

# Fossil Fuels

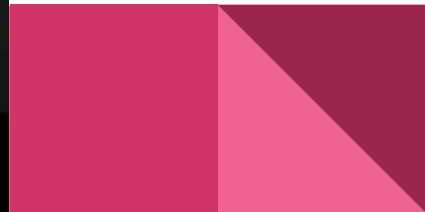
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# What are Fossil Fuels?

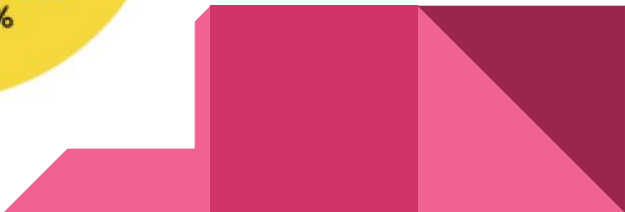
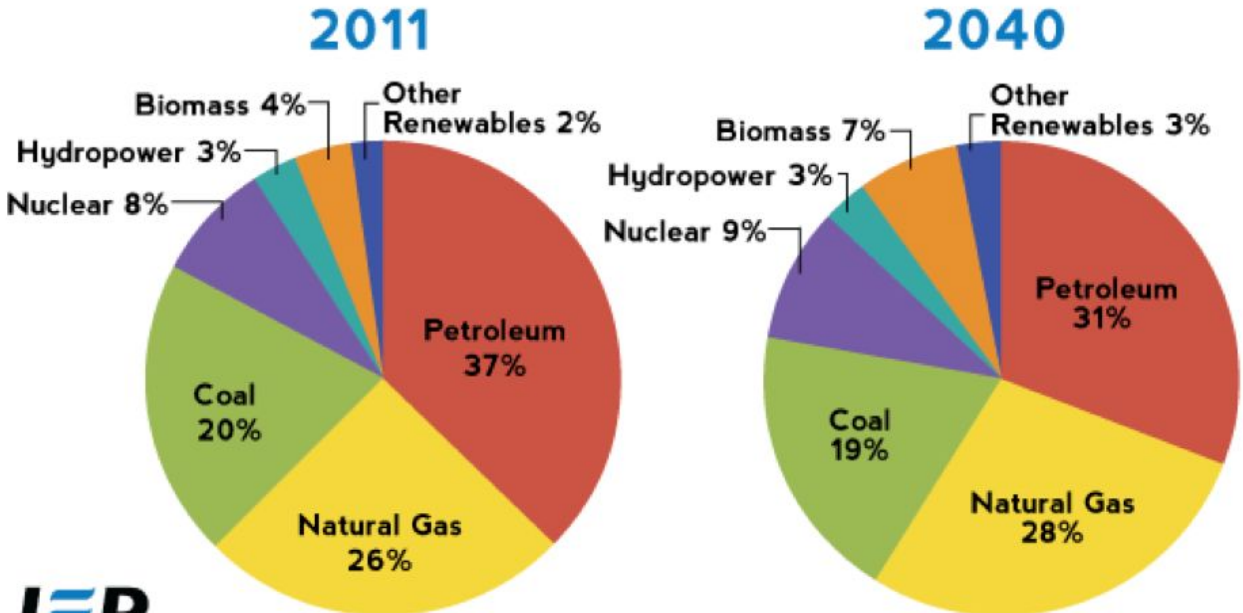
- Fossil Fuels are hydrocarbons that are formed from the remains of dead plants and animals
- As a general term: “buried combustible geologic deposits of organic materials, formed from decayed plants and animals that have been converted to crude oil, coal, natural gas, or heavy oils by exposure to heat and pressure in the earth's crust over hundreds of millions of years”




# Fossil Fuels



# Fossil Fuel Usage Percentage



# Main Types of Fossil Fuels: Coal

- Coal: made of carbon, hydrogen, oxygen, nitrogen, and sulphur
  - Three main types:
    - Anthracite: hardest, more carbon, higher energy content
    - Bituminous
    - Lignite: softest, lower in carbon, high in hydrogen and oxygen
  - One of the most abundant fossil fuels
  - Large environmental impacts: more than a quarter of US total global warming emissions, 80 percent of all those from power plants
  - Clean Coal Technology: cut back on release of Carbon Dioxide, billions invested
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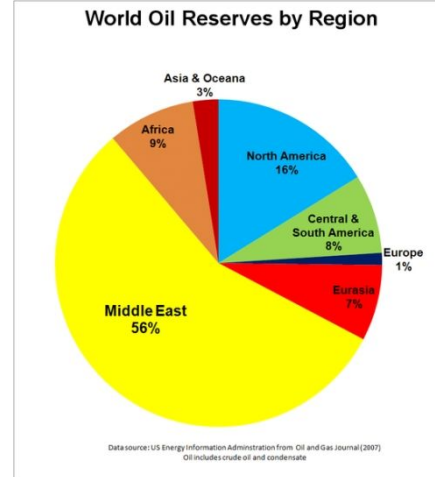
# Main Types of Fossil Fuels: Natural Gas

- Natural Gas: Lighter than air, made up of methane, highly flammable
- It is tasteless, colorless, and odorless, so distributors add mercaptan to allow natural gas to be easily detected
- Slightly more than  $\frac{1}{2}$  of American homes use natural gas for heating
- Cleanest burning fossil fuel: primarily producing carbon dioxide, water, and small amounts of nitrogen oxide

