

Carbon Credits: Climate Solution or Greenwashing Tool? A Mixed-Methods Analysis of Public Discourse and Market Trends



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Abstract

This study investigates whether carbon credits are perceived as a credible climate mitigation mechanism or merely a form of corporate greenwashing by examining the gap between institutional narratives and public discourse. Introduced under the Kyoto Protocol in 1997, carbon credits were designed as a market-based instrument to reduce greenhouse gas (GHG) emissions and support organizations in achieving net-zero targets. Governments, corporations, and international organizations have consistently promoted carbon credits as an effective pathway towards decarbonization and sustainable development. However, recent investigations have raised concerns regarding the environmental integrity and effectiveness of voluntary carbon markets. Reports evaluating projects certified by major registries, particularly Verra, suggest that a substantial proportion of carbon credits failed to deliver the emission reductions claimed. Independent assessments further indicate that only a limited share of certified projects generated measurable and additional climate benefits. This growing discrepancy between institutional claims and empirical evidence has contributed to increasing public skepticism, with carbon credit frequently being criticized as instruments of greenwashing rather than genuine climate solutions.

This study adopts mixed-methods research design by integrating qualitative and quantitative analytical techniques. Data were collected from multiple digital platforms, including Quora, Reddit, X (formerly Twitter), Facebook, corporate sustainability reports, and published research articles. Public attention and online engagement were examined using Google Trends data from 2015 to 2024 and Talkwalker social listening analytics. Sentiment analysis was conducted using the Valence Aware Dictionary and Sentiment Reasoner (VADER), which classified public opinions into positive, neutral, and negative categories. A word cloud was developed to identify the dominant themes discussed in relation to carbon credits. In addition, Exploratory Data Analysis (EDA) was employed to examine relationships among issued, retired, and outstanding carbon credits, while market size projections were analysed to evaluate financial trends within the voluntary carbon market.

The findings reveal a significant increase in public interest in carbon credit after 2021, primarily driven by COP26 commitments, corporate net-zero pledges, and growing climate policy discussions. Google Trends data indicate a marked increase in search activity during 2023 and 2024, corresponding with regulatory developments and greater emphasis on nature-based carbon removal initiatives. Market analysis further demonstrates that the voluntary carbon market, valued at approximately USD 2.0 billion in 2022, is projected to grow at a compound annual growth rate (CAGR) of 34.6% through 2030. Renewable energy projects constitute the largest market segment, followed by afforestation, reforestation, and energy-efficiency initiatives. Despite this rapid market expansion, sentiment analysis indicates that public discourse remains largely skeptical, with concerns centered on transparency, accountability, and the actual environmental effectiveness of carbon credit projects. The study highlights a substantial trust gap between governments, corporations, and the public, emphasizing the need for stronger governance, rigorous verification standards, and transparent communication to improve the credibility and effectiveness of carbon markets in supporting global climate mitigation objectives.

Keywords- carbon credit, carbon market, trading, emission, projects, government, pollution, policy, energy, offset, footprint, net zero

Introduction

Climate change has emerged as one of the most pressing global challenges of the twenty-first century, prompting governments, international organizations, and businesses to adopt innovative mechanisms for reducing greenhouse gas (GHG) emissions. Among these mechanisms, carbon credit has gained significant prominence as a market-based approach for achieving emission reduction targets while supporting sustainable development. Introduced under the Kyoto Protocol in 1997, carbon credits were designed to encourage cost-effective mitigation by allowing countries and organizations to offset their emissions through investments in certified climate projects. This framework enabled developed nations to finance emission reduction initiatives in developing countries while earning tradable carbon credits, thereby promoting international cooperation in addressing climate change (ClimateSeed, 2025). A carbon credit generally represents the reduction or removal of one metric tons of carbon dioxide equivalent (CO₂e), making it the fundamental unit of carbon trading in both compliance and voluntary carbon markets (Singapore's Carbon Markets Cooperation).

Over the past two decades, carbon credits have evolved from a policy instrument into a central component of global corporate sustainability strategies. Organizations across industries increasingly rely on carbon offsets to achieve environmental, social, and governance (ESG) objectives and fulfil ambitious net-zero commitments. Governments and international institutions continue to advocate carbon markets as an efficient mechanism for mobilizing private investment towards renewable energy, afforestation, reforestation, energy efficiency, and other climate-positive projects, particularly in regions where direct emission reduction remains technologically or economically challenging (Cheong, 2025). Consequently, voluntary carbon markets have expanded rapidly, attracting substantial investments and becoming an important pillar of global climate finance.

