



**All my  
friends  
are dead.**

Avery Monsen and Jory John

# FOSSIL FUELS

By Scientist Cindy for [www.scientistcindy.com](http://www.scientistcindy.com)





## OIL SPILLS

In April 2010, over 4 million barrels of crude oil spilled into the Gulf of Mexico from the Deepwater Horizon oil-drilling platform. An underwater pipeline exploded killing 11 workers. Crude oil contaminated the ocean floor and the coast of the southern United States, killing wildlife and causing extensive ecological damage.





- Extracting mineral and fossil-fuel resources has always had widespread effects. These include economic benefits to communities, including jobs and taxes, and the resulting resources are used around the world. Extraction can also cause major health and environmental impacts to individuals and communities, many of whom do not share in the benefits.



# OBJECTIVES

## OBJECTIVES

- Define fossil fuel and distinguish among coal, oil, and natural gas.
- Describe the processes that formed coal, oil, and natural gas.
- Relate fossil fuels to the carbon cycle.



# WHAT ARE FOSSIL FUELS?

Definition of fossil fuels-

- Combustible deposits in Earth's crust, that are from the decayed matter of prehistoric organisms that existed millions of years ago.



# WHAT ARE FOSSIL FUELS?

The 3 types of Fossil Fuels Are:

1. Coal
2. Oil (petroleum)
3. Natural gas

<https://www.youtube.com/watch?v=jakJ-Tf79ac>

<https://www.youtube.com/watch?v=k1JGGjAm42c>



# WHAT IS COAL?

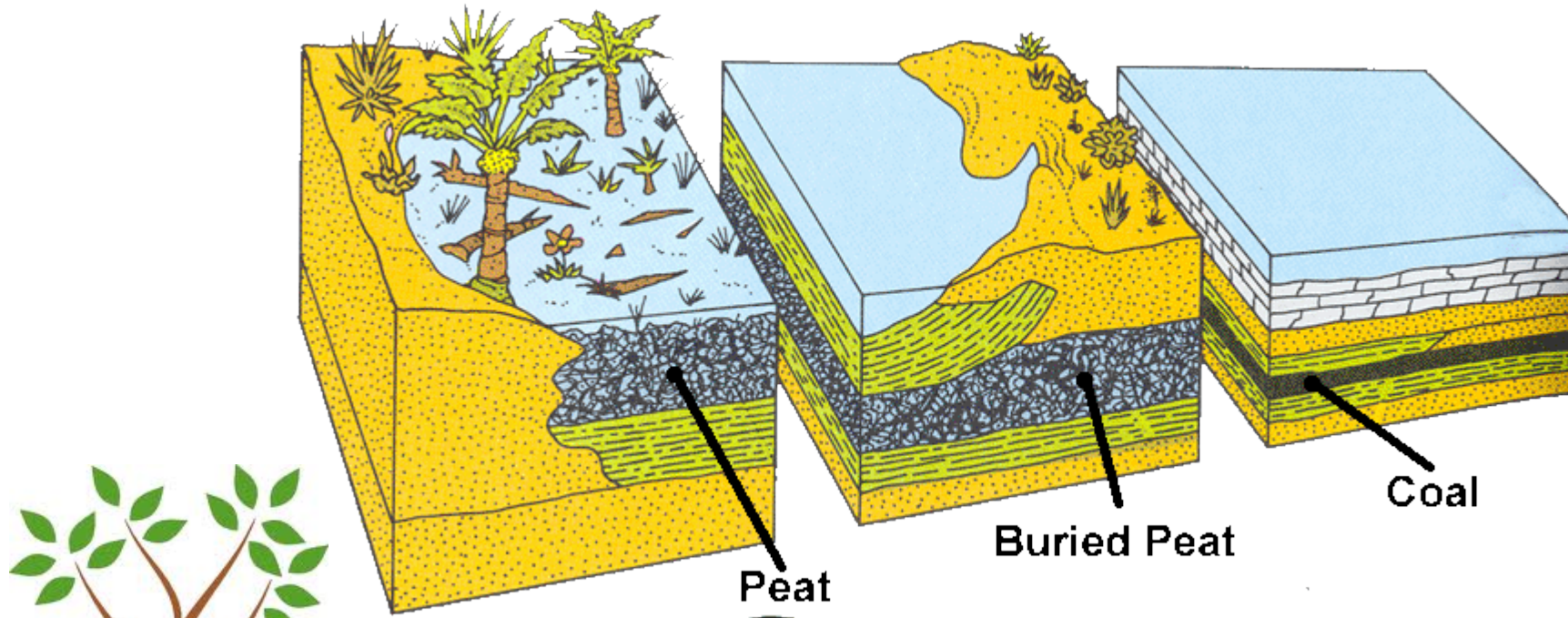
- Coal forms from prehistoric plants that lived three-hundred million years ago (300,000,000mya).
- When plants die, the matter is converted into peat, which in turn is converted into lignite, then sub-bituminous coal, after that bituminous coal, and lastly anthracite.
- This involves biological and geological processes that take place over time.



By  
[http://resourcescommittee.house.gov/subcommittees/emr/usgsweb/photogallery/images/Coal,%20anthracite\\_jpg](http://resourcescommittee.house.gov/subcommittees/emr/usgsweb/photogallery/images/Coal,%20anthracite_jpg), Public Domain,  
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# WHAT IS COAL?