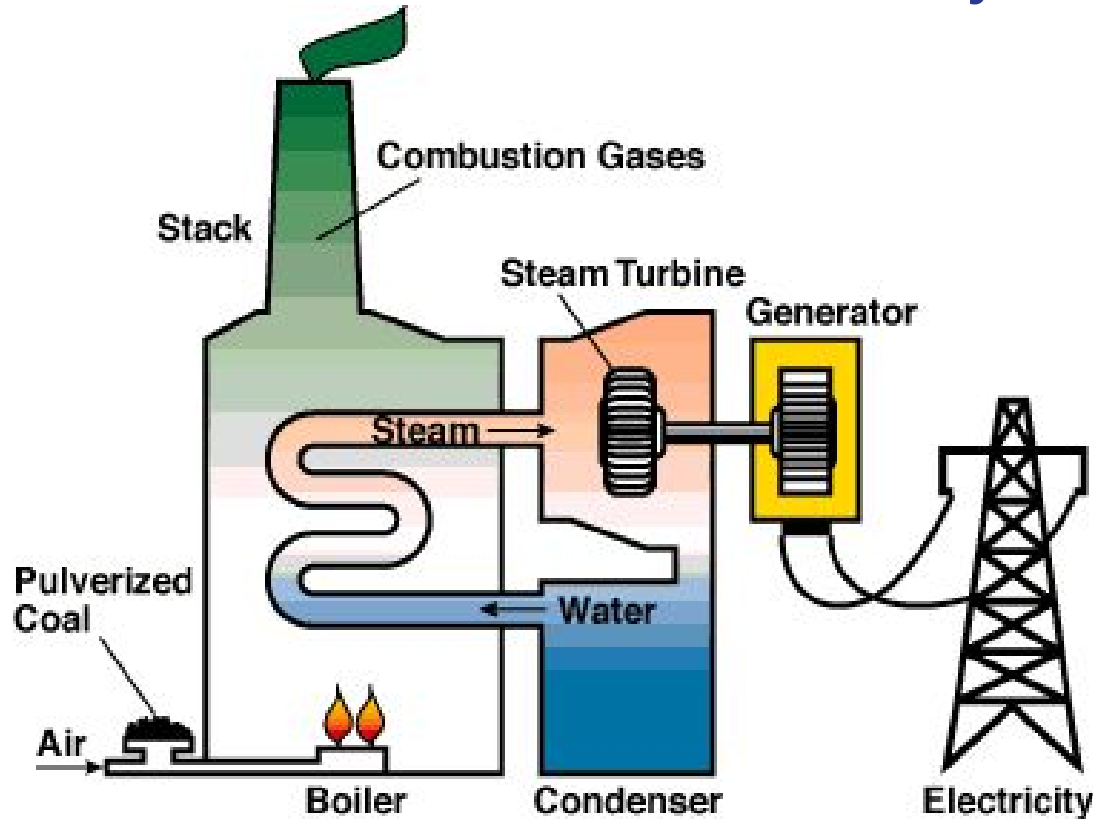


# Main Types of Fossil Fuels: Oil/Petroleum

- Oil: Mix of hydrocarbons with some Oxygen, Nitrogen, and Sulphur
- 56% of the world's known oil reserves located in the Middle East, leading to the creation of the OPEC countries
- Most oil is used in transportation, other uses include industrial, commercial, and residential



