

A REVIEW ON CO2 DISCHARGE AND MANAGEMENT IN THE ATMOSPHERE

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Abstract: Year 2016 was declared as the hottest year of history from the year 1880 by the scientists at NASA. 115,000 years have been passed, but Earth has never experienced such warming. And the trend seems to continue, as even Jan and Feb of 2017 were the warmest months on record in history of 137 years. Global warming is the root cause through which the temperature of earth is exceeding year by year. Carbon Dioxide (CO₂) is a GHG and plays a major role in the formation of global warming because of its enormous concentration present in the atmosphere which is increasing year by year. Scientists report human-made CO₂ emissions continue to rise above levels not seen in hundreds or thousands year, they also predict the costs of the damage incurred through global warming as tens of billions of dollars a year. Technologies such as carbon capture and storage, carbon capture and utilization, increasing the use of renewables, carbon capture and reuse etc are available with us as a sole purpose to minimize CO₂ emissions found in the atmosphere. Technologies stated above will be definitely used in future for sustainable living.

Keywords: CO₂ Emissions, Global Warming, Renewables, Fossil Fuel Combustion, Carbon Capture and Storage (CCS).

I. INTRODUCTION

Starting from the era of Industrial Revolution which began in the year 1750, humans have produced an increase of 40% in CO₂ emissions due to various activities, CO₂ emissions which were below 250 ppm before the start of the industrial revolution but now has reached more than 400 ppm in the present year 2017 as shown in figure 1.1.[1] The Intergovernmental Panel on Climate Change (IPCC) reported in the year 2017 that the researchers were more than 95% confirm that the researchers were more than 95% confirm that the major role played in increasing CO₂ emissions were by the humans due to its various activities also resulting in an increases in Global Warming. [2] Greenhouse is a natural effect that heats the earth’s surface. The major greenhouse gases found in atmosphere are as follows: Water vapor, Carbon dioxide, methane, nitrous oxide, ozone etc. Global warming is the result of a continuous increase of Earths average surface temperature due to effective contributions by greenhouse gases, such as CO₂ due to anthropogenic activities led by humans, which trap heat from the atmosphere and does not allow radiation to escape from earth’s atmosphere. Greenhouse gases are the major and primary gases through which global warming happens on our planet Earth. People generate huge amount Of GHG

(greenhouse gases) in the atmosphere, and CO₂ ranks top as it is produced maximum compared to other GHG and plays a huge role in global warming. The period of time till which GHG remain in the atmosphere is also very important as it can determine the impact which it will make in climate change. The majority of GHG emissions are produced from Human anthropogenic activities such as the burning of fossil fuels, production of electricity, deforestation, power plant exhausts and chemical industries etc. GHG emissions from various sectors are shown in Table 1. [3]

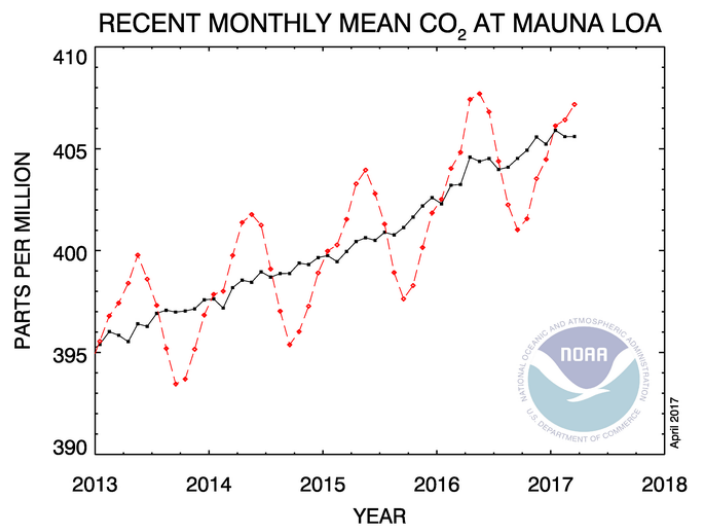


Fig 1: CO₂ emissions crossing the limit of 400 ppm.

