

EVALUATING THE EFFECTIVENESS OF CARBON CREDIT MARKETS IN PROMOTING ENVIRONMENTAL SUSTAINABILITY

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Abstract—This paper explores the success of carbon credit markets in enhancing environmental sustainability and mitigating greenhouse gas (GHG) emissions. The anthropogenic activities like fossil fuel burning, which have contributed to global warming, have contributed to the large accumulation of greenhouse gases in the atmosphere resulting in negative environmental effects. Market-based policies have therefore come up in response to the emerging costs of emissions regulation, and sustainable practices through the introduction of cost-effective policy measures like the carbon credit trading. The primary aim of the green manufacturing is to conserve the environment by cutting down the emission of greenhouse gases. Carbon markets are widely recognized as cost-effective climate policy tools (World Bank, 2023; IPCC, 2022). The study is interested in determining the impact of carbon credit trading on industrial behavior, green manufacturing, and helping to shift towards cleaner technologies, especially in India. It goes further to discuss how electric and hybrid vehicles can help mitigate carbon emissions and improve the environmental performance. The research relies on the secondary data that will be collected in the form of research articles, policy reports, and institutional publications. The results indicate that carbon credit markets are important in the attainment of quantifiable emission cuts through provision of economic incentives to organizations to engage in green practices. In addition, these mechanisms also contribute to increasing the awareness of the ecological cost of carbon emission as well as simplifying the process of investing in sustainable technologies. The effectiveness of the carbon markets, however, is predetermined by the features of the regulation's consistency, market transparency, and the stability of the prices. The paper recommends that carbon credit systems need to be strengthened by improved policy frameworks and market governance in order to amplify the effects of carbon credit systems on the long term environmental sustainability.

Keywords: Carbon Credit Trading, Clean Development Mechanism (CDM), Green House Gases and Kyoto Protocol.

1. Introduction

With the growing pace of climate change, loss of resources and ecological degeneration, environmental sustainability has become an issue with paramount international concern. It refers to the accountable attitude towards the environment in order to avoid exhaustion or deterioration of the natural resources to achieve the quality of the environment, and the health of the present and future generations. The concept emphasizes the tradeoff between economic growth, environmental protection and social justice, the essence of sustainable development. In the recent decades, recent trends of fast industrialization, urbanization, and consumption have had a major role in environmental issues like greenhouse gas emissions, loss of biodiversity, deforestation and pollution. These have enhanced the necessity of having viable strategies and policies that can help reduce environmental destruction and at the same time facilitate economic development. This has led to the main concern of environmental sustainability as the main agenda of governments, organizations, and international organizations. The Sustainable Development Goals (SDGs) of the United Nations, especially Goal 13 (Climate Action) are one of the most important international frameworks that encourage environmental sustainability, and which demand urgent action to address climate change and its effects. In this case, the new solutions to reduce emissions and promote sustainable lifestyles have turned out to be market-based such as carbon credit trading.

The aim of the carbon credit trading systems is to create economic incentives against greenhouse gas emission by selling and buying emission allowances. Such mechanisms not only motivate industries to use cleaner technologies, but also help to meet the broader environmental sustainability goals. Therefore, the concept of environmental sustainability and how it is connected with the carbon credit trade systems is vital to assess their efficiency in solving the current environmental issues and the prospects of a sustainable future.

Global warming is the overall rise in the average surface temperature of the earth since the pre-industrial era (1850-1900) and is mainly caused by human activities like release of fossil fuels, which raises the level of heat-trapping greenhouse gases (GHGs) in the atmosphere. Though the natural processes, like changes in the intensity of the sun and feedback mechanisms of the Earth also play a role in the changes in climate, the anthropogenic activities, including industrialization, agricultural activities, and deforestation are identified as the leading causes of global warming (IPCC, 2022). Among them, the emission of greenhouse gases can be listed as the most important factor that contributes to the acceleration of climate change. To curb this increasing issue of increased GHG emissions, the United Nations Framework Convention on Climate Change (UNFCCC) was formed, whereby industrialized countries and the emerging economies pledged to reduce and control the emissions with the agreed targets. The Convention focuses on adoption of mitigation policies and periodic reporting systems to check the progress. As an example, a typical passenger car produces about 4.6 metric tons of carbon dioxide every year, which is a considerable source of emissions worldwide. In this case, the shift to greener solutions, like electric cars, becomes essential.