# How Fossil Fuels Generate Electricity





# Efficiency

## Electricity Cost

Cost to produce 1 MWh

Natural gas

\$66/MWh\*

Hydro

\$86

Coal

\$95

Wind

\$97

Geothermal

\$102

Biomass

\$113

Nuclear

\$114

Petroleum

\$125

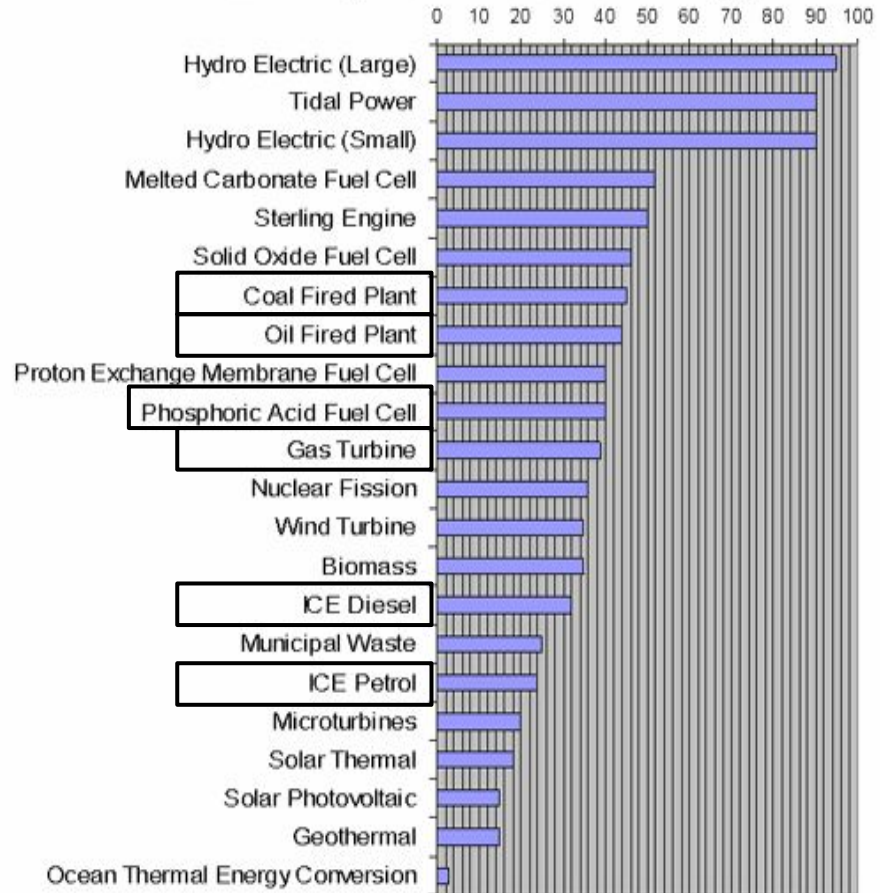
Solar PV

\$211

\*2009 dollars for plants entering service in 2016  
Source: EIA

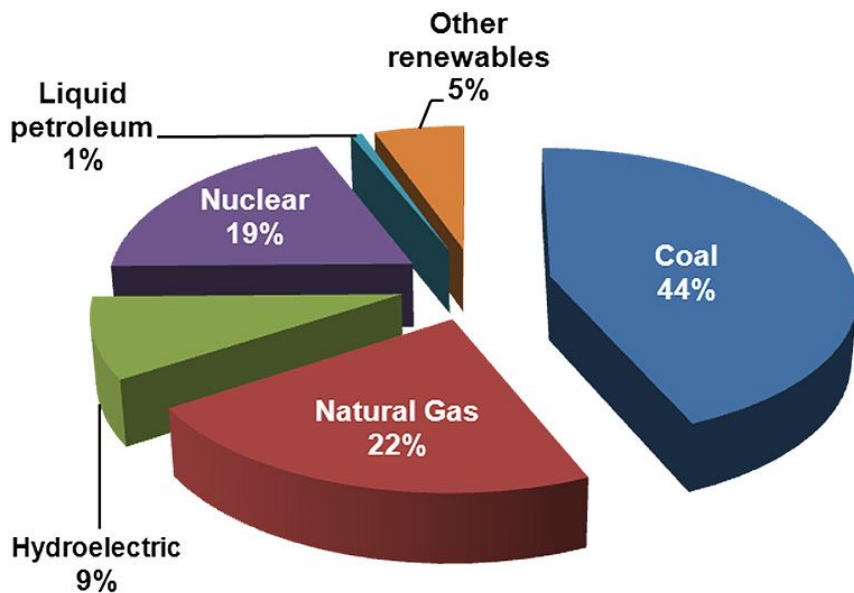
The Wall Street Journal

## Electricity Generation Efficiencies (%)



# Generating Electricity

U.S. Electricity Generation (2010)



# Inception of Fossil Fuel Usage: Coal

- Coal is the most common fossil fuel: use dates back to the Romans in England during the 2nd and 3rd centuries
- Other groups throughout history such as the English and early Hopi Indians also used coal sparingly; widespread use came during the Industrial Revolution
- Commercial coal mines began operating in Virginia in the 1740's
- During the 1800's, coal fueled steamships and railroads
- United States has enough coal for 200-300 years

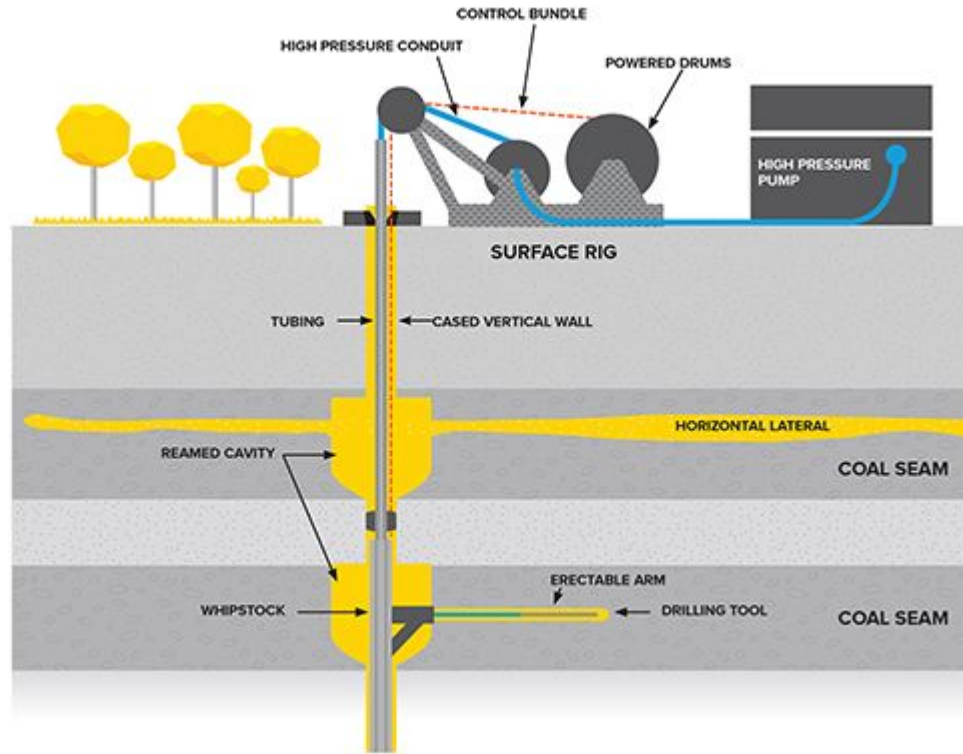


# Coal in the Present Day

- Coal is located in layers beneath the Earth's surface
- Two methods of mining:
  - Surface Mining: taking away the overlying layers to reach coal just under the Earth's surface
  - Underground Mining: Drilling vertical or slanted shafts to provide ventilation for workers deep underneath the Earth's surface
- Coal is loaded onto small cars/conveyor belts inside the mine
- Carried by larger trucks to be crushed and turned into usable fuel



# Coal Mining



# Inception of Fossil Fuel Usage: Natural Gas

- First documented uses of natural gas by the Ancient Greeks and Chinese
- First commercialized use by the British in 1785 to light houses and streets
- 1885 invention of the Bunsen Burner allowed for vast new opportunities for Natural Gas: cooking and heating, home appliances
- Over 900 US gas systems today