1,000s of years



1,000s of years



1,000s of years



1,000s of years



**PREHISTORIC PLANTS**  
300,000,000 mya  
(Three-hundred million years ago)

Decayed plant matter that gets extremely compressed for thousands of years, forms **PEAT**

If **Peat** is extremely compressed for thousands of years, it forms **LIGNITE**.

If **Lignite** is extremely compressed for thousands of years, it forms **BITUMINOUS COAL**

If **Bituminous coal** is extremely compressed for thousands of years, it forms **ANTHRACITE**.

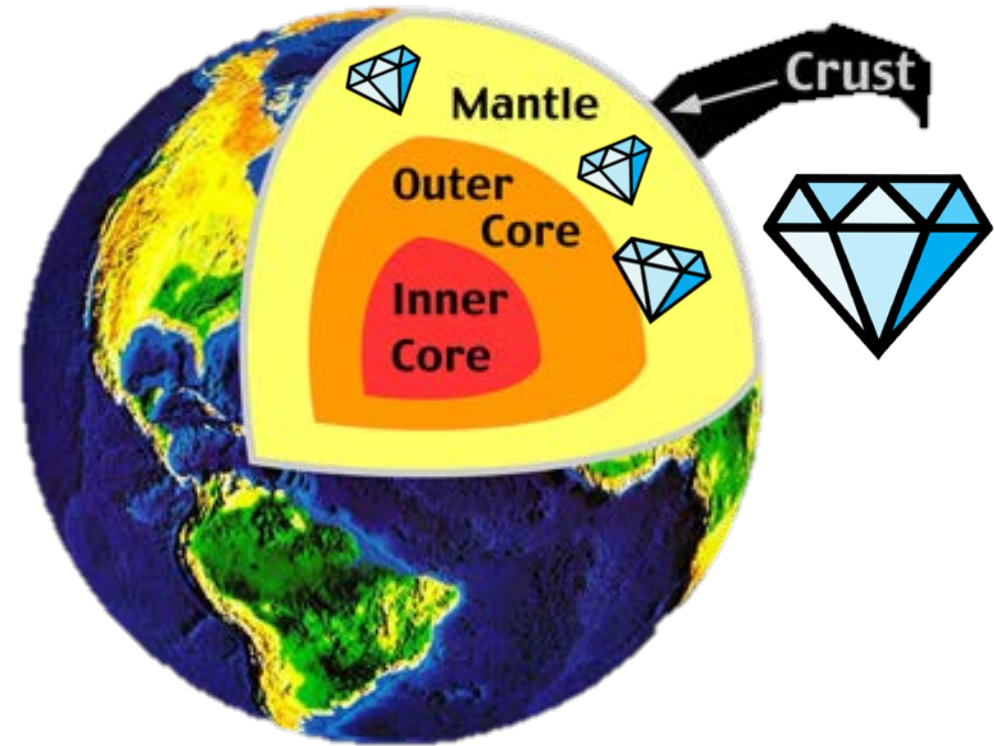
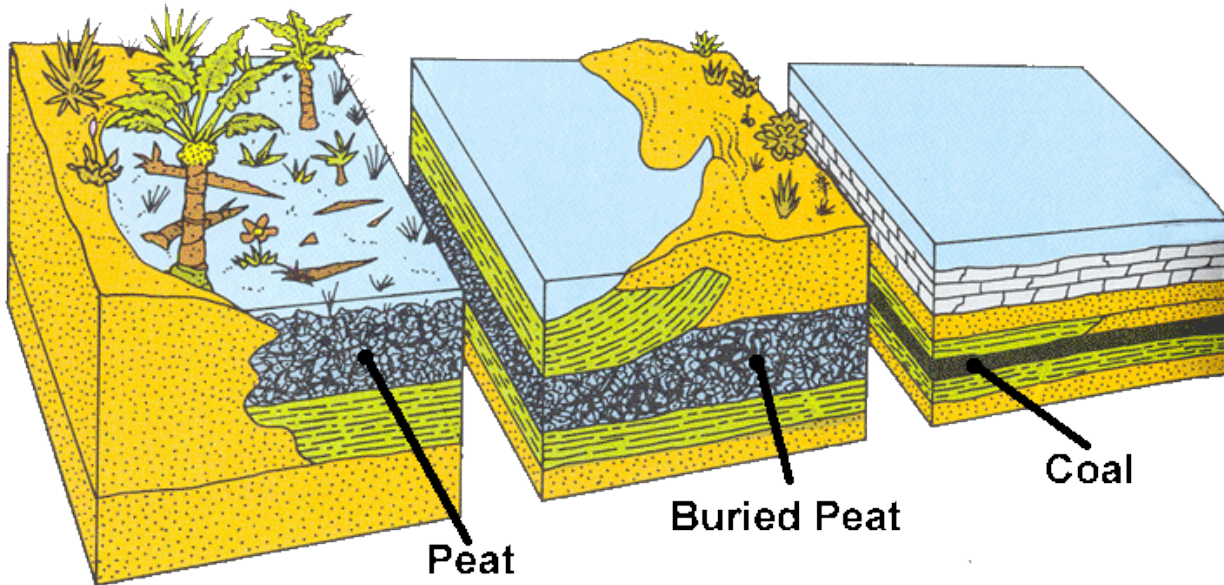




# DIAMONDS ARE NOT MADE FROM COAL!

**FUN FACT!**

- Diamonds are made in the Earth's Mantle in a time before plants or animals existed!
- Coal is made in the Earth's Crust from prehistoric plants!



