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RESEARCH ARTICLE

The Evolution of Environmental Marketing Strategies in the Age of Climate Awareness

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ABSTRACT

With mounting environmental concerns, corporate strategies have been continuously aligned to conform with environmentally sound practices. This research investigates the influence of sustainability-driven marketing strategies on corporate environmental performance (CET), specifically on CO_2 emissions reduction, energy efficient growth, effective waste management, and consumer perception and attitudes. Employing a multi-source dataset from a combination of corporate sustainability reports, consumer surveys and third-party audits, the research investigates the outcomes from comprehensive, moderate, and limited sustainability marketing strategies. Specifically, firms that adopt more long-term and transparent environmental marketing initiatives attain significantly higher reduction rates of CO_2 emissions and energy consumption, and waste management efficiency. Additionally, consumer perception analysis showcases that greater sustainability message transparency directly correlates with improved brand trust and heightened premium willingness-to-pay for sustainable qualities in products. Moreover, digital marketing strategies are found to play an analogous role, where organizations that invested in online channels reported substantially higher public sentiment and stakeholder interaction rates. The article emphasis a on need for transparency regulations regarding sustainability claims to ensure that what businesses commit to on the environmental front aligns with real, measurable results. The results suggest that companies should integrate sustainability communication deeply into their business and not limit it to an additional marketing activity. Future studies should uncover the long-term effects of sustainability marketing, best practices in industry for sustainable marketing and how new digital technologies may shape consumer environmental behavior.

Keywords: environmental marketing; corporate sustainability; consumer trust; CO_2 emissions; waste reduction; energy efficiency; digital sustainability

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1. Introduction

In our modern business landscape, environmental marketing has become one of the most important comparative strategies as customers are becoming increasingly aware of climate change, as well as other matters of corporate sustainability. In the past few decades, this field has grown from a fringe concern to a fundamental aspect of contemporary marketing, highlighting a world-wide need to combat environmental issues. As climate science has matured and public discourse has intensified, consumers have become increasingly savvy about what their shopping cart says about the environment. And in light of this, firms are reconsidering their marketing paradigms to be more in line with environmental principles, seeing sustainability as not only a moral obligation to the territory but also as a generator of competitive advantage [1].

Environmental marketing was confined to only a few eco-friendly brands. These early initiatives went a long way toward spotlighting product features, such as packaging and or energy designs that were biodegradable or efficient. But as ecological issues came to loom larger in the public consciousness, there was increasing demand for more substantive and transparent environmental claims. At the same time, allegations of "greenwashing," in which companies overstated or invented their environmental credentials, have made consumers cynical and raised doubts about whether corporations' sustainability claims are genuine. This shift was a watershed moment, challenging businesses to go beyond drawing the occasional smiley face and follow up with credible, more rigorously documented plans for sustainability [2].

The technological revolution has changed how organizations inform about environmental activities. Engaging directly with consumers can also be done in fresh and innovative ways with social media platforms and digital advertising channels, hearing about the latest sustainable initiatives and having discussions about continuous sustainability efforts. But these same platforms open companies up to greater public scrutiny. Misstatements or inaccurate assertions can propagate quickly and, in light of that, erode consumer trust and damage company reputation. The visibility this has garnered has forced organizations to be more transparent and accountable with their practices, so that their environmental marketing holds up to scrutiny [3].

At the same time, regulatory and industry standards are tightening, requiring businesses to substantiate their claims with verifiable data and evidence. Certifications (such as LEED), environmental reporting frameworks (GRI and others), and government regulations are now integral to environmental marketing." Those guidelines, companies in the United States and other nations must do more than follow the rules — they must rely on them to build trust with consumers. The lead and standardization required in these processes adds accountability, which has created a distinction between real and risks of greenwashing branding that has driven the maturation of the field [4].

Environmental sustainability has also affected overall decision making within companies by way of marketing strategies. The best in class have appointed sustainability as a strategic imperative, integrating environmental goals deep within their supply chains, product development processes, and core business models. In the process, they have also reshaped what environmental marketing means. But corporate responsibility has evolved beyond the realm of branding, and is now part and parcel of a company-wide commitment towards sustainability, not just on an environmental stewardship basis, but as a means for long-term financial outperformance as well [5].

There has been much progress, but challenges remain. The matter that remains constant as most businesses is measuring environmental impact and conveying these figures to create a clear message. Consumers want simple, credible information, but the underpinning data is often messy and hard to convey.

Companies must navigate this complexity but remain transparent and authentic. Moreover, navigating between immediate financial constraints and sustainable strategies for the long haul necessitates thoughtful strategies and creative solutions. However, organizations must ensure their green marketing activities align with not only consumer expectations but also broader social objectives such as carbon reductions and a circular economy [5].

Within this ever-changing environment, this paper traces the development of environmental marketing strategies. Drawing on the historical evolution of the field, an analysis of best practices both now and emerging, it covers how companies are responding to the perils and possibilities of increased climate consciousness. It showcases the best strategies that have yielded enterprises most effective in instilling consumer trust, inspiring brand loyalty, and generating impactful environmental results. The article provides insight into the need for business to contend with growing complexity of the sustainability-centric marketplace, and the need for both stock price and environmental good to increase simultaneously.

1.1. Aim of the article

This article intends to explore the evolution of environmental marketing strategies as well as the demand for sustainable business practice and the rising climate consciousness of consumers. Environmental marketing has transformed from a specialized focus into a ubiquitous approach in the past few decades, as public awareness of ecological problems has risen and organizations have been forced to show devotion to sustainability. This article investigates the critical factors behind this evolution, along with shifts in consumer behavior, the influence of digital platforms, and the effect of regulatory and industry standards.

The research shows the historical development of environmental marketing to shed light on the challenges volunteered by motivating businesses towards adding the logo of environmentalism into their marketing strategies. It also brings to attention the innovative solutions that have various success stories as well as best practices on how companies were able to gain credibility, build consumer trust, and be a competitive business in the segment. The article takes a closer look through identifying key campaigns that emphasize environmentalism, brand values, and brand loyalty as pivotal factors for long-term business success.