Sr. No.	Sector or Domain	Contribution
1	Electricity and Heat Production	25%
2	Agriculture, Forestry and other Land Use	24%
3	Industry	21%
4	Transportation	14%
5	Other Energy	10%
6	Buildings	6%

Table 1: Global Greenhouse Gas emissions by various sectors

II. CARBON DIOXIDE (CO₂): SOURCES AND HARMFUL EFFECTS

CO₂ is the primary GHG and plays a huge role in climate change and global warming. It is also a major contributor to climate change. Primarily there are two main sources of carbon dioxide namely as: natural and human anthropogenic sources. Naturally sources include trees, oceans, land, animals etc, while human anthropogenic sources are as

follows:

- Production of electricity – Electricity is the major source of energy and is used to provide energy to homes, business, and industry. The burning of fossil fuel to produce electricity is the biggest source of CO₂ emissions. It accounts for 37% of total US carbon dioxide emissions and 30% of contribution to GHG in 2014. [4][5][6]
- Industrial sector – Fossil fuel is burned in a lot of industrial processes, also a lot of processes emit CO₂ due to chemical reactions. The industrial sector is responsible for 15% of CO₂ emissions and 12% of GHG emissions in the year 2014 in the US. [4][5][6]
- Transportation sector – The burning of fossil fuels such as petrol, diesel etc to transport people and goods from one place to another is the second largest source of CO₂ emissions. It accounts for 31% of total CO₂ emitted and 25% contributed to GHG emissions in the US in the year 2014. The sector includes transportation of railways, marine, airways as well as highways. [4][5][6]
- Deforestation – It is the second major and huge contributor to CO₂ emissions after fossil fuel combustion. It is predicted that 1.5 billion of tons of CO₂ are released into the atmosphere due to cutting down of trees and deforestation each year. Also, 30 million acres of land covered with trees and forests is lost each year because of deforestation resulting in huge loss of revenues to poor people living in local areas, where forests are their source of income. [7]

Due to CO₂ emissions, today the whole world is suffering from multiple problems. All the living organisms staying on the planet are becoming victims of CO₂ emissions. There are many harmful, poisonous, and dangerous effects of CO₂ emissions that can also take our lives from us. Effects of CO₂ are as follows:

- Sea water level rising – The average sea level has already risen by 7 inches compared to last 100 years in history. If the GHG emissions keep rising up in the same manner as it is today the sea level rise by the year 2099 could be nearly from 7 – 23 inches higher compared to the year 1990. A lot of glaciers found in Alaska and US are shrinking dramatically due to warm temperature caused by GHG emissions and are contributing in the phenomena of sea water level rising. [8] Rising water sea level is a great threat to the town and cities residing bear coastal area and the cities which are surrounded by water bodies. Predictions also say some small towns and cities could even submerge and disappear in the floods. [8]
- Ocean acidification – As day by day, CO₂ levels is increasing in the atmosphere, oceans are absorbing the major part of it, and through that manner, CO₂ is dissolved in seawater to form carbonic acid which causes ocean acidification and resulting in the acidity of seawater increases. If the ocean acidity

continues to rise at the same rate as now it will become difficult for corals to make skeleton and for shellfish to make their shells for their protection and safety. Corals are very important marine creatures as they provide shelter to many other different marine organisms. [8] The phenomena of Coral Bleaching happening at Great Barrier Reef in Australia is the best example of ocean acidification as shown in figure 2. Today the place is at the largest risk ever found in history and can become extinct in near future. [9]



Figure 2: Coral bleaching found at Great Barrier Reef in Australia

Droughts (Climate Change): From the year 1970, droughts have become frequent, continuous, severe, and long in duration worldwide. And they are predicted to become more long and severe in future. Because of drought, many areas are disturbed such as no drinking water, no water for agriculture, dams are empty so hydroelectric power plants cannot work as a result no electricity is produced. Due to droughts and high temperature wildfires easily erupt and can destroy the whole forest. [8] Last year Hurricane Matthew, the strongest Caribbean storm in almost a decade has claimed at least 16 lives after causing extensive damages in Haiti, the Dominican Republic and Cuba. [10]

III. MULTIPLE SOLUTIONS

Possible solutions and alternative technologies were required to solve the problem of excess CO₂ emissions found in the atmosphere. Below are the solutions with appropriate data and intellectual concepts that can be thought about being executed or applied in real world conditions to get the problem solved.

Carbon Capture and Storage(CCS) – It is an innovative technology that can capture up to 90% of CO₂ emissions produced by combustion of fossil fuels directly from the exhausts of the power plants and then store it several kilometers under the earth's surface. In below table 2, if CCS technology is applied in China (Ranked no 1 in CO₂ emissions) [11] its important and critical advantages and disadvantages are mentioned

Sr. No.	Advantages	Disadvantages
1	CCS can insure continuous fossil energy consumption without emission of more GHGs	CCS shows several uncertainties and lack integrated practical experience.
2	To reduce the emission from fossil energy consumption, CCS has the greatest potential for GHG emission reduction	The energy conversion efficiency of thermal power plant will be decreased, as CCS consumes a lot of energy.
3	CCS can be viewed as a viable option for China after its technical feasibility in China is proven.	Domestic coal fired power generation cost will increase by 2–3 times after retrofitted with CCS

