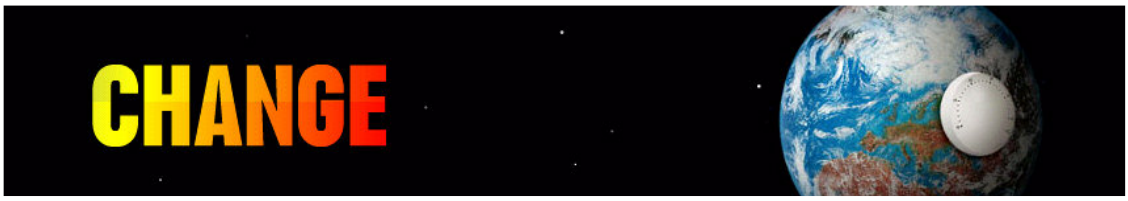

Understanding greenhouse gases

Water vapour: The main greenhouse gas is water vapour (H_2O), which is responsible for about two-thirds of the *natural* greenhouse effect. In the atmosphere, water molecules capture the heat that the earth radiates and then re-radiate into all directions, warming earth's surface, before it is eventually radiated back to space.

Water vapour in the atmosphere is part of the hydrological cycle, a closed system circulating water– of which there is a finite amount on earth - from the oceans and land to the atmosphere and back again through evaporation and transpiration, condensation and precipitation.

Human activities do not add water vapour to the atmosphere. However, warmer air can hold much more moisture, so increasing temperatures further intensify climate change.

Carbon dioxide: The main contributor to the *enhanced* (manmade) greenhouse effect is carbon dioxide (CO_2). Globally, it accounts for over 60% of the enhanced greenhouse gas effect. In industrialised countries, CO_2 makes up more than 80% of greenhouse gas emissions.

There is a finite amount of carbon on earth, which, like water, is part of a cycle – the carbon cycle. This is a very complex system in which carbon moves through the atmosphere, the terrestrial biosphere and oceans. Plants absorb CO_2 from the atmosphere during photosynthesis. They use the carbon to build their tissue, and they release it back to the atmosphere when they die and decompose. The bodies of animals (and humans) also contain carbon since they are built from carbon taken in from eaten plants - or animals that eat plants. This carbon is released as CO_2 when they breathe (respiration) and when they die and decompose.

Fossil fuels are the fossilised remains of dead plants and animals formed over millions of years under certain conditions, and that's why they contain a lot of carbon. Broadly speaking, coal is the remnant of buried forests while oil is converted oceanic plant life. (Oceans absorb CO_2 which, in dissolved form, is used by marine life in photosynthesis.)

Many billions of tonnes of carbon are exchanged naturally each year between the atmosphere, the oceans and land vegetation. Carbon dioxide levels in the atmosphere appear to have varied less than 10% during the 10,000 years before the Industrial Revolution. Since 1800, however, concentrations have risen by about 30% as massive amounts of fossil fuels are burned to produce energy – mostly in developed countries. Currently we are emitting more than 25 billion tonnes of CO_2 into the atmosphere each year.

Recently, European researchers discovered that current concentrations of CO_2 in the atmosphere are higher now than at any time during the past 650,000 years. Ice cores were drilled from a depth of more than 3km in the Antarctic ice, which formed hundreds of thousands of years ago. The ice contains air bubbles that provide a history of atmospheric compositions from different ages in the earth's history.

CO_2 can stay in the atmosphere for 50-200 years depending on how it is recycled back in to the land or the oceans.

Methane: The second-most important greenhouse gas for the enhanced greenhouse effect is methane (CH_4). Since the beginning of the Industrial Revolution, atmospheric methane concentrations have doubled and contributed some 20% to the enhancement of the greenhouse

gas effect. In industrialised countries, methane accounts typically for 15% of greenhouse gas emissions.

Methane is created predominantly by bacteria that feed on organic material where there is a lack of oxygen. It is therefore emitted from a variety of natural and human-influenced sources, with manmade emissions accounting for the majority. Natural sources include wetlands, termites, and oceans. Human-influenced sources include the mining and burning of fossil fuels, livestock husbandry (cattle eat plants that ferment in their stomachs, so they exhale methane and their manure contains it), rice cultivation (flooded paddy fields produce methane since organic matter in the soil decomposes without sufficient oxygen) and landfills (again, organic waste decomposes without sufficient oxygen).

In the atmosphere, methane traps heat and is 23 times more effective at that than CO_2. Its lifetime is however shorter, between 10 and 15 years.

Nitrous oxide: Nitrous oxide (N_2O) is released naturally from oceans and rainforests and by bacteria in soils. Human-influenced sources include nitrogen-based fertilisers, fossil fuel combustion and industrial chemical production using nitrogen, such as sewage treatment. In industrialised countries, N_2O accounts for around 6% of greenhouse gas emissions. Like CO_2 and methane, nitrous oxide is a greenhouse gas whose molecules absorb heat trying to escape to space. N_2O is 310 times more effective than CO_2 absorbing heat. Since the beginning of the Industrial Revolution, nitrous oxide concentrations in the atmosphere have increased by about 16% and contributed 4 to 6% to the enhancement of the greenhouse effect.

Fluorinated greenhouse gases: These are the only greenhouse gases that do not occur naturally, but have been developed by man for industrial purposes. Their share of greenhouse gas emissions from industrialised countries is around 1.5%. But they are extremely powerful – they can trap heat up to 22,000 times more effectively than CO_2 - and they can stay in the atmosphere for thousands of years.

Fluorinated greenhouse gases include hydrofluorocarbons (HFCs) which are used in cooling and refrigeration, including air conditioning; sulphur hexafluoride (SF_6), which is used, for example, in the electronics industry; and perfluorocarbons (PFCs), which are emitted during the manufacture of aluminium and also used in the electronics industry. Arguably the best known of these gases are chlorofluorocarbons (CFCs), which are not only fluorinated greenhouse gases, but also deplete the ozone layer. They are being phased out under the 1987 Montreal Protocol on Ozone-Depleting Substances.

Sources of greenhouse gas emissions in the EU in 2003