# FUN FACT! DIAMONDS ARE NOT MADE FROM COAL!

The formation of natural diamonds requires very high temperatures and pressures. These conditions occur in limited zones of Earth's **mantle** about 90 miles below the surface where temperatures are at least 2000 degrees Fahrenheit.



Most diamonds are much older than Earth's first land plants - the source material of coal!



Geoscience News and Information  
**Geology.com**



# COAL FIRES

[https://www.youtube.com/watch?v=ZjtmaCI9\\_wM](https://www.youtube.com/watch?v=ZjtmaCI9_wM)

<https://www.youtube.com/watch?v=fvoCzunex3I>

<https://www.youtube.com/watch?v=GI2wkwYIU8c>



# OIL

- Fossil fuels are nonrenewable resources— Earth's crust has a finite, or limited, supply of them, and that supply is depleted by use. Although natural processes are still forming fossil fuels, they are forming far too slowly (on a scale of millions of years) to replace the fossil-fuel reserves we are using. Fossil-fuel formation does not keep pace with use, and as fossil fuels are used up, we will have to switch to other forms of energy.



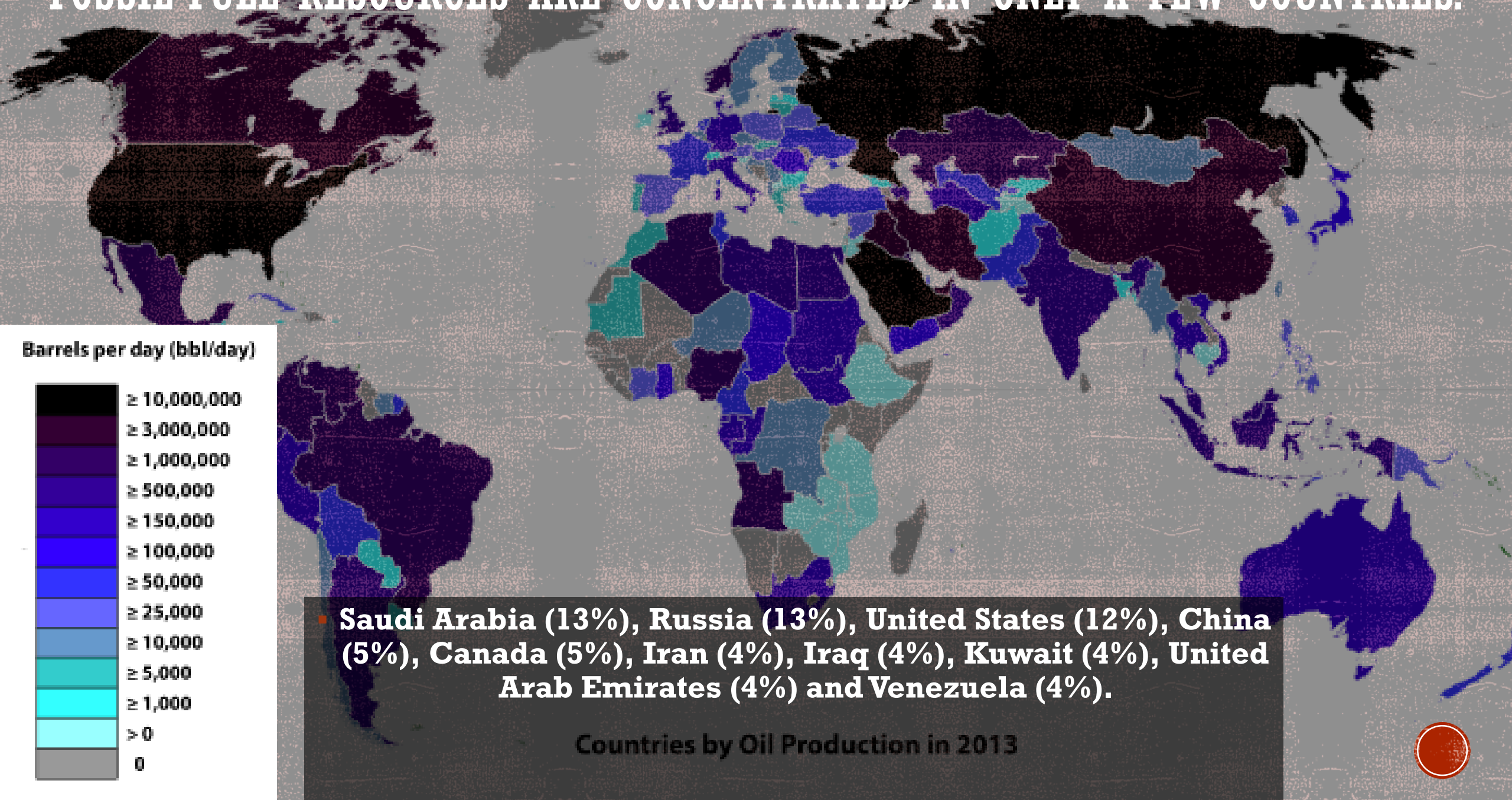
# WHY CAN'T WE JUST "MAKE MORE"?