Despite this rapid expansion, the environmental credibility of carbon credits has become increasingly contested. Although carbon markets are frequently presented as transparent and scientifically verified mechanisms capable of accelerating decarbonization (Merger & Pistorius, 2011), recent investigations have raised serious concerns regarding the quality and effectiveness of certified offset projects. Independent assessments of projects certified by Verra, one of the world's largest carbon credit registries, reported that more than 90% of rainforest carbon credits failed to produce the environmental benefits they claimed, primarily because of inflated baseline assumptions and inadequate demonstration of additionality (Greenfield, 2023). Similarly, a comprehensive meta-analysis conducted by researchers at the Technical University of Munich concluded that fewer than 16%

of evaluated carbon credit projects generated measurable and additional greenhouse gas emission reductions (TUM, 2025). These findings have intensified concerns that carbon credit may allow organizations to claim climate neutrality while making only limited contributions to actual emission reductions.

The growing body of evidence questioning the effectiveness of voluntary carbon markets has fundamentally altered the public discourse surrounding carbon credits. Rather than being viewed exclusively as an innovative climate mitigation instrument, carbon credits are increasingly criticized as facilitating corporate greenwashing by allowing organizations to project an environmentally responsible image without undertaking substantial operational decarbonization (Gregory Trencher *et al.*, 2024; Rohini Pande, 2024). Greenwashing concerns are particularly significant because they undermine public confidence in climate policy, reduce stakeholder trust, and weaken the credibility of broader sustainability initiatives (Abadie *et al.*, 2024; Denton *et al.*, 2020; van der Gaast *et al.*, 2016). The controversy surrounding carbon credit therefore extends beyond environmental performance and encompasses issues of transparency, accountability, governance, and corporate legitimacy.

Public perception has become a critical determinant of the long-term success of climate policy instruments. Digital platforms have transformed the way environmental issues are discussed, debated, and interpreted, enabling citizens to actively evaluate corporate sustainability claims and governmental climate policies. Social media platforms such as Reddit, Quora, X (formerly Twitter), and Facebook have become important spaces where diverse stakeholders' express opinions, challenge institutional narratives, and disseminate information regarding climate action. Consequently, analysing public discourse provides valuable insights into the level of societal trust associated with carbon markets. Unlike conventional surveys, digital platforms generate large volumes of unsolicited public opinions that reflect evolving perceptions in real time, making them particularly valuable for understanding emerging environmental controversies.

Previous research demonstrates that media narratives play a significant role in shaping public acceptance of climate-related technologies and policies. Donnison *et al.* (2023), for example, examined public discourse surrounding Bioenergy with Carbon Capture and Storage (BECCS) in the United Kingdom and reported that media narratives strongly influenced public acceptance by framing the technology either as an essential climate solution or as an environmentally risky intervention. The study highlighted that positive regional narratives often reflected perceived economic benefits, whereas national media frequently emphasized environmental

uncertainties. These findings illustrate how communication influences the social legitimacy of climate mitigation technologies and underscore the importance of public discourse in determining policy acceptance.

Similarly, Ye and Qi (2025) demonstrated that media reporting on carbon trading significantly contributes to the green transformation of Chinese firms by increasing public attention, improving corporate accountability, reducing financing constraints, and encouraging investment in environmental research and development. Their findings suggest that media visibility enhances organizational commitment towards sustainability while simultaneously increasing stakeholder expectations regarding environmental performance. As public scrutiny intensifies, organizations are expected not only to communicate sustainability commitments but also to provide credible evidence supporting their environmental claims.

Conversely, recent governance-focused research has questioned whether current voluntary carbon markets possess sufficient regulatory oversight to ensure environmental integrity. Trouwloon *et al.* (2023) argued that many organizational carbon neutrality claims rely heavily on offsetting mechanisms without demonstrating genuine emission reductions. Their study emphasized that inconsistent disclosure practices, inadequate verification procedures, and weak governance frameworks create opportunities for misleading environmental claims. The authors further recommended stronger monitoring systems, standardized reporting practices, and transparent verification mechanisms to improve accountability within voluntary carbon markets.

While previous studies have substantially advanced understanding of carbon credit effectiveness, governance, and organizational disclosure practices, important research gaps remain. Existing literature predominantly examines either the technical performance of carbon offset projects, policy frameworks, or corporate sustainability reporting. Comparatively limited attention has been devoted to understanding how public perceptions evolve alongside the rapid expansion of voluntary carbon markets. Furthermore, few studies integrate social media analytics, sentiment analysis, digital search behaviour, and market trends to provide a comprehensive assessment of both public opinion and market dynamics. Given that public trust represents a fundamental prerequisite for the long-term success of market-based climate instruments, understanding this relationship has become increasingly important.

The present study addresses this gap by investigating whether carbon credits are perceived as a genuine climate solution or as a mechanism for corporate greenwashing. Specifically, the study integrates multiple data sources, including Quora, Reddit, X (formerly Twitter), Facebook, corporate reports, and published literature, with Google Trends data from 2015 to 2024 and Talkwalker social listening analytics

to examine public discourse surrounding carbon credits. Sentiment analysis using the Valence Aware Dictionary and Sentiment Reasoner (VADER), word cloud visualization, and Exploratory Data Analysis (EDA) are employed to analyse public opinion alongside market indicators such as issued, retired, and outstanding carbon credits and voluntary carbon growth projections. By combining behavioural insights from digital platforms with financial market analysis, the study provides a comprehensive understanding of the disconnect between institutional narratives and public perceptions. The findings contribute to the growing literature on climate finance, sustainability communication, and environmental governance while offering practical recommendations for policymakers, corporations, and regulatory agencies seeking to strengthen transparency, accountability, and public trust in carbon credit markets.

