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Algal-based CO_2 Sequestration Technology and Global Scenario of Carbon Credit Market: A Review

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Abstract: - The objective of this paper is to provide an overview of the global and national scenario of Carbon credit. This paper will also discuss the advantages of the algae-based carbon capture technology in growing carbon credit market. Carbon Dioxide (CO_2), the most important greenhouse gas produced by combustion of fuels, has become a cause of global panic as its concentration in the Earth's atmosphere has been rising alarmingly. However, it is now turning into a product that helps people, countries, consultants, traders, corporations and even farmers earn billion of rupees. A carbon credit is a generic term for any tradable certificate or permit representing the right to emit one tone of CO_2 or CO_2 equivalent (CO_2-e). Businesses can exchange, buy or sell carbon credits in the international markets at the prevailing market price. India and China are likely to emerge as biggest seller and Europe is going to be biggest buyers of carbon credits. Using algae for reduction the CO_2 concentration in the atmosphere is known as algae-based carbon capture technology. This new technology has attracted companies that need inexpensive CO_2 sequestration solutions. Algae farming emerge as the best CO_2 sequestration technique in comparison with other methods.

Keywords: - *Carbon credits, Global warming, Algae-based CO_2 sequestration, Carbon trading.*

I. INTRODUCTION

Carbon Dioxide (CO_2), the most important greenhouse gas produced by combustion of fuels, has become a cause of global panic as its concentration in the Earth's atmosphere has been rising alarmingly, due to anthropogenic interventions. The concept of carbon credits came into existence as a result of increasing awareness of the need for controlling emissions. The mechanism was formalized in the Kyoto Protocol, an international agreement between more than 170 countries, and the market mechanisms were agreed through the subsequent Marrakesh Accords [6]. Businesses can exchange, buy or sell carbon credits in the international markets at the prevailing market price. India and China are likely to emerge as biggest seller and Europe is going to be biggest buyers of carbon credits. Algae farming emerge as beast GHGs reduction technology. Algae can consumes tons of CO_2 for growth, thus reducing harmful greenhouse gases [2] and earn carbon credit. The objective of this paper is to provide an overview of the global and national scenario of Carbon credit. Further more we will also discuss the key advantages of the algae-based carbon capture technology in growing carbon credit market.

II. CARBON CREDITS

A carbon credit is a generic term for any tradable certificate or permit representing the right to emit one tone of CO_2 or CO_2 equivalent (CO_2-e) [3]. Carbon credit is an application of an emissions trading which is a market-based approach used to control pollution by providing economic incentives for achieving reductions in the emissions of pollutants. The carbon trade to meet Kyoto Protocol targets is registered and monitored under the Clean Development Mechanism (CDM) of the United Nations Framework Convention on Climate Change [6].

How carbon credit works?

1. Company A in a developing country cuts GHGs emissions with the help of investment from developed countries. It gets an assessment done by a private consultant to establish the quantum of reduced emissions.

2. The Consultant then forwards the proposal to a national authority for validation. In India it is the environment ministry. Once attested, the project's carbon credits are then certified and are made available for international trading.
3. These credits can be traded at international carbon exchanges like the Chicago Climate Exchange. The price of accredit fluctuates like stocks. Credits can be brought at a lower price and offloaded when prices go up on demand.
4. The Company B in a developed country buys the carbon credits from the exchange to allow itself more emissions and meet its Kyoto targets. Those who have invested in green projects redeem the credits generated from these projects. Excess credits are traded.