- Although natural processes are still forming fossil fuels, they are forming far too slowly (on a scale of millions of years) to replace the fossil-fuel reserves we are using. Fossil-fuel formation does not keep pace with use, and as fossil fuels are used up, we will have to switch to other forms of energy.

It takes  
time!



# FOSSIL-FUEL RESOURCES ARE CONCENTRATED IN ONLY A FEW COUNTRIES.



• **Saudi Arabia (13%), Russia (13%), United States (12%), China (5%), Canada (5%), Iran (4%), Iraq (4%), Kuwait (4%), United Arab Emirates (4%) and Venezuela (4%).**

Countries by Oil Production in 2013



# WHERE DO FOSSIL FUELS COME FROM?

- *THE BETTER QUESTION TO START WITH IS WHEN DO FOSSIL FUELS COME FROM!*

- The Carboniferous Era

- Three hundred million years ago, the climate of much of Earth was mild and warm, and atmospheric carbon dioxide levels were higher. Vast swamps were filled with plant species that have long since become extinct. Many of these plants—horsetails, ferns, and club mosses—were as large as trees



# THE CARBONIFEROUS ERA

- The Carboniferous Era spanned from 359 million to 299 million years ago.
- Tropical swamps dominated the Earth, and the lignin stiffened trees grew to greater heights and number.
- As the bacteria and fungi capable of eating the lignin had not yet evolved, their remains were left buried, which created much of the carbon that became the coal deposits of today (hence the name "Carboniferous").





# THE CARBONIFEROUS ERA

- Perhaps the most important evolutionary development of the time was the evolution of amniotic eggs, which allowed amphibians to move farther inland and remain the dominant vertebrates for the duration of this period.
- Also, the first reptiles and synapsids evolved in the swamps.
- Throughout the Carboniferous, there was a cooling trend, which led to the Permo-Carboniferous glaciation or the Carboniferous Rainforest Collapse.
- <https://www.youtube.com/watch?v=ldSiWt624FA>



# THE RECIPE FOR FOSSIL FUELS

- Fossil fuels—coal, oil, and natural gas—supply over 80% of the energy used in North America.
- A fossil fuel is composed of the remnants of organisms, **compressed in an oxygen-free environment.**
- Fossil fuels resulted from photosynthesis that captured solar energy millions of years ago.



# NOT ALL PREHISTORIC PLANTS TURNED INTO FOSSIL FUELS

*In most environments,  
decomposers such as  
bacteria and fungi  
rapidly decompose  
plants after their death.*

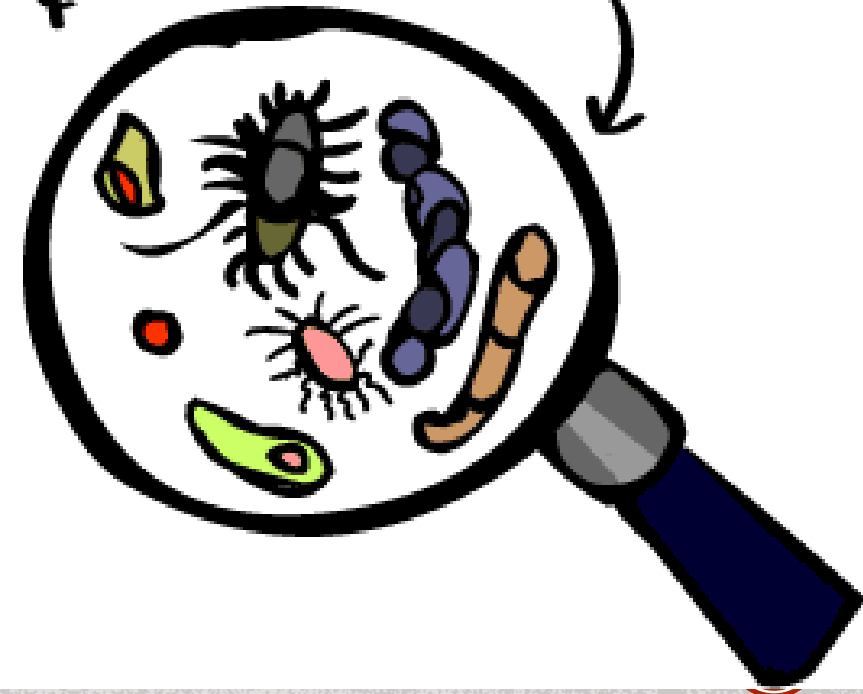


# DECOMPOSERS

They consume (eat) dead plants & animals and decomposes them - reduces them to simpler forms of matter.

