Science and Human society (Geology, Mineral and Environment)

Coal Production and Environment

Fossil fuel energy has contributed human society, but we need to think environment issue related with fossil fuel.

- **Annual world coal production is more than 8 billion metric tons in these days.**
- **Carbon dioxide from consumption of coal is 75 % of global carbon dioxide.**
- **Carbon Capture and Storage (CCS) is developing.**

Coal production (2022)

China occupies 51 % of coal production in the world

Production in the world is around 8.9 billion tons.

Units：Mt, 2022 (Data source: Enerdata, 2023)

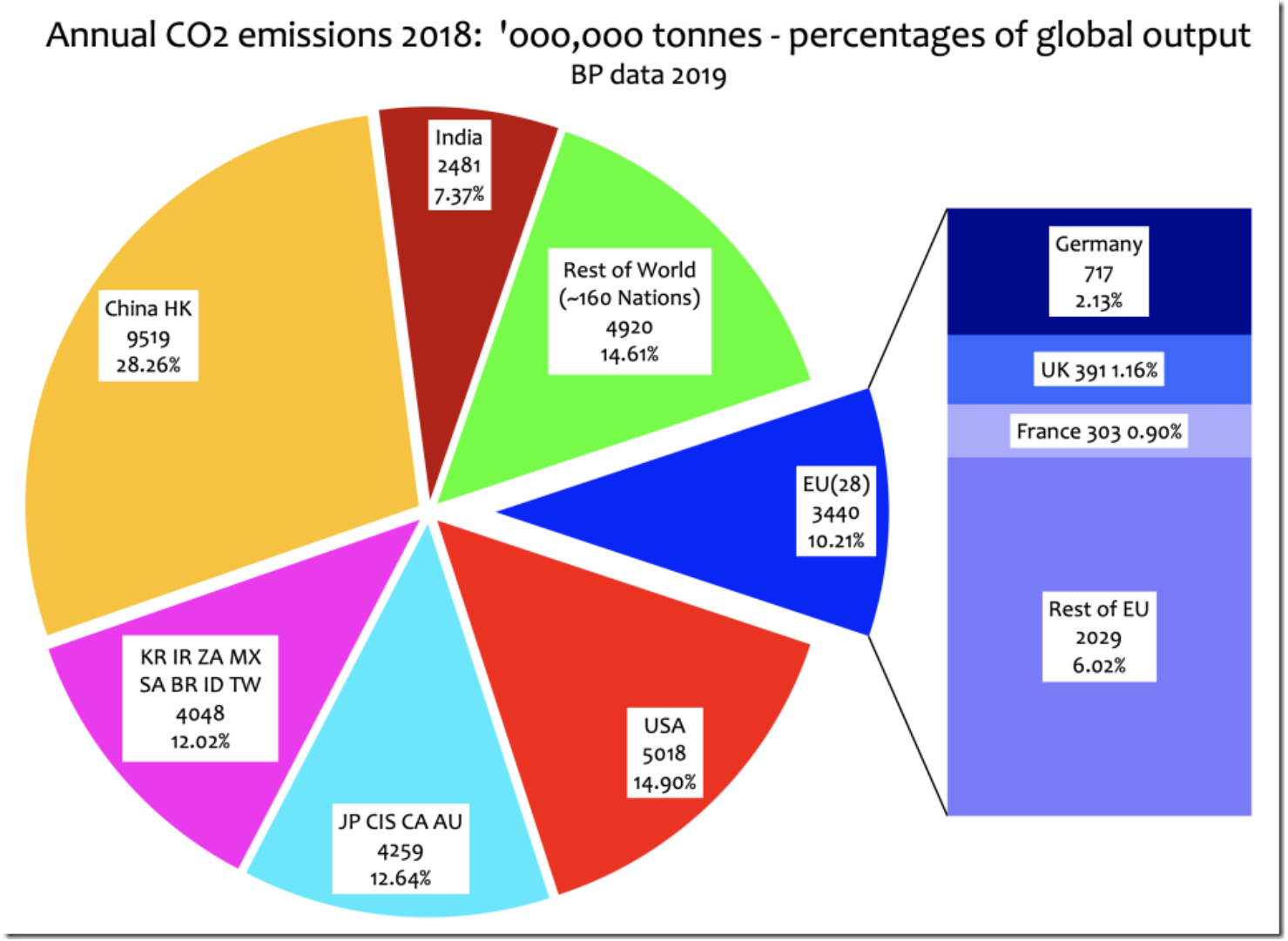
China 4430, India 937, Indonesia 690, USA 540, Australia 459,

