Energy Resources

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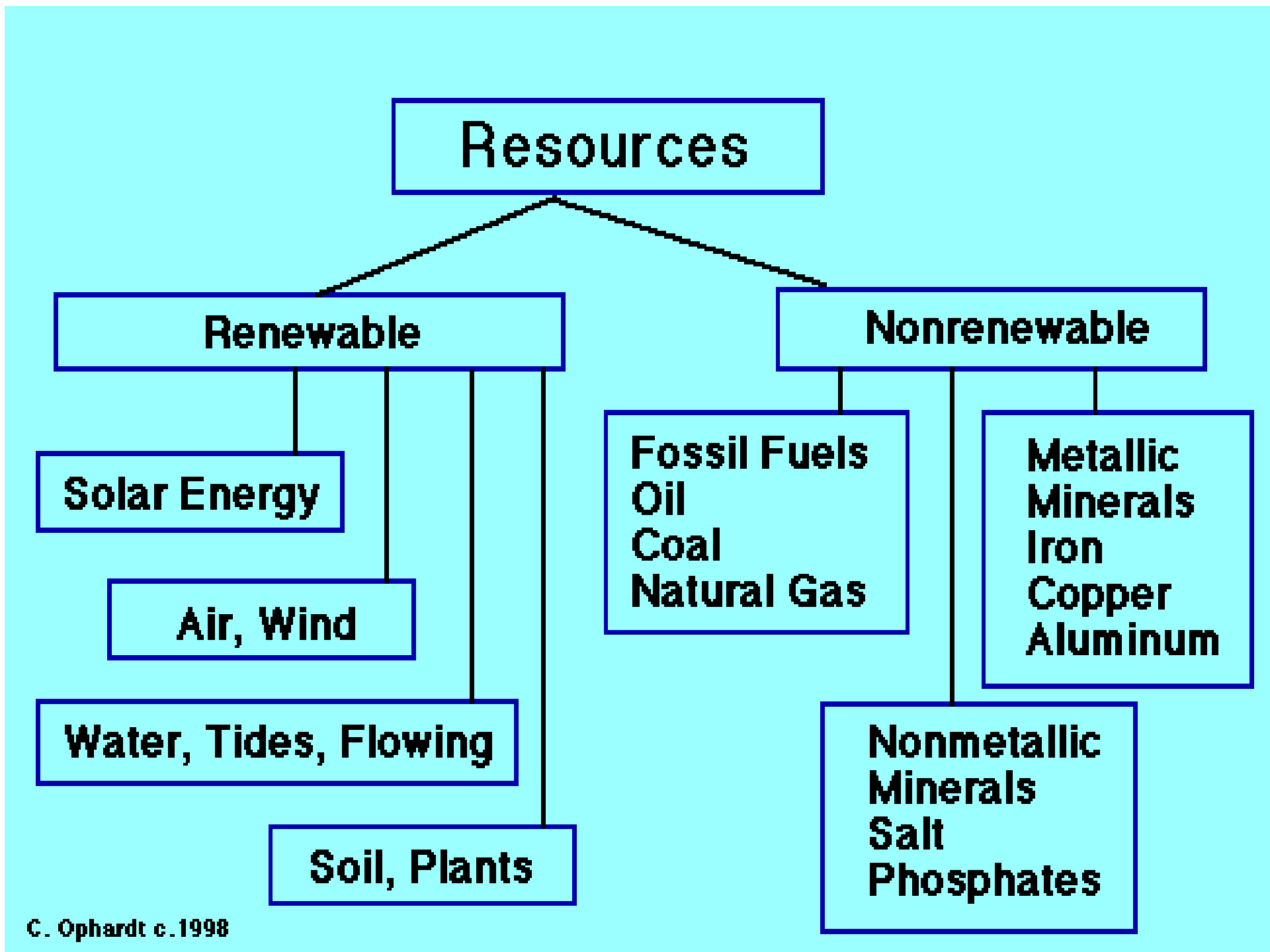
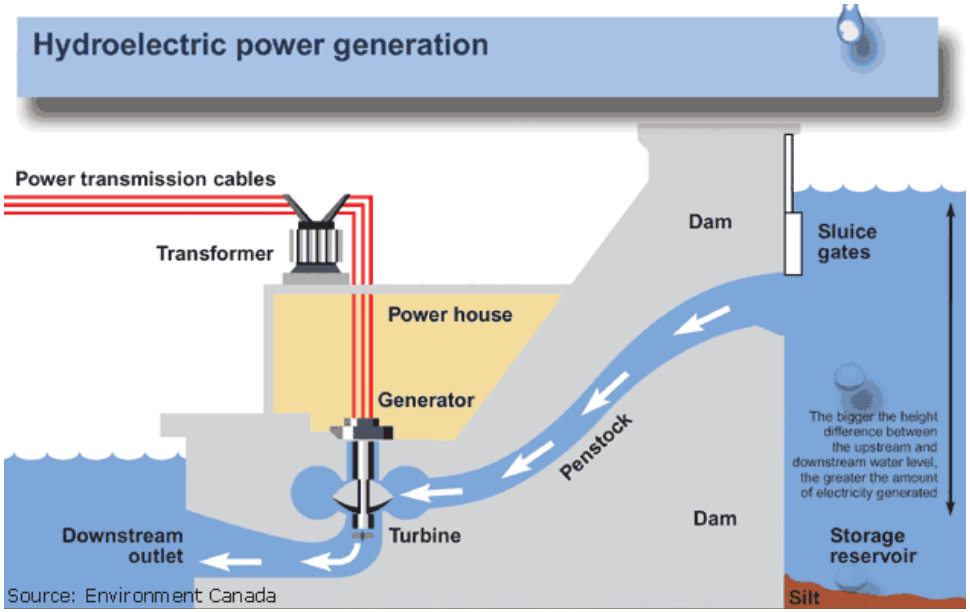
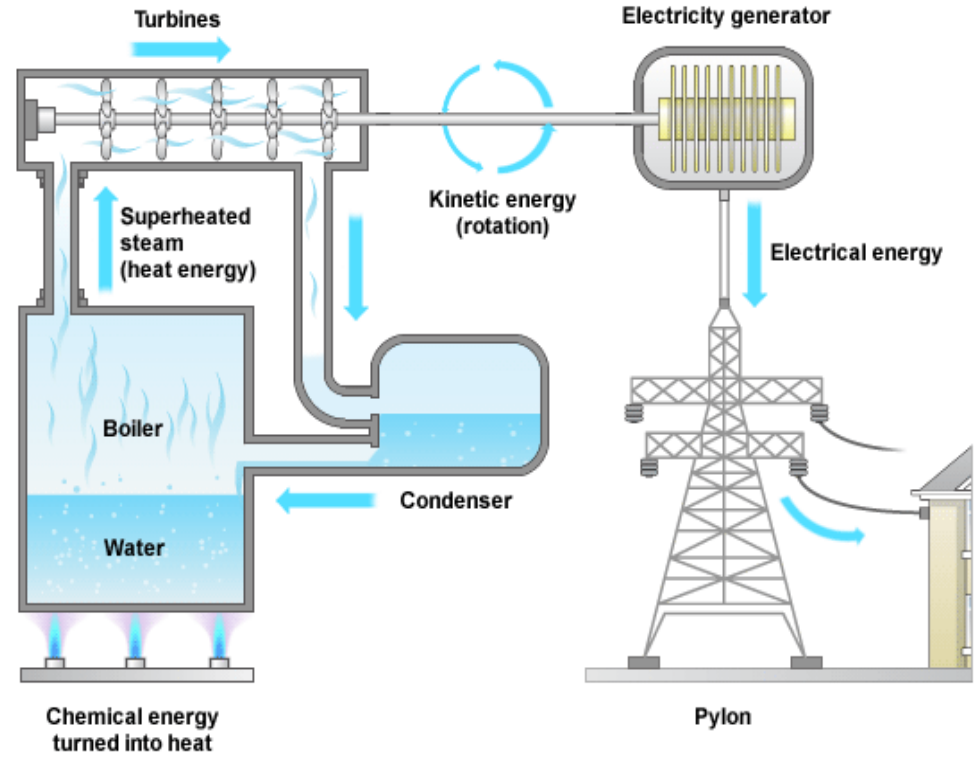

Resources
Renewable
Nonrenewable
Solar Energy
Air, Wind
Water, Tides, Flowing
Soil, Plants
Fossil Fuels
Oil
Coal
Natural Gas
Metallic
Minerals
Iron
Copper
Aluminum
Nonmetallic
Minerals
Salt
Phosphates
C. Ophardt c.1998

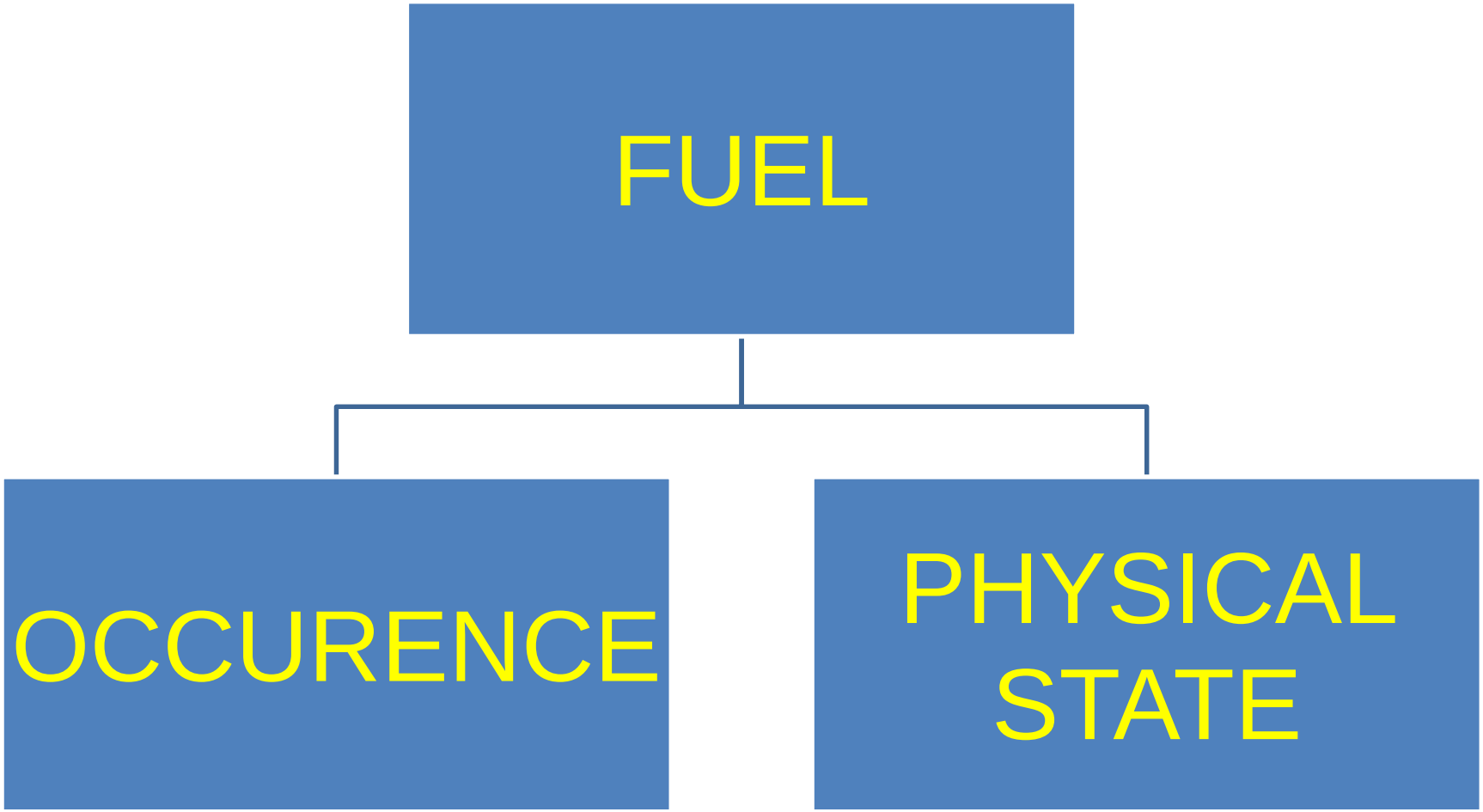
Background

- Energy
  - A Key to all Luxuries
- Different Forms
  - Finished
    - Electrical
  - Moderate
    - Mechanical
  - Raw
    - Chemical
  - Fuels