# Natural Gas in the Present Day

- One of the cleanest, safest, and most useful of all energy sources
- Supplies more than  $\frac{1}{2}$  of the energy consumed by residential and commercial customers
- 99% of the natural gas used in the United States is supplied domestically
- Often extracted through a pumping system (Horse-Head Pump)
- Usually collected from deposits within the Earth's Crust



# Inception of Fossil Fuel Usage: Oil/Petroleum

- The earliest recorded uses date back to the Ancient Egyptians and Ancient Greeks (Eternal Fires)
- Earliest oil wells drilled in 347 AD in China
- Whale oil was used throughout the Industrial Revolution for heating, candle wax, etc; took a backseat to Coal
- US Production of Oil: 2.1 million barrels a year in 1861; 63 millions barrels a year in 1900
- Invention of the automobile greatly increased widespread oil demand



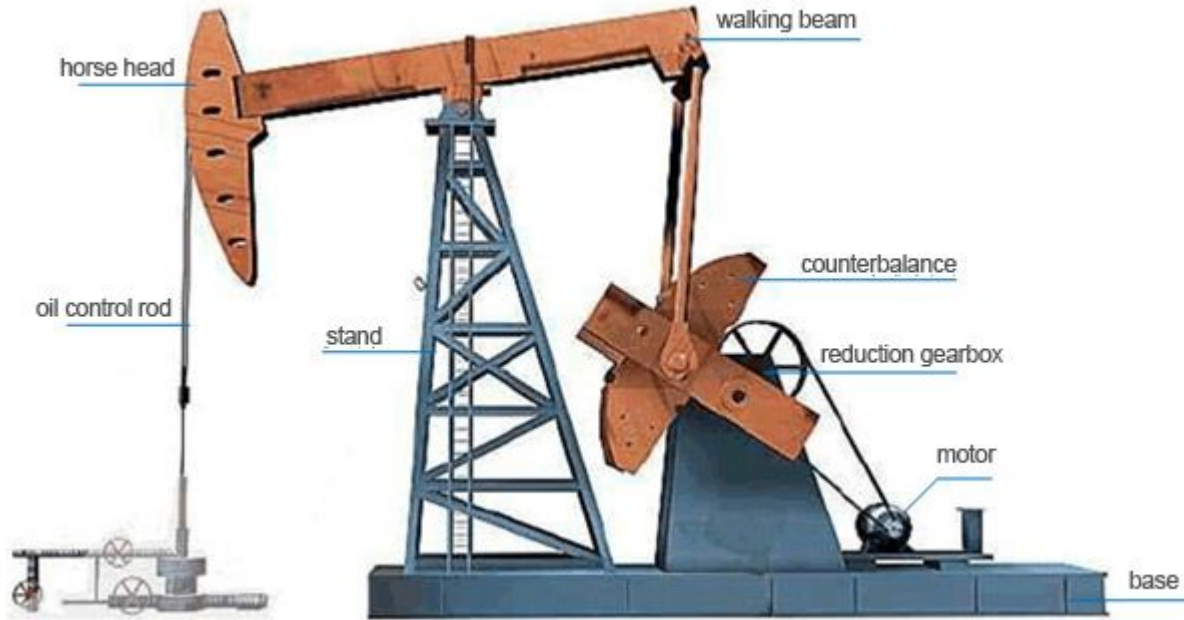


# Oil/Petroleum in the Present Day

- Beginning of the 21st Century led to increased insecurities in oil supply due to international destabilization; production has still been expanding rapidly
- Current global oil production: 89 billion barrels per day
- Remains as the world's primary fuel source for transportation
- Oil is extracted or pumped out of underground reservoirs; also found in shale and tar sands
- Crude Oil is processed in refineries to create fuel, gasoline, petroleum, and other oil-based products