The article goes beyond the analysis on strategies existent, to address on the future of environmental marketing, focusing on aspects such as authenticity and transparency. It has the ambition of providing valuable context to managers hoping to slot into a sustainability-centric marketplace, as well as public officials, academics, and other voices involved in determining the vectors of environmental advertising going forward. The article seeks to add to our understanding of how firms can better align their marketing with wider environmental goals, illustrating how in the climate conscious age, sustainable practices need not be mutually exclusive with competitive advantage, and can indeed complement each other in potentially powerful and mutually reinforcing ways.

1.2. Problem statement

It is important to adapt Environmental marketing strategies as the awareness has risen on climate change and consumer sentiment has changed. However, these changes along with several other forces are creating real tension for businesses in balancing the need for genuine environmental practices while meeting competitive market pressures and financial performance expectations. While there is most definitely so much new demand for sustainable products and services, plenty of organizations are struggling to tell their environmental story in a genuinely believable and transparent way, resulting in consumer cynicism and so-called “greenwashing” accusations. The sheer complexity of measuring and verifying environmental impact,

along with this widespread skepticism – represents a major barrier for businesses trying to differentiate through sustainability initiatives.

However, the emergence of the digital age has also brought both new opportunities and threats to eco-marketing. While green businesses can communicate directly with eco-conscious groups, through social media, instant messaging and online advertising. But these platforms also magnify scrutiny, as consumers are able to quickly identify a lack of depth or integrity in a brand's claims. Increased exposure of corporate environmental strategies exposes businesses to a more rigorous degree of accountability and puts pressure on firms to evolve their approaches in order to retain legitimacy.

Furthermore, anti-greenwashing regulations are becoming stricter and stricter. Companies are tasked with providing verifiable evidence that they are following new laws, standards, and certifications. These moves are aimed at preventing false claims and enhancing transparency, but they can add new burdens on companies, which need to get used to a number of tangled reporting requirements and ever-changing regulations.

The convergence of these trends: consumer cynicism, digital scrutiny and regulatory pressure — speaks to the growing prominence of a more holistic, substantive and credible form of environmental marketing. The trick is executing on efforts that satisfy expectations and can withstand public relations and regulatory scrutiny, in order to create genuine trust and engagement over time. For companies that aim to navigate in a climate conscious and sustainability-driven marketplace, it's critical that they address this issue.

2. Literature review

For business and consumer issues, environmental marketing has grown from a narrow concept into an all-encompassing approach over the years. The early instances of scholarly inquiry into the field usually focused on how organizations could utilize eco-friendly practices to appeal to environmentally conscious consumers. These first attempts magnified the advantages of connecting business strategy to increasing ecological concerns, including improving brand image and obtaining a competitive advantage. But with the idea gained some traction, it also met stiff resistance. In particular, the growing issue of "greenwashing" has grown to a major problem undermining consumer trust and making it difficult to verify legitimate environmental claims. Much early discourse in the space revolved around whether these efforts were serious or simply greenwashing [6].

Later analyses have also tried to pinpoint successful mechanisms that businesses can leverage to create trust and transparency. Research has shown that sustainability should be embedded into the core of the business and not as spin or marketing facade. That includes investigating how companies have adopted environmentally friendly practices across supply chains, production processes and product design, showing that a true commitment to sustainability can deliver real benefits for the environment and the bottom line. Additionally, a correspondingly important theme has arisen around the notion of corporate social responsibility (CSR), highlighting the need for corporations to engage their stakeholders — and communicate their efforts in a consistent and clear manner [7].

The growing complexity of environmental issues has also driven marketing innovation. Digital platforms and social media emerged as important tools for environmental marketing on both micro and macro scales, allowing organizations to engage with consumers more directly, and provide real-time updates on sustainability initiatives in engaging and interactive ways. These technological developments have enabled companies to address wider audiences more efficiently and allowed for increased scrutiny from the public. Even so, in the related literature, a lot of the more recent papers are dedicated to implications of

digital transformation and what positions companies have to adopt to deal with the opportunities as well as with the risks of the new channels [8].

Apart from technological evolution, the increasing impact of regulatory frameworks and industry standards have also influenced discourse. Recent research has shown how stricter guidelines and certifications have pushed companies to take a more transparent and measurable approach when making environmental claims. This has opened a broader discussion on accountability, with researchers investigating the difficulties businesses face in complying with regulatory requirements and engaging their audiences in a meaningful way in terms of their communication [9].

This literature demonstrates a field that has evolved considerably over time. Initial work established fundamentals by characterizing the environmental marketing while later studies have investigated more nuanced hurdles, approaches, and innovations. The discussion today is a work in progress, mirroring the changing relationship between consumer expectations, technological innovation, and regulatory change as society strives to be sustainable.

3. Materials and methods

Using a methodology that combines data from corporate sustainability reports, consumer surveys, and independent third-party environmental audits, the research investigated how environmental marketing strategies influence corporate environmental performance. These data sources deliver insights on how environmental marketing strategies impact CO_2 emissions, energy consumption, waste reduction, consumer trust attitudes, perceptions of brand authenticity, and the like, hence providing a comprehensive overview.

The scope of the investigation aligns with emerging global evidence showing that environmental claims must be substantiated through transparent methodological frameworks to retain credibility in consumer and regulatory settings. To ensure conceptual validity, the analytical approach in this study was informed by contemporary assessments of global environmental policy design and sustainability governance, which emphasize methodological transparency and cross-sector comparability [10, 11]. This alignment is necessary given that climate-action support is increasingly shaped by public perceptions of data reliability and the interpretability of environmental metrics across different institutional contexts [12].

The method used is consistent with previous studies on sustainable business performance measurement and CSR frameworks [13-15].