Global and Indian Scenario of Carbon credit

Last year global carbon credit trading was estimated at $5 billion, with India's contribution at around $1 billion. India is one of the countries that have 'credits' for emitting less carbon [4]. India and China have surplus credit to offer to countries that have a deficit. India has emerged as a world leader in reduction of greenhouse gases by adopting Clean Development Mechanisms (CDMs) in the past few years. More than 200 Indian entities have applied for registering their CDM Project for availing carbon credits. India has 478 registered CDM projects, accounting for 28.3 per cent of the global credits. Each credit, equivalent to a reduction of one metric tonne of CO_2, sells from anywhere between Rs 650-1,115 [1]. This has potential to generate annual revenue worth several hundred million dollars. India has generated some 30 million carbon credits and has roughly another 140 million to push into the world market. The 800 million farming community in India has also a unique opportunity where they can sell Carbon Credits to developed nations. Government of India has a target of installing 12.34 million biogas plants by 2010. This target has a global warming mitigation potential (GMP) of 120 Mt CO_2 equiv. $year^{-1}$ and US $1,197 million as carbon credit under the clean development mechanism (CDM) [8].
Carbon credits can be created in many ways but there are two broad types CO_2 sequestration (capturing or retaining carbon dioxide from atmosphere) and CO_2 saving project (such as use of renewable energies). Recently, algae had shown a great potential to earn carbon credits with other by products benefits.

III. ALGAE-BASED CO_2 SEQUESTRATION TECHNOLOGY

Using algae for reducing the CO_2 concentration in the atmosphere is known as algae-based CO_2 sequestration Technology. The growth of algae requires carbon dioxide as one of the main nutrients needed. There is an opportunity to efficient sequester CO_2 by using flue gas emissions from industrial sources as the CO_2 feed for algae cultivation. An acre of algae farm can consumes 60 tons CO_2 per year (Table 1). It is estimated that a 3 acre algae farm will consume up to 54,000 metric ton of carbon dioxide and produce 29 metric ton of biomass per year.

Table-1 Production/Consumption of CO_2 per year

Produces/Consumes	CO_2 (in tons per year)
Average person produces	2.3
Average car produces	6
An acre of normal forest consumes	2-3
An acre of oranges consumes	1-2
An acre of typical farm consumes	2
An acre of algae consumes(approx.)	60

An additional benefit from this technology is that the oil found in algae can be processed into a biodiesel. Remaining components of the algae can be used to make ethanol and livestock feed. Algae emits no GHGs on energy production in comparison to all potential feedstocks for biofuel production [5].

Key advantages of the process of CO_2 sequestration using algae

- Owing to the fact that high purity CO_2 gas is not required for algae cultivation, flue gas containing CO_2 and water can be fed directly to the photobioreactor.
- Power plants that are powered by natural gas or syngas have virtually no SO_2 in the flue gas. The other polluting products such as NO_x can be effectively used as nutrients for micro algae.
- Algae can grow in temperatures ranging from below freezing to 158^oF.
- The entire process is a renewable cycle.

Table No.2 GHGs emission (Kg of CO_2 produced per Kilo Joule of energy produced) from biofuel feedstocks [7].

Crop	Used to produce	GHGs emission
Corn	Ethanol	81-85
Sugar cane	Ethanol	4-12
Switch grass	Ethanol	-24
Wood residue	Ethanol, Biodiesel	N/A
Soybeans	Biodiesel	49
Rapeseed, canola	Biodiesel	37
Algae	Biodiesel	-183

- Micro algae culturing yields high value commercial products that will offset the capital and the operation costs of the process.

In addition to biofuels, algae are also as the starting point for high-protein animal feeds, agricultural fertilizers, biopolymers / bioplastics, glycerin and more.

IV. CONCLUSION

Carbon credit is thus expected to redefine global trade and may bring about a drastic change in the ratings of various countries in the global market in the near future. The companies or projects that could benefit from carbon credits are: Renewable energy; biomass; Hydropower; Geothermal; Wind and solar energy; Co-generation; Fuel switch; waste processing; landfill gas extraction; biogas applications; afforestation /reforestation, etc. As algae consumes carbon dioxide, thus reducing harmful greenhouse gases and earn carbon credit. The by-product left over after extracting the oil can be used in cattle feed, vitamins, pigments, cosmetics, etc. and algae can also be used to clean up waste water. Algae-based CO_2 sequestration techniques thus provides the companies the opportunity to capture CO_2 (and possibly earn carbon credits) while at the same time other benefits also such as feedstock for biofuel, fertilizer, nutrient supplements etc.

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