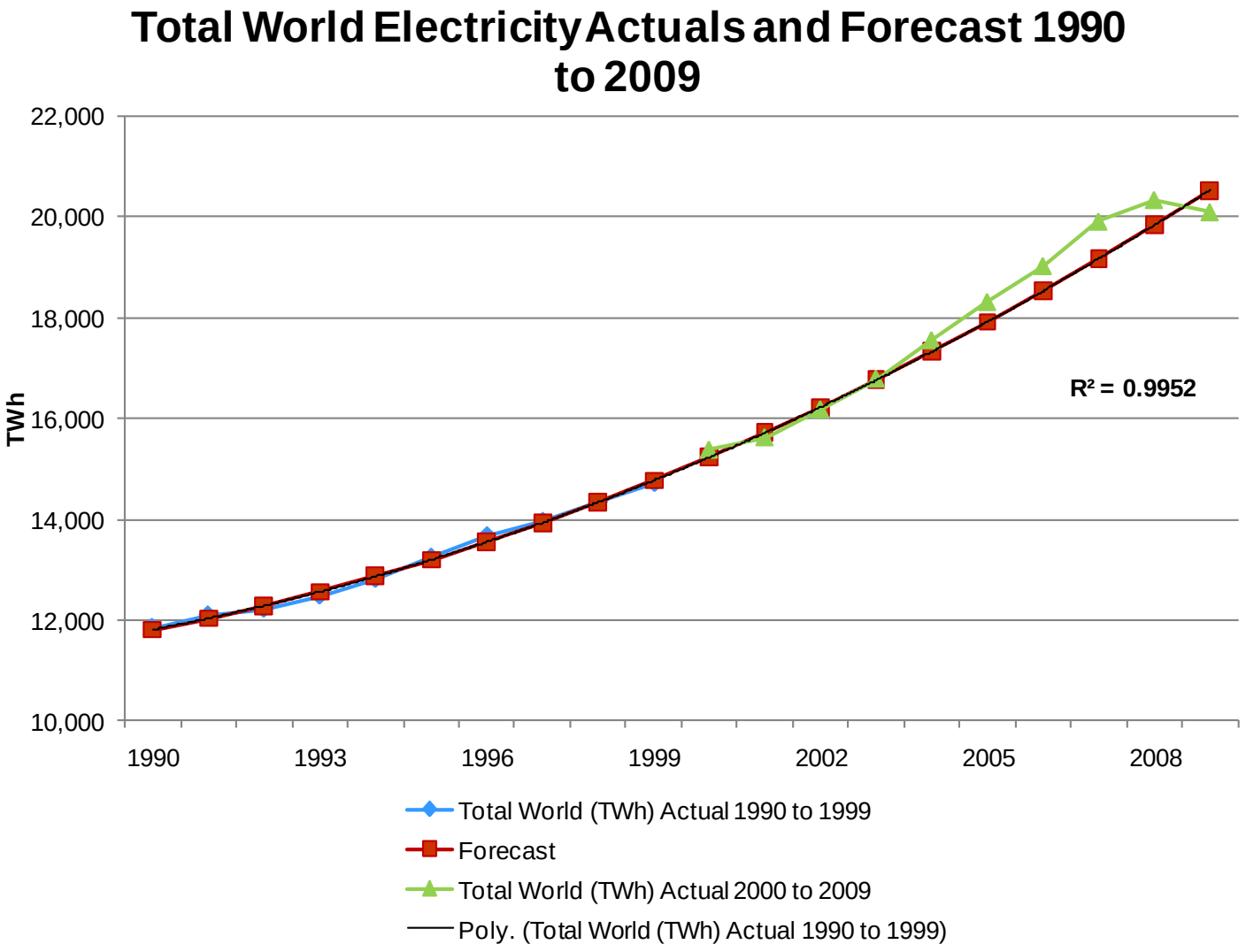


Source: "The Future of Natural Gas: An Interdisciplinary MIT Study", 2010, http://web.mit.edu/mitei/research/studies/naturalgas.html