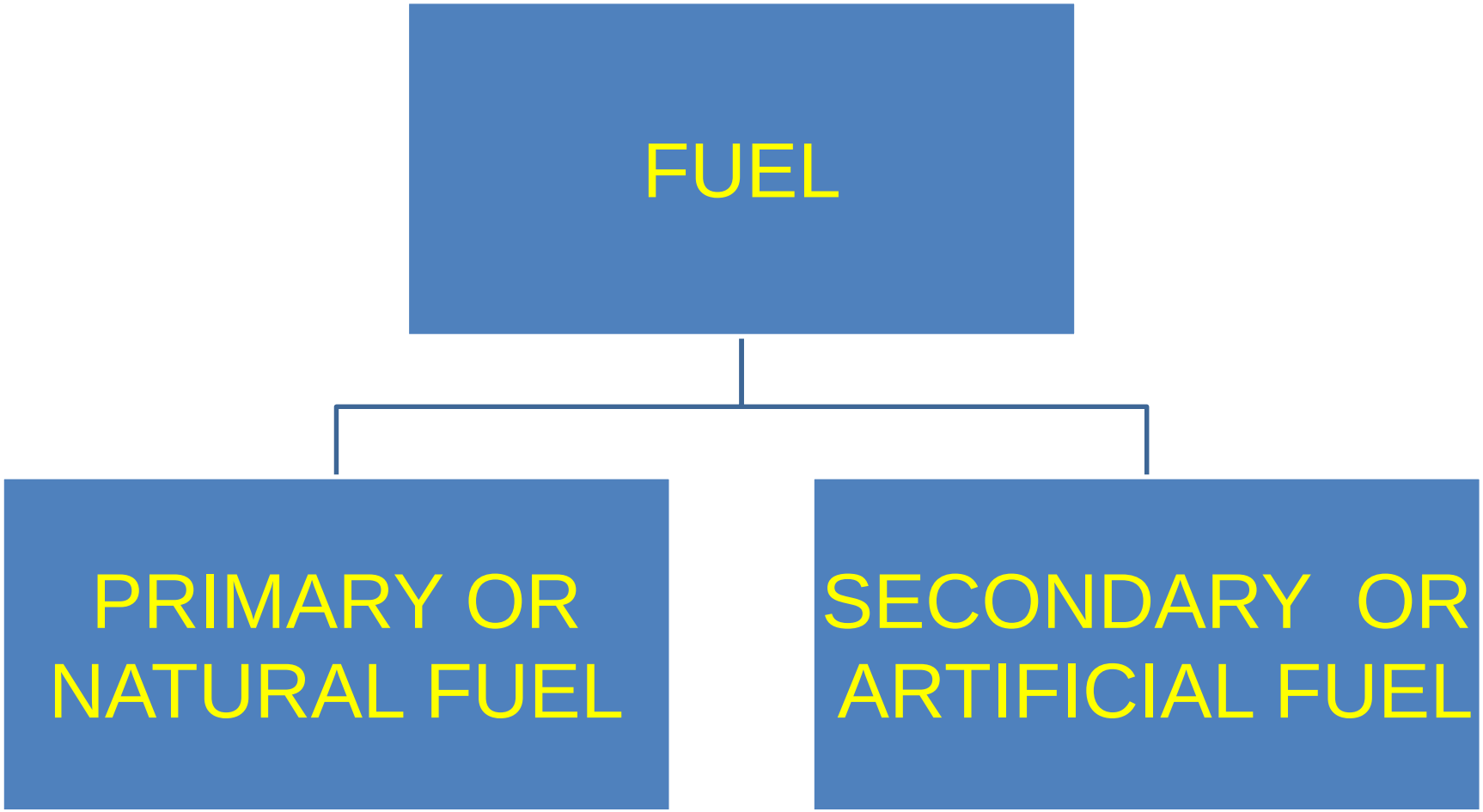




CLASSIFICATION OF FUEL



On the basis of occurrence

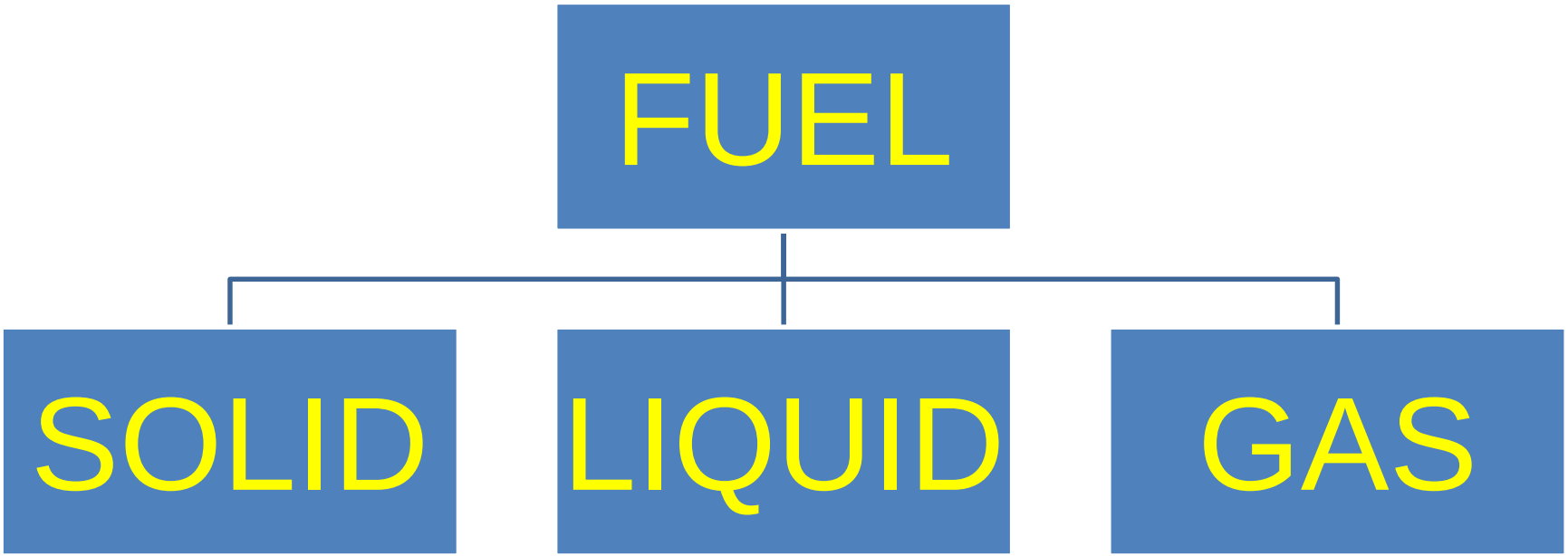


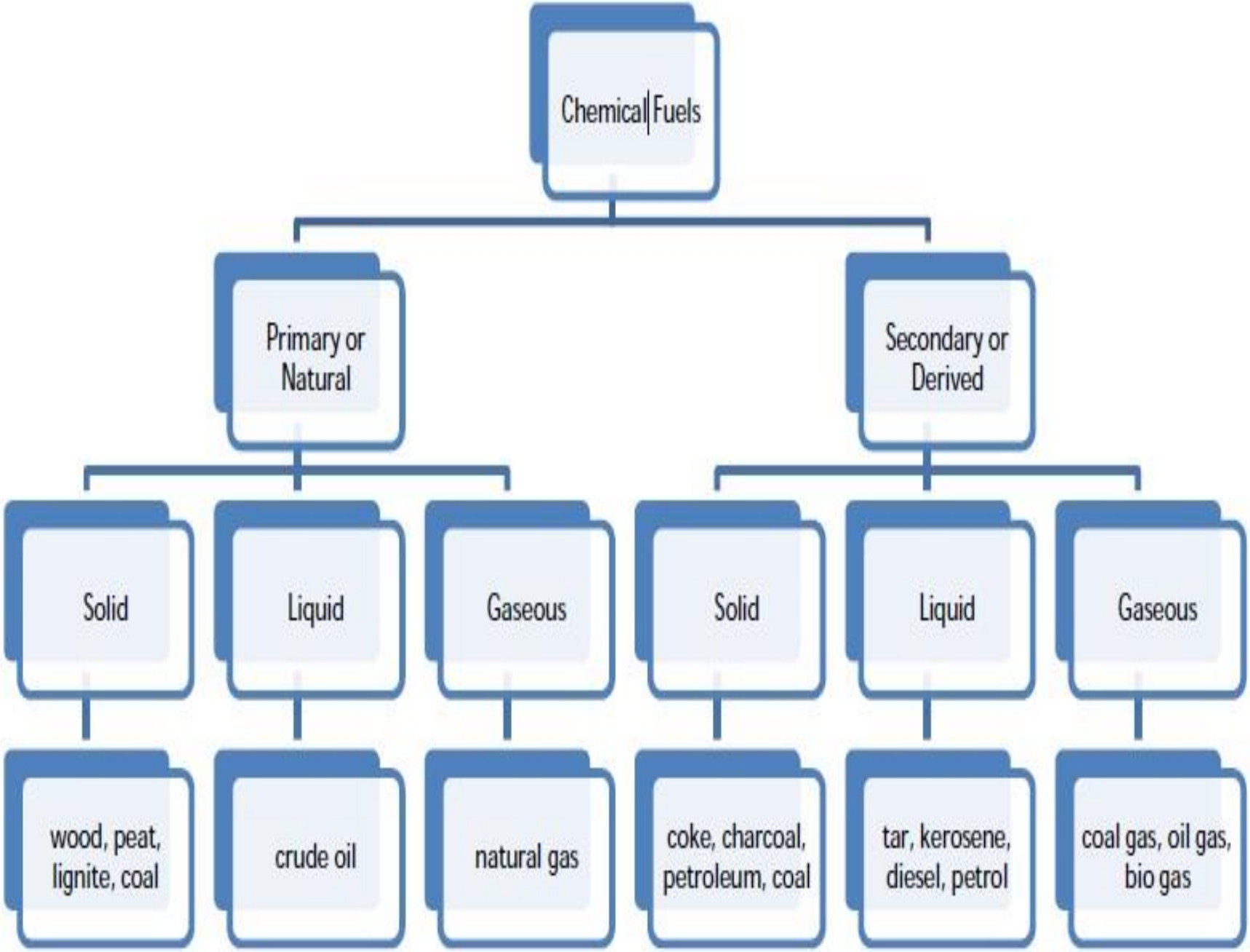
CLASSIFICATION OF FUEL

Fuels are classified as

- **Primary fuels** – Fuels which occur naturally such as coal, crude petroleum and natural gas. Coal and crude petroleum, formed from organic matter many millions of years ago, are referred to as fossil fuels.
- **Secondary fuels** – Fuels which are derived from naturally occurring ones by a treatment process such as coke, gasoline, coal gas etc.

On basis of physical state




Chemical Fuels
Primary or Natural
Secondary or Derived
Solid
Liquid
Gaseous
Solid
Liquid
Gaseous
wood, peat, lignite, coal
crude oil
natural gas
coke, charcoal, petroleum, coal
tar, kerosene, diesel, petrol
coal gas, oil gas, bio gas

What are fossil fuels?