Literature Review

The rapid expansion of voluntary carbon markets has attracted considerable academic attention regarding their environmental integrity, governance, and public acceptance. Although carbon credit continues to be promoted as an effective market-based mechanism for achieving net-zero emissions, an increasing body of literature questions whether they generate meaningful climate benefits or merely provide organizations with an opportunity to project an environmentally responsible image. Existing studies primarily focus on credit quality, transparency, governance, consumer trust, and sustainability communication, suggesting that the long-term credibility of carbon markets depends not only on financial growth but also on public confidence and effective regulatory oversight.

One of the most prominent concerns surrounding voluntary carbon markets relates to the quality and effectiveness of certified carbon credits. Empirical evidence indicates that the environmental benefits claimed by many offset projects are often overstated. Probst *et al.* (2024) reported that only approximately 16% of issued carbon credits could be considered environmentally credible and capable of delivering measurable emission reductions. The study emphasizes that the gap between claimed and actual climate benefits necessitates stronger regulatory oversight, transparent verification systems, and greater accountability within carbon markets. Without rigorous governance mechanisms, organizations may continue to rely on carbon credits to overstate their environmental performance, thereby reinforcing concerns regarding corporate greenwashing.

Public perception represents another important dimension influencing the success of climate mitigation policies. Kochling (2025) introduced the concept of the carbon perception gap, describing the tendency of individuals to underestimate their own carbon footprint while believing that others

contribute more significantly to greenhouse gas emissions. Although respondents acknowledged climate change as a serious environmental challenge, many believed that they were already making adequate contributions toward sustainability. This perception highlights a disconnect between environmental awareness and behavioural change, indicating that public understanding of carbon emissions remains limited despite increasing climate consciousness. The findings suggest that effective communication strategies are essential for improving environmental literacy and encouraging meaningful behavioural change.

Corporate sustainability communication has also become a major area of investigation. As organizations increasingly announce ambitious net-zero and carbon-neutral commitments, concerns have emerged regarding the credibility of these claims. Trouwloon *et al.*, (2023) reviewed corporate carbon neutrality disclosures and argued that the absence of standardized regulatory frameworks allows organizations to make broad environmental claims without adequately demonstrating actual emission reductions. The study recommends stronger disclosure requirements and independent verification mechanisms to evaluate whether public sustainability commitments accurately reflect organizational actions. Improving the transparency and comparability of corporate carbon claims is therefore considered essential for strengthening stakeholder confidence and reducing misleading environmental communication.

Consumer attitudes towards different carbon reduction strategies have also received increasing scholarly attention. Chu (2025) compared consumer perceptions of inseting, which involves reducing emissions within an organization's own operations, and offsetting, which relies on purchasing external carbon credits. The findings revealed that consumers considered setting initiatives to be more authentic and credible than offsetting strategies. Organizations demonstrating measurable internal emission reductions generated higher levels of consumer trust and stronger purchase intentions than those relying primarily on carbon offsets. The study concludes that consumers increasingly value tangible sustainability initiatives over symbolic environmental commitments. Similar findings were reported by Haug (2023), who applied the Theory of Planned Behaviour to examine perceptions of voluntary carbon offsetting among young consumers in Denmark. Although participants expressed considerable concern regarding climate change, they possessed limited knowledge of voluntary carbon markets and perceived carbon offsetting as complex and difficult to understand. Respondents also expressed low confidence in corporate environmental claims and questioned the effectiveness of offsets in addressing climate change. High costs, inadequate information, and low institutional trust further reduced their willingness to participate in voluntary carbon markets. The study

concludes that improving transparency and communicating carbon market mechanisms in a clear and accessible manner are essential for increasing public engagement and trust.

Transparency has consistently emerged as one of the most significant challenges confronting voluntary carbon markets. Delacote (2024) argued that limited disclosure regarding project locations, baseline methodologies, financial transactions, and benefit-sharing arrangements significantly undermines market credibility. The lack of publicly available information restricts independent verification of environmental and social outcomes, making it difficult for stakeholders to distinguish between high-quality and low-quality carbon projects. The study recommends comprehensive disclosure of transaction records, project costs, revenue allocation, and community benefits to improve accountability and strengthen confidence in voluntary carbon markets.