## PRIMARY DECOMPOSERS

Fungi & Bacteria



# THE RECIPE FOR FOSSIL FUELS

- So, in order for a prehistoric plant to make fossil fuels, it must have been in a swamp where it was covered by water when it died.
- This would have protected the plant from decomposers



# THE RECIPE FOR FOSSIL FUELS

- Their watery grave prevented the plants from decomposing much;
- wood-rotting fungi cannot act on plant material where oxygen is absent,
- anaerobic bacteria, which thrive in oxygen-deficient environments, do not decompose wood rapidly.
- Over time, more and more dead plants piled up.
- As a result of periodic changes in sea level, sediment (mineral particles deposited by gravity) accumulated, forming layers that covered the plant material.
- Aeons passed, and the heat and pressure that accompanied burial converted the nondecomposed plant material into a carbon-rich rock called coal and converted the layers of sediment into sedimentary rock. Much later, geologic upheavals raised these layers so that they were nearer Earth's surface.



# WHAT IS COAL?

- **COAL –**

- **A black, combustible solid composed mainly of carbon, water, and trace elements found in Earth's crust; formed from ancient plants that lived millions of years ago.**



# WHAT IS OIL?

- OIL

- A thick, yellow to black, flammable liquid hydrocarbon mixture found in Earth's crust; formed from the remains of ancient microscopic aquatic organisms (mostly diatoms).



# WHAT IS NATURAL GAS?

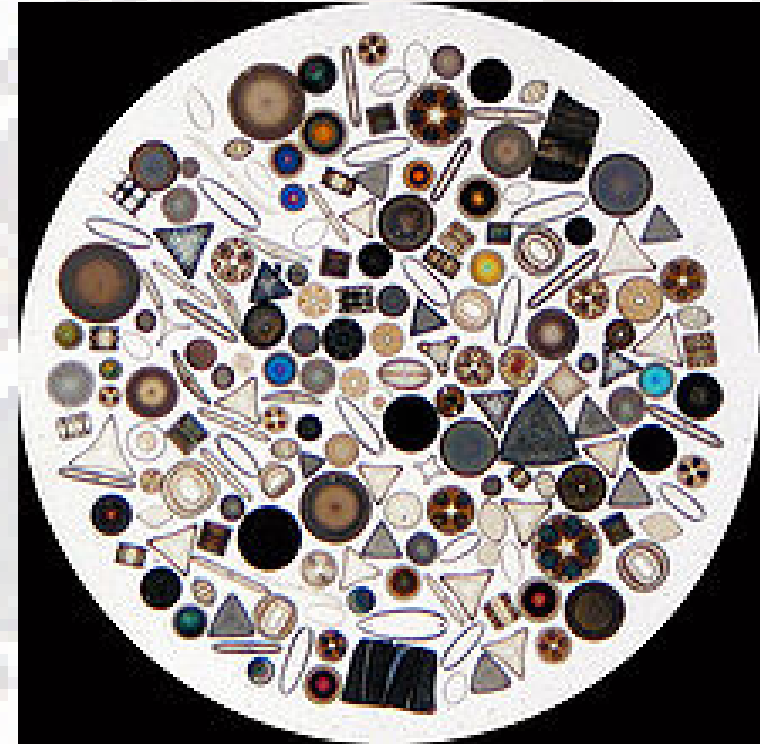
- natural gas
  - - mixture of energy-rich gaseous hydrocarbons (primarily methane) that occurs, often with oil deposits, in Earth's crust.





# OIL

- Oil is another fossil fuel formed more than 300 million years ago from tiny aquatic creatures, mostly diatoms.
- Diatoms are sea creatures the size of a pin head.
- They do one thing just like plants; they can convert sunlight directly into stored energy.
- Diatoms are a major group of algae, and are among the most common types of phytoplankton.
- Diatoms are unicellular, although they can form colonies in the shape of filaments or ribbons, fans, zigzags, or stars.

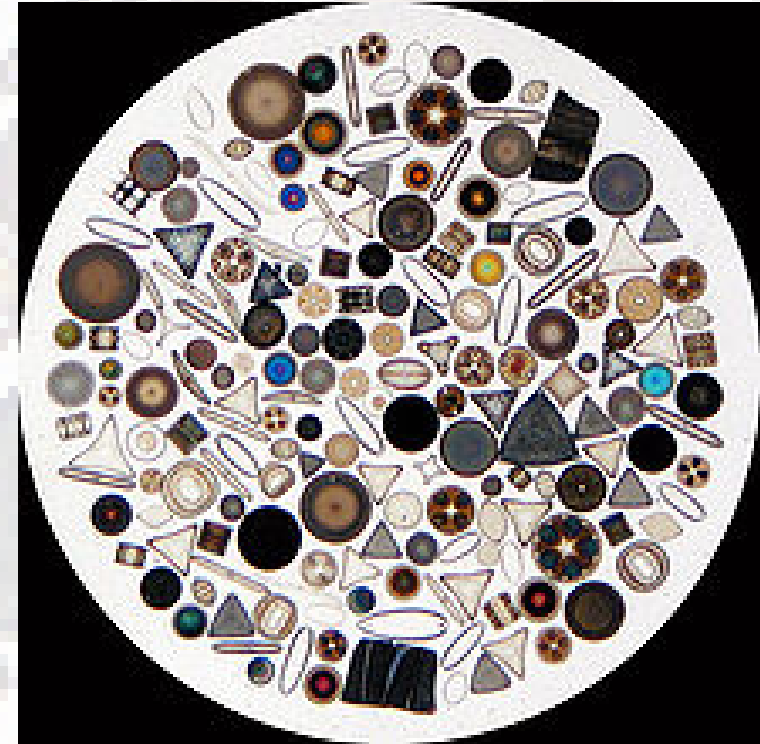


**Diatoms**



# OIL

- Oil formed when large numbers of microscopic aquatic organisms died and settled in the sediments.
- As these organisms accumulated, their decomposition depleted the small amount of oxygen present in the sediments.
- The resultant **oxygen-deficient** environment prevented further decomposition.
- Over time, the dead remains were covered and buried deeper in the sediments.
- Although we do not know the basic chemical reactions that produce oil, the heat and pressure caused by burial presumably aided in the conversion of these remains to the mixture of hydrocarbons (molecules containing carbon and hydrogen) known as oil.