Moreover, trading of carbon credits has become a useful tool in controlling the emission through market-based mechanisms. In this system, any organization that emits less than the required limits is allowed to earn carbon credits which can be traded with other organizations, countries or governments. As a member to the Kyoto Protocol in 2002, India has been able to engage in such mechanisms, especially Clean Development Mechanism (CDM), enjoying the benefits of foreign investment. Although initially large corporations dominated this area, small and medium enterprises are now entering into carbon credit trading. Carbon credit trading is a cap-and-trade system, which facilitates the reduction of emission at a cost-effective rate in industries (Stavins, 2020).

2. An Overview of The Kyoto Protocol:

Kyoto Protocol was adopted on 11 December 1997 and formally effective on 16 February 2005 following a long ratification process. It works within the larger context of the United Nations Framework Convention on Climate Change and is a big move towards international action to combat climate change. The agreement obliges the industrialized countries and the economies that are in transition to set certain targets on the reduction of greenhouse gas emission, whereas the parent convention asks countries majorly to design policies and report on progress. The protocol is designed on the basis of responsibilities that are differentiated, i.e. developed nations have legally binding responsibilities, because their contribution to global emissions has been higher than that of the developing nations in the past. In its initial commitment period of 2008-2012, the participating countries had an objective of jointly cutting down on emissions to the tune of 5 percent less than the amount of 1990 levels and involved 37 industrialized countries and the European Union. The agreement was later renewed by the Doha Amendment adopted in 2012, and the amendment offered the second commitment period between the year 2013 and 2020 but the full implementation was to rely on the number of ratifications. One of the most important aspects of the protocol is that it introduces the flexible mechanisms, namely the Clean Development Mechanism, Joint Implementation, and emission trading, which enables the countries to realize their targets in a cost-effective and cooperative approach and foster sustainable development.

3. Review of Literature:

The idea of carbon credit trading and its contribution to the reduction of greenhouse gas emissions have been widely discussed in the literature. The initial research points to the increasing importance of carbon markets on the international level. The greenhouse gas market has been growing at a very high pace as noted by Trivedi (2016) with more countries, regions and corporate alliances joining it, showing that it is relevant globally. On the same note, Fowler (2016) examined the issues and prospectus relating to the application of carbon credit trading in agriculture sector with a focus on the contribution of farmers and the intricacies of its application. Singh (2014) undertook the analysis of the problems of companies that hold carbon credits, especially the financial losses as a result of fluctuations on the market, the uncertainty of investments related to Clean Development Mechanism (CDM) in the Kyoto Protocol in the Indian context. In addition, Garg (2017) investigated advantages and issues of the carbon credit trading activities in organizations and concluded that although these mechanisms help in environmental responsibility, their success requires a robust regulatory framework and organizational dedication. Moreover, Raghuram Rajan (2021) presented the economic impacts of the greenhouse gas emissions in general and revealed the benefits and drawbacks of the carbon credit systems.

In a global policy perspective, Stavins (2003) presented background knowledge about market-based environmental policies which are mainly the emissions trading systems showing that the mechanisms can produce lower costs of emission reduction than more traditional regulatory strategies. In line with this position, Ellerman, Convey, and de Perthuis (2010) examined the European Union Emissions Trading Scheme (EU ETS) and discovered that it not only led to quantifiable emission cuts in the industries, but also noted the significance of proper distribution of the emission allowances and regulation. Moreover, in the Stern Review, Nicholas Stern (2007) pointed to the economic risks posed by climate change and made a plea in favor of carbon pricing and trading as an effective policy tool. The research also highlighted the fact that sustainability at an early stage is cheaper than at a later stage and clearly set out the relationship between the sustainability of the environment and economic growth over time.

The empirical and policy relevance of carbon markets has also been further reinforced by recent research. Bayer and Aklin (2020) showed that emissions trading systems have a significant role to play in quantifiable cutback of emissions across nations. Narassimhan et al. (2021) reviewed global carbon markets and found that some of the major challenges include price volatility, inconsistencies in regulations, and lack of transparency in the market. As it was highlighted by Klenert et al. (2022), carbon pricing schemes are better to be combined with social equity to guarantee the environmental and economic advantages. Zhang et al. (2023) discovered that carbon markets can make a significant impact in lowering emissions in the developing economies, especially when they are backed up by effective policy frameworks and governance systems. Moreover, the World Bank (2023) indicated that currently, almost 23 percent of the global greenhouse gas emissions are included in carbon pricing practices that demonstrates the increasing popularity and relevance of market-based climate solutions on the global stage.