The rapid growth of voluntary carbon markets has also intensified concerns regarding their future sustainability. Kreibich and Hermwille (2021) examined the evolution of voluntary carbon markets following the Paris Agreement and highlighted a growing imbalance between increasing corporate demand for carbon credits and the limited supply of high-quality offsets. Their review demonstrated that hundreds of multinational corporations have incorporated carbon credits into their net-zero strategies, particularly in hard-to-abate sectors such as aviation, steel, cement, and energy. However, the transition from the Kyoto Protocol to the Paris Agreement fundamentally altered international carbon accounting by requiring all countries to account for emission reductions through Nationally Determined Contributions (NDCs). This transformation introduced new governance challenges, including the risks of double counting and declining credit quality. The authors caution that, without stronger political support and operational safeguards, increasing market demand could encourage the proliferation of low-quality credits, thereby weakening global climate ambitions.

The ambiguity surrounding corporate climate terminology further complicates stakeholder understanding. Trouwloon *et al.* (2023) observed that organizations frequently use the terms carbon neutral, net zero, and carbon offsetting interchangeably, despite representing different climate strategies. Such inconsistent terminology creates confusion among stakeholders and makes it difficult to assess the ambition and credibility of corporate climate commitments. Their analysis further revealed that although voluntary carbon market transactions exceeded 164 million tons of CO₂e in 2022, fewer than one-quarter of corporate offset claims disclosed sufficient information regarding credit type, quality, or vintage. The absence of standardized reporting practices and transparent disclosure reinforces public skepticism and strengthens concerns regarding corporate greenwashing.

Governance remains one of the most important determinants of carbon market credibility. Schneider and La Hoz Theuer (2019) argued that the implementation of the Paris Agreement fundamentally transformed international carbon markets by requiring internationally transferred mitigation outcomes to contribute towards national climate commitments. While Article 6 introduced mechanisms intended to improve environmental integrity, the authors identified three major risks that continue to threaten the effectiveness of global carbon markets: double counting, inflated baseline estimates, and non-additional projects. These shortcomings may generate hot air credits that create the appearance of climate action without delivering genuine environmental benefits. The study concludes that transparent accounting systems, harmonized international standards, and robust governance frameworks are essential for ensuring that carbon markets contribute meaningfully to climate mitigation rather than facilitating nominal compliance.

Collectively, the existing literature demonstrates that although carbon credits remain an important component of international climate policy, substantial concerns persist regarding their environmental effectiveness, governance, transparency, and public acceptance. Most previous studies have examined either the technical performance of carbon offset projects or governance and disclosure challenges. Comparatively limited research has integrated public sentiment, digital discourse, and market dynamics to examine whether the rapid growth of voluntary carbon markets has been accompanied by increasing public trust. Addressing this gap, the present study combines sentiment analysis, social media analytics, Google Trends, Talkwalker analytics, and market trend analysis to provide a comprehensive assessment of the disconnect between institutional narratives and public perceptions of carbon credits.

Methodology

Objectives of the Study

1. To assess public perception and sentiment (positive, negative, and neutral) toward carbon credits as expressed across social media and digital platforms.
2. To examine the frequency, timing, and geographic distribution of carbon credit discussions online, identifying patterns in public interest over the past decade.
3. To explore how carbon credits are discursively framed, as either a legitimate climate mitigation mechanism or a corporate greenwashing tool, based on positive and negative discourse themes.
4. To analyze the growth trajectory, project type composition, and market size projections of the global voluntary carbon credit market.

Data Collection:

A comprehensive data approach was utilized, and data was gathered from various social media responses

from platforms like Twitter, Reddit, Quora, blogs, research paper and organizations involved in carbon credit.

Timeline and Reach Analysis:

Data for timeline analysis was taken from Google trends for last 10 years showing the highs and lows in the topic and what caused the discussion to peak at certain points while dipping at others. Reach analysis was done for last 7 days using Talkwalker data to gain insight into what kind of people are searching for information related to carbon credits and what opinion they are exerting based on this.

Sentiment Analysis:

Sentiment analysis was conducted using the VADER sentiment analysis tool to segment the social media responses into positive, negative and neutral. This analysis provided insights into what general audience was talking about carbon credits concept and what their perception about this mechanism is and the way it is portrayed in the media by organization and policy makers.

Word Cloud:

Word clouds were created using articles and blogs from editorial and social media to show what is portrayed in the media by companies and policymakers in comparison to what is being perceived by normal audiences. It showed the buzz words people are talking about, highlighting words of high relevance and discussion and giving a quick crux to the whole discussion.

EDA Analysis:

For the exploratory data analysis (EDA), we made use of data from the Berkeley Voluntary Carbon Offset Report that gives us insights into the distribution of issued credits, retired credits, and credit remaining. In analysing this dataset spanning from 2014 to 2020, we used visualization methods such as a correlation heatmap to study inter-variable relationships and scatter plots to study distribution patterns and possible trends.