WORLDWIDE ELECTRICITY

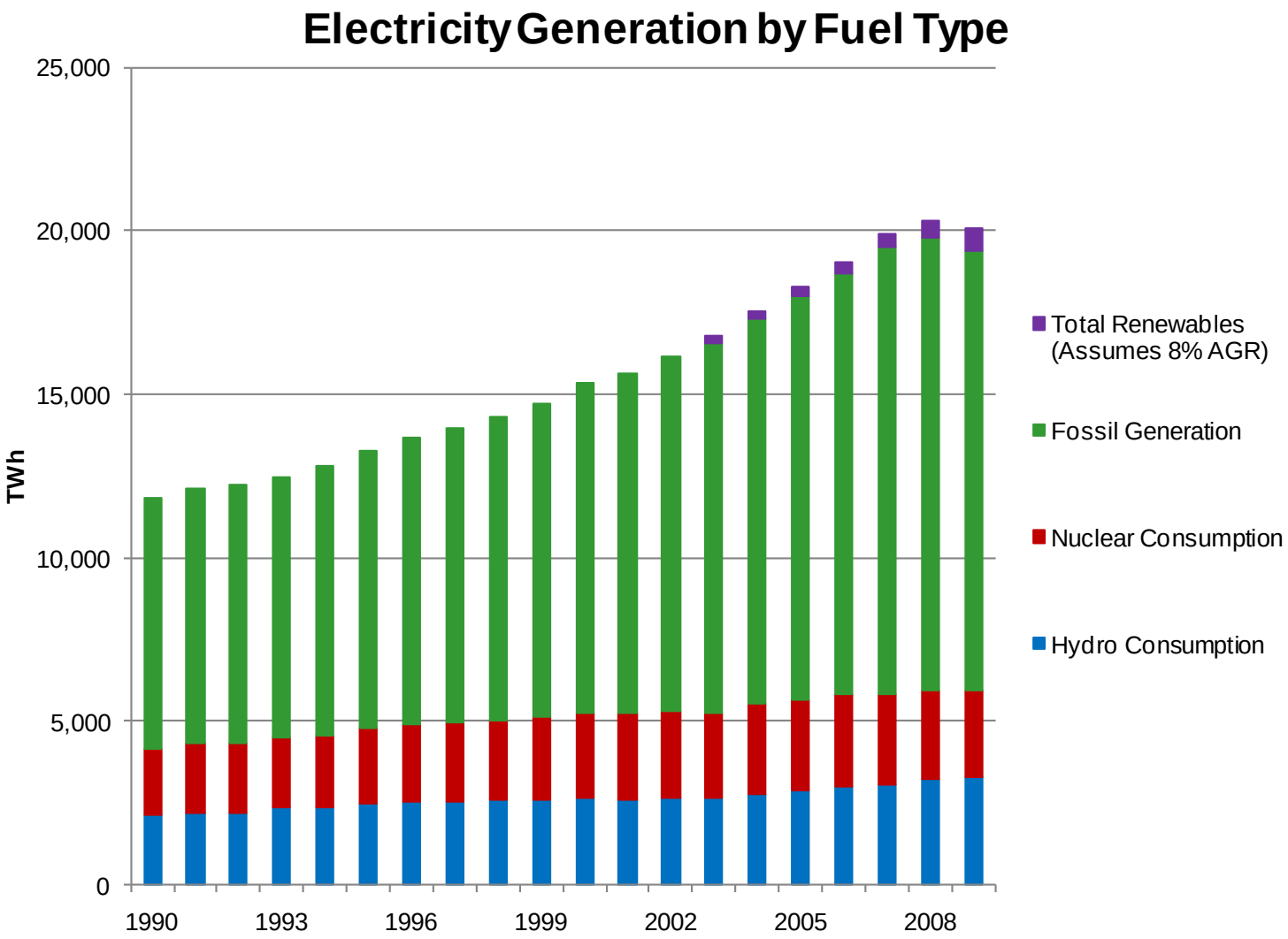
Worldwide Electricity Production

- Looking at the past (1990 to 1999) to project the future (2000 to 2009) has been a very good proxy
- Historical growth rate from 1990 to 1999 averaged 2.44% and from 2000 to 2009 averaged 3.18%
- Overall growth rate from 1990 to 2009 has been 2.83%

