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DETECTING GREEN WASHING RISK THROUGH CONTRADICTIONS BETWEEN CORPORATE DISCLOSURES AND EMISSIONS

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Abstract:

This analysis examines how comparisons between corporate climate claims and emissions distinguish operational progress from potential Green washing in global sustainability reporting. A retrospective analysis of Apple's global operations from 2010 to 2019 consolidates 90 numerical records and ten selected disclosures, applying descriptive statistics, annual changes, Pearson and Spearman correlations, and structured claim comparisons. Across eight annual observations, renewable electricity sourcing correlates negatively with reported Scope 2 electricity emissions intensity, with a Pearson coefficient of negative 0.994; excluding the final zero emissions observation leaves the association essentially unchanged. Declining product emissions intensity accompanies rising comprehensive emissions in four of six annual intensity reductions. None of four eligible comprehensive reduction claims contradicts reported totals. These patterns distinguish electricity emissions attribution, product efficiency and aggregate outcomes, without identifying causal mechanisms or establishing the absence of Green washing. The contribution refines disclosure assessment by separating numerical contradiction from divergence across metrics and accounting boundaries. For international assurance and investment screening, the evidence supports matching claims with comparable metrics, periods, baselines and methods before judging credibility.

Key Words: Green Washing; Carbon Disclosure; Emissions Intensity; Claim Consistency; Corporate Carbon Accounting

1. Introduction:

Corporate climate communication can be numerically accurate yet leave the scale of environmental progress unresolved. A company may reduce emissions attributed to purchased electricity, improve product efficiency and report progress against a selected baseline while its comprehensive footprint remains above an earlier level. These statements address different quantities and comparison periods. Treating them as interchangeable can distort investment screening, assurance judgments and public assessments of corporate responsibility. Green washing concerns communication that creates misleadingly favourable beliefs about environmental practices or products, making the relationship between claims and supporting evidence central to environmental accountability (Delmas & Burbano, 2011; Lyon & Montgomery, 2015).

Information asymmetry provides the theoretical starting point. Managers possess information about environmental activities, inventories and accounting choices that external audiences cannot readily verify. Corporate disclosures communicate selected aspects of that information, but their interpretation depends on the scope of the signal and the evidence available to its recipient. Signaling theory explains how communication operates under unequal information, while research on sustainability disclosure distinguishes informative reporting from communication intended primarily to protect legitimacy (Connelly et al., 2011; Hummel & Schlick, 2016). Institutional decoupling further explains why environmental commitments, implemented activities and aggregate outcomes can develop at different rates. An initiative can be implemented without producing an equivalent improvement across the entire organization or value chain (Bromley & Powell, 2012).

Existing research establishes that environmental communication can diverge from performance, but the interpretation of that divergence remains conditional. Kim and Lyon (2015) compare corporate claims with performance and identify circumstances associated with exaggeration and understatement. Marquis et al. (2016) demonstrate that scrutiny and transparency expectations influence selective disclosure. These contributions establish the importance of reporting incentives and external monitoring. They do not imply that every favourable statement accompanying rising aggregate emissions constitutes deception. A claim about improved product efficiency can remain accurate when expanding output increases comprehensive emissions. Evaluating such a claim therefore requires explicit attention to its denominator, organizational boundary and comparison period.

Two mechanisms complicate the relationship between environmental initiatives and reported outcomes. Efficiency improvements may be offset by changes in production scale, product composition or resource demand, so lower emissions intensity need not produce lower absolute emissions (Sorrell, 2015). Renewable electricity procurement can also reduce attributed emissions through contractual accounting without independently demonstrating equivalent additional reductions in physical generation emissions (Brander et al.,

2018). More broadly, evidence of adopted carbon management practices does not necessarily establish improved aggregate emissions performance (Doda et al., 2016). These findings support distinguishing operational initiatives, attributed emissions and comprehensive environmental outcomes before assessing the credibility of corporate progress claims.