Market Size Analysis:

For market research analysis, we utilized the Voluntary Carbon Market Report from Grand View Research (Carbon Credits, 2025) that gives information on market size, pricing mechanisms, regional distribution, and growth drivers. A secondary data analysis method was utilized to extract and synthesize insights, both supply-side factors (issuance, pricing, regional trends) and demand-side factors (corporate commitments, regulatory impact)

Results And Analysis

1.Trend/Timeline Analysis

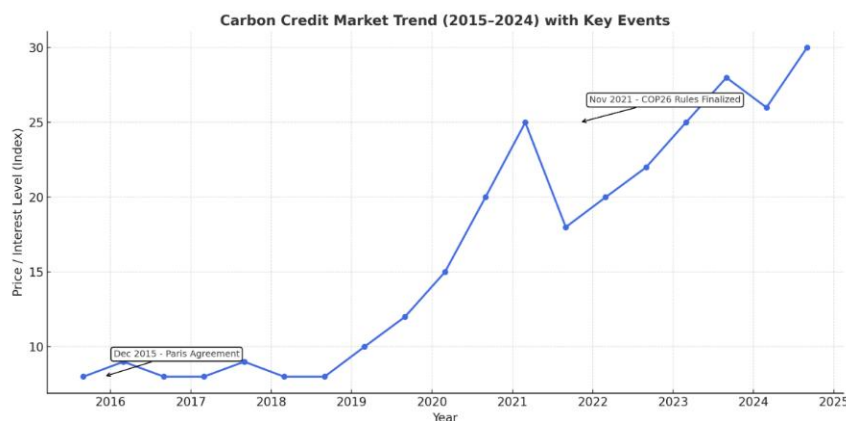
The interest of the carbon credit market between August 2015 and the end of 2024 in terms of timeline indicates a pronounced upward trend, as well as the

periods of growth, stability, and fluctuation. The period between 2015 and about mid 2018 saw the market activity being flat, which is an indication of little focus on carbon credits.

Interest began to grow gradually between the end of 2018 and the beginning of 2020. This was probably affected by the rising global debates on climate

change, heightened corporate sustainability projects, and policy debates before the 2019 UN Climate Action Summit (Fig.1). Nevertheless, at the beginning of 2020, the COVID-19 epidemic slightly decreased the pace due to the shift of the attention of many businesses to the short-term operational challenges.

Figure 1 : Carbon Credit Market Trends with Key Event



Source: Google Trends (<https://trends.google.com/trends/explore>)

Another significant shift is noticed since the year 2021 when the trend curve has been on a continuous and consistent upward slope. This is in line with the economic recovery after the pandemic, increased climate commitments on COP26 (November 2021) and the appearance of more companies in voluntary carbon markets as part of their net-zero plans. The greatest peak is in the late 2023-November 2024 period, when the interests are at peak. Some of the factors that may have come together to cause this increase in the number of applications are the tightening of corporate reporting requirements, the impending regulatory changes in carbon accounting, and the growing pressures of nature-based removal

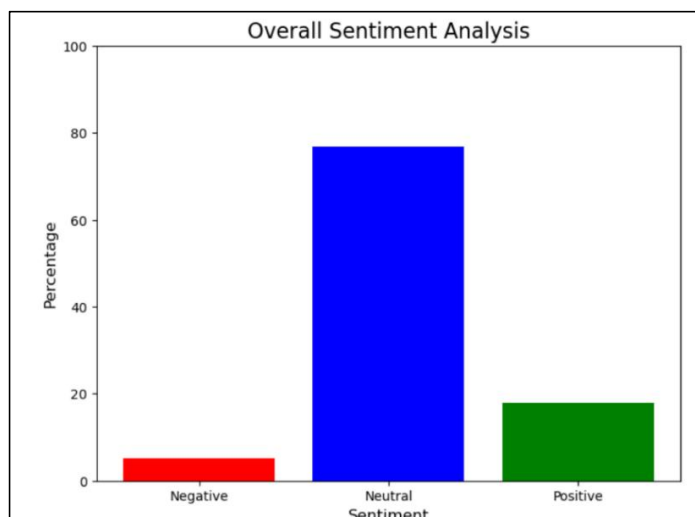
projects.

Generally, the trend indicates that the carbon credit market has ceased to be a niche environmental tool to being a mainstream business issue in the past decade. The sharp rise after 2021 demonstrates an accelerated adoption process.

2.Sentiment Analysis

Sentiment analysis of various social media avenues (Fig.2) was used to understand the perception of the masses concerning the subject matter. The text was divided and classified into Negative, Neutral and Positive sentiments. The results indicate that there are mostly neutral and straightforward positive inclinations in the opinionated parts.

