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Climate Change, Global Warming and CO_2 Sequestration

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Summary

The climate of planet Earth remained more or less congenial, warm, pleasant and mostly predictable during the spread and development of human civilization. Before the Industrial Revolution, Earth's atmosphere contained about 280 ppm Carbon Dioxide. This equated to a global average temperature of about 14^0 C. Once we started burning fossil fuel, this started to rise due to 'Green House Effect' causing 'Global Warming'. Now it is 380 ppm increasing 2 ppm annually. The other Greenhouse Gases (GHG) like methane, nitrous oxide, ozone and Fluorocarbons etc are also showing an increasing trend. The extra heat raised the temperature leading to melting of ice, rise of sea level and change in seasons and rainfalls.

As a result of increasing GHGs, average surface temperature of the earth has increased by 0.6^oC over 20^{th} century, worldwide precipitation has increased by about 1%, ice cover has decreased and average sea level has increased. It is predicted that with current trend of emissions of GHG, the average global surface temperature may rise 1.4 to 4^oC in next century leading to grave consequences to the earth, the biosphere and mankind.

Worldwide, the total CO_2 emissions in 2005 were over 27000 million tonnes. The top 5 countries are USA (21%), China (19%), Russia (6%), Japan (4%) and India (4%). Indian GHG emissions are about 4% of global emissions in 2005 with a growth rate of 5%. It is estimated that GHG emissions will rise to 3% annually over 2030 and will be over 5% of global emissions in 2030 with CO_2 from fossil fuel as the main contributor.

There are various options for reducing CO_2 concentration in the atmosphere which broadly include reduction of emissions (efficiency & conservation, low carbon fuel, Renewables etc) on the one hand and sequestering the emitted CO_2 in a variety of underground geological locales on the other. Each of these options will have a role to play in tackling CO_2 emissions depending upon various factors including cost..

The idea of CO_2 sequestration in underground geological formations as a mitigation option was conceived in early 1990s. In 1996, the world's first large-scale CO_2 storage project was initiated by Statoil, Norway at the Sleipner gas field in the North Sea. Subsequently, a series of major programs were initiated in the United States, Canada, Europe and Australia.

As the concept of geological sequestration developed, it was recognized that CO_2 can be sequestered in geological formations by three principal mechanism viz. hydrodynamic trapping (like gas reservoir & storage), solubility trapping (like EOR) and mineral trapping (like ECBM). Three principal types of geological formations have the potential to sequester significant and large amounts of CO_2 which include active, depleted and also abandoned oil and gas reservoirs, deep saline aquifers and deep coal seams. Worldwide, assessment of CO_2 storage volume for sequestration ranges from 370 to 11000 Giga tonnes (GT) with maximum potential in saline aquifers.

Currently, the actual or planned commercial CO_2 geological storage locations are major high CO_2 gas production facilities such as Sleipner and Snohvit gas fields in the North Sea, In Salah in Algeria and Gorgon in Australia. The storage potential through EOR has also increased over the years due to associated economic benefits. The three largest CO_2-EOR projects in the United States are the SACROC, the Wasson-Denver in the Permian basin in Texas and the Rangely Weber project in the Rocky Mountain of Colorado. Smaller numbers of CO_2-EOR projects are also currently underway in Argentina, Trinidad, Turkey and Canada (Weyburn oil field). To date, there has been only one CO_2 enhanced CBM recovery (ECBM) demonstration project, located in the northern San Juan Basin United States.