Measurement choices introduce an additional source of apparent inconsistency. Carbon inventories depend on organizational boundaries, emissions factors, modeled activities and reference periods. Revisions can change reported trends without an equivalent change in underlying operations. Different carbon accounting frames can therefore produce tensions between measures and interpretations, while methodological diversity can limit the usefulness of disclosed information (Andrew & Cortese, 2011; Ascui& Lovell, 2011). The carbon disclosure literature also identifies persistent questions concerning measurement, assurance and the relationship between reporting and environmental performance (Hahn et al., 2015). A numerical comparison that ignores these distinctions risks confusing a change in accounting with a change in environmental conditions.

International reporting evidence reinforces the importance of comparability. Matisoff et al. (2013) identify differences in transparency across emissions scopes, countries and industries. Sullivan and Gouldson (2012) show that voluntary carbon reporting can remain insufficient for investment decisions when disclosures do not permit meaningful comparisons. Reporting practices themselves also provide an incomplete indicator of information quality: separate sustainability reports, assurance and reporting guidance do not consistently produce more informative disclosure (Michelon et al., 2015). Accordingly, participation in established reporting arrangements cannot replace examination of the specific evidence supporting an environmental claim.

The unresolved issue addressed here concerns how to distinguish operational improvement, divergence between intensity and absolute outcomes, and numerical inconsistency within comparable claims. The reviewed research does not establish that these conditions can be inferred from one another. This analysis addresses that measurement problem by linking selected statements with their corresponding metrics and retaining differences in boundaries, baselines and accounting methods. Its contribution lies in applying these distinctions jointly within a traceable corporate reporting record. The approach supports a bounded assessment of claim consistency without treating that assessment as a validated classification of Green washing.

Apple's global operations provide an informative setting because the available reporting record combines facilities electricity consumption, renewable sourcing, product emissions intensity, comprehensive emissions and accompanying environmental statements. The evidence comprises ten fiscal years from 2010 to 2019, ninety numerical records and ten selected disclosure statements. The empirical design is a retrospective single company analysis using descriptive statistics, annual changes, correlations and structured claim comparisons. Separate analytical samples reflect the availability of operational measures, product intensity observations and eligible statements. Global operational coverage connects the case with international reporting debates, while the single company design limits generalization across firms and jurisdictions.

This study aims to determine how reported environmental improvements correspond with comprehensive emissions and with the claims used to communicate progress. The overarching research question asks how comparisons between disclosures and emissions can distinguish differences in measurement from numerical contradictions. The analysis evaluates the association between renewable sourcing and reported electricity emissions intensity, examines whether declining product intensity accompanies declining comprehensive emissions, and assesses selected claims after aligning their comparison boundaries. It identifies a strong descriptive operational association, repeated divergence between product intensity and comprehensive outcomes, and no direct contradiction among four eligible comprehensive reduction claims. These findings distinguish numerical consistency from broader environmental credibility and support reporting practices that make claim boundaries and accounting revisions visible.

2. Theory, Conceptual Framework and Hypothesis Development:

2.1 Theory and Mechanisms:

This analysis examines Green washing risk through the relationship between environmental claims and reported emissions. Firms face pressure to demonstrate environmental responsibility while maintaining production, sales and profitability. These demands create incentives to communicate improvements before corresponding changes become visible across the value chain. Delmas and Burbano, 2011, locate these incentives within institutional, organizational and individual pressures. Their framework supports examining communication and environmental performance together rather than treating positive disclosure as evidence of improvement.

Institutional decoupling explains why environmental commitments, operational activities and environmental outcomes may diverge. A firm can implement renewable electricity procurement without reducing every category of emissions. Bromley and Powell, 2012, distinguish gaps between policies and practices from gaps between activities and intended outcomes. This distinction matters because an implemented environmental initiative may produce limited aggregate improvement without being fictitious or improperly reported.