# Horse-Head Pump



# Oil Rigs

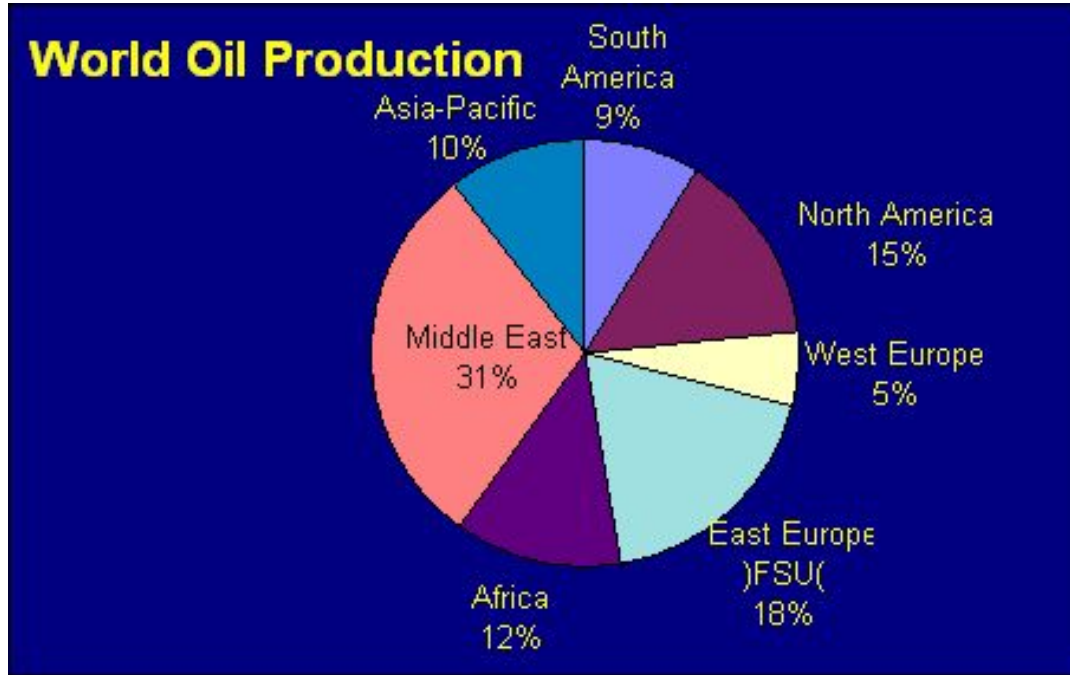


# Oil Rigs: Accidents

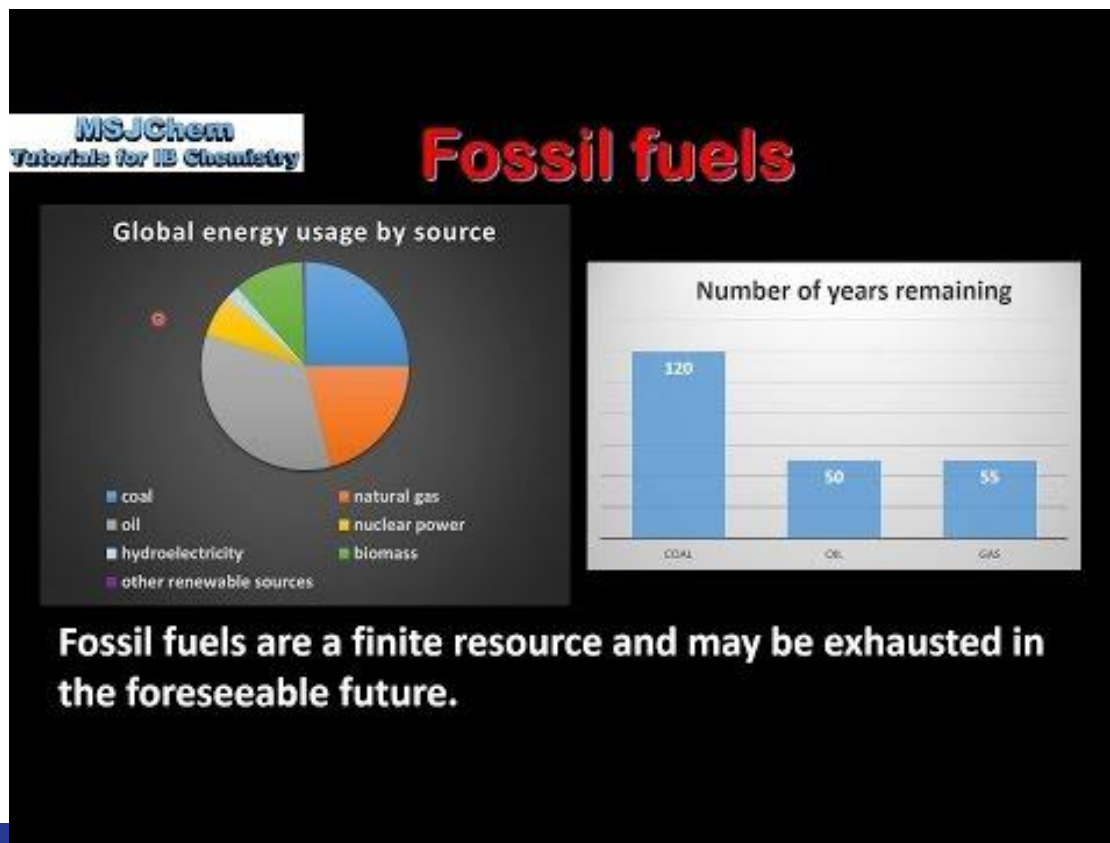
- Exxon Valdez
- Deep Water Horizon



# World Oil Production

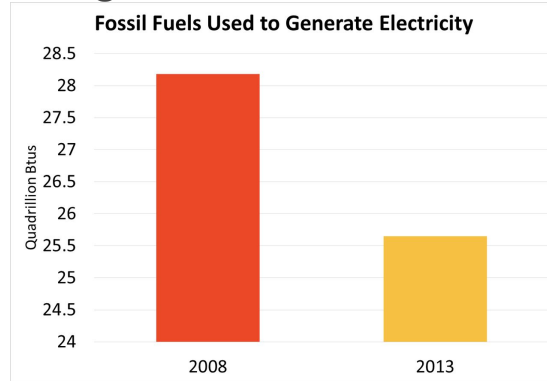


# Benefits of the Fossil Fuel, Coal:



# Fossil Fuels vs. Renewable Energy

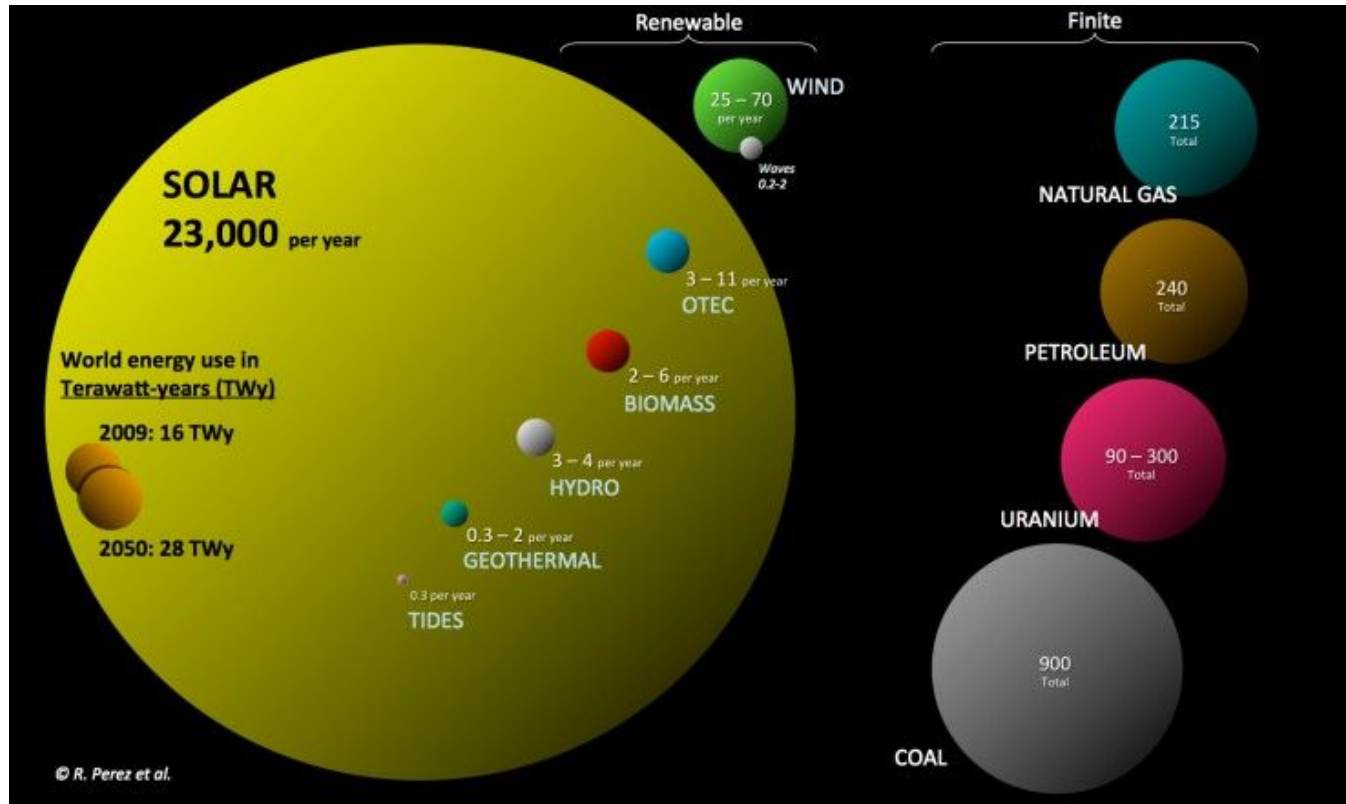
- Long-term decline beginning on the use of Fossil Fuels



- Fossil fuels only rely on the resource at hand, whereas renewable sources need a given condition (sun, wind, etc.) to function
- Fossil fuel processing is far more expensive compared to solar and wind farms, and have a dramatically higher carbon footprint



# Fossil Fuels vs. Renewable Energy



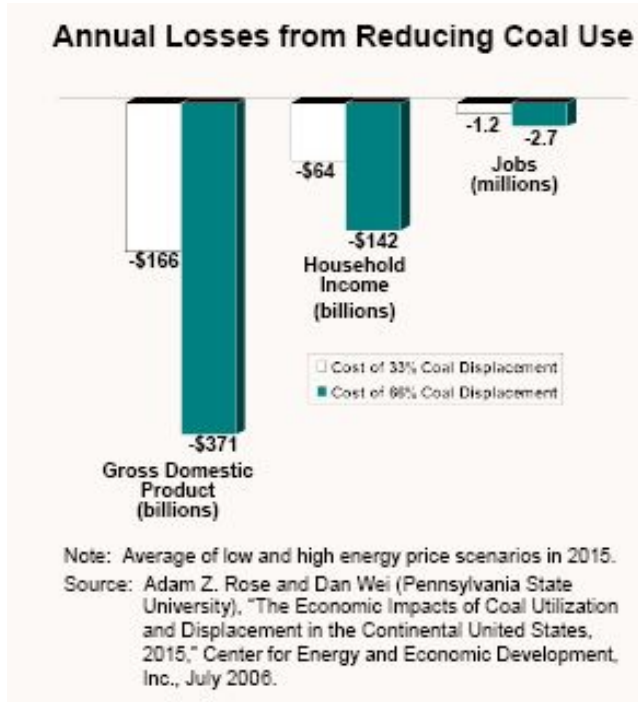


# Economic Benefits of the Fossil Fuel, Coal:

- Researchers at Pennsylvania State University estimated the economic benefits of coal and the potential impact of replacing coal with more expensive energy sources such as natural gas and a 10 percent mix of renewables. They netted out the positive offsetting impacts of investments in replacement fuels and electric generating capacity. By 2015,
- The annual benefit of coal use at currently projected levels is estimated at more than \$1 trillion in gross domestic product (GDP), \$360 billion in additional household income and nearly 7 million jobs.



# Continued



- In contrast, a 33 percent reduction in coal-fired electric power generation would reduce GDP by \$166 billion, household income by \$64 billion and employment by 1.2 million below what it otherwise would be.
- A 66 percent reduction in coal-fired electric power generation would reduce GDP by \$371 billion, household income by \$142 billion and employment by 2.7 million.
- The negative impact of displacing coal would be felt nationally, regionally and in nearly every state, even after considering the positive impacts of replacement energy sources.

# Some Economic Implications of Coal

- Often times people are transfixed on the environmental implications of coal use, that they forget to consider the possible economic implications of no longer using a prominent energy sources such as coal
- From the research of economist Harvey Brenner at John Hopkins University:
- Brenner's research connects the dots between the economic benefits of coal use and the public health consequences of reduced coal utilization. His finding: the loss of jobs causes increased premature mortality.
- It is important to note that in 1984, Brenner of Johns Hopkins University conducted the first major research on the impacts of unemployment on public health for the Joint Economic Committee of Congress in 1979 and 1984. In his 1984 study, Brenner found that every 1 percent increase in unemployment resulted in a 2 percent increase in premature deaths.