3.1. Data sources and standardization

The main data source was found through corporate sustainability reports, and 50 publicly available reports were analyzed across sectors. These findings were cross-verified with third-party environmental audits to eliminate bias and ensure report consistency [9].

To enhance methodological transparency and address reviewer recommendations, all primary data repositories, verification procedures, and documentary sources utilized in this study are consolidated in Table 1. Although the manuscript had earlier described the data, datasets and analytical approach in general terms, it did not provide a detailed account of sustainability report versions, audit reports and survey methodological standards provenance. This summary also informs on the source of each dataset, type of reporting used for data collection and shows that datasets align with well-known global environmental disclosure systems – CDP, GRI, SASB & TCFD. All measurements of environmental performance came from publicly available or independently accessible data, and were converted to standardized accounting metrics following accepted principles of environmental accounting. The table also lists the QA mechanisms

used—such as cross-verification with ISO-aligned audits, stratified sampling for survey data, and consistency checks with regulatory benchmarks—to enhance analytic reliability and reproducibility.

Table 1. Primary Data Sources, Access Links, and Verification Criteria Used in the Study

Data Source Type	Repository / Access Link	Description and Relevance to Study	Verification / Quality Criteria Applied
Corporate Sustainability Reports (50 reports)	CDP Global Disclosure System: https://www.cdp.net/en/companies/companies-scores		
GRI Sustainability Disclosure Database (archived): https://www.globalreporting.org	Primary dataset for CO_2 emissions, energy use, and waste metrics across sectors.	Third-party audit cross-verification; GRI Standards alignment; completeness and consistency checks.	
Environmental Impact Audits (20 audits)	ISO 14001 Audit Bodies: https://www.iso.org/iso-14001-environmental-management.html	Independent assessments validating reported environmental performance.	Auditor accreditation verification; audit–report congruence scoring; deviation threshold <5%.
North American Consumer Survey (n = 1,000)	Collected via study-specific panel; OECD Survey Standards: https://www.oecd.org/sdd/surveys	Measures trust and authenticity perceptions of sustainability claims.	Stratified random sampling; demographic weighting; response-pattern validation.
European Consumer Survey (n = 1,000)	Eurostat Survey Guidelines: https://ec.europa.eu/eurostat	Captures authenticity judgments and sustainability attitudes.	Age/gender/SES representativeness; removal of incomplete responses; reliability $\alpha > 0.70$.
Asian Consumer Survey (n = 500)	UN Statistics Guidelines: https://unstats.un.org	Measures willingness-to-pay for sustainable products.	Double-sampling verification; z-score outlier removal (±3.0).
Global ESG Benchmarking Frameworks	GRI Standards: https://www.globalreporting.org/standards		
SASB Standards: https://sasb.org/standards			
TCFD Framework: https://www.fsb-tcfd.org	Harmonization of emissions, energy, and waste metrics; disclosure alignment.	Cross-framework concordance; unit standardization; missing-data imputation (Eq. 1).	
Digital Marketing & Engagement Data	Meta API: https://developers.facebook.com		
YouTube Analytics API: https://developers.google.com/youtube/analytics	Measures social-media engagement rates, sentiment, and traffic.	API-rate limit controls; bot-traffic filtration; sentiment-model accuracy >85%.	
CSR & Stakeholder Engagement Data	CSR repositories (GRI; UN Global Compact): https://www.globalreporting.org		
https://www.unglobalcompact.org	Supports assessment of CSR integration and stakeholder communication practices.	Triangulation with interview data; keyword-frequency scoring; ESG compliance mapping.	
Environmental Regulatory	UNFCCC National Reporting	Provides regulatory	Country-level cross-checks;

Data Source Type	Repository / Access Link	Description and Relevance to Study	Verification / Quality Criteria Applied
Benchmarks	Repository: https://unfccc.int/documents	baselines for interpreting firm-level compliance.	temporal alignment of reporting years.
Supplementary Academic Sources	Scopus: https://www.scopus.com		
Web of Science: https://www.webofscience.com	Supports theoretical framing and variable operationalization.	Peer-reviewed status; relevance screening; publication year filter (2017–2025).	

Table 1. (*Continued*)

As shown in Table 1, the study draws on internationally recognized sustainability disclosure systems, sectoral audit frameworks, and standardized survey-protocol guidelines. Collectively, these repositories form the evidentiary foundation for all quantitative and qualitative analyses undertaken. It is expected that integrating the CDP-validated disclosure, a GRI-based sustainability report, ISO-standard audit process and geographically disseminated sample would enhance the reliability of environmental-oriented operational and perceptual measures employed in this study. By being the first study in transparency-critical policy research that reports the origin and verification procedures of each dataset, this paper integrates well with best expectations for empirical openness in sustainability scholarship and gives future scholars a clear instruction to replicate or enhance the methodological design.

At the same time, generic consumer surveys were carried out in three major regions (North America, Europe and Asia) and responses were stratified using random sampling to ensure broad representation across demographic and socioeconomic profiles [6, 16].

Data were collected from March to July 2023 using online research panels, representative for the nation. Quotas for age, gender, education level, and household income were applied to each regional. Inclusion criteria required respondents to be over 18 years old and have made at least one consumer purchase in the previous three months, reflecting established protocols in studies examining eco-consumer attitudes and environmentally responsible purchasing behavior [17, 18]. Exclusion criteria included incomplete survey responses and evidence of response-patterning, which were removed through automated quality checks. The recruitment approach reflects current evidence demonstrating that regional variation in environmental awareness and willingness to pay for sustainable goods can meaningfully influence the generalizability of consumer-based sustainability findings [19, 20].

To enhance the reliability of self-reported corporate sustainability data, third-party audits conducted independent assessments of organizational environmental impact. This triangulated methodology (corporate reports + audits + consumer perception data) follows best practices in environmental performance evaluation [14].

A summary of the data sources and verification methods is provided in Table 2.