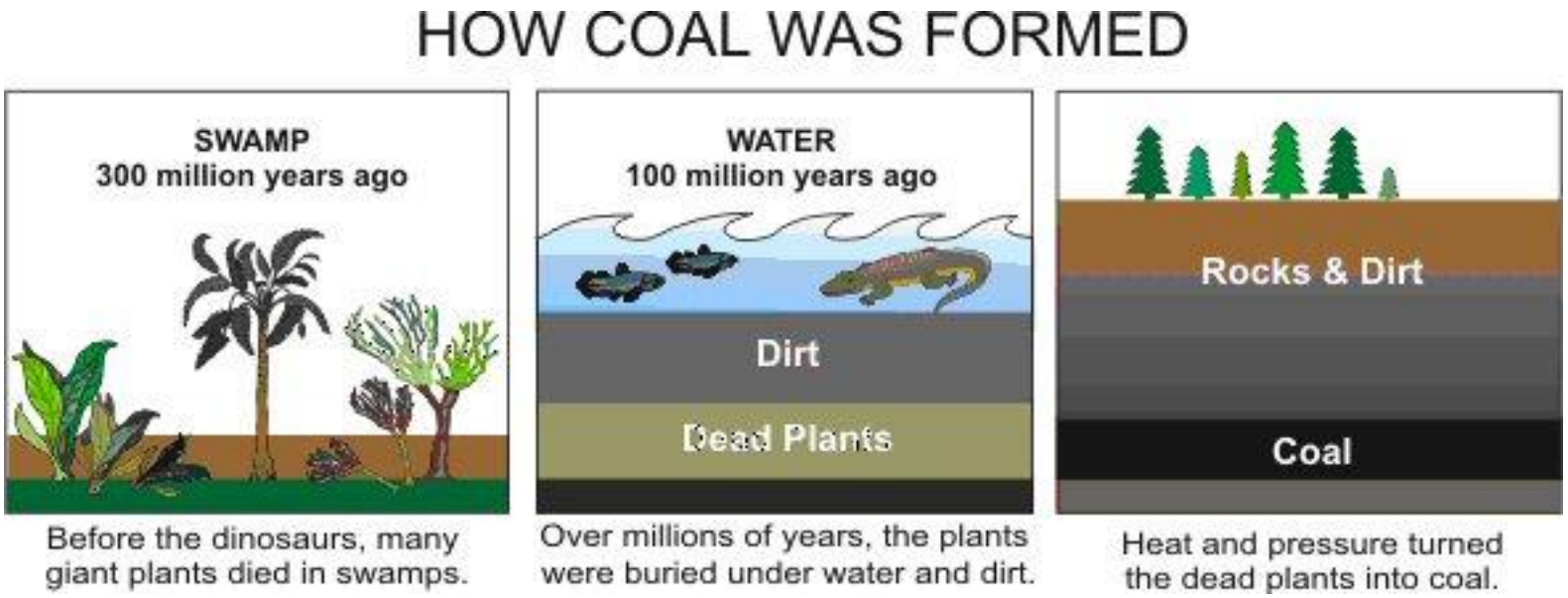
Solid = _____

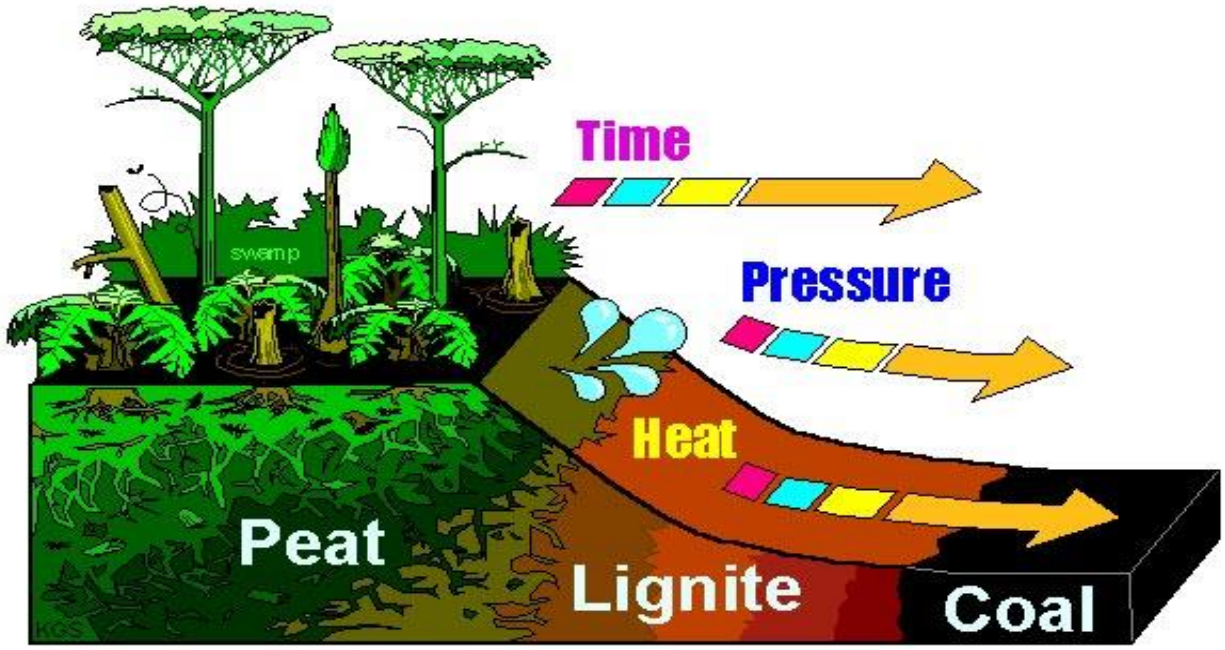
Liquid = _____

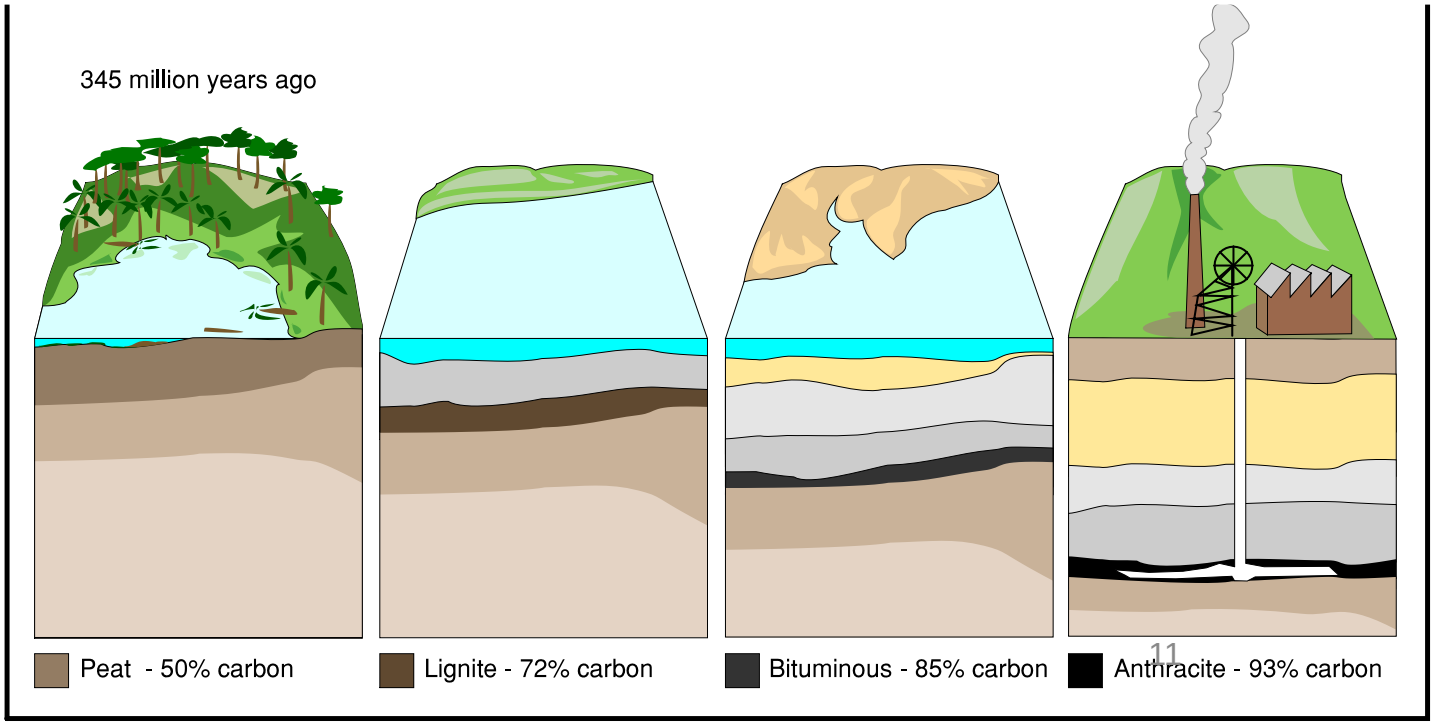
Gas = _____

Fossil fuels took millions of years to form. Once they are used, we cannot replace them. Therefore, we call them _____ _____ _____.

Most coal was formed from plants which grew 300 million years ago. The time period is called CARBONIFEROUS ERA

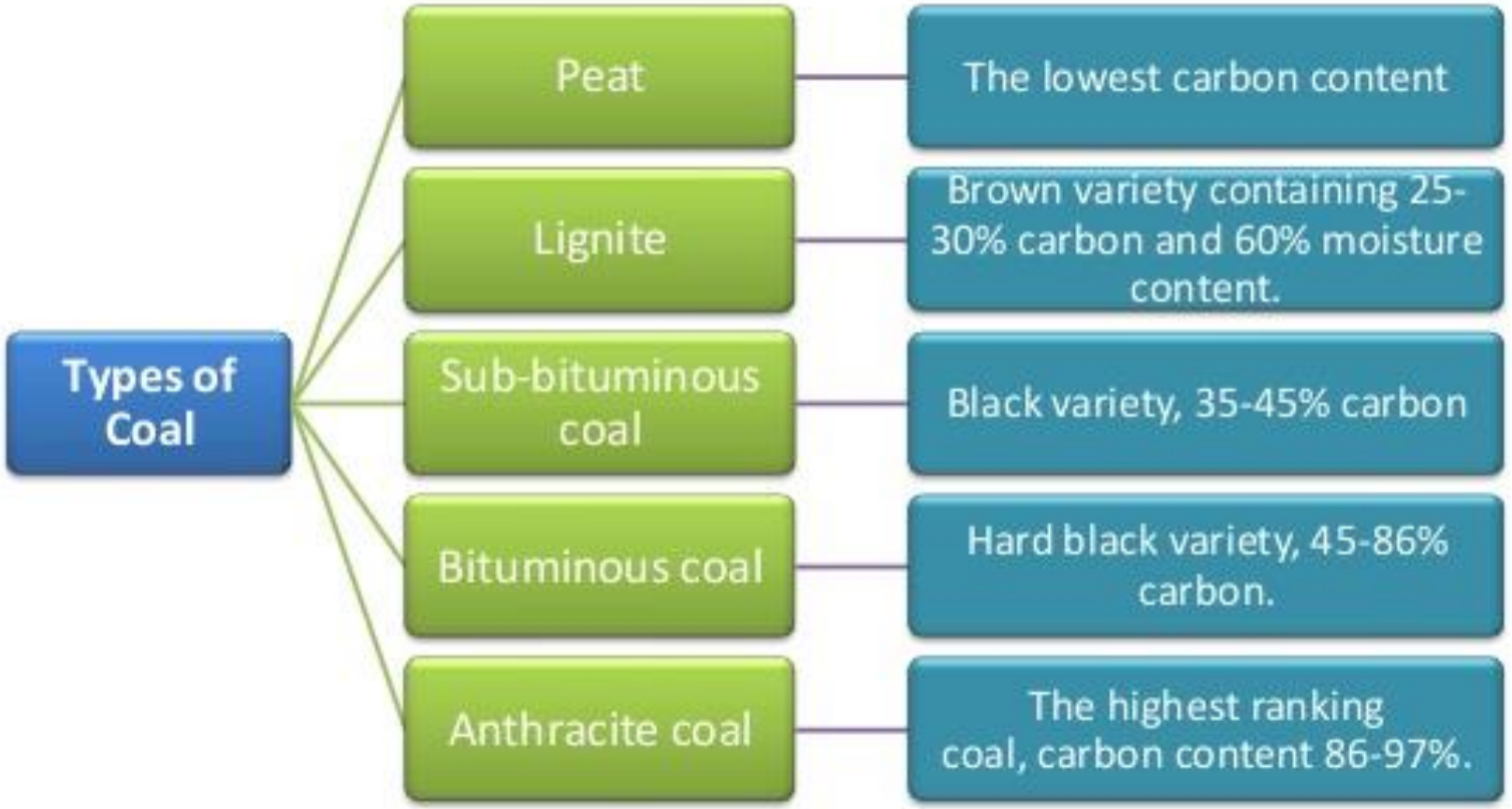



swamp
Time
Pressure
Heat
Peat
Lignite
Coal


345 million years ago
Peat - 50% carbon
Lignite - 72% carbon
Bituminous - 85% carbon
Anthracite - 93% carbon

Solid Fuels – Coal

Formed from dead plants buried for several million years.