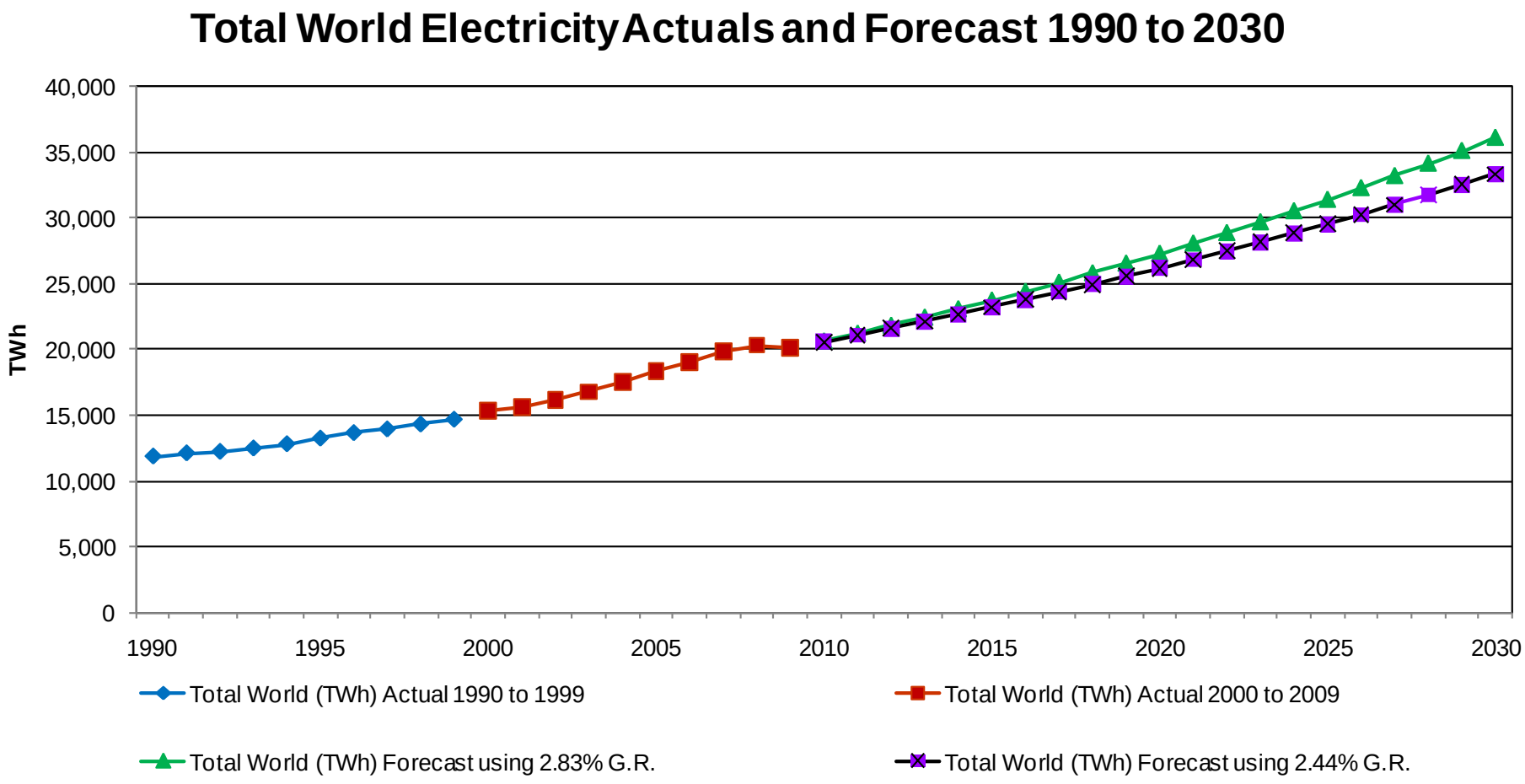


Worldwide Electricity Production, cont.