Organizational costs provide a competing explanation for differences between communication and performance. Environmental reporting can change more quickly than production systems, supplier relationships and capital equipment. Wickert, Scherer, and Spence, 2016, explain how organizational conditions shape the relative costs of communicating and implementing corporate responsibility. Accordingly, a disclosure and emissions gap may reflect implementation constraints, selective communication or both. The analysis cannot infer managerial intent from that gap alone.

External scrutiny can constrain selective disclosure by increasing the probability that stakeholders identify omitted impacts. Marquis, Toffel, and Zhou, 2016, find that scrutiny and transparency expectations influence corporate disclosure selectivity. Their evidence challenges the assumption that environmentally damaging firms necessarily disclose less complete information. We therefore treat disclosure boundaries as observable characteristics requiring examination, rather than assuming that emissions growth establishes concealment.

The focal outcome is a potential inconsistency between a specific environmental claim and evidence addressing the same claim. Green washing is broader because it concerns communication that creates misleadingly favourable beliefs. Lyon and Montgomery, 2015, identify several forms of misleading environmental communication that cannot be reduced to one numerical discrepancy. Consequently, a contradiction provides a reason for further investigation, while consistency within selected statements does not establish the absence of Green washing elsewhere.

2.2 Conceptual framework and hypothesis development:

The framework distinguishes operational improvement, aggregate environmental outcomes and disclosure comparability. Its observed measures comprise renewable electricity share, facilities electricity consumption, reported Scope 2 emissions, emissions per product, comprehensive emissions and the boundaries of selected disclosures. These measures represent different quantities rather than interchangeable indicators of a single latent construct. Ascui and Lovell, 2011, show that carbon accounting encompasses distinct frames whose interaction can generate apparent contradictions. We therefore establish comparability before interpreting differences as evidence of misleading communication.

Renewable electricity procurement represents an operational mechanism through which a firm can reduce the emissions attributed to purchased electricity. Its corresponding outcome is reported Scope 2 emissions per unit of facilities electricity consumption. This ratio separates changes in the reported electricity emissions factor from changes in electricity demand. Under comparable reporting boundaries, a greater renewable share should correspond to lower reported Scope 2 emissions intensity.

The competing mechanism concerns the difference between accounting attribution and additional physical emissions reductions. Contractual procurement can lower reported emissions without demonstrating an equivalent change in electricity generation. Brander, Gillenwater, and Ascui, 2018, identify this limitation in the market-based approach to Scope 2 accounting. The expected relationship therefore concerns reported emissions intensity and does not independently establish physical decarbonization.

H1: Higher renewable electricity share is associated with lower reported Scope 2 emissions per unit of facilities electricity consumption, where reporting boundaries and accounting methods remain comparable.

Product emissions intensity addresses a different mechanism. Lower emissions per product can reflect changes in materials, manufacturing processes, product design or energy efficiency. However, comprehensive emissions also depend on production scale, product composition and activities outside the measured product boundary. An intensity improvement can therefore coexist with increasing absolute emissions.

The direction of the aggregate relationship remains conditional. Efficiency gains may reduce emissions, while expanding demand can offset those gains. Sorrell, 2015, explains why improvements in efficiency need not produce proportional reductions in aggregate energy demand. This mechanism provides a plausible explanation for intensity and absolute emissions moving in opposite directions, but the available measures do not establish whether rebound effects caused a particular divergence.

We consequently examine the correspondence between intensity and absolute outcomes without imposing a directional hypothesis that requires unobserved production volumes or product composition. Facilities electricity consumption remains a separate operational measure and does not substitute for product output.

RQ1: To what extent do reductions in emissions per product coincide with reductions in comprehensive absolute emissions?

Disclosure comparability provides the third mechanism. Claims may refer to facilities, products, the value chain, a calendar period or a fiscal period. They may also compare current emissions with an original or recalculated baseline. A claim about renewable electricity cannot be evaluated directly against comprehensive emissions, and an intensity claim does not necessarily promise an absolute reduction.