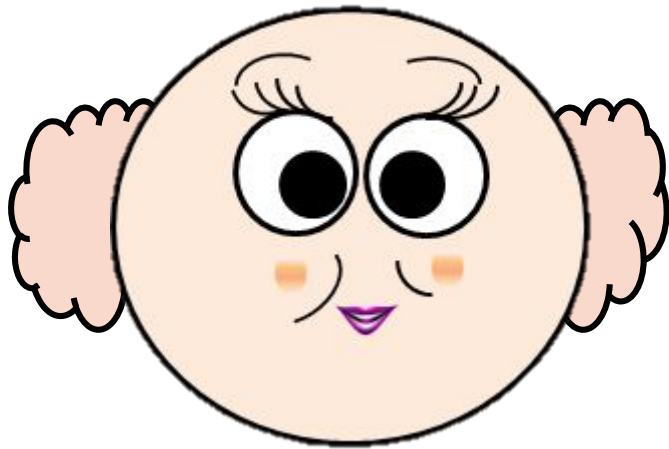


**Diatoms**

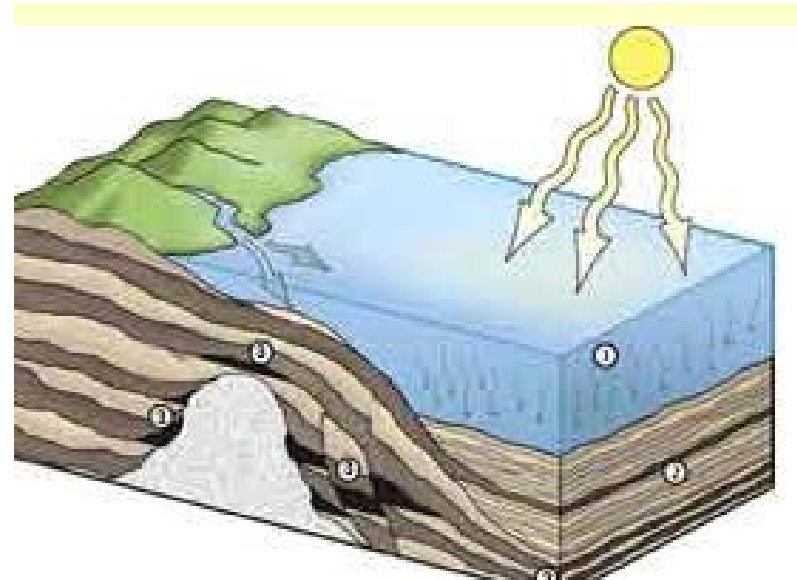


# THE RECIPE FOR OIL

- Diatoms died they fell to the sea floor (1). Here they were buried under sediment and other rock (2). The rock squeezed the diatoms and the energy in their bodies could not escape. The carbon eventually turned into oil under great pressure and heat. As the earth changed and moved and folded, pockets where oil and natural gas can be found were formed (3).



**Diatom**



# ***ANCIENT OIL & GAS***

- The first evidence for oil product usage was from a *very* long time ago – natural bitumen has been found on stone tools from Neanderthal sites in Syria dating from ~40,000 years ago.
- Oil has been used for more than 5,000-6,000 years.
- The ancient Egyptians, used liquid oil as a medicine for wounds
- Oil has been used in lamps to provide light.
- Used as a building material
- Used for water-proofing
- Used in embalming