Figure 2 : Overall Sentiment Analysis about Carbon Credit



Source: Around 500 comments extracted from different social media platforms (Authors own analysis using NLP)

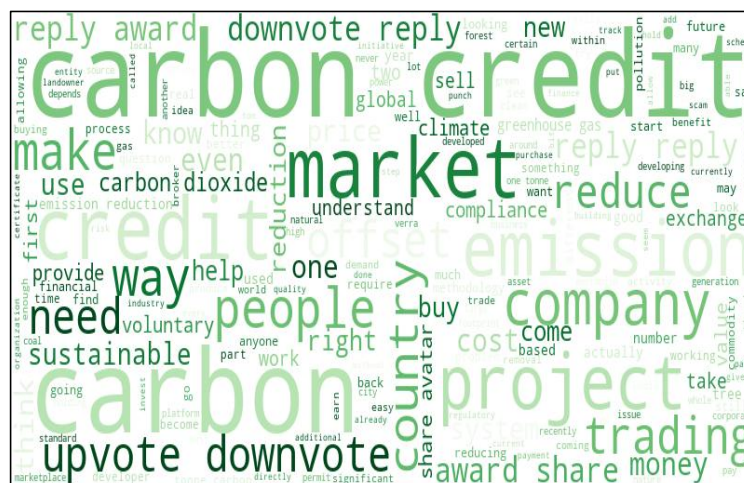
The sentiment overall, as the bar chart illustrates and the aggregated data validates, is Neutral with 76.8% of the total conversation constituting it. This implies that the greater part of the popular speech is not an opinion-based speech, but one that is factual, objective, or informational.

Social medias	Negative	Neutral	Positive
Reddit	5.9%	76.7%	17.4%
Twitter	4.7%	71.7%	23.6%
Quora	4.6%	78.5%	16.9%
Instagram	5.6%	80.3%	13.7%
Overall	5.2%	76.8%	17.9%

This means that there are over three positive comments per negative comment which puts the number of negative comments at an extremely favourable ratio of opinions amongst the engaged

A platform-based analysis indicates that all channels are very neutral, but Twitter is most opinionated and positive, with 23.6 percent of the content in Twitter expressing a positive opinion. Instagram, in its turn, is the most neutral site, and the least proportion of positive comments. On all social media, the level of negative sentiment is always low, with an average of 5%.

Figure 3 : Positive Word Cloud about Carbon Credit



The following insights are obtained after analysis is performed on positive comments, according to the keywords (Fig.3). The discourse is that the carbon credit system is a proactive and accessible market that individuals and companies can engage in. It is highly felt as to there being a functional marketplace within which the participants can sell, buy, and trade credits and this is not seen as an obligation but as a practical means of making a difference. The discussion

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is constantly connected to such market operations as positive environmental effects, and there are references to the fact that such projects contribute to the climate, contribute to sustainable development, and directly decrease carbon dioxide and other greenhouse gases through projects in renewable energy and forest protection. Moreover, the discussion seems to be held in an active online community, as such terms as share, reply, upvote, and downvote are used, which means that the users are making efforts to learn and analyze the choices. Such an interested audience demonstrates the need of quality and legitimacy as well: when buying the

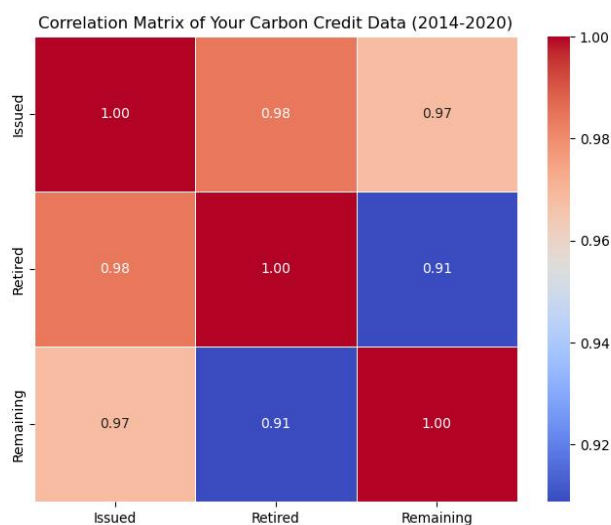
Verra, to be sure that the purchased reduction is real and effective.

[illegible]

On the other hand, a negative analysis of the negative discourse shows (Fig.4) that there is an opinion regarding the carbon credit structure as a defective and cumbersome system. The prevailing issue is concerned with the financial ramifications and terms such as money, pay and cost bring out the perception that credits are nothing more than another tax or financial penalty by the government. This is accompanied by a lot of frustration over the bureaucracy of the process and comments on policy, regulation, compliance as well as the intricate

documentation involved are often heard. The skepticism over how effective the system can be is deep-rooted and some are even employing harsh language such as calling it shit as a sign of their lack of trust in the system. One of the fundamental ideas of this story is that the market functions as a greenwashing instrument, which enables a polluting company or industry to pay to keep on burning fossil fuel and releasing greenhouse gases and in effect evade making dramatic changes. This brings to the conclusion that the whole effort is an issue that does not bring a real cut in emissions and hence is not an effective solution to climate change.