- Renewables are calculated from capacity values
  - Geothermal (80%)
  - Solar (40%)
  - Wind (40%)



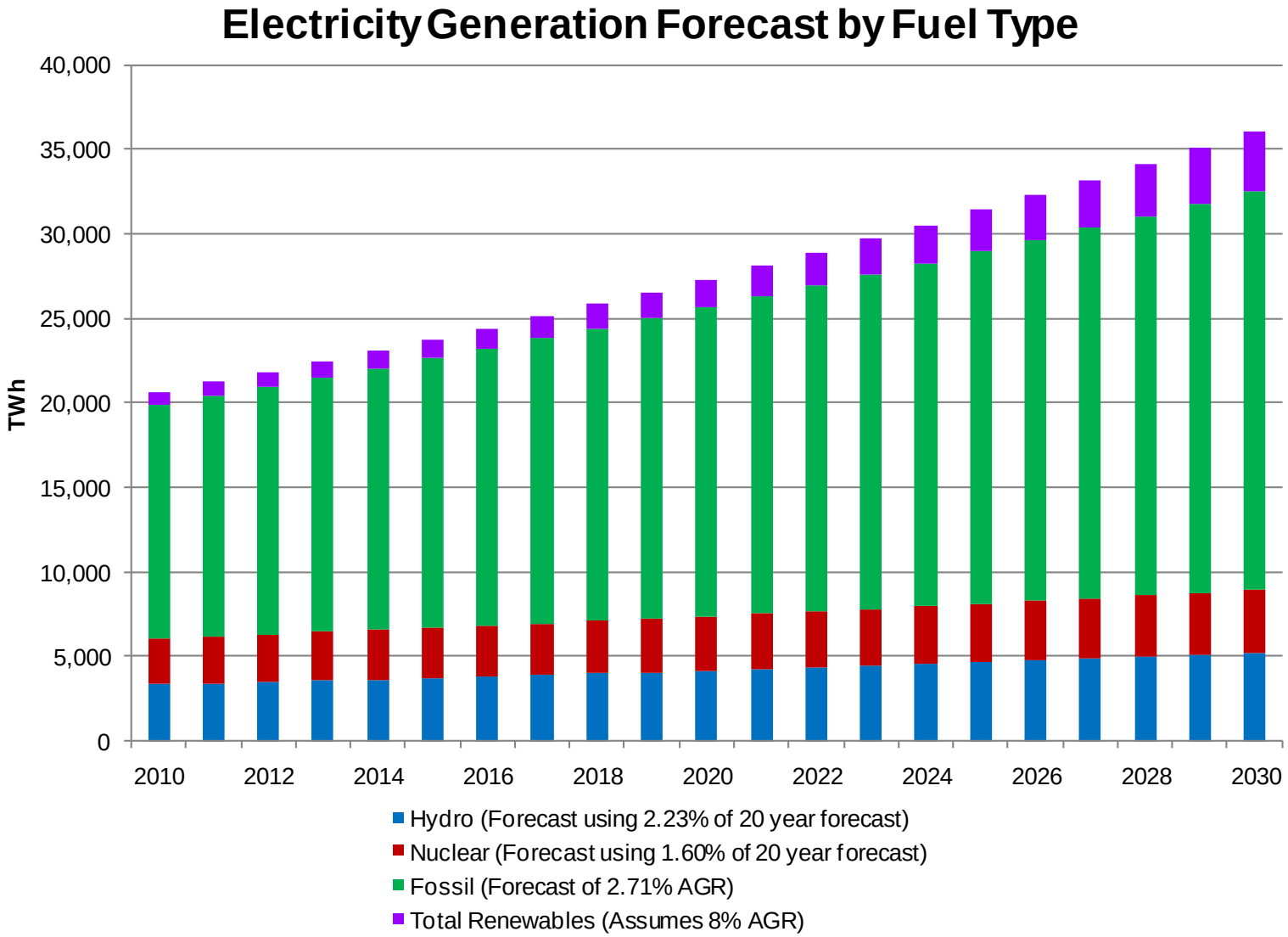
Worldwide Electricity Production, cont.