Anthracite > Bituminous > Sub-bituminous > Lignite > Peat

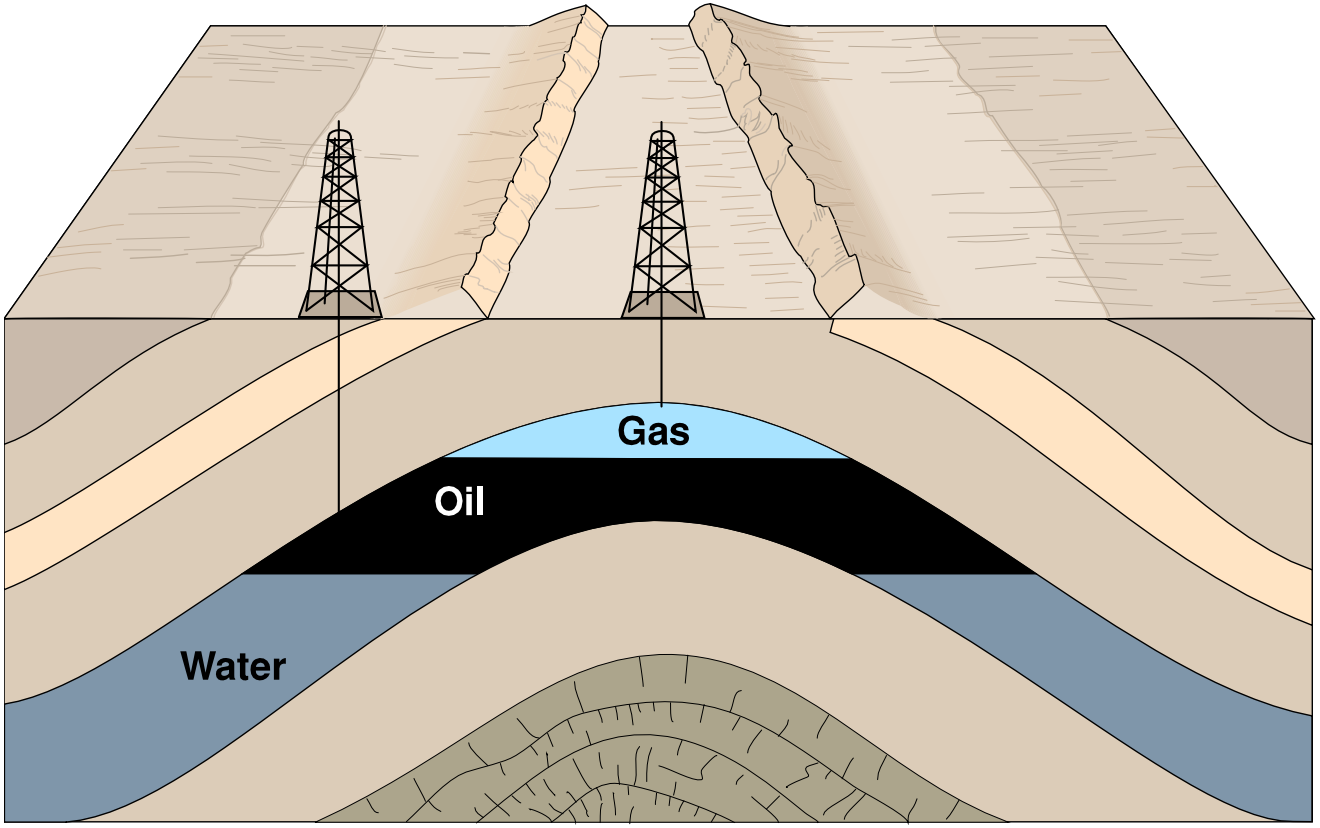
Engineering Chemistry (revised edition)
ISBN: 978-81-265-4475-2

How oil and gas were formed

1. In the ocean - Plants use sun's energy to survive and animals get their energy by eating plants
2. Plants and animals in ocean die. The one's that are not eaten fall to the bottom of the sea.
3. A few millions of years later - layers of mud forms on top of the dead animals and plants
4. Another few millions of years later - layers of sand builds up on top of the mud
5. Pressure of all these layers of mud and sand squashes and turns in to mud stone
6. Pressure of all these layers of mud and sand squashes and turns plants and animals to oil and natural gas
7. Now, scientist burn oil and gas in power stations but this releases harmful gases

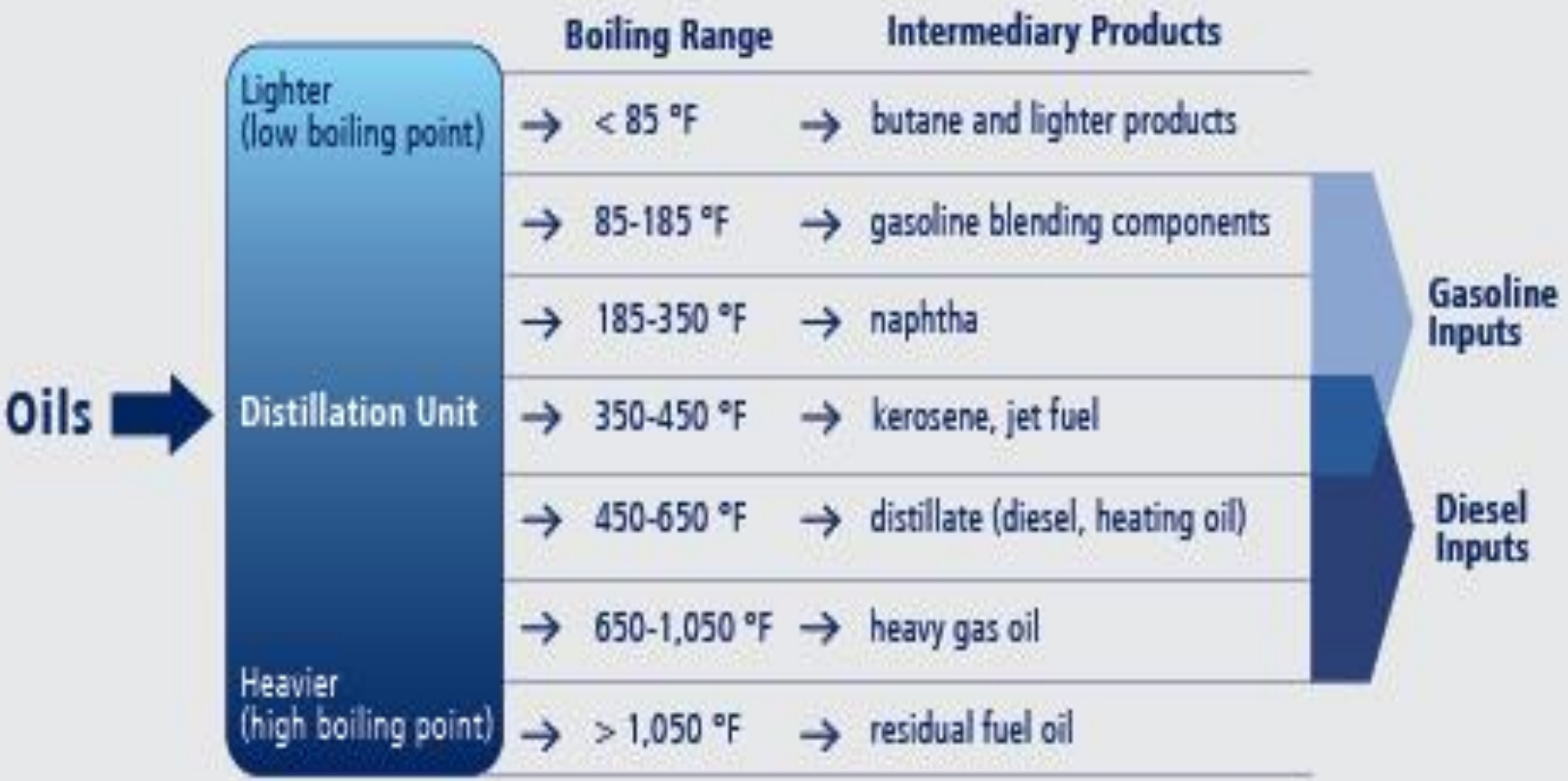
OIL and NATURAL GAS (Methane)

Made from the decayed remains of sea creatures which died millions of years ago

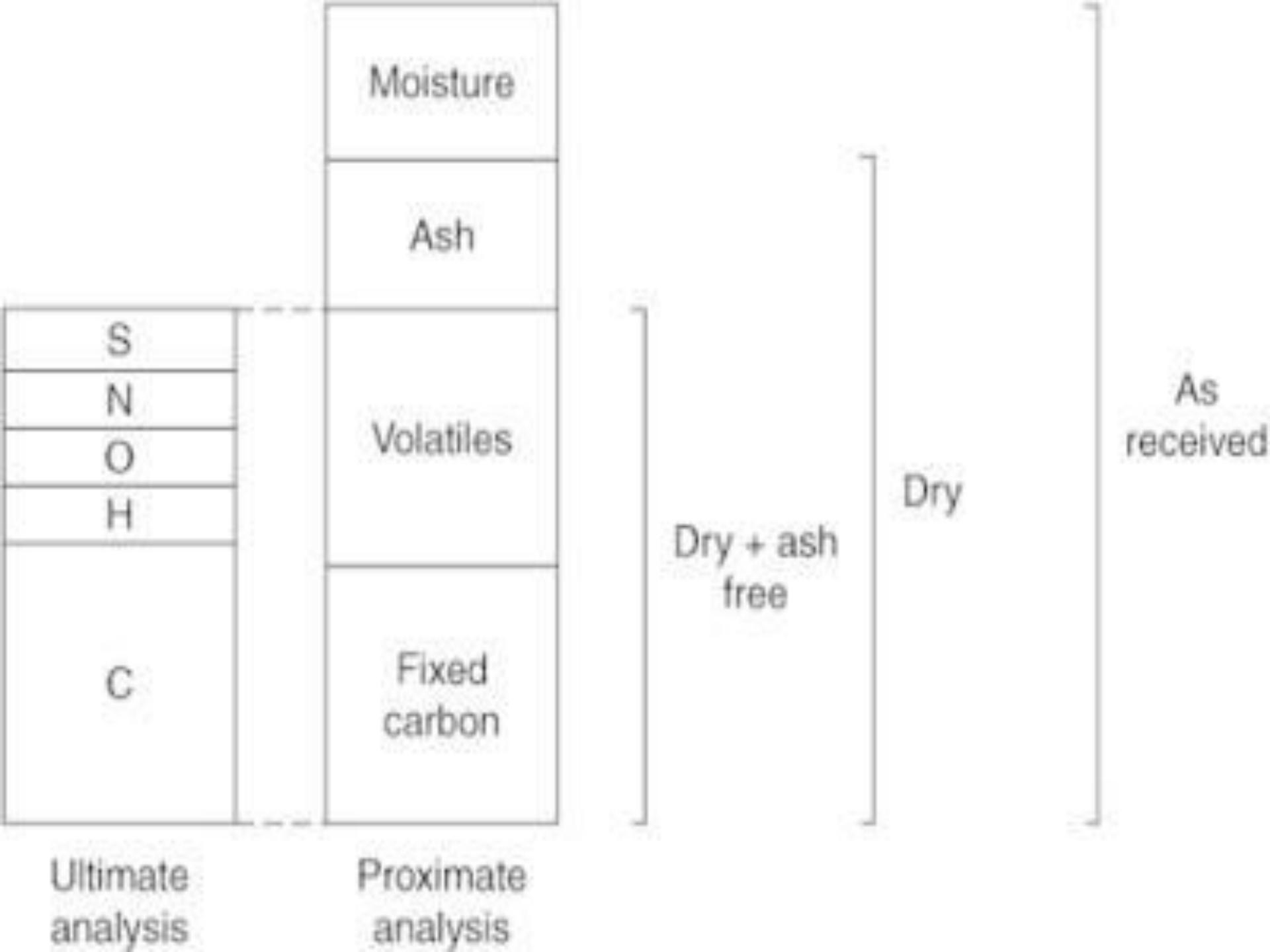


Even though it was not made from dead plants or animals, nuclear fuel is considered to be a fossil fuel because it comes from the ground and is running out.