Table 2: CCS advantages and limitations when installed in China [12]

In the year 2015, the global CO₂ emissions were 36262 MtCO₂ (Million tonnes). According to the data of Global CCS Institute there are presently 22 large scale CCS projects and their combined CO₂ capture capacity is around 40 Mtpa (Million tonnes per annum). Compared with global emissions it shows approximately CCS is only contributing 0.12% to reduce CO₂ emissions from the atmosphere. [11][13]

Maximize the use of Renewables in India – Renewables help us reduce carbon footprints and is a great weapon to fight against climate change. Switching to renewables reduce our dependence on fossil fuels and they help us cut down GHG emissions and are capable enough to satisfy our energy needs and demand. Production of electricity in India through various Renewable Resources in the year 2016 were 85,631 MW, while the overall electricity production was 302087.84 MW. Above data indicates Renewables contribute approximately 28.35% of the total electricity produced in India. [14] Investments globally today is 250 billion dollars per year in renewable energy that’s more in the world invests in fossil fuels and nuclear power combined, it is also projected that global investments in renewables will reach 500 billion dollars in next 10 -15 years. [15]

Carbon Capture and Utilization (CCU) – Researchers found a way through which captured CO₂ can be converted into methanol fuel and can be used as a substitution for gasoline. [16] Recent research also shows the conversion of CO₂ to ethanol which is a very important chemical and industrial element and has multiple applications. [17]Carbon Clean Solutions built a plant in Tuticorin in southern India that captures carbon dioxide from its coal-fired boiler and converts it into soda ash. The company also claims that it would be world’s first commercial scale plant set to capture 60,000 tons of CO₂ annually. [18]The system of algae cultivation can be made more productive by adding CO₂ to their medium or solution. Algae lamps used for lighting purpose in darkness runs on photosynthesis process having a tube with glowing green algae inside which absorbs all the CO₂ emissions and glows the light outside. It is able to absorb a ton of CO₂ in a year while compared with trees, it would require 150 – 200 trees. [19]

Paris Climate agreement: India’s contribution and goals
 On 2 October 2016, India ratified the Paris Agreement. Some of the goals and targets set by India’s Nationally Determined Contribution (NDC) for Paris climate agreement are as follows:

- To reduce the emissions intensity of GDP by 33% to 35% by 2030 below 2005 levels.
- To increase the share of non-fossil based energy resources to 40% by expanding use of Renewables and reaching target of 175 GW of Renewable energy of installed electric power capacity by 2030, with help of transfer of technology and low cost international finance including from Green Climate Fund (GCF).
- To create an additional (cumulative) carbon sink of 2.5–3 GtCO₂e through additional forest and tree cover by 2030.[20]

For India to meet the targets set for Paris Climate Change, following below work and contribution would be needed

- To create and expand the use of Renewable energy and meet the target of 175 GW of Renewable’s, India needs to maximize more of 48.94% Renewables as compared to present status. Presently India produces 85,632 MW of electricity by renewables and to reach the goal of 175 GW of electricity being produced it needs 48.94% further contribution in renewables. [20] [14]
- At present, the total forest cover and tree cover is 79.42 million hectare (Mha) and the total carbon stock is estimated to be 7,044 million tones. To meet the target of an additional 10 Mha forest and tree cover, India’s needs an extra 10.42% contribution and growth in environments and forests. Also to meet the goal of creating an additional carbon sink of 2.5 – 3 billion tonnes, India’s needs to increase its sequestration and carbon sink capacity by 30% more of what it presently has.[20] [21]

IV. CONCLUSION

CCS technology involves a large amount of infrastructure and investments. In many developing countries it is still in the R&D phase. It has a greater amount of challenges to face rather than reducing CO₂ emissions. For developing countries it is still a very big step to initiate. After detail research, proper practical adaptability and compatibility with real conditions and under the guidance of people who are already running successful CCS plants the thought of installing CCS should be executed.

Renewables provide clean, green and free energy that is inexhaustible. They also eliminate environmental and human faced problems such as pollution, acid rain, climate change etc. For a developing country like India Renewables can be considered as a major solution to reduce CO₂ emissions, as India is gifted with abundant natural resources such as solar, wind, hydro etc.

Forest covers are another alternative after renewables as they not only reduce CO₂ emissions by absorbing it, but also are responsible for many other benefits such as avoiding climate

change, reducing wildfires, providing opportunities for forest goods, providing habitat to diverse animals and plants and they are a source of income for many people.

As a result utilizing Renewables and Forest covers, solutions which are free of cost and are naturally available to us in abundance we should try to reduce CO₂ emissions through them. Afterwards we have latest technology such as CCS and CCU available to us.

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