Accounting revisions can further change reported trends without an equivalent change in underlying operations. Hahn, Reimsbach, and Schiemann, 2015, identify measurement, disclosure and assurance issues

within the carbon reporting literature. These issues require us to distinguish an unexplained inconsistency from a difference attributable to reporting boundaries, revised estimates or comparison periods.

Nevertheless, methodological explanations should not automatically resolve every discrepancy. Cho, Laine, Roberts, and Rodrigue, 2015, show how conflicting institutional demands can sustain differences between organizational communication, decisions and actions. The analysis therefore checks whether the explanation addresses the relevant claim and quantifies the difference where evidence permits. Conflicts that remain unresolved warrant further scrutiny rather than an automatic finding of deception.

RQ2: Which apparent conflicts between environmental disclosures and emissions remain unresolved after aligning the metric, organizational boundary, reporting period, baseline and accounting method?

H1 specifies an expected association between renewable procurement and reported electricity emissions intensity. RQ1 evaluates correspondence between product intensity and comprehensive emissions. RQ2 evaluates the consistency of claims and comparable evidence. None represents an identified causal effect on Green washing. Governance, stakeholder pressure and managerial incentives provide theoretical explanations but do not enter the empirical framework as measured predictors because the dataset contains no corresponding observations.

3. Data:

This analysis links corporate environmental disclosures with reported emissions through traceable source records, explicit comparison rules and reproducible calculations. The resulting samples distinguish operational improvement, changes in comprehensive emissions and inconsistencies between comparable claims and reported outcomes.

3.1 Data Sources, Population and Sample Construction:

The evidence comprises Apple's facilities and environmental responsibility reports, supplemented by a secondary report of its earliest comprehensive emissions estimates. Apple, 2011 and 2012, provide facilities electricity consumption and renewable sourcing information. Apple, 2013, supplies additional operational information, while Apple, 2019, consolidates historical facilities and product emissions indicators. Moren, 2012, provides the comprehensive emissions estimates for fiscal years 2010 and 2011 because their original comprehensive inventories were not recovered. These two observations retain their secondary source classification.

The workbook also incorporates a later retrospective corporate report for several historical series and the final observation. Accordingly, the assembled dataset represents a retrospective reconstruction rather than information available at each historical observation date. The report corpus contains ten corporate publications and one secondary article. Source identifiers, report titles, URLs, printed page locators and retrieval timestamps remain in the workbook. The corporate publications and article are publicly accessible, but no open data licence is identified. Public availability therefore does not remove publisher copyright.

The substantive population comprises corporate environmental claims and corresponding emissions outcomes. No enumerated population of eligible corporations was assembled. The accessible frame consists of one purposively selected company and its available reporting records. Apple provides a globally distributed consumer electronics setting, but the data contain no country, subsidiary, supplier or facility observations. Global operational coverage must therefore be distinguished from geographical representativeness.

The principal unit is the company fiscal year. The complete annual backbone covers fiscal years 2010 to 2019 and forms a single company time series. It is not a corporate panel. The workbook does not record the exact opening and closing calendar dates of every fiscal year, so these boundaries cannot be reconstructed without additional source work. Annual frequency permits comparison with annual environmental statements but cannot identify changes within a reporting year.

Electricity consumption represents a period flow. Renewable sourcing is a period share. Comprehensive emissions represent annual reported inventories that incorporate modeled product life cycle impacts, including expected product use. They are not directly observed atmospheric emissions occurring entirely within the reporting year. No variable is treated as a financial stock or an end of period balance.

Inclusion required an identifiable company, fiscal year, metric, numerical value, unit and source location. Disclosure records additionally required an identifiable statement and comparison boundary. The workbook documents one selected statement per reporting year, rather than exhaustive extraction of every environmental claim. It contains no dated protocol establishing that sampling and coding decisions preceded inspection of the evidence. The resulting analysis is therefore exploratory.