Table 2. Data Sources and Verification Methods in Environmental Marketing Research

Data Source	Region	Sample Size	Primary Metric	Verification Method
Sustainability Reports	Global	50 reports	CO_2 Emissions (t/year)	Third-Party Audit
Consumer Surveys (North America)	North America	1,000	Trust Scores (1-5)	Stratified Sampling Check
Consumer Surveys (Europe)	Europe	1,000	Authenticity Ratings	Demographic Representation
Consumer Surveys (Asia)	Asia	500	Premium Willingness (%)	Double Sampling Verification
Environmental Impact Audits	Various	20 audits	Waste Reduction (%)	Independent Audit Review

The audit procedures followed standardized environmental assessment protocols, including verification of greenhouse-gas accounting, cross-checking of operational energy data, and validation of waste-management process records. These audit mechanisms align with comparative environmental governance models that emphasize independent verification as a safeguard against inflation of environmental claims and greenwashing tendencies [21, 22]. Independent auditing has become increasingly central to sustainability reporting because it strengthens public trust in environmental performance disclosures and reduces perceived asymmetries between organizational narratives and operational realities [23].

3.2. Data preprocessing and standardization

To ensure comparability across datasets, all sustainability metrics were converted into standardized units:

- CO_2 emissions in metric tons per year,
- Energy consumption in megawatt-hours per year,
- Waste reduction as a percentage change.

This standardization aligns with established methodologies in environmental marketing assessments [13, 24].

1. Handling Missing Data: To address missing data points, a multiple imputation technique was used, where missing values (x_i^{imp}) were estimated based on the distribution of observed data:

$$x_i^{imp} = \bar{x} + z_i \cdot \sigma \quad (1)$$

Where $\bar{x}$ sample mean, z_i standard normal variable (N (0,1)), σ sample standard deviation.

This approach ensures statistical validity and maintains dataset integrity [25].

2. Outlier Detection: To identify and correct extreme values, a Z-score transformation was applied:

$$Z_i = \frac{x_i - \mu}{\sigma} \quad (2)$$

Where Z_i is the Z-score for observation x_i, μ is the mean, and σ is the standard deviation.

Values exceeding ±3.0 standard deviations were flagged for review, following best practices in environmental impact studies [26].

2. Survey Data Transformation: Survey responses were coded into continuous scales for statistical analysis:

- Consumer trust & authenticity: Scale of 1 to 5.
- Willingness to pay a premium: Percentage willingness to pay more for sustainable products.
- Summarized adjusted metrics are shown in Table 3.

Table 3. Thematic Analysis of Transparency and Engagement Practices in Environmental Marketing

Theme	Frequency	Representative Quote	Example Strategy	Outcome Achieved
Transparency	12	"Consumers need clarity, not complexity."	Publish comprehensive reports	Increased consumer trust
Consistent Messaging	10	"Keep the message straightforward and consistent."	Simplify language in campaigns	Enhanced authenticity
Stakeholder Engagement	8	"Involving stakeholders builds credibility."	Conduct stakeholder meetings	Stronger brand loyalty

Theme	Frequency	Representative Quote	Example Strategy	Outcome Achieved
Authentic Claims	9	"Make only claims you can back up with data."	Verify metrics with audits	Improved perception
Continuous Improvement	6	"Show progress over time."	Update goals and targets annually	Ongoing trust building

Table 3. (*Continued*)

3.3. Statistical and econometric analysis

The primary statistical techniques used include multiple regression modeling, chi-square testing, t-tests, and numerical scenario modeling.

3.3.1. Regression model for consumer trust and brand authenticity

To determine the key predictors of consumer trust (Y), a multiple linear regression model was applied:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \epsilon \tag{3}$$

Where X_1 perceived authenticity, X_2 frequency of sustainability claims, X_3 clarity of communication, ϵ is error term. Model specification was grounded in contemporary sustainability analytics literature, which highlights the need for multi-factor models that capture behavioral, communicative, and operational dimensions of environmental marketing simultaneously [27, 28]. Regression inputs were examined for multicollinearity, and model selection followed the principle of parsimony, ensuring that predictors were theoretically justified and statistically independent. This approach follows best practices in branding and consumer perception modeling [2, 29].

3.3.2. Chi-Square test for authenticity and trust correlation

To assess the association between brand authenticity and trust scores, the chi-square test was used:

$$\chi 2 = \sum \frac{(O_i - E_i)^2}{E_i} \tag{4}$$

Where O_i observed values, and E_i expected values under the null hypothesis.

3.3.3. T-Test for regional variations in consumer willingness to pay

$$t = \frac{\bar{X}_A - \bar{X}_B}{\sqrt{\frac{s_A^2}{n_A} + \frac{s_B^2}{n_B}}} \tag{5}$$

Where $\bar{X}_A, \bar{X}_B$ means of regional samples, s_A, s_B standard deviations, and n_A, n_B sample sizes.

3.4. Numerical modeling of sustainability scenarios

To estimate the projected impact of different sustainability marketing efforts, the relative improvement formula was applied:

$$Relative\ Improvement(\%) = \frac{Baseline\ Value - Final\ Value}{Baseline\ Value} \times 100 \tag{6}$$

This numerical modelling aligns with previous research on green innovation and sustainability impact assessments [4, 30].

3.5. Model development for marketing strategy impact on sustainability metrics

To quantify the effectiveness of environmental marketing strategies, this study employs a structural equation modeling (SEM) approach. This methodology allows for simultaneous evaluation of multiple

dependent and independent variables, incorporating both direct and indirect effects of marketing initiatives on corporate sustainability performance.

Following prior research on sustainable marketing analytics [1, 3, 31], the latent constructs examined in the SEM framework include:

- Marketing Strategy Intensity (MSI) – a composite index capturing the frequency, transparency, and credibility of sustainability claims.
- Environmental Performance (EP) – a measured outcome integrating CO_2 emissions reduction, energy efficiency improvements, and waste minimization.
- Consumer Perceptions (CP) – a construct integrating brand trust, authenticity ratings, and willingness to pay premium prices.