Russia 440, South Africa 255

Each country's carbon dioxide emissions (2019)

Amount of both China and US occupies 43 % in world CO_2 emissions.

Both countries are followed by India, Russia, Japan and Germany.



Burning of coal rises carbon dioxide in atmosphere

Annual global coal production is ca. 8 billion metric tons in 2021.

Carbon content in coal is assumed 0.8 g C/ g coal.

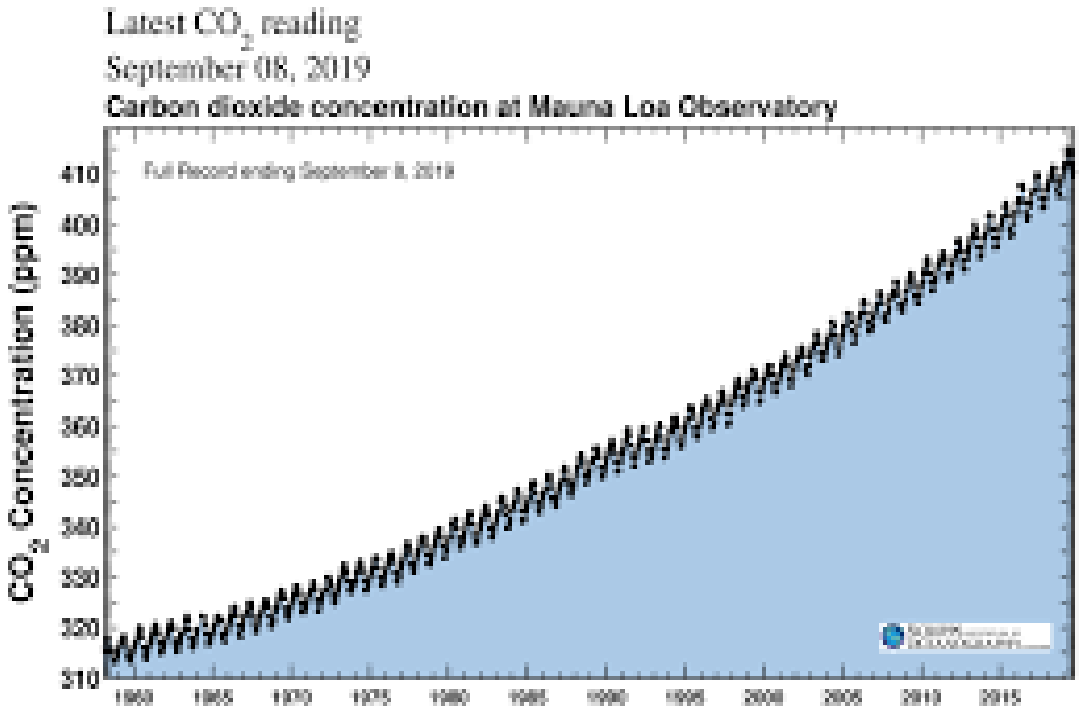
Carbon dioxide amount for carbon 1g is (12+16+16)/12=3.66g CO_2/g C.