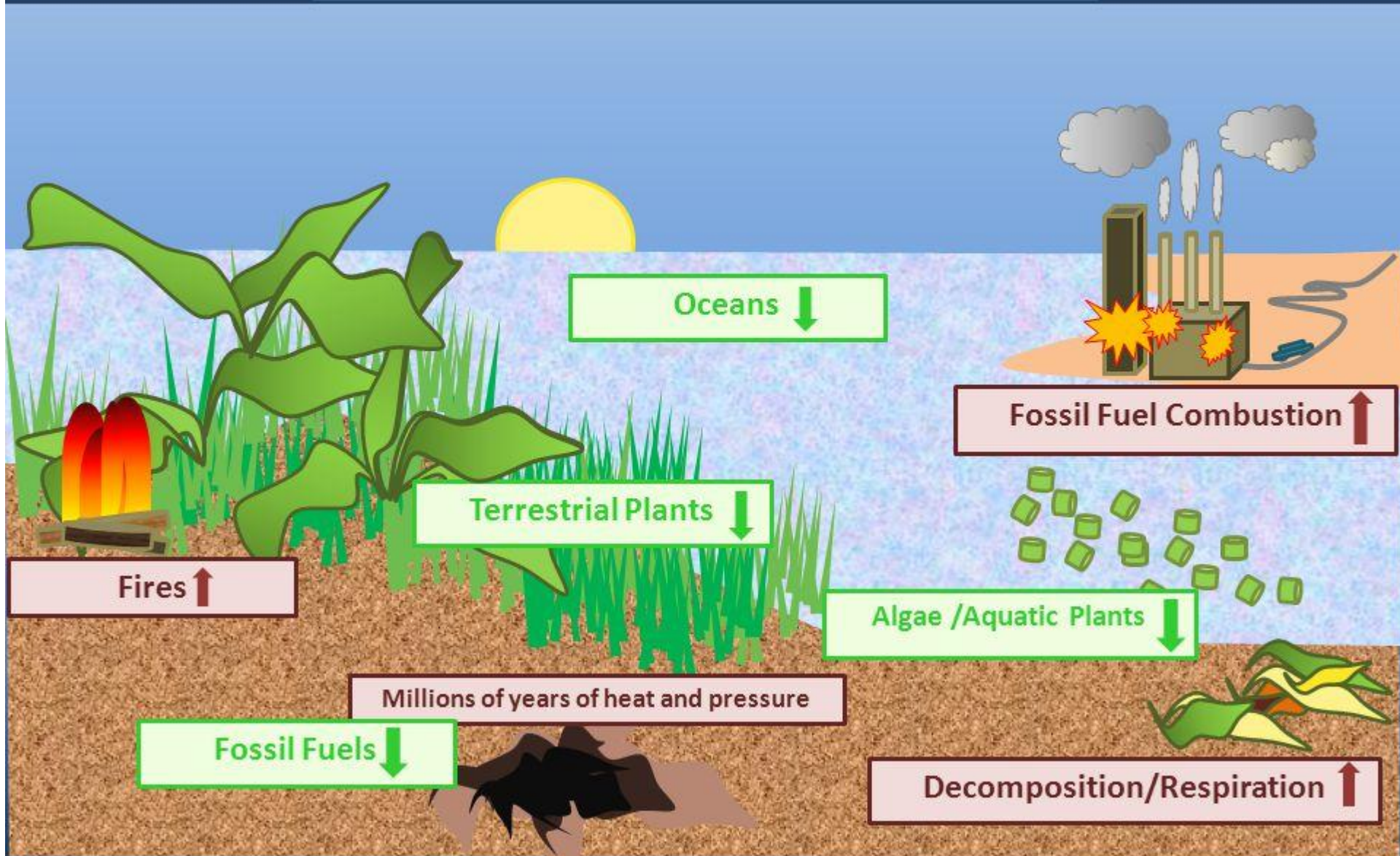
Figure 3. **Oils' Processing and Products**

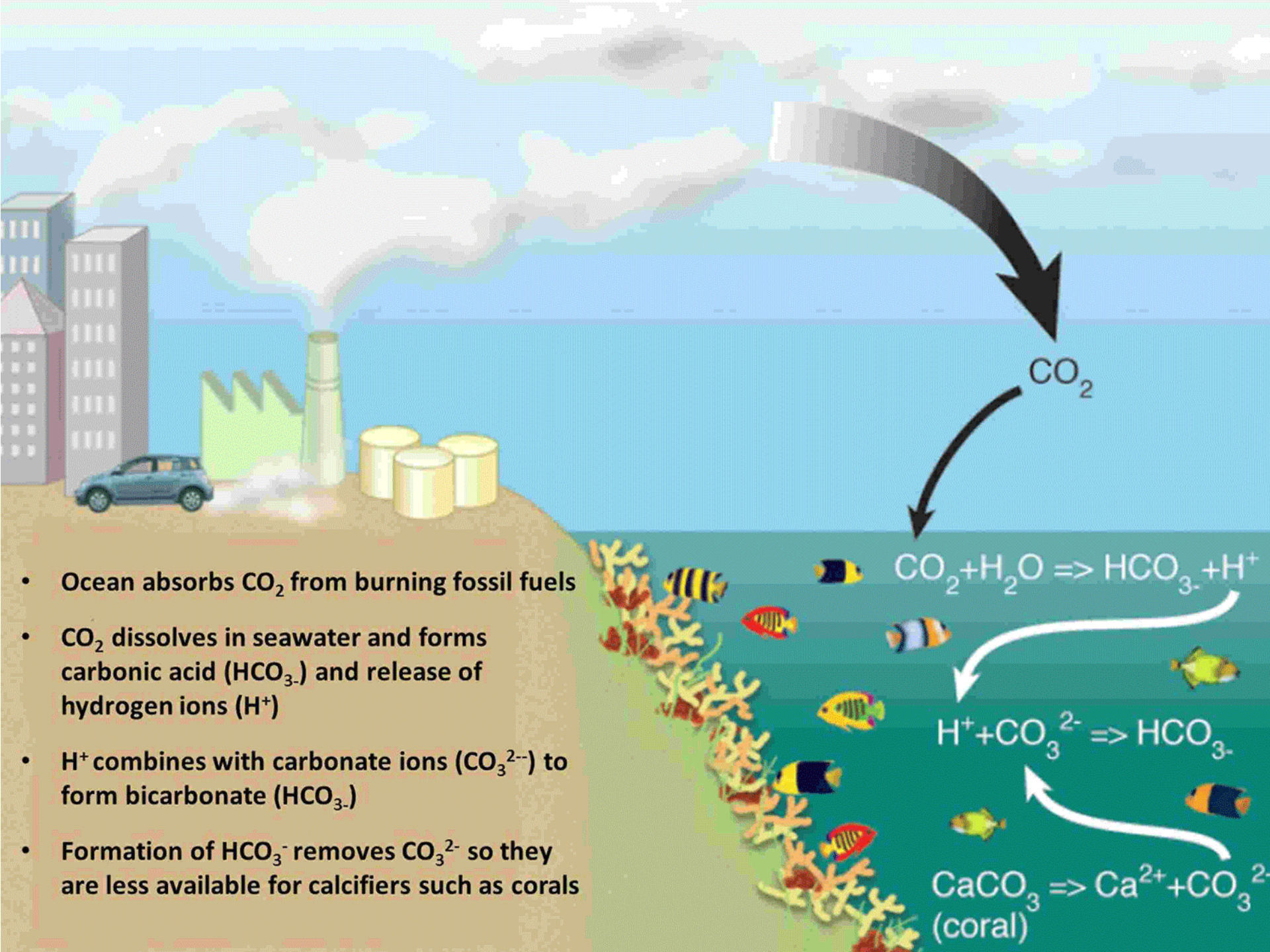


Sources: Energy Information Administration, www.eia.gov/todayinenergy/detail.cfm?id=6970 and International Energy Agency, www.iea.org/stats/defs/sources/petrol.asp

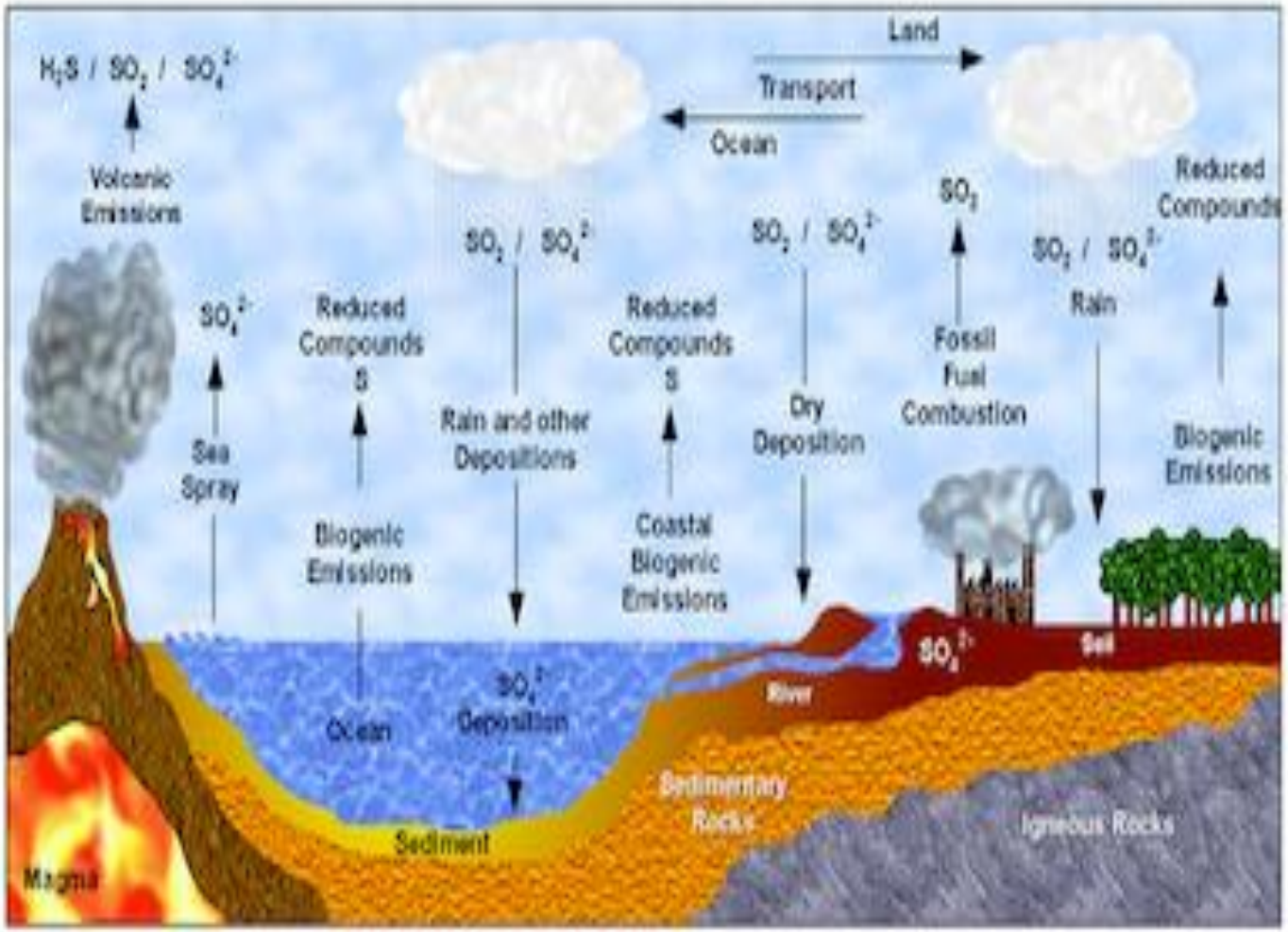

Moisture
Ash
S
N
O
H
C
Volatiles
Fixed carbon
Dry + ash free
Dry
As received
Ultimate analysis
Proximate analysis