The structural equation is represented as:

$$EP = \alpha + \beta_1 MSI + \beta_2 + \epsilon \tag{7}$$

Where EP environmental performance, as a co_2 reduction, energy savings, MSI marketing strategy intensity score, CP consumer perceptions index, ϵ residual error.

This model follows the framework established in previous literature that links green marketing, corporate performance, and consumer response [2, 5, 15].

Additionally, a path analysis was performed to examine whether the relationship between marketing efforts and sustainability outcomes was mediated by consumer trust. The mediation model follows:

$$MSI \rightarrow CP \rightarrow EP \tag{8}$$

A bootstrap resampling technique (n=5000 samples) was applied to validate the mediation effect with bias-corrected confidence intervals.

3.6. Robustness checks and sensitivity analysis

To ensure the reliability of the estimated effects, several **robustness tests** were conducted, following the best practices in environmental marketing analytics [4, 7].

3.6.1. Variance inflation factor (VIF) test for multicollinearity

Since multiple independent variables were included in regression models, a **VIF analysis** was conducted to check for multicollinearity. The VIF formula is:

$$VIF_i = \frac{1}{1-R_i^2} \tag{9}$$

Where VIF_i variance inflation factor for predictor i, R_i^2 coefficient of determination when X_i is regressed against all other predictors. A VIF threshold of 5.0 was used to determine if collinearity was an issue [9].

3.6.2. Heteroskedasticity test (Breusch-Pagan Test)

To ensure the validity of the regression coefficients, a **Breusch-Pagan heteroskedasticity test** was performed:

$$H_0: \sigma_I^2 = \sigma^2 \quad (Homoskedasticity)$$

$$H_1: \sigma_I^2 \neq \sigma^2 \quad (Heteroskedasticity) \tag{10}$$

The test statistic is:

$$BP = \frac{n}{2} \sum_{i-1}^{n} \left(\frac{e_i^2}{\sigma^2} - 1 \right)^2 \tag{11}$$

Where e_i^2 is residuals from the regression, σ^2 is variance of the residuals. If the p-value < 0.05, heteroskedasticity is present, requiring robust standard errors.

3.6.3. Sensitivity analysis for model assumptions

To assess the stability of findings, sensitivity analysis was conducted:

1. Exclusion of extreme values: Data points exceeding 3.5 standard deviations from the mean were excluded.
2. Alternative regression specifications: Log-linear and quantile regression models were tested for robustness.
3. Subsample analysis by industry: The model was run separately for manufacturing, retail, and technology firms to detect sectoral variations [13, 32].

3.7. Policy implications and managerial insights extraction

Beyond quantitative analysis, the study integrates qualitative insights from 15 semi-structured interviews with corporate sustainability officers and marketing executives. Thematic analysis follows best practices in sustainability research [7, 33].

The qualitative coding framework focused on:

- Transparency in sustainability communication – measured as a frequency count of corporate sustainability disclosure terms.
- Consumer trust-building strategies – derived from stakeholder engagement strategies reported in interviews.
- Integration of sustainability goals in corporate decision-making – evaluated based on firms' ESG (environmental, social, and governance) alignment reports.

A hierarchical clustering algorithm was used to categorize best practices in environmental marketing based on recurring themes:

$$d(A,B) = \sqrt{\sum_{i-1}^{n}(x_{Ai} - x_{Bi})^2} \quad (12)$$

Where $d(A,B)$ distance between two corporate sustainability strategies, x_{Ai}, x_{Bi}observed characteristics of firm A and firm B.

This qualitative analysis complements the statistical findings, reinforcing the key mechanisms through which marketing strategies influence sustainability outcomes.

4. Results

4.1. CO_2 emission reductions by marketing strategy type

Decreasing carbon dioxide (CO_2) emissions is an important aspect of corporate environmental responsibility, especially in the high-environmental footprint industries. There has been growing focus on the link between marketing transparency and emissions abatement, with previous research suggesting that transparent sustainability messaging can lead to operational improvements. The paper investigates the impact on CO_2 reductions of maximal, moderate and restricted marketing strategies. The fine-tuned statistical models establish that the more transparent and trustworthy the firms' marketing communications, the bigger their emissions reductions as consumer trust an d regulatory compliance ha rd efforts towards operational sustainability.

Table 4. Comparative CO_2 Emission Reductions by Marketing Campaign Type

Marketing Strategy Type	Baseline Emissions (t/year)	Post-Campaign Emissions (t/year)	Reduction (%)	Standard Error 95%	Confidence Interval
Comprehensive Campaigns	60.000	47.600	20.7	±1.2	(18.3,22.1)
Moderate Campaigns	62.500	54.800	12.3	±1.5	(10.2,14.5)
Limited Campaigns	65.000	57.900	10.9	±1.8	(8,1, 13.5)
Industry Average	62.500	53.600	14.2	±1.6	(11.7, 16.3)

The data in Table 4 clearly shows that there is a direct relationship between marketing strategy intensity and performance in reducing CO_2. Companies also using comprehensive marketing campaigns achieved, on average, a 20.7% reduction, compared to a 12.3% decrease in the case of firms using moderate strategies. Conversely, only a 10.9% reduction in emissions could be attributed to limited marketing efforts, highlighting the lessened results of one-off sustainability communities. A jump of 14.2% (the industry average decrease) means firms with moderate sustainability transparency do significantly better than those who engage in very little sustainability (at an advanced level). 95% confidence intervals confirm the statistical significance of these results, indicating a strong relationship between transparent marketing and emissions performance.

4.2. Energy efficiency gains by marketing strategy type

Promoting energy efficiency is essential for lowering operational expenses and decreasing environmental effects. The contribution of corporate environmental marketing strategies toward energy savings is the subject of this study. Internal congruity between sustainability messaging and actual practices creates economic and market-related pressure to invest in energy-efficient improvements, which is operationalized through sustained, transparent marketing campaigns. Table 5 present the amount of measurable energy efficiency achieved from environmental marketing, separated into comprehensive, moderate, and limited campaigns that share different levels of transparency.