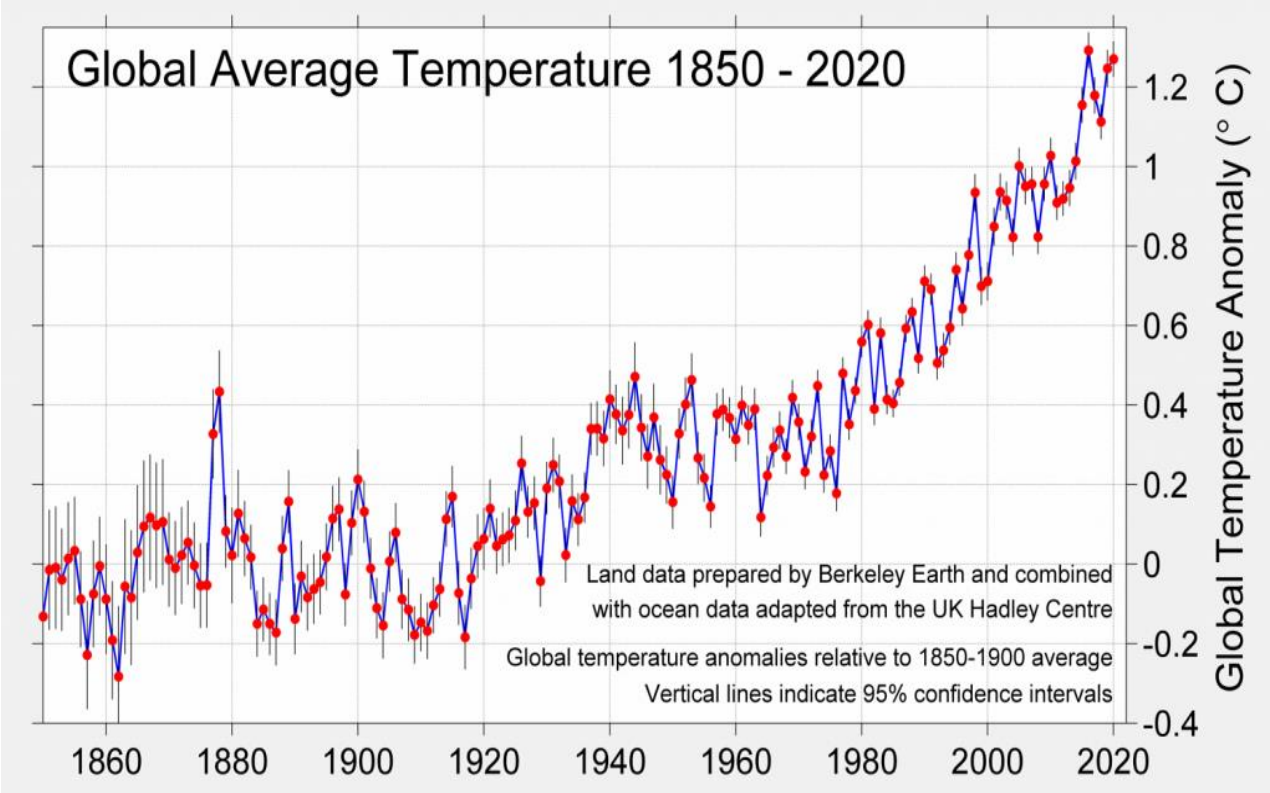
Carbon dioxide amount of coal is 8 billion metric ton x 0.8 x 3.66

=23.5 billion ton

This is about 75 % of total amounts of CO_2.

Carbon dioxide concentration and Global average temperature





The Greenhouse Effect

Solar energy makes the earth warm. Most heat is released to a space but some heat is absorbed in greenhouse gas such as carbon dioxide.

Greenhouse gas is increasing due to industry development. As a result, global warming is going.

