CO_2 in 5 minute

1. What is CO_2?

CO_2 is the chemical formula for carbon dioxide, a natural part of the air we breathe. Close to 0.04 percent of the air is CO_2, and at room temperature CO_2 is a gas with no color and no odor.

Biologically CO_2 is very important because it is takes part in the photosynthesis and in respiration, which are essential processes for living species. The photosynthesis is a biochemical reaction that takes place in green plants when sunlight is used to transform CO_2 and water to glucose, oxygen and energy. The opposite reaction takes place during respiration of living species; oxygen and glucose is then transformed back to CO_2 and water.

2. Environmental impacts of CO_2 Emissions

Increasing CO_2 emissions is mainly a result of combustion of fossil fuels like coal, oil and gas for energy production. There has been a large increase in global anthropogenic (human made) CO_2 emissions since the industrial revolution 250 years ago as shown in Figure 1.

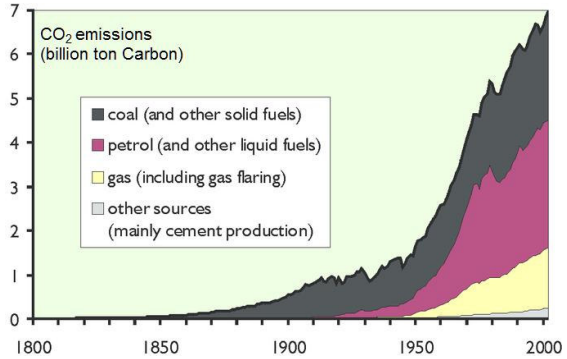

Figure 1. Global CO_2-emissions. Source: Wikipeda.

The atmospheric CO_2 concentration has increased by one third since the industrial revolution, and today 0.038 percent of the atmosphere is CO_2. Further increase in atmospheric CO_2 concentration is expected, according to the IPCC. How large the increase will be is strongly dependent on which strategies that are implemented to reduce the CO_2 emissions. Scenarios for future atmospheric CO_2 concentration are shown in Figure 2 together with expected increase in global temperature.

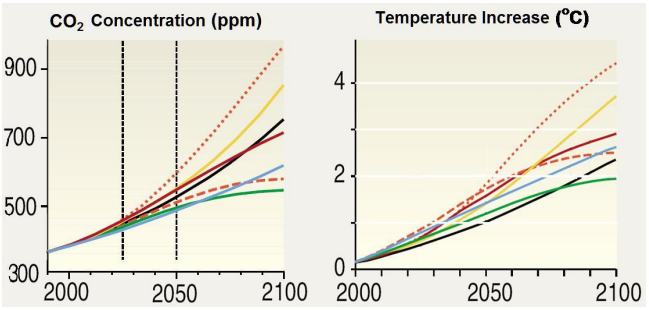

Figure 2. Scenarios for atmospheric CO_2 concentration and global temperature increase. The different lines represent different models. Source: IPCC.

The Greenhouse Effect

Radiation from the sun will be reflected by the surface of the earth as infrared radiation. The greenhouse effect is a natural process where some gases in the atmosphere reflect the infrared radiation back to the earth. Without this natural greenhouse effect, the global average temperature would have been -19 °C, and not +15 °C as it is today.

Water vapor is the most important gas leading to greenhouse effect, but because atmospheric water vapor concentration is hardly effected by human activity, this is referred to as natural greenhouse effect.

Gasses leading to greenhouse effect are called greenhouse gasses (GHG). If the atmospheric concentration of GHGs increases due to human activity the result will be man made greenhouse effect. The most important GHGs leading to manmade greenhouse effect are CO_2, ozone (O_3), N_2O, methane (CH_4) and CFCs (Clorofluor-carbones). The most important GHG leading to anthropogenic global warming is CO_2.

According to IPCC, there is no doubt that increasing anthropogenic CO_2 emissions are leading to global warming.

The consequences of too high global warming will be melting of glaciers, leading to reduced water and food resources. The sea

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level will rise, and there will be more extreme weather, more draughts, and more floods. As a consequence more than 200 million humans can become climate refugees. Ecosystems will be disrupted, and 15 to 40 percent of all species can be extinct.

Acidification of the Oceans

CO_2 can be dissolved in the oceans, and increasing atmospheric CO_2 concentration will increase the amount of dissolved CO_2. The result will be acidification of the oceans, which can lead to serious consequences for species living under water.

3. Strategies to cut emissions

A global warming of more than 2 °C increase in global average temperature will lead to serious consequences, and IPCC have therefore suggested that global GHG emissions should be reduced by 50 to 80 percent by 2050. This is a tremendous challenge, especially when energy demand and fossil fuel consumption increases rapidly in developing countries like China and India. Even if we are able to keep the increase in average global temperature below +2 °C, there will be dramatic climate changes, especially in artic areas.

Reduction of global CO_2 emissions requires a combination of several strategies; the energy consumption must be reduced through *enhanced energy efficiency* and the production of *renewable energy* must be increased. The potential of such measures are far too small to close the gap between global energy demand and renewable energy production, and the world will therefore be dependent on fossil fuel for decades.

Additional strategies are requires to obtain sufficient cut in global CO_2 emissions. Governments must establish economic incentives and regulatory framework to strengthen research and development of new low emission technologies.

Another alternative for reducing CO_2 emissions is to switch from fossil fuel energy production to nuclear energy. However, this is considered as a bad strategy due to the potential hazards related to nuclear energy production and nuclear waste. Another argument is that the potential for CO_2 emission reduction due to increased nuclear energy production is relatively small.

4. CO_2 Capture and Storage

A promising technology for reducing global CO_2 emissions is Carbon dioxide Capture and Storage (CCS), which has a large potential for reducing global CO_2 emissions on a relatively short time-scale. CCS includes CO_2 capture from CO_2 sources, transportation of CO_2 to a storage site, and safe underground storage of CO_2. CCS is applicable to large CO_2 point sources like fossil fuelled power plants and large industrial sources.

CO_2 capture refers to the process where CO_2 from a flue gas is separated from the other flue gas components.

Transportation of compressed CO_2 can be performed by pipelines or ship.

CO_2 storage can take place in suitable underground geological structures, for example depleted oil and gas reservoirs or saline formations; so-called aquifers, see Figure 3. Before CO_2 storage can be deployed on a global scale, methods and standards for CO_2 storage must be established to ensure safe storage without leakages.

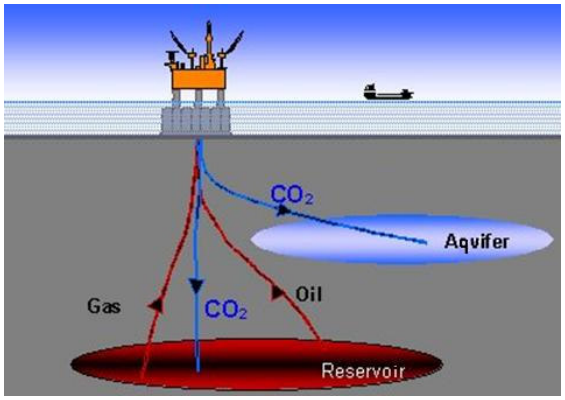

Figure 3. Geological storage of CO_2 in aquifer and CO_2 used for EOR.

CO_2 can be injected in oil fields to increase the oil production (EOR – Enhanced Oil Recovery). In this way CO_2 becomes a valuable product, and CO_2 for EOR can be a cost effective way to establish infrastructure for CCS.

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