- 2030 Forecast using 2.83% (1990-2009) increases the electricity demand by 80%
- 2030 Forecast using 2.44% (1990-1999) increases the electricity demand by 66%

Worldwide Electricity Production, cont.

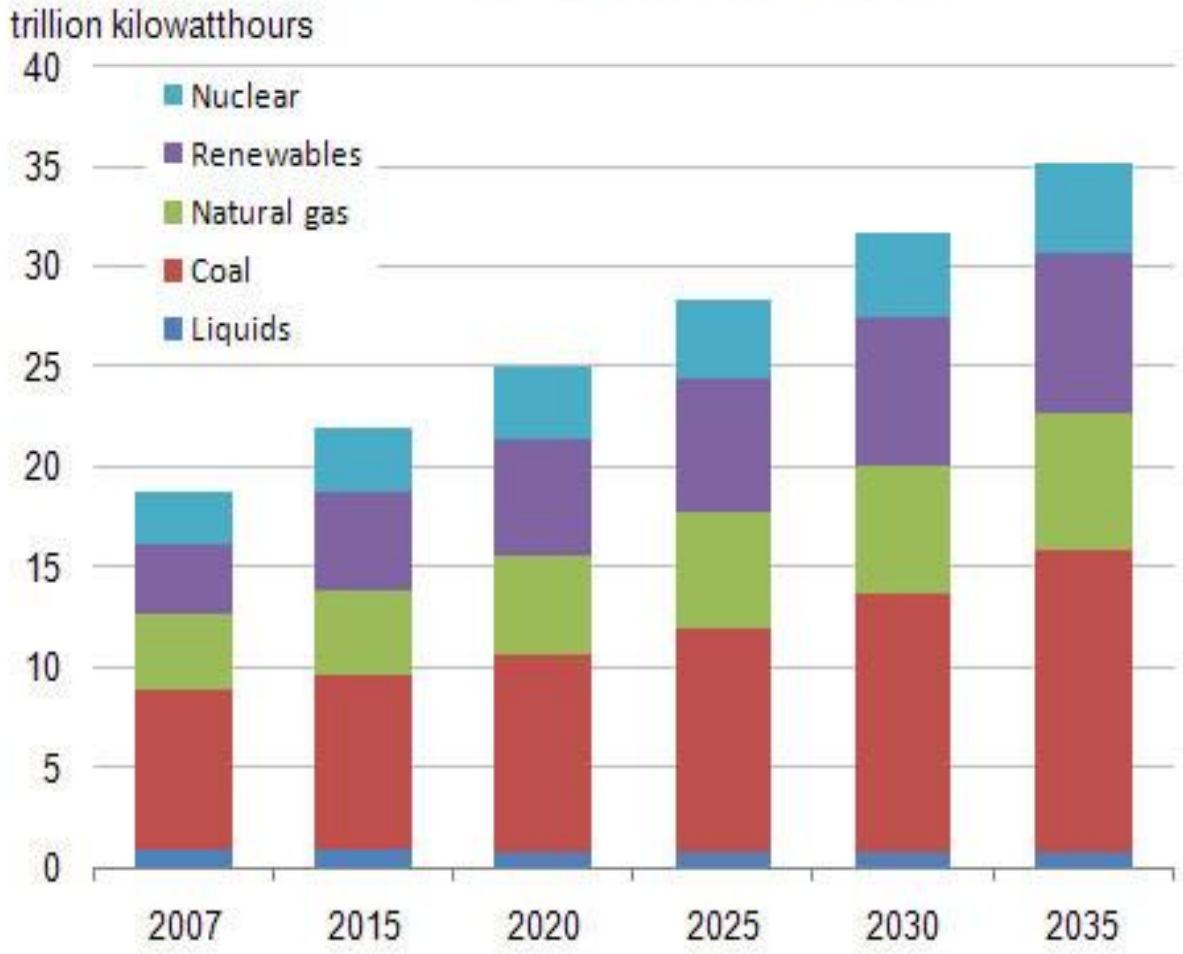
- Forecast in chart is based on base demand growth rate of 2.83%
- Increase of 16,000 TWh from 2009



Worldwide Electricity Production, cont.