Table 5. Energy Efficiency Improvements by Marketing Strategy Type

Marketing Strategy Type	Initial Energy Use (MWh)	Final Energy Use (MWh)	Efficiency Improvement (%)	Adjusted R^2	Significance (p-value)
Comprehensive Campaigns	110.000	92.800	15.6	0.71	<0.01
Moderate Campaigns	115.000	101.200	12.0	0.63	0.02
Limited Campaigns	120.000	109.500	8.8	0.57	0.04
Industry Average	115.000	100.600	12.5	0.66	<0.01

The results empirically support that companies with consumer-based, open environmental advertising programs have stronger increases in energy efficiency. Efficiency gains were highest (15.6%) for firms using sustained sustainability messaging, relative to moderate strategies (12%) and limited actions (8.8%). The p values ($p<0.05$) indicate that marketing strategy does influence energy conservation directly; whereas table 7 shows the amount of energy efficiency variation explained by marketing transparency with R square adjusted=0.71. These findings are consistent with previous research that has highlighted the importance of stakeholder involvement and regulatory coherence for sustainability progress.

4.3. Waste reduction achieved by environmental marketing strategy

Effective waste disposal is a key element of corporate sustainable development. Organizations who adopt an organized environmental marketing approach have higher tendencies to use circular economy and

as a result waste generation can be reduced. The analyses measure the influence of marketing at varied intensity levels on waste management performance, as reflected in the decrease (i.e., percentage reduction) between baseline versus post-campaign periods in waste outputs.

Table 6. Waste Reduction Performance by Marketing Campaign Type

Campaign Type	Initial Waste Output (kg)	Final Waste Output (kg)	Waste Reduction (%)	Significance (p-value)	Elasticity Estimate
Targeted Campaigns	500.000	382.500	23.5	<0.01	1.34
Intermittent Campaigns	510.000	421.500	17.3	0.02	1.12
Limited Campaigns	520.000	442.000	15	0.04	0.89
Industry Average	510.000	415.333	18.6	<0.01	1.19

The data in Table 6 shows that the higher the environmental marketing, the better the waste reduction performance. Targeted sustainability messaging achieved a substantial 23.5% reduction in waste disposal, compared with moderate campaigns (17.3%) and limited efforts (15.0%). This is a sizeable elasticity estimate (1.34), which means that if marketing intensity is increased by one percent, waste reduction will improve by 1.34%. The results highlight the role of corporate transparency and consumer engagement in the organizational improvements of sustainability operations.

4.4. Consumer perceptions of environmental marketing

The success of corporate sustainability is still a complex phenomenon that derives from corner elements such as consumer trust and brand authenticity. Transparent and structured environmental marketing campaigns can increase brand credibility and shape purchase decisions. We now consider marketing intensity and how that's perceived by consumers as it relates to trust, authenticating sustainability claims, and willingness to pay a premium for sustainable goods. Previous studies have shown that brands that consistently provide genuine messaging regarding environmentalism develop higher levels of consumer engagement, leading to long-term brand loyalty.

Table 7. Consumer Perceptions by Marketing Campaign Intensity

Campaign Intensity	Authenticity Score (1-5)	Trust Score (1-5)	Premium Willingness (%)	Elasticity Estimate	Significance (p-value)
Comprehensive Campaigns	4.7	4.6	33.2	1.15	<0.01
Moderate Campaigns	4.3	4.1	27.9	0.92	0.02
Limited Campaigns	3.9	3.6	23.5	0.71	0.04
Industry Average	4.3	4.1	27	0.95	<0.01

The results in Table 7 support a strong correlation between being transparent in environmental marketing and the consumer marketing trust. Companies running rigorous sustainability campaigns scored the highest in authenticity (4.7) and trustworthiness (4.6). In contrast, low-marketing firms received a significantly lower score for consumer trust (3.6)—an indication that they may be met with skepticism in the face of weak or inconsistent environmental messaging.

The elasticity estimate (1.15) indicates that a 1-point increase in brand authenticity scores results in a 1.15% increase in consumer willingness pay a premium. The results are in line with past studies highlighting the relationship between perceived sustainability focus and consumer buying choices.

4.5. The influence of environmental marketing on corporate social responsibility (CSR) engagement

CSR, including ESG factors (environmental, social and governance), is one of the key contributors to sustainable business. CSR strategies supported by environmental marketing: It generates a network, with common interests and promotes the sustainability while involving many parties. Thus, Table 8 presents the effect of marketing publicity on CSR campaigns with stakeholders' engagement, transparency rates and regulatory compliance from stakeholders.

Table 8. CSR Engagement and Transparency Metrics by Marketing Strategy Type

Marketing Strategy	Stakeholder Meetings Per Year	Transparency Score (1-10)	CSR Compliance (%)	Public Sustainability Reports (Annual)	Significance (p-value)
Comprehensive Campaigns	12.5	9.3	87.2	4.5	<0.01
Moderate Campaigns	8.7	7.8	74.5	3.2	0.02
Limited Campaigns	5.4	6.2	59.8	2.1	0.04
Industry Average	8.8	7.6	73.8	3.3	<0.01

Firms with strong sustainability strategies averaged 12.5 stakeholder engagement meetings each year, compared with limited marketing campaign firms (5.4 meetings). Transparency scores also displayed a similar pattern, with full campaigns averaging 9.3 (out of 10), versus 6.2 for limited campaigns.

Transparent marketing firms had the highest CSR compliance rate (87.2%) while firms with CSR alignment had the lowest (40.5%) suggesting a positive correlation between marketing engagement and corporate responsibility alignment. The results point out that environmental marketing is more than just a name on the business card, it is a natural part of the operation.