Although there has been considerable research on the carbon credit mechanisms, very little has been done on the effectiveness of the mechanisms in developing economies like India, especially on its availability on the market, regulatory issues and the involvement of the small and medium enterprises. This paper tries to fill this gap.

4.1. Research Objectives:

1. To evaluate the effectiveness of carbon credit markets in reducing greenhouse gas emissions and promoting environmental sustainability.
2. To analyze the role of carbon credit trading mechanisms in encouraging sustainable practices among industries and organizations.

5. Research Methodology:

The research design is a conceptual research design that uses secondary data. The data used to conduct the study is based on a very broad spectrum of reputable and trustworthy sources that include published research articles and academic journals, books, newspaper articles, digital libraries and verified online databases. Moreover, pertinent data of working papers of renowned universities and institutional reports have also been taken to reinforce the analysis.

Secondary data will allow one to have a holistic view of carbon credit markets, how it operates, and how it facilitates environmental sustainability. The data gathered have been methodically reviewed and analyzed to come up with trends, patterns and important insights touching on the greenhouse gas emissions, carbon trading practices and policy frameworks. This strategy will make sure that the research is based on literature available and will present an overview of the topic.

6. Carbon Credit Trade

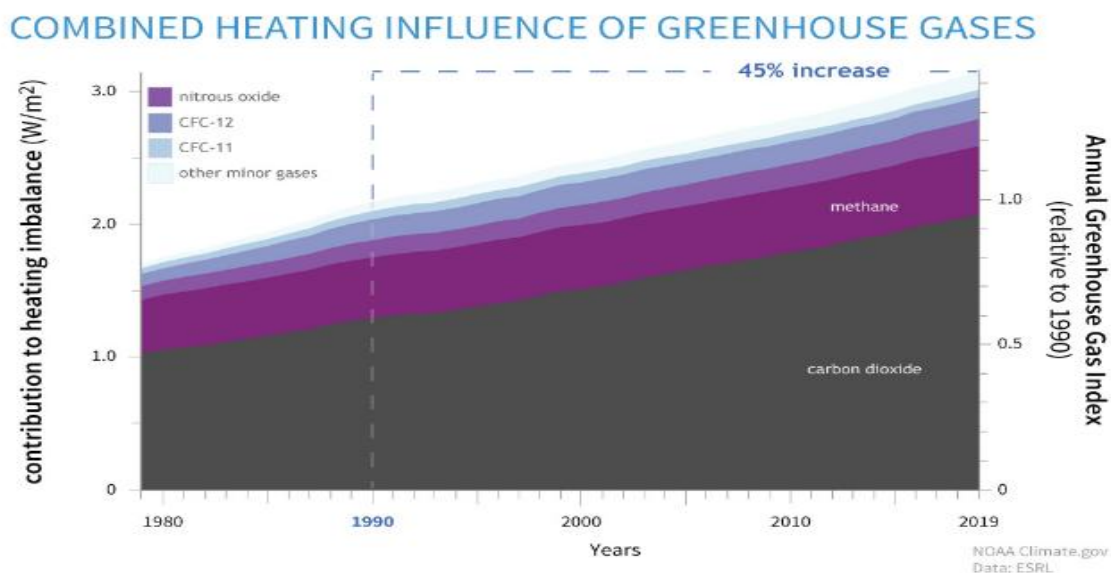
Carbon credit trade is also a significant instrument of monitoring and realizing the goals of emission reduction stipulated in the United Nations Framework Convention on Climate Change. One of the most significant greenhouse gases, carbon dioxide is very crucial in controlling the heat levels on earth, by trapping heat in the greenhouse effect, but excessive emission has thrown off this natural balance leading to global warming. The steep increase in the concentration of greenhouse gases which has been chiefly as a result of human activities including the burning of fossil fuels and deforestation has increased the level of concern on the environment around the globe. To deal with these issues, governments have come up with regulatory measures such as the Environment Protection Act 1986 India and the Hazardous Waste Management and Handling Rules 1989 India to contain pollution and safeguard natural resources.

Carbon credits are a market-based response to control emissions by use of systems like cap-and-trade where entities are assigned a certain amount of emissions, which decrease with time. Companies which produce less than their quota can buy excess credits, which will generate a financial incentive to reduce pollution. Carbon trading in India is majorly

applied under the Clean Development Mechanism that allows the developed nations to invest in developmental projects of emission reduction in the developing nations where the rates are comparatively low. One metric ton of carbon dioxide is referred to as the carbon credit and can be purchased, sold, or held based on the performance of an organization. This strategy will motivate industries to use cleaner technologies and increase their energy efficiency.