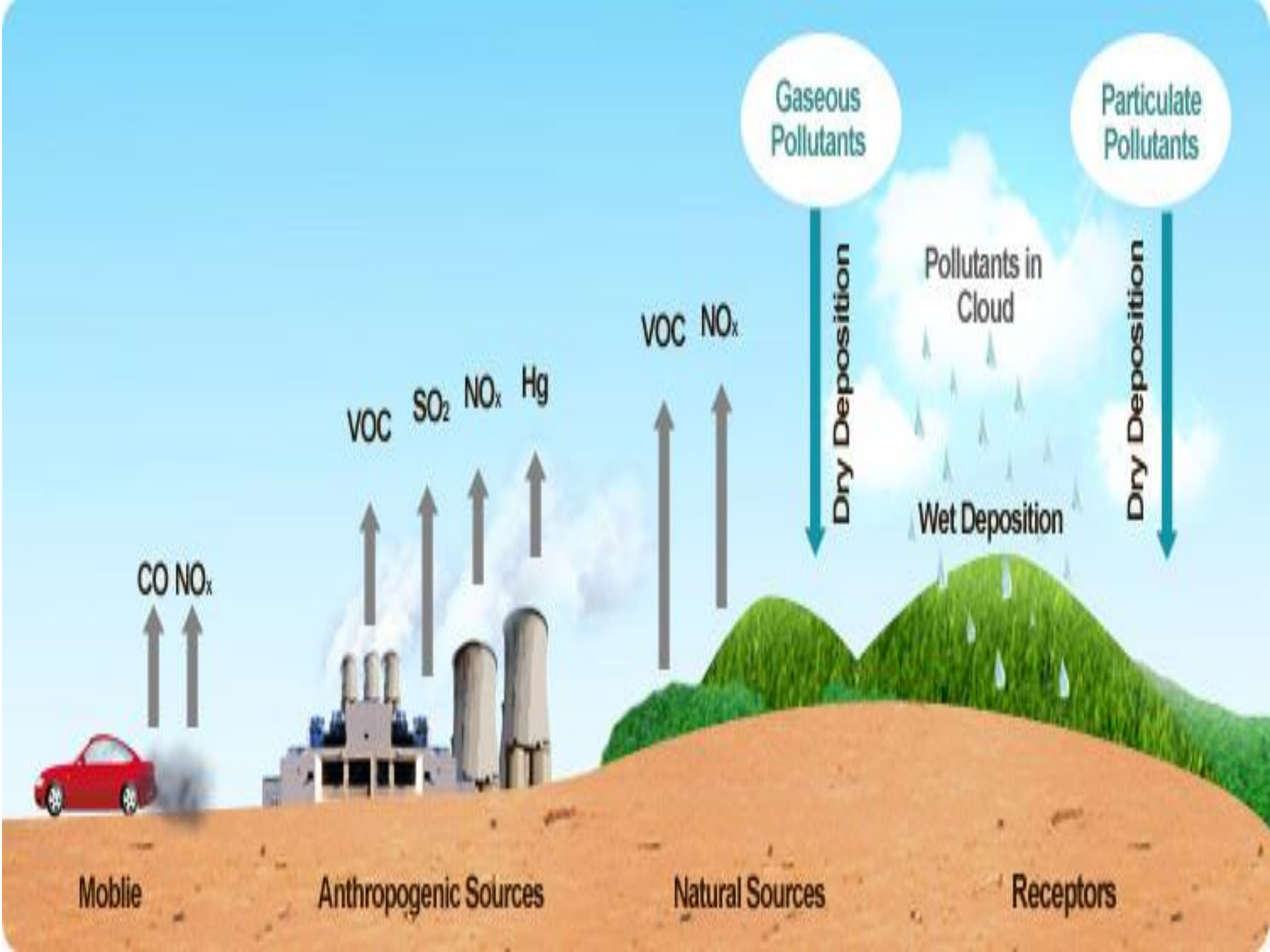
The Carbon Cycle





- Ocean absorbs CO_2 from burning fossil fuels
- CO_2 dissolves in seawater and forms carbonic acid (HCO_{3-}) and release of hydrogen ions (H^+)
- H^+ combines with carbonate ions (CO_3^{2--}) to form bicarbonate (HCO_{3-})
- Formation of HCO_3^- removes CO_3^{2-} so they are less available for calcifiers such as corals


H_2S / SO_2 / SO_4^{2-}
Volcanic Emissions
Land
Transport
Ocean
SO_4^{2-}
Sea Spray
Reduced Compounds S
Biogenic Emissions
SO_2 / SO_4^{2-}
Rain and other Depositions
Reduced Compounds S
Coastal Biogenic Emissions
SO_2 / SO_4^{2-}
Dry Deposition
SO_2
Fossil Fuel Combustion
SO_2 / SO_4^{2-}
Rain
Reduced Compounds
Biogenic Emissions
Ocean
SO_4^{2-} Deposition
Sediment
Magma
River
SO_4^{2-}
Soil
Sedimentary Rocks
Igneous Rocks

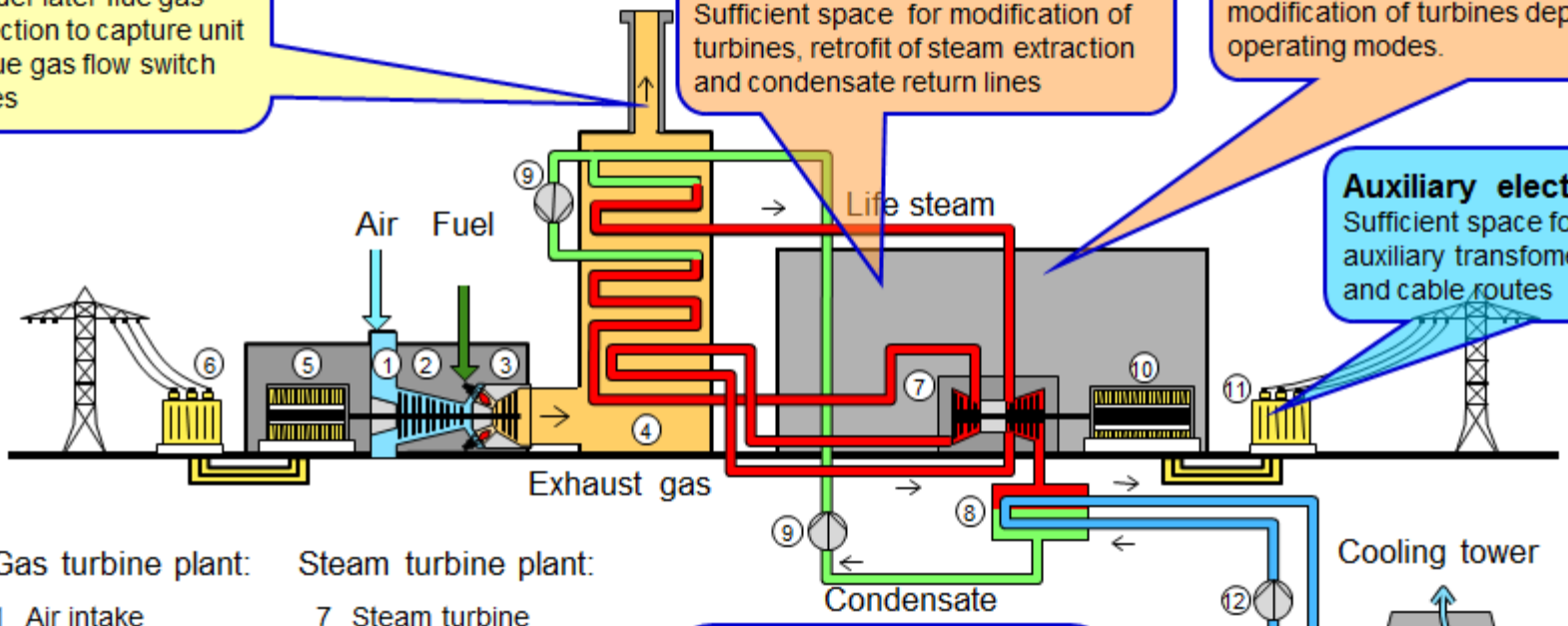

Gaseous Pollutants
Particulate Pollutants
Dry Deposition
Pollutants in Cloud
Dry Deposition
Wet Deposition
VOC NOx
VOC SO2 NOx Hg
CO NOx
Moblie
Anthropogenic Sources
Natural Sources
Receptors

Stack:
Consider later flue gas connection to capture unit and flue gas flow switch devices

Turbine building:
Sufficient space for modification of turbines, retrofit of steam extraction and condensate return lines

Steam turbines / Reheating:
Adaptability for steam extraction; options for modification of turbines depend on required operating modes.

Auxiliary electric supply:
Sufficient space for additional auxiliary transfomer(s), switchgear and cable routes



Gas turbine plant:

1 Air intake
2 Compressor
3 Gas turbine
4 Heat recovery steam generator
5 Generator
6 Transformer

Steam turbine plant:

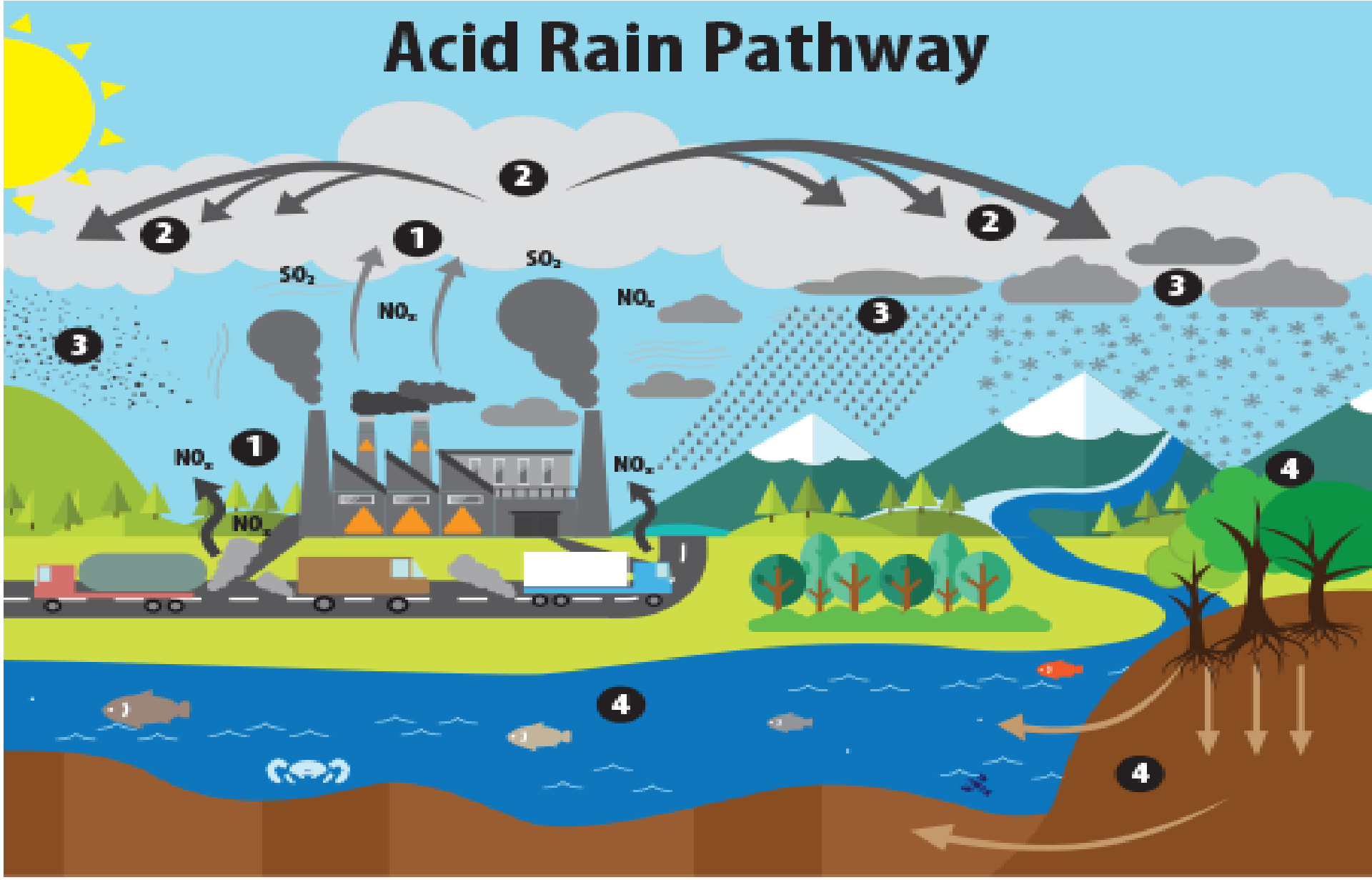
7 Steam turbine
8 Condenser
9 Feeding pump
10 Generator
11 Transformer
12 Circulating pump

Cooling system:
Sufficient space for additional circulation pumps and service water system, sufficient space for extension of cooling capacity