# Continued

- Brenner applied his model to the findings of two studies that estimated the adverse economic impacts of reduced coal use - a 2001 Penn State study and an analysis of the impacts of the Kyoto Protocol by DRI, a noted economic forecasting and consulting organization. Brenner adjusted the results of these studies to approximate the income and unemployment effects of a hypothetical complete elimination of coal.
- Brenner reports "the estimated additional mortality in the year 2010, based on four different variations of the model, ranges from an additional 170,507 to 368,915 deaths for the displacement of 100% of coal-based generation. The author's moderately conservative estimate is based on an annual change model at 195,308 deaths."

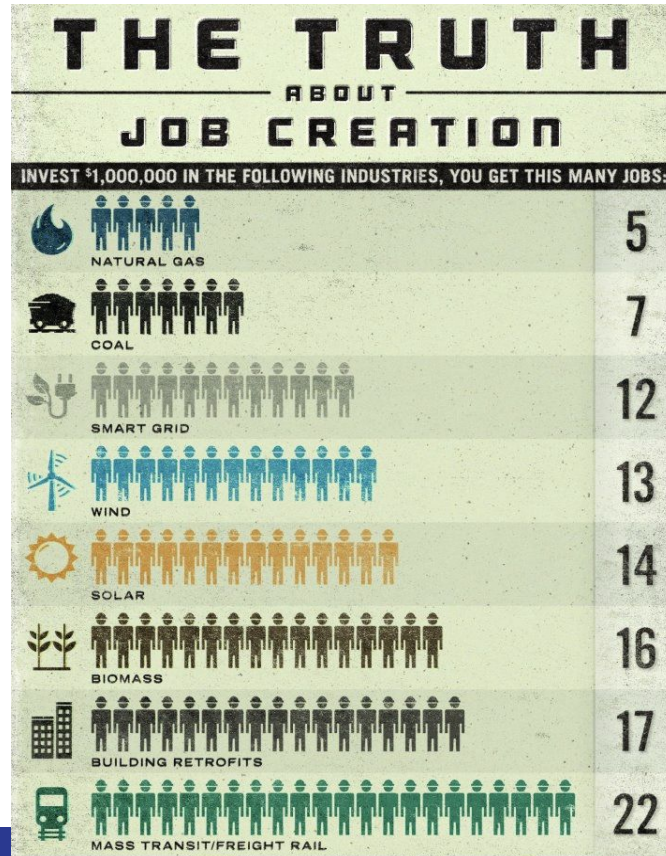


## Continued pt2

- Applying his analysis to specific climate change policies affecting coal-fired generation, Brenner says: "Given an estimated potential displacement of 78% of U.S. coal generation based on EIA's study of proposed climate change initiatives, the indicated premature mortality from reduced income and increased unemployment would exceed 150,000 deaths annually, absent direct and effective mitigation programs."



# Fossil Fuels vs. Renewable Energy



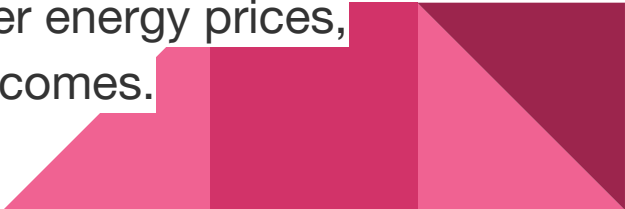
SOURCE: Political Economy Research Institute at the University of Massachusetts.

# Policy Implications of Coal:

- To put the health risks from a mandatory switch from coal in context, Brenner's estimate of potential premature deaths from national climate change legislation is many times greater than U.S. Environmental Protection Agency's estimates of the benefit in reduced premature mortality from new national ambient air quality standards.



# Continued

- Together, the Penn State and Brenner studies offer profound evidence that policy initiatives such as climate legislation must be evaluated from two perspectives: in addition to direct economic impacts on output, income and employment, policymakers need to consider the potential indirect public health consequences of policies that restrict energy supply choices.
  - This prescription applies not just to national legislation, but to state and regional climate initiatives such as those in California and the Northeast. All of these programs should be carefully assessed to determine their potential adverse public health consequences related to higher energy prices, increased unemployment and reduced household incomes.
- 




# Continued pt2

- Thus, the benefits of coal, and the cost of eliminating it, should be weighed against benefits from the incremental reduction in air pollution and CO2 emissions. Adding up the benefits and subtracting the costs properly can help us realistically determine our next steps towards producing a more sustainable society
- Simply saying that we should eliminate coal is a rudimentary and not well thought out argument



# Benefits of the Fossil Fuel, Natural Gas

- Highly efficient form of energy and cleanest of the fossil fuels
  - Produces less carbon dioxide emissions than coal and oil
  - As well as less sulfur dioxide( the primary precursor of acid rain), nitrogen oxides (primary precursor of smog), and particulate matter, which can affect health and visibility
  - Can be used to make fertilizer for ethanol
  - Can be used to generate clean power, and is the raw material that goes into lightweight cars, wind power blades, solar panels and other energy efficient materials
- 

# Benefits of the Fossil Fuel, Oil

- Oil has a high energy density, which means that a small amount of oil can produce a large amount of energy
- Plays a large role in human products such as Vaseline, cloth, medicines, etc and is able to be transported throughout the world
- It is easy to produce and refine
- Oil is a constant power source and reliable. It can be produced at any time of the day unlike other energy sources such as wind energy



# Economic Benefits of Natural Gas, Oil

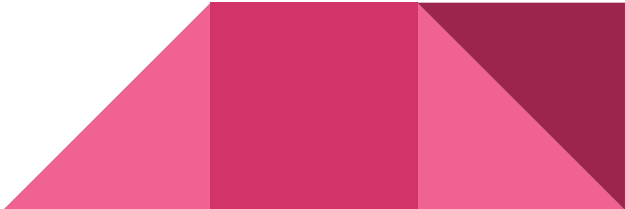
**The Annual Economic Benefits of Oil and Gas  
Exploration and Production:  
Gains in US Business Activity  
(Monetary Values in Constant 2014 Dollars)**

Total Expenditures	<b>\$3,411,010,049,109</b>
Gross Product	<b>\$1,171,303,677,484</b>
Personal Income	<b>\$658,311,398,569</b>
Retail Sales	<b>\$242,646,639,893</b>
Employment (Permanent Jobs)	<b>9,312,478</b>

Note: Direct activity is based on various measures of industry performance as reported by the Bureau of Economic Analysis, the Bureau of Labor Statistics, and the Energy Information Administration. Total activity (including indirect and induced effects) is based on simulations of the US Multi-Regional Impact Assessment System.