Carbon in itself is a basic element that is present in the atmosphere, oceans, soil, and living organisms and is a key component in the maintenance of ecological balance in the form of carbon cycle. Although the green house effect plays a crucial role in life sustainability, high emission of carbon dioxide has resulted in abnormal increase in global temperatures. Researchers have shown that the concentration of carbon dioxide in the atmosphere has risen tremendously since the industrial revolution because of the unremitting human processes. The international climate change awareness started to form with key events like the First World Climate Conference 1979, which also raised the issue of the necessity of international action. In sum, effective application of carbon trading systems and having a clear understanding of carbon processes is vital to ensuring a low-carbon future and sustainable development.

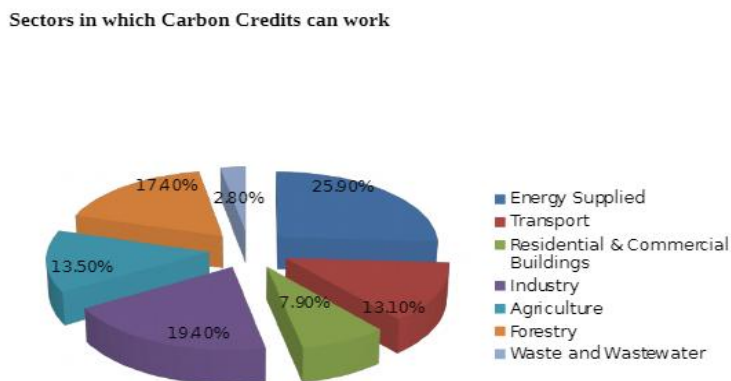
Graph 1 showing the combined heating influence of Greenhouse Gases



Source: 2019 AGGI report/NOAA Climate Gov Data: ESRL

The graph compares the change in the energy balance of the Earth based on the amount of watts per square meter to pre-industrial levels about 1750 and shows the effect of major human-induced greenhouse gases (carbon dioxide, methane, nitrous oxide, chlorofluorocarbons (CFC-11 and CFC-12), and a few minor contributors). It indicates that the current climate system is taking in excess of 3 watts of extra solar energy each square meter, which means a definite tendency towards warming. The 2019 Annual Greenhouse Gas index published by National Oceanic and Atmospheric Administration reported that the overall warming impact of major greenhouse gasses has grown about 45 percent since 1990, another indication of the increasing human activity on the climate system on Earth.

Graph 2 showing the sectors in which carbon credits work



Source- Extracted from Mudgal - A Case Study: Ajay K. Garg, Satyendra Arya and Rakesh K.

The mechanisms of carbon credits are offering massive opportunities in various sectors and the most visible and sensitive one with the highest participation is the energy sector, which comprises 25.90% of all the participation. The industrial sector is the second-largest contributor with the share of 19.40, which indicates the increasing number of emission reduction and sustainability projects carried out by industries. Forestry is also crucial with its contribution of 17.40 since afforestation and reforestation activities also aid in carbon sequestration and credit generation. Agriculture sector, which is highly government-sponsored in most countries, has a portion of 13.50, and it has potential with sustainable agricultural practices and land-use. On the same note, the transportation industry contributes 13.10 per cent, with increased fuel efficiency and the implementation of cleaner technologies providing opportunity to reduce the emission. The residential and commercial buildings contribute 7.90 because the emissions are caused by the use of electricity and other household and operational processes and they are therefore appropriate in carbon credit interventions. Finally, waste management though comparatively minor with the share of 2.80 is a significant field where efficient use of waste and wastewater treatment can result in definite emission cuts and production of carbon credit.