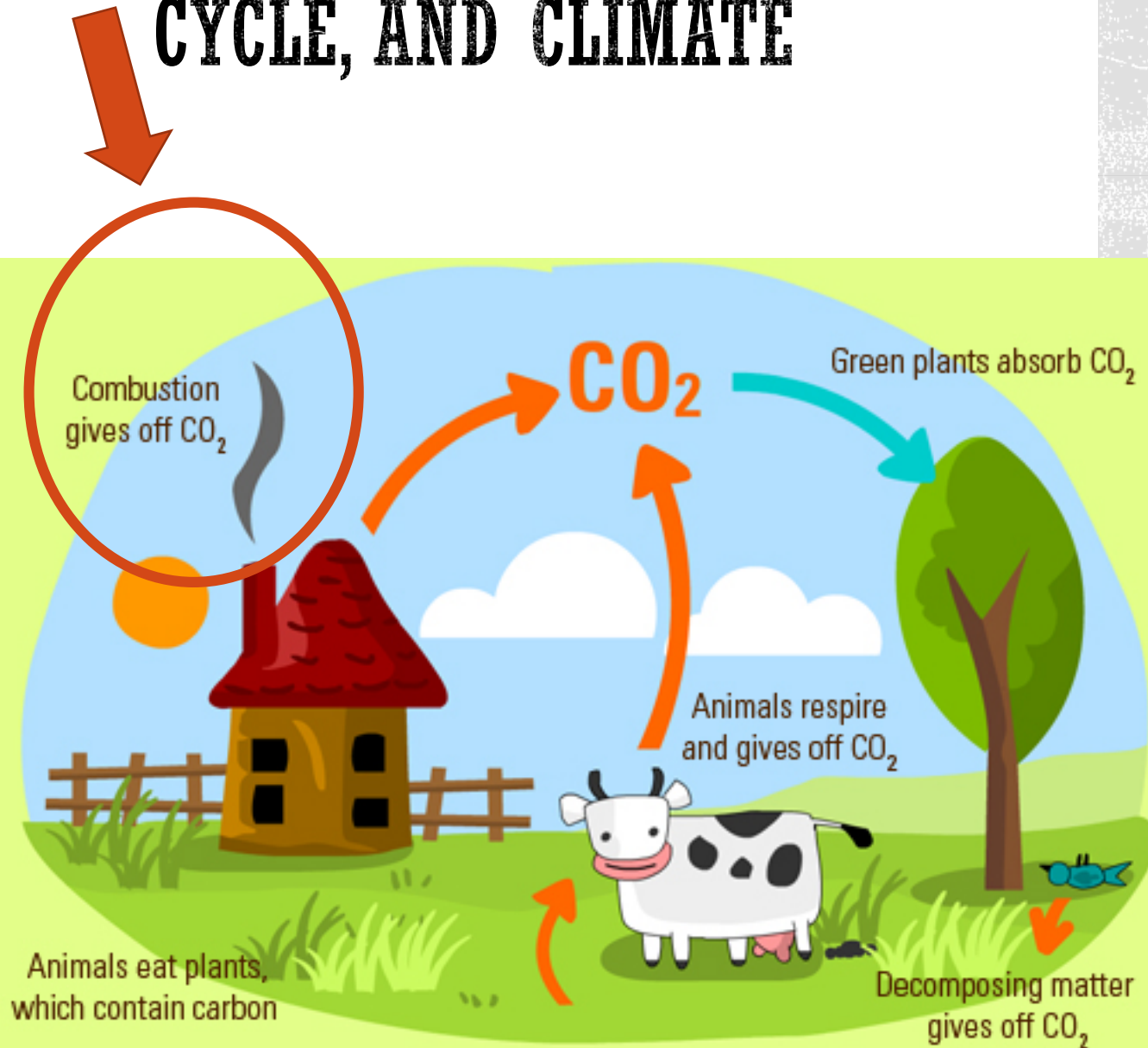


# WHAT IS NATURAL GAS?

- Natural gas is a mixture of energy-rich gaseous hydrocarbons (primarily methane) that occurs, often with oil deposits, in Earth's crust.
- It composed primarily of the simplest hydrocarbon, methane ( $\text{CH}_4$ ) formed in essentially the same way as oil, only at higher temperatures, typically greater than  $100^\circ\text{C}$ .
- Over millions of years, as the remains of organisms were converted to oil or natural gas, the sediments covering them were transformed into sedimentary rock, including sandstone and shale.



# FOSSIL FUELS, THE CARBON CYCLE, AND CLIMATE



- Burning of fossil fuels represents the completion of the carbon cycle, part of a natural system.
- Normally, solar energy and carbon dioxide are captured through photosynthesis, stored for weeks or years, then consumed and released.
- In the case of fossil fuels, however, the energy and carbon accumulated over millions of years but are now being released in just a few hundred years.
- The carbon dioxide (CO<sub>2</sub>) concentration of the atmosphere is rapidly increasing from levels associated with a relatively cool climate to levels associated with a substantially warmer climate.

# COAL

Coal is found in different grades, largely as a result of the varying amounts of heat and pressure it was exposed to during formation. Coal exposed to high heat and pressure during its formation is drier, is more compact (and therefore harder), and has a higher heating value (that is, a higher energy density). Lignite, subbituminous coal, bituminous coal, and anthracite are the four most common grades of coal



1,000s of years



Decayed plant matter that gets extremely compressed for thousands of years, forms **PEAT**

1,000s of years



If **Peat** is extremely compressed for thousands of years, it forms **LIGNITE**.

1,000s of years



If **Lignite** is extremely compressed for thousands of years, it forms **BITUMINOUS COAL**