4.6. The role of digital marketing in environmental campaigns

Advancing digital platforms have seen the progression of this environmental marketing over time, essentially facilitating a closer and more immediate interaction between firms and consumers; hence being able to exchange company efforts or practices towards sustainability as well as reduce greenwashing skepticism. The rise of social media, online sustainability reports and interactive corporate social responsibility (CSR) platforms offer new paths for environmental transparency. Table 9 indicates how effective digital marketing tools are in targeting sustainability goals in terms of consumer engagement rates, brand reach, and public sentiment analysis.

Table 9. Effectiveness of Digital Marketing in Sustainability Engagement

Digital Marketing Strategy	Social Media Engagement Rate (%)	Sustainability Web Traffic (Monthly)	CSR Video Views (Annual)	Brand Sentiment Score (1-10)	Significance (p-value)
Comprehensive Campaigns	8.9	152.300	4.1M	8.4	<0.01
Moderate Campaigns	6.5	97.200	2.9M	7.1	0.03
Limited Campaigns	4.2	65.800	1.5M	6	0.05
Industry Average	6.6	105.100	3M	7.2	<0.01

Companies with comprehensive digital sustainability strategies had an average social media engagement rate of 8.9% — 49% higher than companies with no or limited digital (4.2%). Brand sentiment analytics further supported this trend; companies delivering the same core digital sustainability message across its channels scored 8.4 (out of 10), whereas sporadic digital companies scored 6.0.

The results corroborate prior research on the impact of environmental transparency when digital platforms can be utilized to improve consumer trust and engagement, establishing that consumers implicitly trust companies that are forthcoming about their sustainability efforts.

5. Discussion

The results from this research add to the debate on environmental marketing strategies and corporate sustainability performance, offering recent empirical evidence on the impact of sustainability-focused marketing programs on reducing CO_2, enhancing energy efficiency, improving waste management, and shaping consumer perceptions. The primary aim of this study was to empirically evaluate whether varying intensities of environmental marketing—operationalized as transparency, consistency, and digital engagement—are associated with measurable improvements in corporate environmental performance. Positioning the analysis within contemporary debates on climate-action governance enables a richer understanding of how corporate narratives intersect with broader societal expectations and behavioural drivers [17, 34]. The findings corroborate past research in that they reinforce the critical importance of marketing transparency and authenticity as determinants of measurable environmental improvements; they also expand the literature in innovative ways by introducing new insights into both digital sustainability engagement and CSR alignment.

Several past studies highlighted the green marketing role in improving both environmental and business performance. Ali et al.[15] demonstrated that consumer goods companies implementing structured green marketing strategies gained a competitive edge by improving sustainability compliance and brand differentiation. The article findings extend this argument by showing that firms across multiple industries—not just consumer goods—experience substantial environmental benefits when implementing sustained, transparent sustainability messaging. Irma et al.[30] further emphasized the production-side role of sustainable materials in reducing emissions, particularly in industries such as construction, where fly ash has been introduced as a cement substitute. While their study focused on material innovation, our results suggest that marketing strategies can play a similarly impactful role by driving operational accountability and influencing consumer demand for eco-friendly products.

The results should also be viewed in the context of increasing international pressure for climate accountability, coupled with growing public and real support of action on climate change; thus reconfiguring corporate incentives to communicate environmental information openly [12]. The results should also be viewed in the context of increasing international pressure for climate accountability, coupled with growing public and real support of action on climate change; thus, reconfiguring corporate incentives to communicate environmental information openly. Recent work on consumer empowerment and environmental awareness further indicates that marketing interventions now operate within a landscape where ecological knowledge, risk perception, and climate anxiety significantly influence purchasing behaviour and trust formation [35, 36].

Majid et al. examined eco-efficiency and sustainable innovations among European SMEs, finding that investments in renewable energy and waste reduction strategies improved both environmental impact and financial performance[31]. The study builds on this by demonstrating that corporate sustainability performance is significantly amplified when such investments are accompanied by transparent environmental marketing. In particular, firms with credible, long-term environmental messaging enjoy greater reductions of CO_2 emissions, energy use, and waste generation than firms with variable sustainability messaging. This reinforces the argument that green innovation and sustainability marketing should go hand in hand in order to attain tangible results.

Perception of consumers is significant to success of environmental marketing strategies, which are proved by Wahyuni & Zulfikar [37], where they defined perceived authenticity as a key determinant of green purchase intention. The research supports this finding, as we discovered that higher authenticity scores in corporate sustainability communication were directly related to enhanced consumer trust and willingness to pay price premiums for sustainable products. These findings imply that companies must be more mindful of building credibility into their sustainability promises now to combat any skepticism resulting from greenwashing and build brand loyalty over the long haul. This is consistent with the work of Prihatiningrum et al.[32], suggesting that harmonizing corporate sustainability initiatives with consumer expectations improves stakeholder engagement and brand value. The findings lend further empirical support that sustained environmental marketing translates into tangible gains in stakeholder engagement metrics, such as sales or buy-in, compliance with corporate social responsibility (CSR) and sustainability reporting issues across respective industries.

The article findings also underline the important role of digital platforms in magnifying sustainability marketing efforts. Daoud et al.[38] explore how digital media can enhance environmental awareness and demonstrate that companies implementing real-time engagement strategies exhibit higher levels of consumer loyalty. These findings are consistent with our own, which show that organizations taking advantage of digital channels (through social media and online sustainability reporting) consistently report higher levels of engagement among target consumers and enhanced brand sentiment. This indicates that for firms that want to get the most benefit from their sustainability efforts should embed digital transformation in their marketing approaches. Additionally, according to Dangelico and Vocalelli [24], stakeholder engagement and online transparency are crucial factors in green marketing success, which is well-represented in the study at hand.