Source: The Perryman Group

... and development activity (including multiplier  
... gross product each year, as well as more  
By both measures, this activity represents



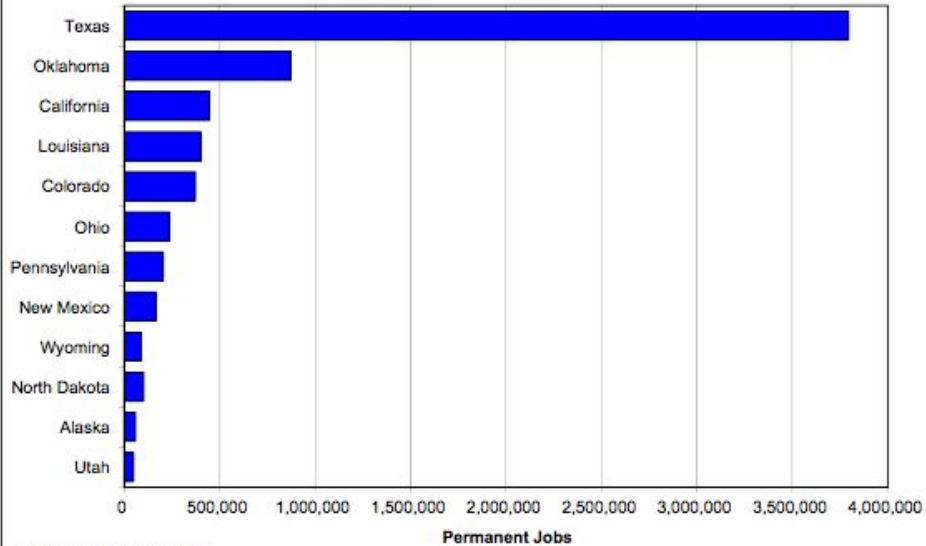
# Continued

<b>The Current Economic Benefits of Oil and Gas Exploration and Production: Gains in Selected Major Energy-Producing States</b>		
	<b>Gross Product (Billions of 2014 Dollars)</b>	<b>Employment (Permanent Jobs)</b>
Texas	\$472.535	3,794,527
Oklahoma	\$111.569	874,456
California	\$57.010	446,800
Louisiana	\$47.925	401,191
Colorado	\$47.686	373,349
Ohio	\$30.343	234,807
Pennsylvania	\$25.716	205,478
New Mexico	\$20.543	164,626
Wyoming	\$11.389	88,548
North Dakota	\$11.322	102,087
Alaska	\$7.405	58,201
Utah	\$6.221	49,054
<b>US TOTAL</b>	<b>\$1,171.304</b>	<b>9,312,478</b>

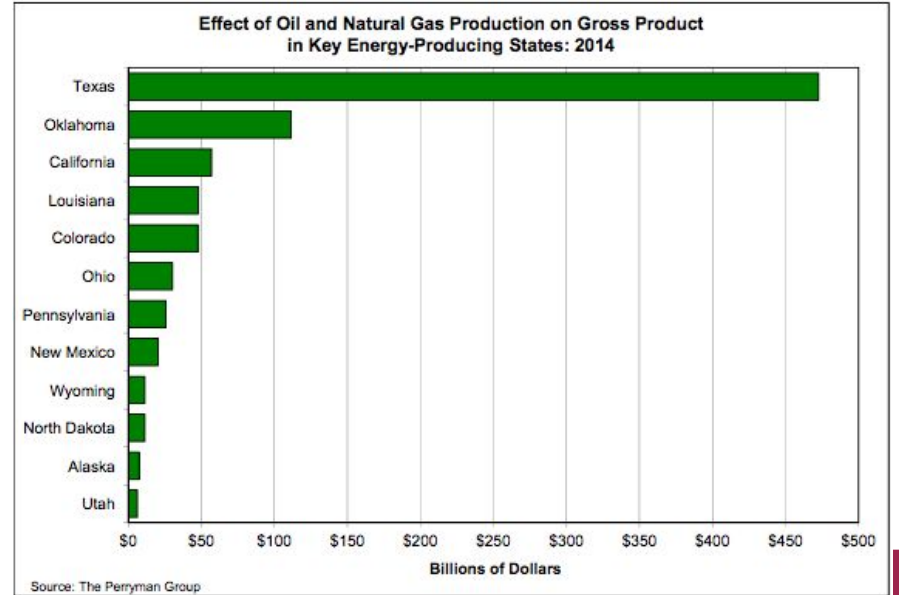
Source: The Perryman Group

# Continued

Effect of Oil and Natural Gas Production on Employment  
in Key Energy-Producing States: 2014



Effect of Oil and Natural Gas Production on Gross Product  
in Key Energy-Producing States: 2014



# Conclusion

Fossil fuels are overall a reliable and somewhat efficient source of energy and have been used for centuries. Although they have proved their place in the energy division, the pollution contribution is drastic, the resources are finite and the efficiency is inferior to many renewable sources.



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