- EIA produced the following results in the AEO 2010
  - Using 3.3% growth rate for non-OECD countries and a 1.1% growth rate for OECD countries
  - Renewable energy increases by 3.0% per year
  - Coal generation increases by 2.3% per year
  - Natural Gas increases by 2.1% per year
  - Nuclear increases by 2.0% per year

Figure 6. World net electricity generation by fuel

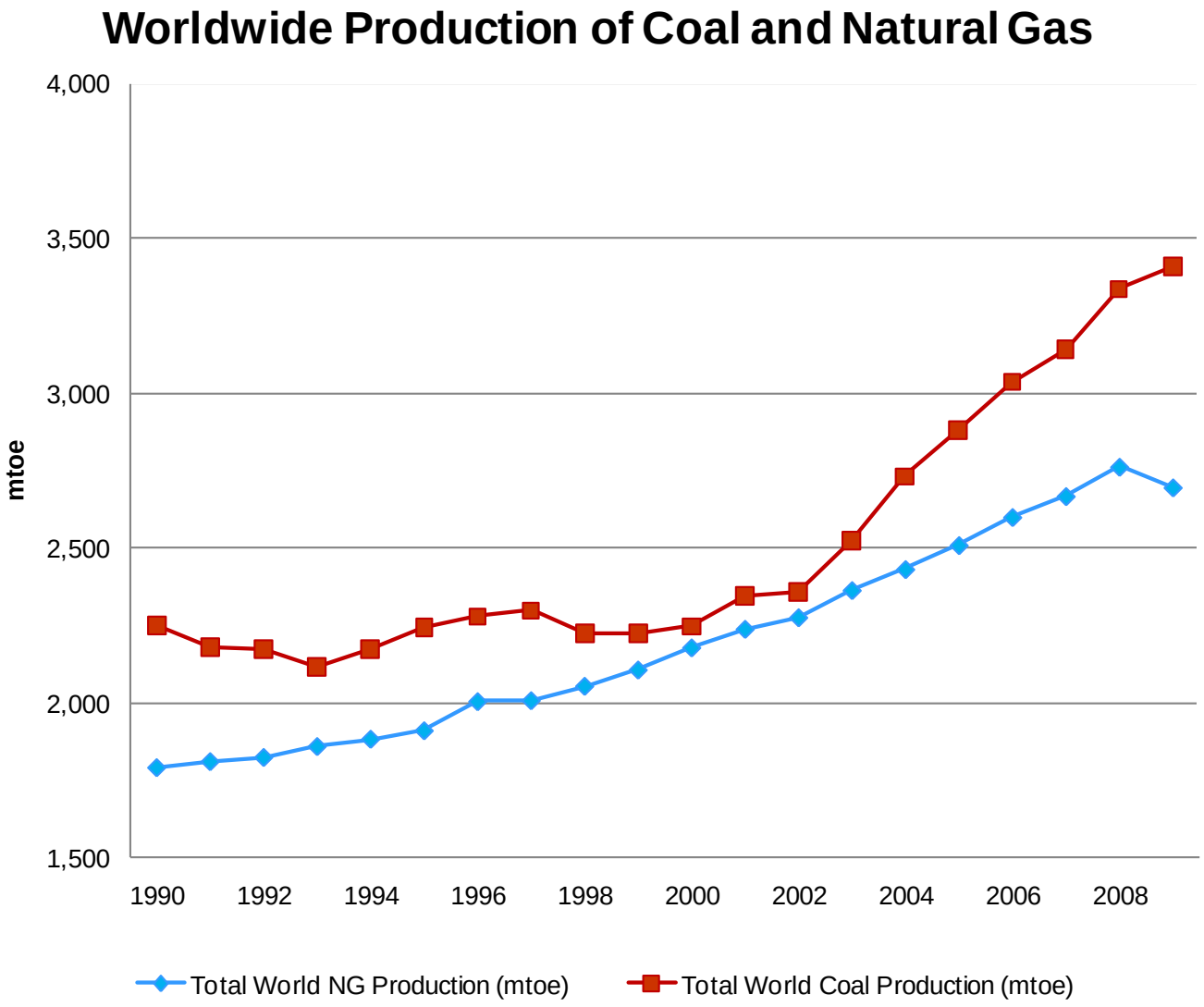


Source: EIA Annual Energy Outlook 2010

ADDITIONAL ITEMS

Growth in Coal and Natural Gas Production

- Coal (1993 to 2009) has been the leader in worldwide fossil generation
  - By growth in: China (684 mtoe) and India (89 mtoe)
  - Reductions in: U.S. (-64 mtoe) and Europe/Eurasia (-78 mtoe)
- Natural gas usage (1993 to 2009) has also been growing
  - In China (49 mtoe),
  - India (20 mtoe), and
  - the Middle East (105 mtoe) which was led by Iran (44 mtoe)



Things to Keep in Mind

- China's Nuclear Power Generation Expansion Plan
  - 20 plants under construction, with more to come
  - 60 GW by 2020 and 200 GW by 2030
- Gulf of Mexico Deepwater Drilling Moratorium
  - Provides approximately 30% of US crude oil production

Additional Items: Environmental Issues

- Renewables mandates could potentially reduce need for fossil fuels world wide
- In the U.S., renewable energy levels are currently mandated by state.
- Coal plants are being shut down worldwide either by mandate or economics
  - U.S.
  - Canada
  - Europe
- Generators will face taxes and output caps on specific emissions, including:
  - NO_x
  - SO_2
  - CO_2
  - Mercury
  - Particulates
- Emission caps will be applied at different levels
  - State
  - Generation Fleet
  - Plant

QUESTIONS?

APPENDIX

Abbreviations, Definitions, Etc.

- *EIA:* Energy Information Administration
- *OPEC:* Organization of the Petroleum Exporting Countries
  - Algeria, Angola, Ecuador, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, United Arab Emirates, Venezuela
- *OECD:* Organization for Economic Co-Operation and Development
  - Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States
  - Countries that the EIA has significant data
- *Non-OECD:* all other countries not previously listed as an OECD member
- *Middle East:* Iran, Iraq, Kuwait, Oman, Qatar, Saudi Arabia, Syria, United Arab Emirates, Yemen
- *EU:* European Union
  - Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, United Kingdom
- *btu:* British Thermal Unit
  - Amount of energy required to heat one pound of water 1°F
- *short ton:* US measurement of coal
- *tonne:* metric version of a ton
- *mtoe:* million tonnes oil equivalent
- *mmbtu:* million Btu