Digital sustainability communication functions not only as an information conduit but also as a behavioural amplifier. Evidence indicates that real-time messaging, interactive engagement, and algorithmically targeted content increase consumer receptivity to environmental information, thereby strengthening trust formation and reducing perceived ambiguity around sustainability claims [38, 39]. Integrating digitalization with sustainability strategies has also been shown to enhance organizational adaptability and competitiveness, as firms that leverage data-driven marketing tools achieve higher levels of stakeholder engagement and message authenticity [40].

The results highlight the importance of institutional frameworks that encourage sustainability transparency from a policy standpoint. Deo and Prasad[41] linked climate change adaptation and mitigation to corporate marketing strategies and emphasized that in order for sustainability disclosures to be more meaningful, governments should incentivize such disclosures through regulations. The research backs up this claim by showing that corporations with more transparency in sustainability reporting have better environmental performance and more consumer trust. Supporting this, an emerging perspective relates to market-driving sustainability strategies, wherein Sheth and Parvatiyar [42] urged companies to play a leading role in sustainability transformations rather than just being aware of market-driven sustainability paradigms. The study suggests that companies that embrace sustainability as a fundamental brand value, rather than just a marketing program—they typically report substantially better long-term environmental and financial performance.

Geographical and cultural aspects also warrant more investigations as the study accounts for regional differences across North America, Europe, and Asia; however, there is a dearth of research on cultural dimensions of perceptions about sustainability and purchasing behaviors. Comparative studies between

developed and developing markets might further shed light on how different regions influence the effectiveness of environmental marketing campaigns. Although this research supports the importance of digital strategy in sustainability engagement, it does not tease apart one form of digital marketing from another (i.e. social media campaigns vs. e-mail marketing). Avenues for further research include determining which digital channels have the greatest impact on consumer engagement and trust-formation.

The article offers substantial empirical evidence on the relationship between environmental marketing strategy and firm sustainability performance. The results show that long-term transparency, authenticity and stakeholder engagement bring measurable environmental and business value. Future research may extend longitudinal designs, sector specific sustainability strategies and international comparisons to further validate strategic best practice. Furthermore, interventions of policy that drive sustainability disclosure and optimizing digital marketing will be highly necessary to transpire company adherence to environmental negative practices into actual long-run environmental impact.

6. Limitations

Although our findings are robust, some limitations must be acknowledged. Finally, industry-specific variation is still extremely important, as different industries continue to have differentiated regulatory pressure, operational restrictions, and consumer demands around sustainability. Although this study provides an overarching analysis across sectors, the future stream of research should center towards sector specific sustainability marketing strategies to derive sector contextual recommendations. Second, the research focuses on short-run sustainability effects, which provides the opportunity for additional longitudinal work that examines whether environmental marketing efforts yield corporate benefits over longer time horizons.

A further limitation is that survey respondents may over-inflate their willingness to pay premiums for sustainable products because of social desirability bias, which tends to lead individuals to exaggerate how they behave in their everyday lives. Subsequent research should seek to triangulate consumer sentiment analysis with actual purchase behavior data to cross-validate self-reported intentions in this area. The data presented in the current study is limited to macroeconomic conditions, regulatory and market competition dynamics which were not analyzed in isolation and thus, the external environment plays a role as a moderator in determining the corporate sustainability performance. Future research needs to include macroeconomic and policy impact assessments to understand the interactions better.

A key strength of this study is its multi-source dataset integrating corporate reporting, third-party audits, and cross-regional consumer surveys. The triangulation of these sources enhances the validity of measurements and substantiates a call on sustainability research by an increasing number of scholars to combine behavioral, organizational and policy level data in order to adequately observe dynamics of environmental performance [18, 43]. However, there are some limitations that should be noted. The cross-sectional nature of the data limits prevalence for causal pathways – as has been demonstrated in wider climate-behaviour research comparing environmental attitudes and performance outcomes across time-varying context [17]. Also, survey responses may reflect social-desirability bias, particularly given increasing public awareness of climate impacts [44]. Sectoral heterogeneity in regulatory exposure and operational constraints introduces variation not fully captured in this analysis, consistent with findings that environmental performance differs markedly across industries with distinct carbon-intensity profiles [45]. Future longitudinal and sector-specific analyses are therefore warranted.

7. Conclusions

The article presents empirical material that transparent and strategically integrated environmental marketing is a factor that can play a significant role in the corporate sustainability performance. The analysis shows that companies that interact environmental promises in a coherent and transparent manner, through multi-source datasets and corporate sustainability reports, third-party auditing, and surveys of consumers in different regions are more likely to drive quantifiable changes to the CO2 reduction index, energy efficiency, and waste management. Such results support the perception that environmental marketing is not just a promotion instrument, but also a working mechanism that could empower corporations to be more responsible and credible when it comes to sustainability efforts.

The findings also reveal that consumer attitudes to authenticity and transparency are the core of the sustainability communication effectiveness. Increased demands on plausible environmental claims require companies to see to it that there is a close correspondence between the marketing accounts and attributed environmental performance, which can be verified. These trends are exacerbated by digital communication mediums, given that transparency made possible through technology enables firms to share sustainability achievement in real-time and at the same time focus on overcoming skepticism relating to greenwashing. Digitizing the process of sustainability communication strategies thus is a crucial element of the modern environmental marketing practice.

The article has also highlighted the need to have uniform regulatory regimes and standardized sustainability reporting systems. A well-defined and enforceable disclosure policy ensures that the consumer trust is enhanced, and the information asymmetry is minimized, as well as the creation of comparable level of environmental performance within a firm or an industry. Genuineness in environmental marketing finally relies on the strong verification measures, institutional conformity and organizational dedication to sustainable environmental objectives.

The next steps in the further research should be the longitudinal effects of environmental marketing intensity, industry-specificity of differences in the effectiveness of sustainability communication, and the addition of cross-cultural research to enhance the understanding of consumer differences in interpreting environmental claims. Further research in these domains should be expanded in the future to better understand how the environmental marketing will change with the emergence of new technologies, regulatory changes, and changing social expectations.

Conflict of interest

The authors declare no conflict of interest

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