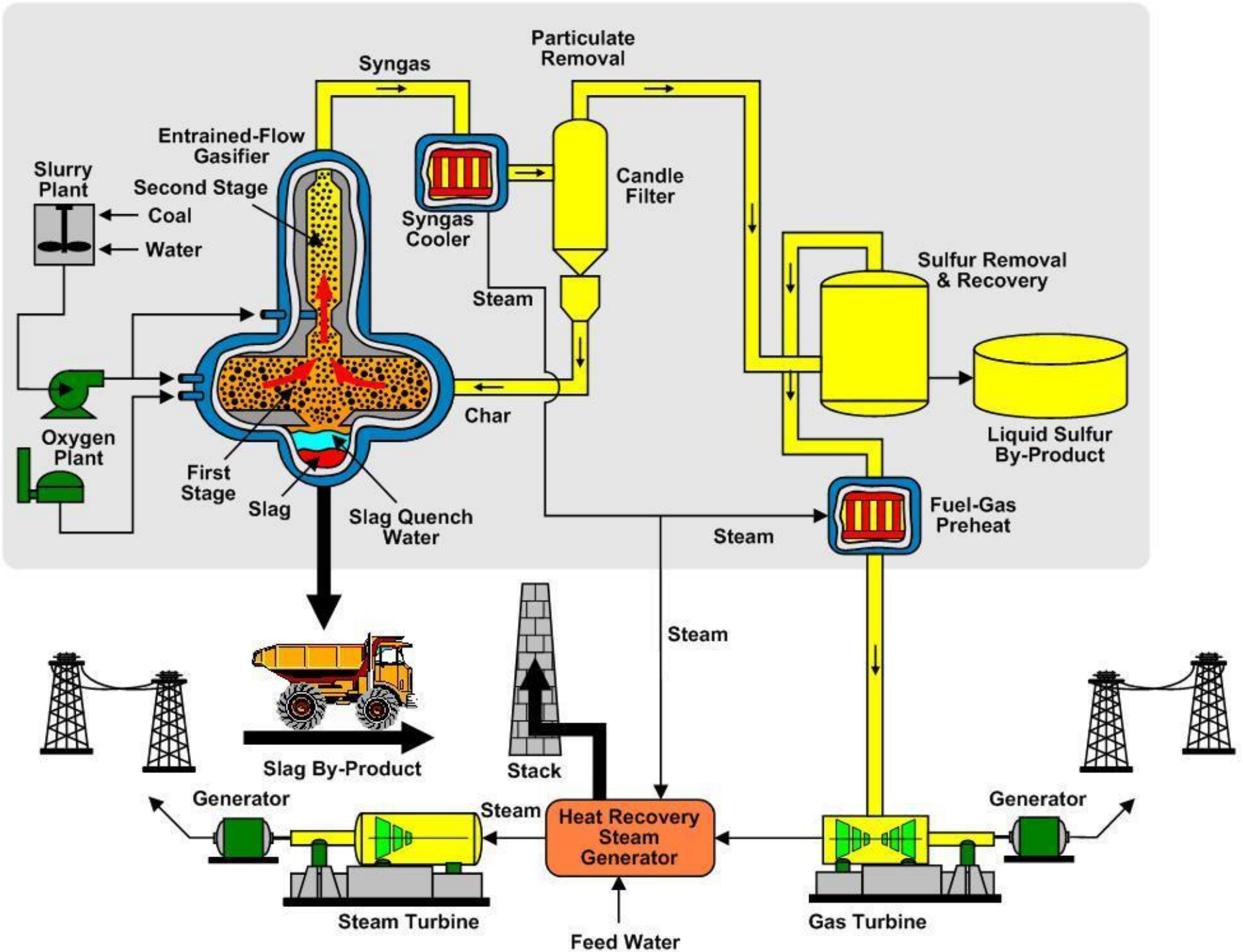
Water supply / Waste water treatment:
Sufficient space for corresponding retrofit measures; Provision of additional water utilization rights

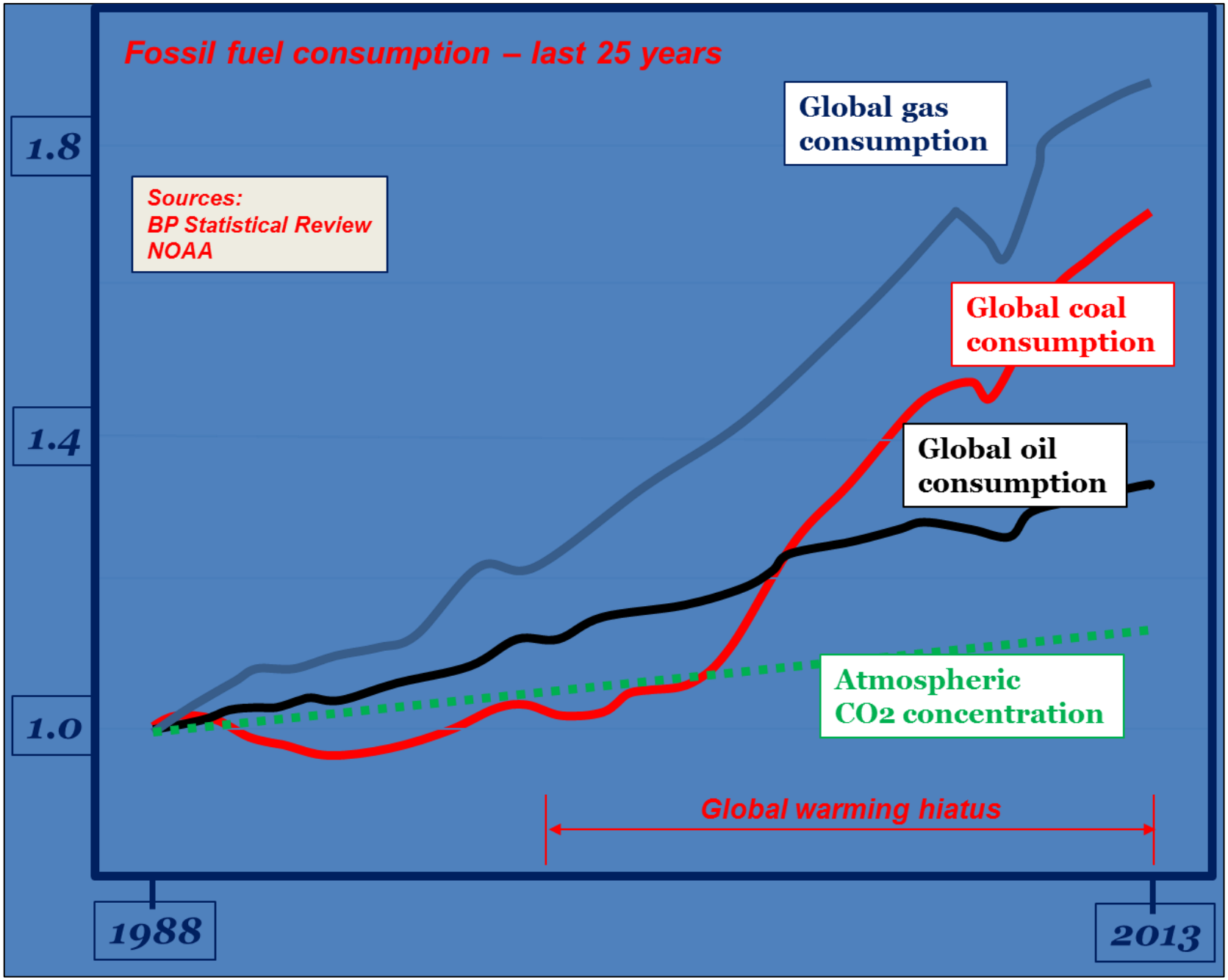
Elaboration of capture ready measures requires insight into an appropriate capture process

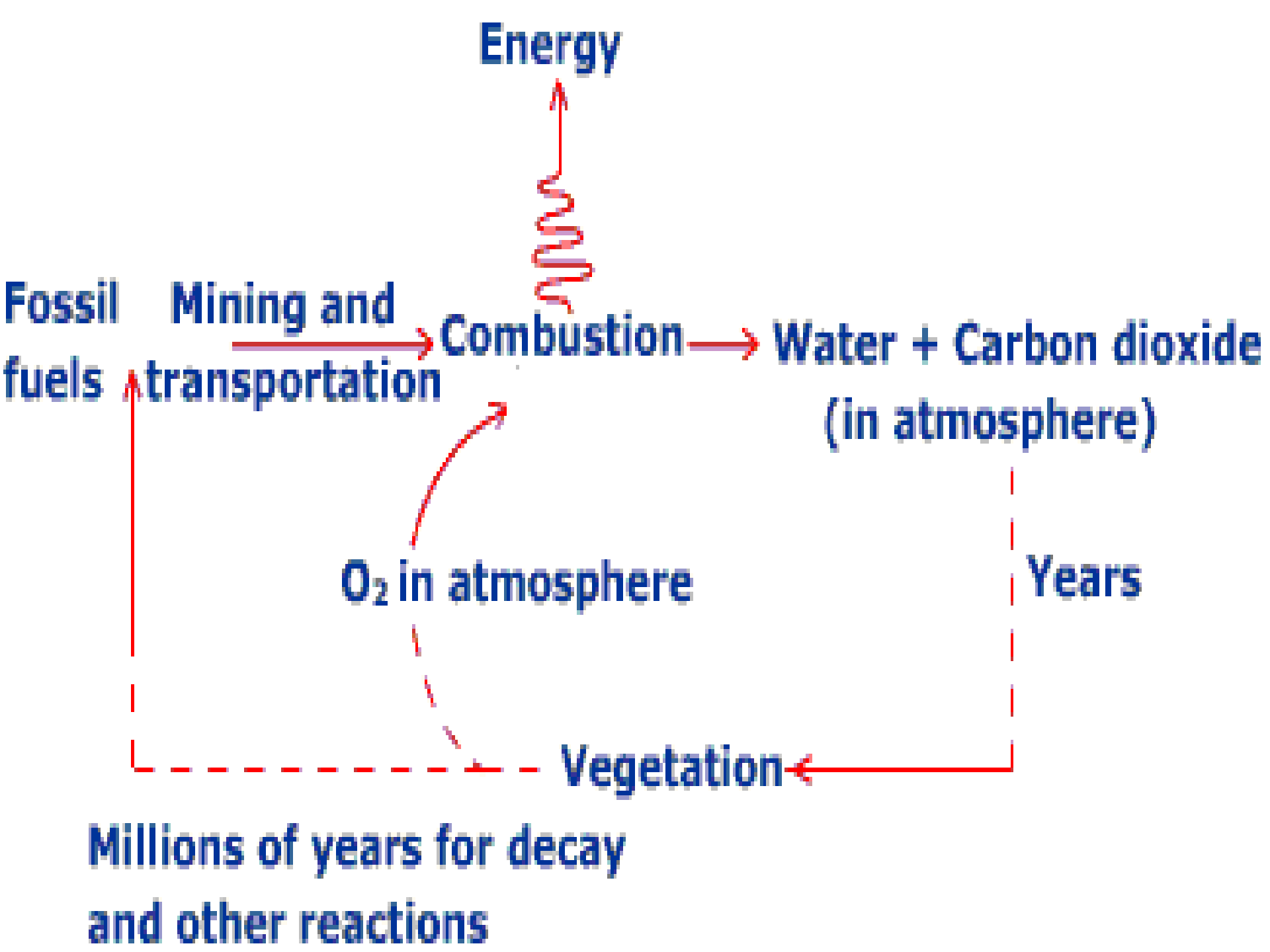
Acid Rain Pathway



This image illustrates the pathway for acid rain in our environment:
(1) Emissions of SO_2 and NO_x are released into the air, where (2) the pollutants are transformed into acid particles that may be transported long distances. (3) These acid particles then fall to the earth as wet and dry deposition (dust, rain, snow, etc.) and (4) may cause harmful effects on soil, forests, streams and lakes.


Syngas
Particulate Removal
Entrained-Flow Gasifier
Slurry Plant
Second Stage
Coal
Water
Syngas Cooler
Candle Filter
Steam
Sulfur Removal & Recovery
Liquid Sulfur By-Product
Oxygen Plant
Char
First Stage
Slag
Slag Quench Water
Fuel-Gas Preheat
Steam
Steam
Slag By-Product
Stack
Generator
Steam
Heat Recovery Steam Generator
Generator
Steam Turbine
Feed Water
Gas Turbine


Fossil fuel consumption – last 25 years
Global gas consumption
Sources:
BP Statistical Review
NOAA
Global coal consumption
Global oil consumption
Atmospheric CO2 concentration
1.8
1.4
1.0
Global warming hiatus
1988
2013


Energy
Fossil fuels
Mining and transportation
Combustion
Water + Carbon dioxide (in atmosphere)
O_2 in atmosphere
Years
Vegetation
Millions of years for decay and other reactions