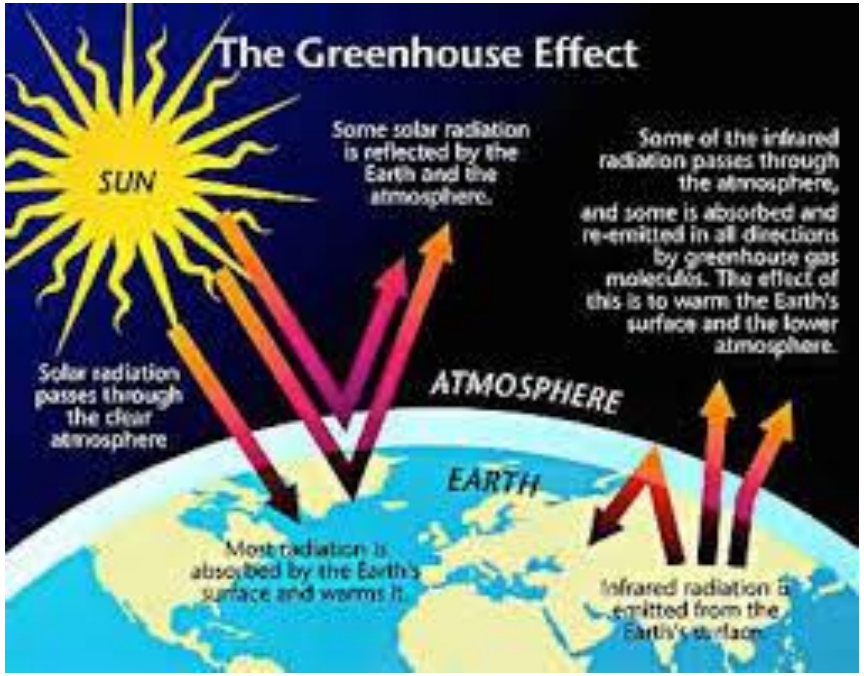


Figure is refers to Alliance for Sustainable Communities

Other facts for global warming

Changes in the Earth's orbit around the sun and changes in the tilt and wobble of the Earth's axis can lead to cooling or warming of the Earth's climate because they change the amount of energy our planet receives from the sun.

Patterns of solar irradiance and solar variation have been a main driver of climate change over the millions to billions of years of the geologic time scale.

How to decrease carbon dioxide emission

1 Power system except coal burning system

- Solar power energy
- Geothermal energy
- Wind power energy
- Hydraulic (Water) power energy
- Nuclear power energy
- Saving energy technology and life habit

How to decrease carbon dioxide emission
2 Capturing carbon dioxide technology and industry

Reduction CO_2 in huge emission source

CO_2 Isolation	Under surface (CCS)
	In the ocean
Conversion and Use	Decomposition to carbon
	Conversion to chemical products

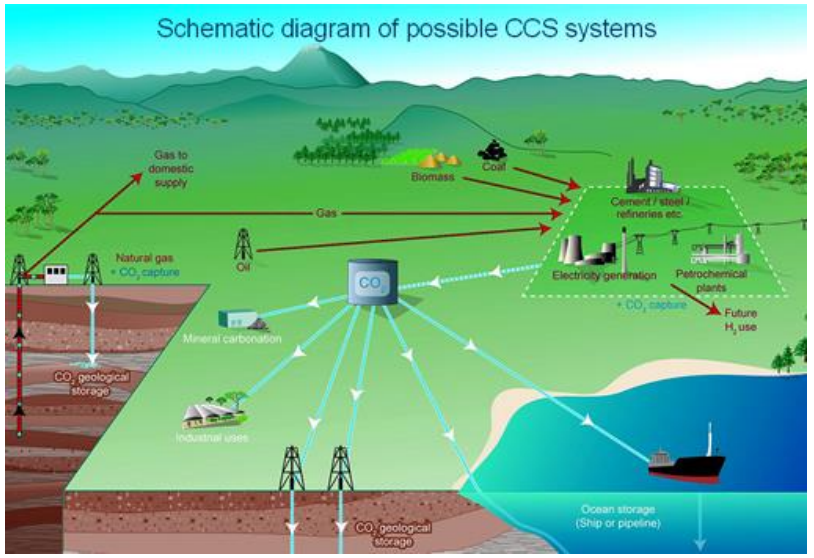
Reduction CO_2 in atmosphere

Plant	Large scale afforestation
	Marine plants
Animal	Coral reef

Carbon Capture and Storage (CCS)

If global temperature rise is to be limited to 2 degrees Celsius above preindustrial levels, one trillion tons of carbon should be taken away. Emissions reduction pathway includes in renewable energy consumptions (including nuclear energy), improvements in energy deficiency, fuel switching and CCS.