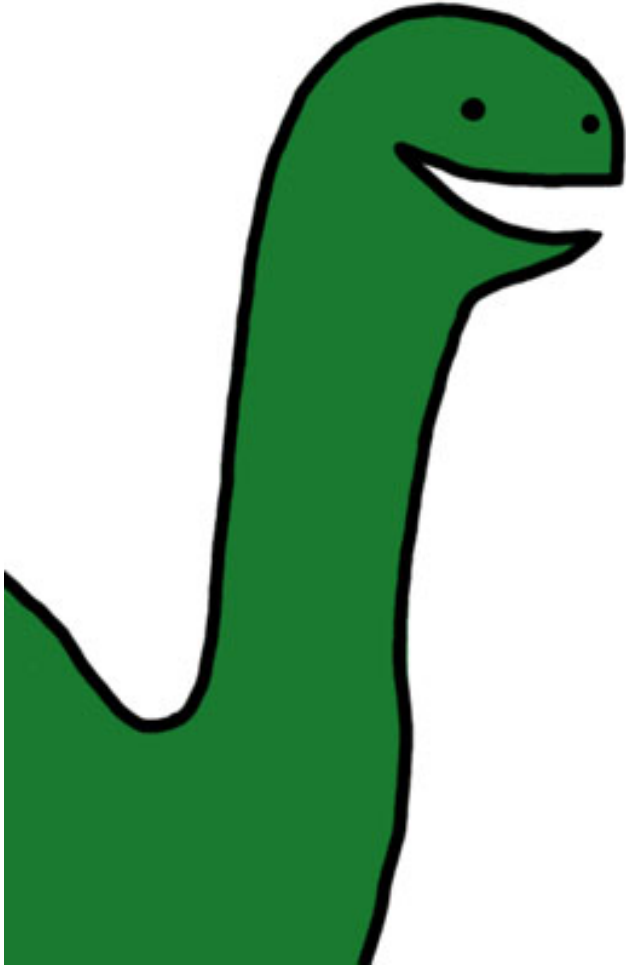
1,000s of years

If **Bituminous coal** is extremely compressed for thousands of years, it forms **ANTHRACITE**.

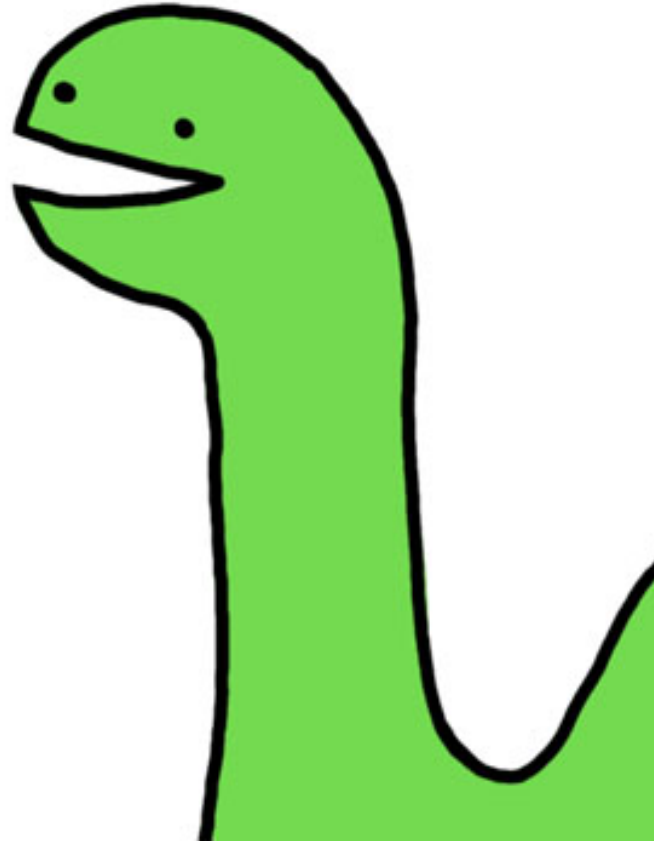
**PREHISTORIC PLANTS**  
300,000,000 mya  
(Three-hundred million years ago)



What do you want  
to be when you grow up?



A non-renewable  
resource!



## ENERGY DENSITY

- Energy density - The amount of energy contained within a given volume of an energy source.





# NATURAL GAS

- Use of natural gas is increasing in three main areas—generation of electricity, transportation, and commercial cooling.
- Natural gas as a fuel for trucks, buses, and automobiles offers significant environmental advantages over gasoline or diesel: Natural gas vehicles emit up to 93% fewer hydrocarbons, 90% less carbon monoxide, 90% fewer toxic emissions, and almost no soot.
- Engines that use natural gas are essentially the same as those that burn gasoline.
- As a fuel, natural gas can be cheaper than gasoline.





## NATURAL GAS

- The main disadvantage of natural gas is that deposits are often located far from where the energy is used.
- Because it is a gas and is less dense than a liquid, natural gas costs four times more to transport through pipelines than crude oil.
- To transport natural gas over long distances, it is first compressed to form liquefied natural gas (LNG), then carried on specially constructed refrigerated ships



# ALTERNATIVE ENERGY

- <https://www.youtube.com/watch?v=0c4xk5dB014>
- <https://www.youtube.com/watch?v=1nCWPOv3LdE>
- <https://www.youtube.com/watch?v=qMJNvQ8X5Fw>
- <https://www.youtube.com/watch?v=EnYjlsGXugo>
- <https://www.youtube.com/watch?v=0c4xk5dB014&t=45s>



# WHAT WOULD HAPPEN IF WE SUDDENLY HAD NO OIL?

- How Long Will Oil and Natural Gas Supplies Last?
- It is difficult to project when the world will run out of oil and natural gas, but by some estimates even with oil from shale deposits, the peak level of oil production may have already passed, meaning that global resources are in decline.
- In contrast, shale deposits could mean many more decades of ample, inexpensive natural gas.