6.1. Cap-and-Trade System and Usage of Carbon Credits

Cap-and-trade is a popular method of controlling carbon and other pollution of the atmosphere by establishing a fixed number of emissions that an organization or entity is allowed to emit, but is free to trade to achieve this. In this system, any organization which emits below its allowed quota can sell its unused quota to others who exceed the limit thus creating a market incentive to reduce emissions. The major part of this system is the Carbon Emission Reduction (CER) certificate whereby one carbon credit is earned per metric tonne of greenhouse gases reduced, avoided or removed in particular projects or activities. The carbon credits are generated world wide by programs which capture greenhouse gases in the atmosphere or prevent its emission and every verified reduction leads to the generation of one credit. Such credits are not only beneficial in environmental protection, but also economic benefits; an example is that communities and indigenous groups have used the revenues generated by the sale of carbon credit to purchase land, enhance infrastructure and sustainable development whilst conserving the natural resources. The idea to make greenhouse gas emissions a commodity appeared under the Kyoto Protocol particularly with the developed countries being allocated emission limits in units like Assigned Amount Units (AAUs). The surplus emission allowances of countries could be sold to those who exceed their quota hence creating the carbon market. Besides AAUs, there are other tradable units Removal Units (RMUs) of forestry activities, Emission Reduction Units (ERUs) of joint implementation projects, and Certified Emission Reductions (CERs) of clean development mechanisms, all equal to one tonne of CO₂. International registry systems are used to monitor such transactions in order to achieve transparency and compliance. A mechanism designed to deter any country who over sells its allowance and cannot fulfill its pledge is the so called commitment period reserve where each country must hold a certain number of units of emission in its registry. By integrating environmental accountability and economic factors, the cap-and-trade system and the use of carbon credits, in general, are effective in ensuring sustainable practices.

7. Carbon Credit Trade – Future Prospect

EU climate targets for 2050 and 2030

By 2050, the EU has made efforts to ensure that its greenhouse gas emission is cut to between 80 and 95 per cent of its level in 1990. That ruling can be reconciled with the cuts that, based on the Intergovernmental Panel on Climate Change (IPCC), the group of industrialized nations should make in case the rise of temperatures in the world is to be kept to two degrees Celsius above the pre-industrial levels. This goal has to be reconsidered against the backdrop of the long-term international goals outlined in the Paris Agreement. Europe, too, like other leading economic zones of the world, needs to increase its aspirations. Germany accepts that it has a role to play to ensure that it makes an appropriate and fair contribution to achieving the European climate target. Member States that are economically powerful ought to contribute according to their capabilities, within the EU climate goal. In the case of Germany, it should be kept in mind that since the year in which the greenhouse gas emissions are referred to is 1990, the reduction in the number of greenhouse gas emissions in eastern Germany after the reunification can be factored in. The long-term climate objective is supposed to be a driver and a standard in target setting by the EU in the medium term.

Area of action	1990 (in million tonnes of CO ₂ equivalent)	2014 (in million tonnes of CO ₂ equivalent)	2030 (in million tonnes of CO ₂ equivalent)	2030 (reduction in % compared with 1990)
Energy sector	466	358	175 – 183	62 – 61 %
Buildings	209	119	70 – 72	67 – 66 %
Transport	163	160	95 – 98	42 – 40 %
Industry	283	181	140 – 143	51 – 49 %
Agriculture	88	72	58 – 61	34 – 31 %
Subtotal	1209	890	538 – 557	56 – 54 %
Other	39	12	5	87%
Total	1248	902	543 – 562	56 – 55 %

In October 2014, the European heads of state and government were in agreement of the 2030 targets. The European Council was able to agree upon the reduction of greenhouse gas emissions in the EU by at least 40 per cent by 2030 in comparison to the situation in 1990. The target to be met by increasing the use of renewable was established at least 27 per cent of final energy consumption.

The energy efficiency target is also 27 per cent (at least) (compared with the business-as-usual scenario). German government favors increasing the EU energy efficiency target of 2030 to 30 per cent.

8. Conclusion:

To sum up, carbon credit trading has become so that it can be used as a market-based initiative that aims at reducing greenhouse gas emissions as well as enhancing environmental sustainability. It places economic value on carbon emissions thereby encouraging organizations to use cleaner technologies, use more energy-efficient technologies, as well as orient their operations towards sustainable practices. The paper notes that although carbon markets have played a significant role in ensuring that the world is experiencing quantifiable emission cuts, their success highly hinges on the presence of strong regulatory policies, open markets, and stable prices.

Carbon credit trading in the Indian market has huge potential opportunities in the face of rising investments in renewable energy and rising environmental awareness. Nevertheless, there are still difficulties like the uncertainty of policy, the small and medium enterprises, and the absence of well-organised domestic carbon market that hinders its full potential. To solve these problems by means of enhanced institutional support, explicit policy principles, and enhanced monitoring systems are critical in making markets efficient.

Moreover, as the world increasingly devotes itself to net-zero emissions, carbon markets will be instrumental in climate policies of the future. However, the concerns of price volatility and unequal participation by the global are still major issues. Hence, enhancing global collaboration, the market design, and incorporating social equity factors are crucial in making carbon credit systems successful in the long term. On the whole, carbon credit trading has enormous potential in terms of helping to achieve climate targets globally and facilitate the process of transition to a low-carbon and sustainable economy.

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