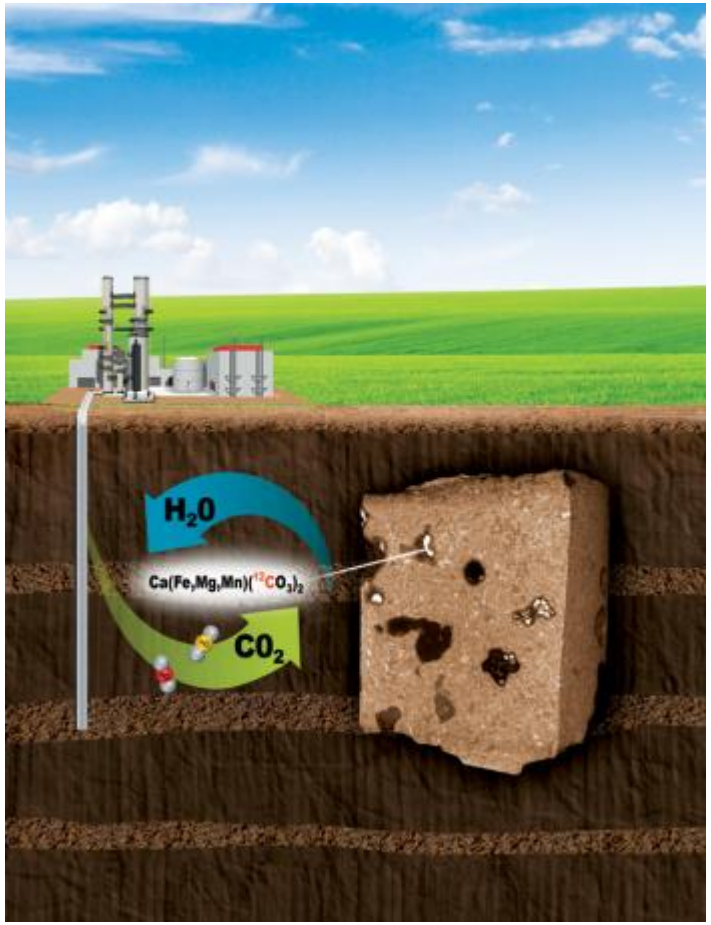
The cost of climate change mitigation will jump 138 % relative to the expense with CCS included. Renewables can replace some uses of fossil fuel energy sources, but it's more difficult to decarbonize industry. That's why CCS is so important. Right Figure is after UCAR Education



Iceland: CarbFix project -- To reduce emissions from Iceland's geothermal plants and aluminum smelters

Iceland's basalts have no cap rocks and relatively young and full of cracks and fissures. Carbon dioxide could easily escape before it could react with the basalts and mineralize. CarbFix developed a unique injection system that allows us to co-inject water with the gaseous carbon dioxide.

The acidic, carbon dioxide-saturated water immediately begins to attack the basalts. As the water moves through cracks and pore spaces, it leaches out calcium, magnesium and iron ions. The dissolved carbon dioxide reaches a solubility threshold and carbonate minerals begin to precipitate. Hydrogen sulfide also reacts with the basalt to form minerals, specifically pyrite.
Reference: Zalzal (2017) Earth, June 2



Video on CCS is introduced.

Carbon Capture and Storage (British Geological Survey)
https://www.bgs.ac.uk/discovering-geology/climate-change/carbon-capture-and-storage/