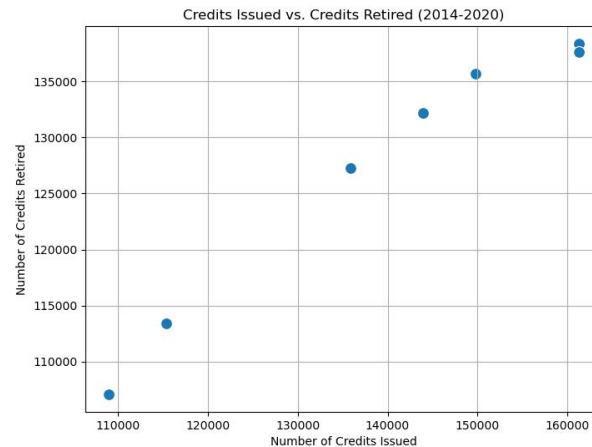
Figure 5 : Correlation Heatmap about Keywords related to Carbon Credit



Correlation Heatmap (Fig.5) indicates that during the years 2014 to 2020, the issuance of credits (supply), the

retirement of credits (demand), and the balance itself had very strong and positive relationships. The most notable one is the correlation of issues/retired credit which is almost perfect and is +0.98, showing that the market supply and demand increased in nearly the same direction.

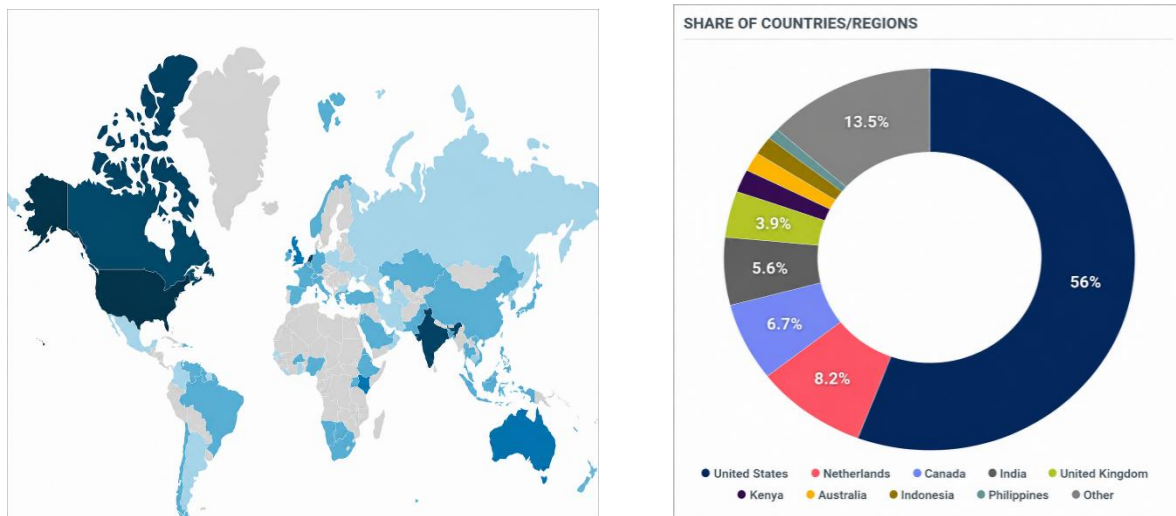
Figure 6 : Scatter Plot of Credits Issued vs. Credits Retired (2014-2020)



This strong relationship is statistically confirmed by the scatter Plot (Fig.6). It presents the points of data that are in a narrow upward-sloping line, which is a clear demonstration that during the years when more credits were issued, there were predictable high numbers of credits that were also retired.

5.Reach Analysis

Figure 7: Geographic Distribution of keyword Carbon Credit



Source: Talkwalker (https://app.talkwalker.com/app/page#/FREE_SEARCH)

Geographical distribution of the data indicates (Fig.7) a two-fold nature, in that there is extensive global distribution and extreme concentration in particular national centers. This shows that although the subject has got a wider global popularity, the amount of interaction is very high in some of the major territories.

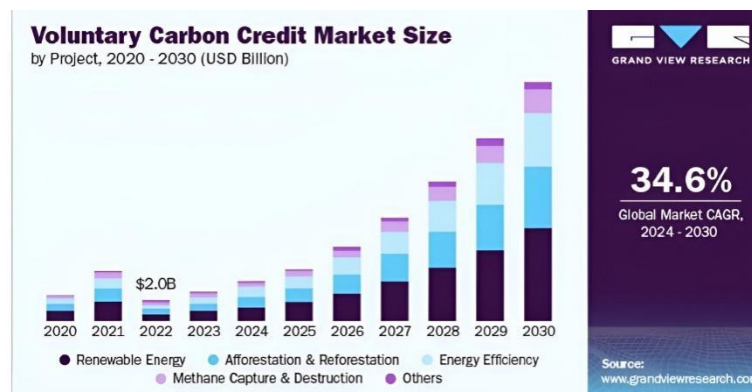
The most notable aspect of this distribution is that there is eminent dominance of the United States which unilaterally comprises most of the engagement, at an astonishing rate of 56 percent. This places the U.S. not as a large participant, but as the center of operation and discussion under analysis. This high level of concentration indicates that the topic of the subject has a special relevance and impact in the United States.