Biomass Composition

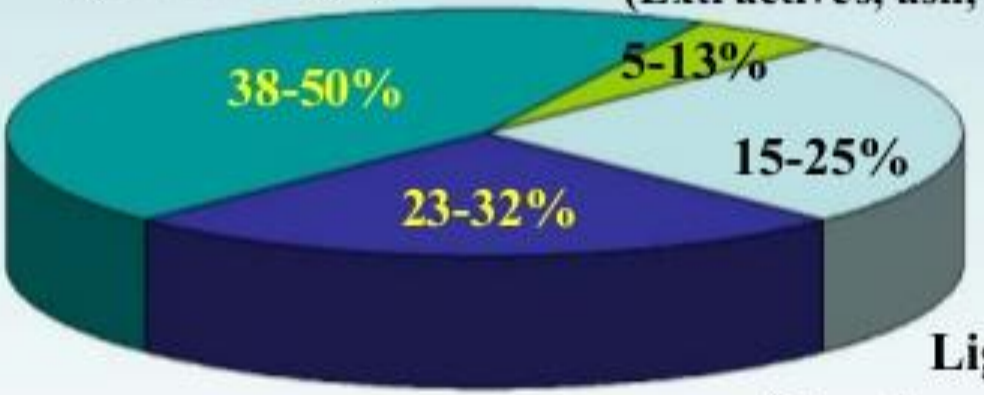
Hardwoods

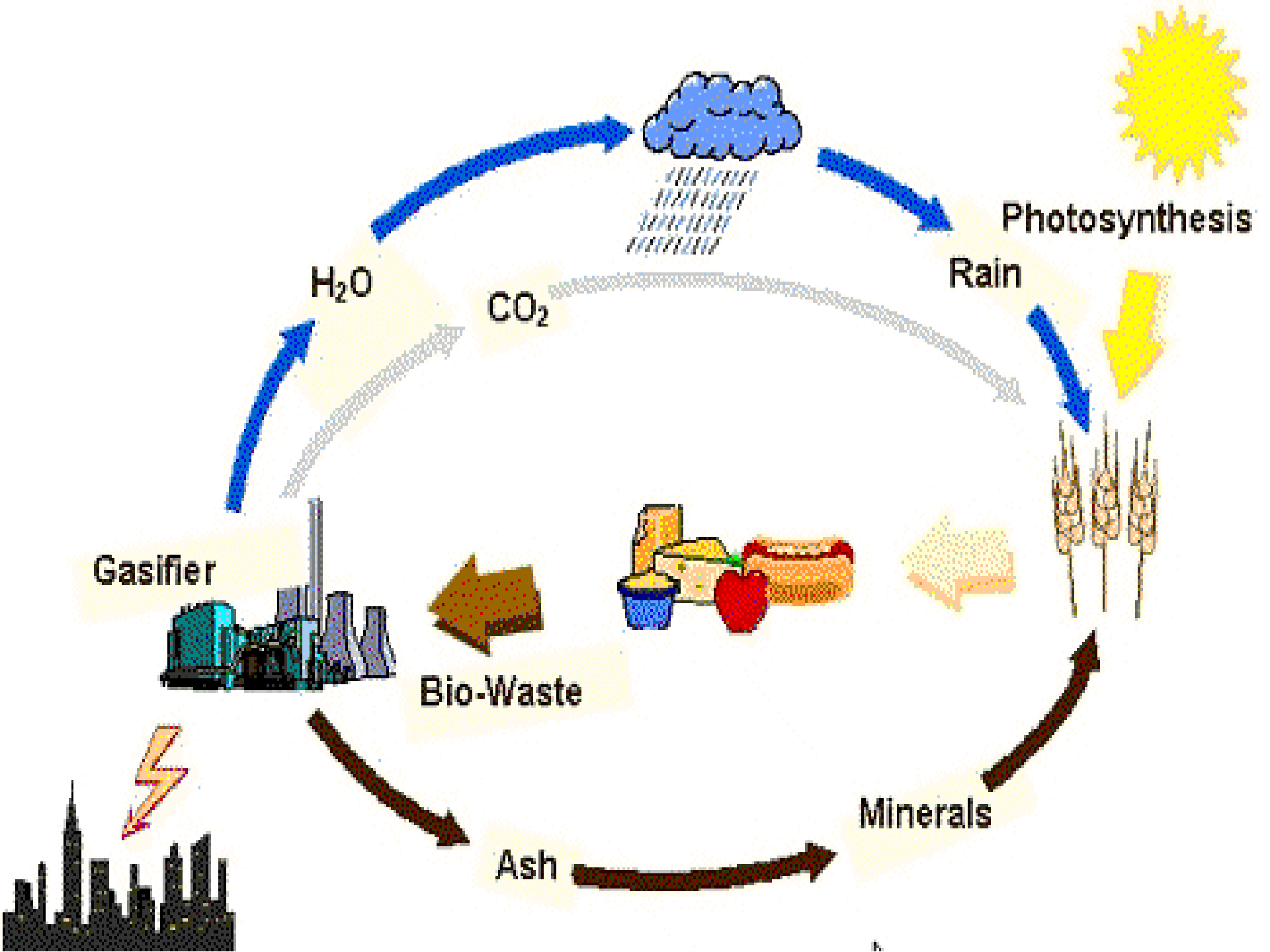
Grasses

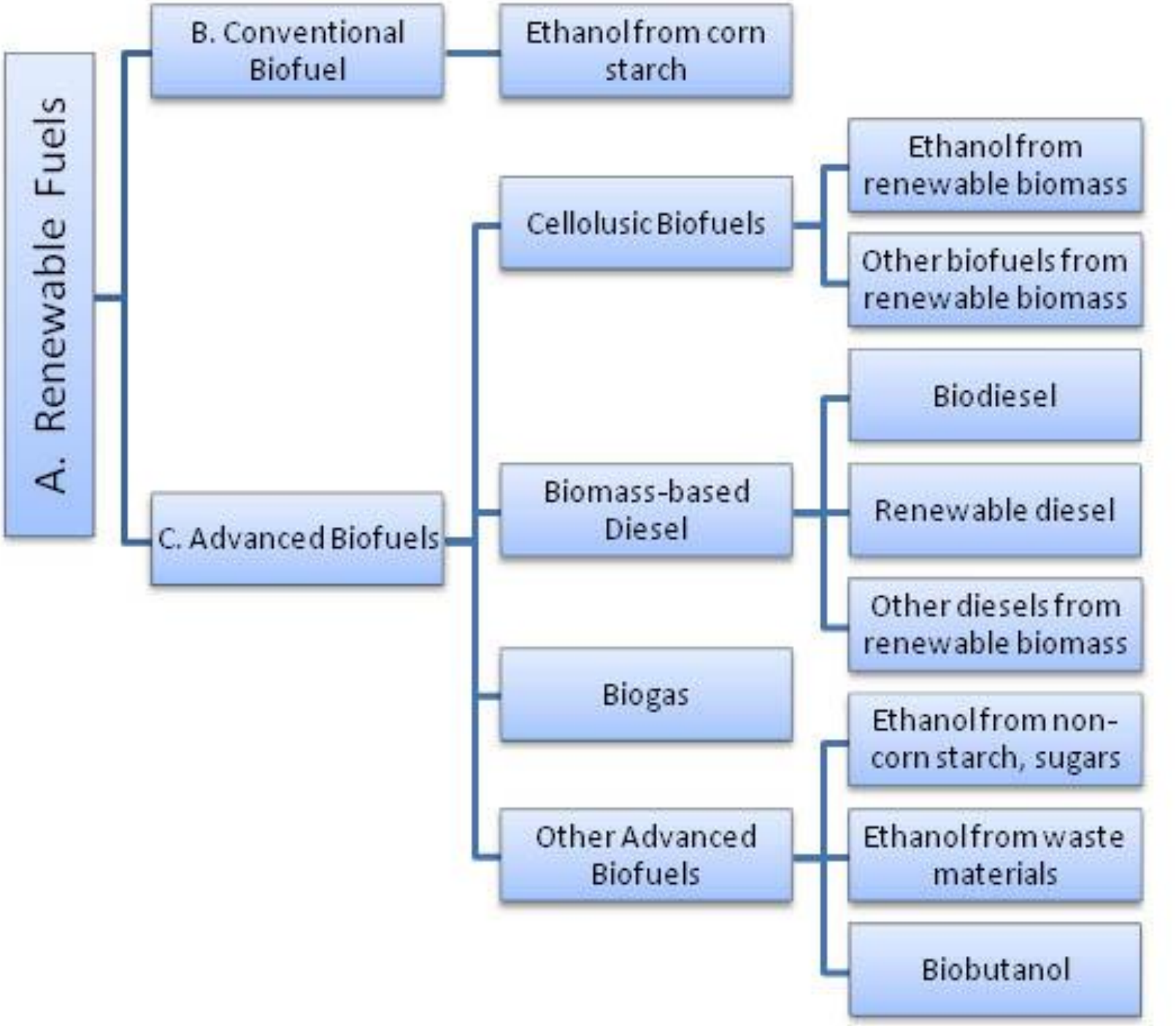
Crop residues

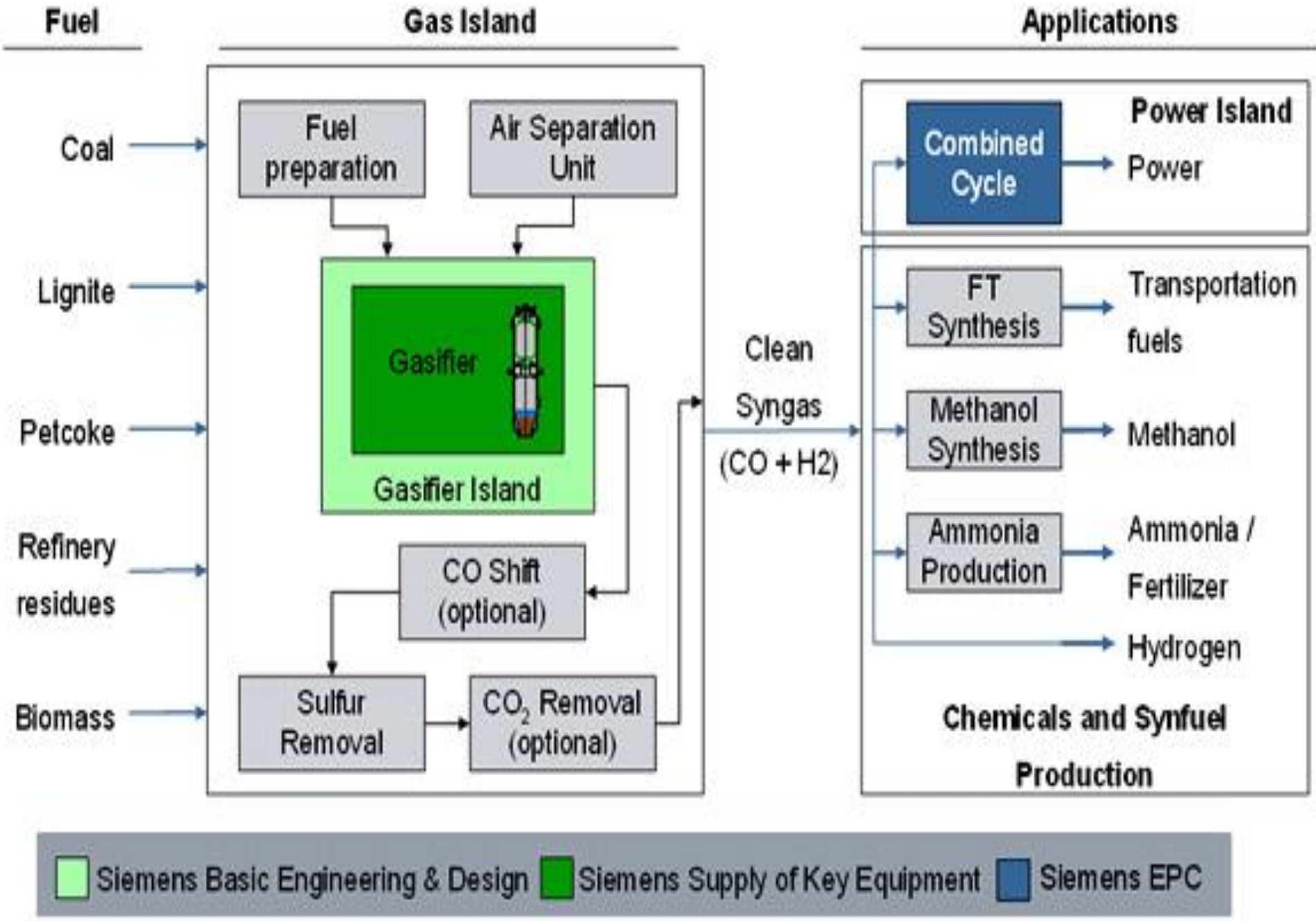
MSW

Softwoods




Photosynthesis
Rain
H_2O
CO_2
Gasifier
Bio-Waste
Minerals
Ash


A. Renewable Fuels
B. Conventional Biofuel
Ethanol from corn starch
C. Advanced Biofuels
Cellolusic Biofuels
Ethanol from renewable biomass
Other biofuels from renewable biomass
Biomass-based Diesel
Biodiesel
Renewable diesel
Other diesels from renewable biomass
Biogas
Other Advanced Biofuels
Ethanol from non-corn starch, sugars
Ethanol from waste materials
Biobutanol


Fuel
Gas Island
Applications
Coal
Lignite
Petcoke
Refinery residues
Biomass
Fuel preparation
Air Separation Unit
Gasifier
Gasifier Island
CO Shift (optional)
Sulfur Removal
CO_2 Removal (optional)
Clean Syngas (CO + H2)
Power Island
Combined Cycle
Power
FT Synthesis
Transportation fuels
Methanol Synthesis
Methanol
Ammonia Production
Ammonia / Fertilizer
Hydrogen
Chemicals and Synfuel Production
Siemens Basic Engineering & Design
Siemens Supply of Key Equipment
Siemens EPC

Characteristics of Good Fuels:

- High Calorific Values
- Moderate Ignition Temperature
- Low Moisture Content
- Low Ash Content
- Moderate Velocity of Combustion
- Should not produce harmful products
- Low Cost
- Easy Storage & Transportation
- Easily Controllable

Thank You