Conversions

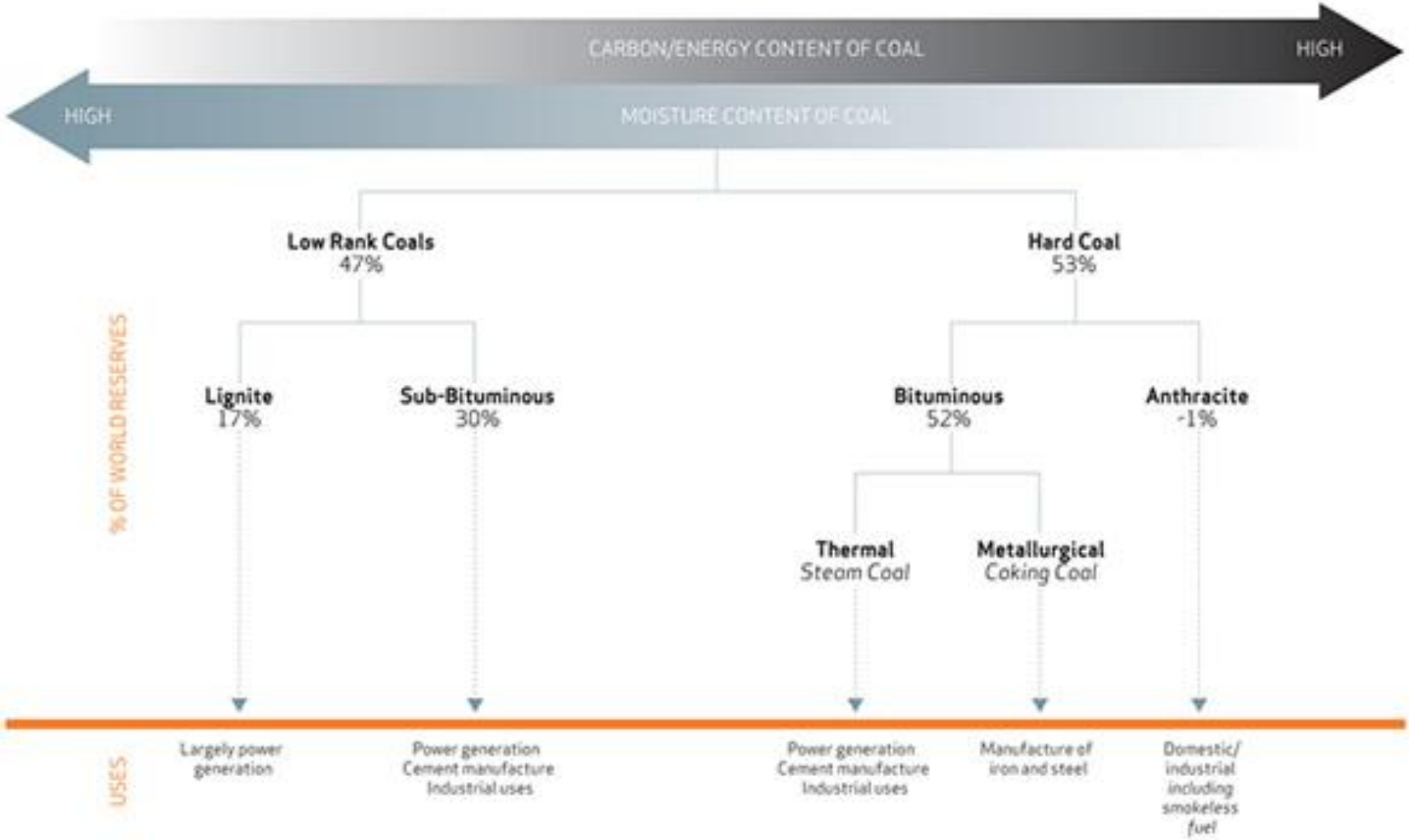
- 1 mtoe = 1.528 metric tonnes
- 1 metric tonne = 2,204.62 lb
- 1 short ton = 2,000 lb
- 1 mtoe = 1.1 short tons
- 1 cubic meter = 35.3144 cubic feet
- 1 btu = 0.000293 kwh
- 1 toe = 40 million Btu
- 1 toe = 1.5 metric tonnes of bits, sub-bits, antra
- 1 toe = 3 metric tonnes of lignite
- 1 toe = 12 MWh

Differences Among Crude Types

Sweet	-less than 0.5% sulfur -most sought after -peak production has lapsed
Sour	-more than 0.5% sulfur -75% of world supply -can be toxic and corrosive
Light	-flows freely at room temperature -produces (low viscosity) -produces higher percentage of gasoline and diesel fuels from one barrel at the refinery
Heavy	-high viscosity -API less than 20° -shallow field depths -lower production costs -high refining costs

Source: http://www.forbes.com/2005/10/14/chevron-conoco-valero-tesoro-cz_kk_1013soapbox_inl.html
http://nextbigfuture.com/2008/01/bakken-and-torquay-formations-saudi.html
http://www.theoildrum.com/node/4038

Various Coal Types



Source: World Coal Institute

Sources of Data

- This presentation has been built around data from the BP Statistical Review 2010 (http://www.bp.com/liveassets/bp_internet/globalbp/globalbp_uk_english/reports_and_publications/statistical_energy_review_2008/STAGING/local_assets/2010_downloads/Statistical_Review_of_World_Energy_2010.xls) unless otherwise noted

- Other public data sources with similar information (thought not necessarily the same) are available from the Energy Information Administration (EIA), International Energy Agency (IEA), Exxon Mobil, and Shell