The second level of participation outside the U.S. is powerfully propelled by India, the European and other developed economies. The Netherlands has a large portion of 8.2% share and Canada has 6.7%. Another significant contribution of major Asian economies is also revealed in the data with a significant contribution of 5.6 percent by India. The United Kingdom (3.9%), and the other major countries such as Kenya, Australia, and the

Philippines are also noted to be engaged further.

6. Market size Analysis

Figure 8 : Market Size Projection for Carbon Credit



Source: Grand View Research(www.grandviewresearch.com)

The strongest trend is the strong growth trend of the market. The market is expected to increase at an outstanding Compound Annual Growth rate (CAGR) of 34.6 percent in the period between 2024 and 2030, having a base of 2.0 billion in 2022(Fig.8). This means that the demand of the voluntary carbon credits is rapidly increasing and by the end of the decade the market size will increase many folds. The only difference is that in 2023, a slight contraction is observed, and thereafter a growth phase that is sustained and quicker.

Renewable Energy Projects Dominance.

Renewable Energy projects lead the pack throughout the term by far being the biggest individual portion of the market. The category is the base of the market value, and it is expected to see the largest increase in the absolute dollar terms. Its domination underscores the importance of such projects as solar, wind, and hydropower in bringing forth many carbon credits.

Key Supporting Segments

The structure of the market is facilitated by other essential types of projects even though renewable energy is in the first position:

Afforestation and Reforestation: This segment is always the second biggest source of market. The significant and rapidly growing share indicates the growing significance of nature-based solutions in the voluntary carbon market. These are the essential projects to eliminate carbon and a major place of investment.

Energy Efficiency: The third pillar of the market is comprised of projects based on the enhancement of energy efficiency. This segment is also recording some steady growth, which is on the demand of credits created through lowered energy use and related emissions.

Niche and Other Segments

Smaller yet significant ones are projects with Methane

Capture & Destruction and a small group of collectively known Other. Despite their strong performance, their market presence is very low individually, their presence shows a diversified market that benefits from the use of different approaches aimed at reduced emissions.

CONCLUSION

The carbon credit market has transformed from its initial status as a niche environmental tool into a common business element during the past ten years. The timeline analysis shows that interest in the subject started to rise after mid-2018 and continued to increase throughout the study period. The period from 2021 onward experienced rapid growth because of three main factors, which included the post-pandemic economic recovery and the increased climate commitments made during COP26 and the rise of corporate net-zero initiatives. The market shows a significant increase in interest, which follows the financial development that started with \$2.0 billion in 2022 and is expected to grow at an impressive Compound Annual Growth Rate (CAGR) of 34.6% from 2024 to 2030. The market expansion mainly occurs through Renewable Energy projects, which remain the dominant market segment, while Afforestation & Reforestation and Energy Efficiency serve as important supporting sectors.

The discussion about this fast-expanding industry occurs worldwide but shows its most intense activity in particular countries. The United States leads all other countries as the main participant in the dialogue, which produces 56% of the talking and creates the central point for the discussion. The Netherlands provides 8.2% to the total, while Canada generates 6.7% and India contributes 5.6%. The analysis of sentiment in this discourse shows that 76.8% of it remains neutral, which indicates that the content serves different purposes. The opinionated parts of the text show a positive trend because positive

sentiment accounts for 17.9% of content, which exceeds negative content that only makes up 5.2%. Twitter users generate the highest amount of positive content, which reaches 23.6% of their total output, while all studied platforms maintain a steady pattern of negative content that constitutes a small fraction of their total output.

Two separate narratives emerge from the opposing emotional responses of the people. The positive view frames the carbon credit system as an accessible market which companies and individuals can use to advance sustainable development while decreasing their carbon emissions. The negative discourse views the framework as an imperfect system which creates excessive demands and people doubt its capacity to function while they worry about its potential use as a "greenwashing" mechanism that enables polluting companies to avoid environmental responsibility through financial penalties. Market analysis for the years 2014-2020 demonstrate that the system operated at a historical level of functionality which confirmed its operational status. The data from this period establishes a high positive correlation of +0.98 between credits issued (supply) and credits retired (demand) which demonstrates that supply increases resulted in matching consumption growth. The scatter plot shows a strong linear relationship which demonstrates that the market operated during that period with predictable growth patterns and balanced development.

LIMITATIONS OF THE STUDY

This study has multiple limitations associated with its data sources. It acknowledges the limitation in data posed by reliance on social media and other digital platforms, which is prone to be identified as AI generated content. The study relied on a small sample size for research related to market trend and public opinion for qualitative research and sentiment analysis. The data used for correlation analysis is from 2014-2020 which might miss out on the crucial developments which has taken place post 2020 and might not reflect the current market trend in the best manner.

CONFLICT OF INTEREST

No conflicts of interest are declared.

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