Table 1: Sample construction and analytical coverage

Stage	Companies	Observations	Rule or Implication
Accessible annual frame	1	10 company years	Fiscal years 2010 to 2019
Consolidated numerical evidence	1	90 metric records	Distinct company, year and metric combinations
Main annual backbone	1	10 company years	Comprehensive emissions and facilities

Stage	Companies	Observations	Rule or Implication
			electricity available throughout
Renewable sourcing point observations	1	9 company years	Excludes the bounded observation for 2010 from exact numerical summaries
Operational emissions comparison	1	8 company years	Scope 2 and electricity overlap during 2012 to 2019
Product intensity levels	1	8 company years	Available during 2010 to 2017
Product intensity change comparison	1	7 annual transitions	One initial observation lost through differencing
Selected disclosure corpus	1	10 statements	One statement assigned to each fiscal year
Statements ineligible for the direct total reduction check	1	6 statements	Different metrics, boundaries, goals or comparison baselines
Direct claim consistency sample	1	4 statement and outcome pairs	Comparable reported total reduction claims during 2016 to 2019

The 90 numerical records are measurements, not 90 independent company years. No company year was removed from the annual backbone through cleaning. Coverage losses arise from variable availability, differencing and claim eligibility. No broader exclusion register exists for companies considered but not selected.

3.2 Data Integration, Cleaning and Quality Assurance:

Numerical records were integrated through company name, fiscal year and metric name. Disclosure records were aligned with the fiscal year addressed by the statement rather than its publication year. The intended relationship is one numerical observation per company, year and metric, with one selected disclosure per company year. The supplied numerical table contains no duplicate combinations of these three identifiers. Repeated company years across different metrics is legitimate measurements.

All ten annual disclosure records align with the annual numerical backbone. Operational and product life cycle measures have shorter coverage and were not expanded through imputation. No unexpected increase in annual observations occurred. The twelve numerical metrics would occupy 120 cells under complete coverage across ten years. Ninety cells contain extracted values, leaving thirty combinations unfilled: eight across four operational metrics, twenty across four product life cycle categories and two for product emissions intensity.

Source priority follows the documented reporting vintage rather than an assumption that the newest value is always preferable. Comprehensive emissions follow the retrospective series, except for the two earliest observations. Product emissions intensity retains the earlier documented value of 114.2 kilograms for 2015, while noting that another report gives 114.1 kilograms. The final Scope 1 observation retains the sum of rounded components, 50,540 tonnes, alongside the documented assurance figure of 50,549 tonnes. Neither discrepancy was silently overwritten.

Accounting comparability requires more than matching numerical labels. Ascui and Lovell, 2011, explain how different accounting frames generate apparently conflicting carbon measures. Andrew and Cortese, 2011, identify methodological diversity as a limitation on the usefulness of carbon disclosures. These concerns inform interpretation of the documented source differences, but they do not establish that the historical inventory has been harmonized under one method.

Fiscal and calendar measures were kept distinct. The renewable sourcing observation for 2010 is a strict lower bound of 13 percent, not an exact share. It remains available as bounded evidence but is excluded from point estimate summaries and comparisons requiring an exact percentage.

The numerical checks confirmed finite, nonnegative observations, positive electricity denominators and renewable shares within the admissible interval. No statistical outlier threshold, trimming or winsorization was applied. Large movements were retained and interpreted alongside changes in measurement. These include revised aluminum estimates, integrated circuit modeling and business travel accounting. No common method reconstruction was implemented.

Scope boundaries remain separate. Downie and Stubbs, 2013, demonstrate why operational emissions alone can misrepresent a company’s wider footprint. Brander, Gillenwater, and Ascui, 2018, further distinguish reported purchased electricity emissions from evidence of additional physical emissions reductions. The analysis therefore does not substitute operational Scope 2 performance for comprehensive environmental performance.

Missing observations remain unavailable rather than zero. The reported zero for final year Scope 2 emissions is retained because it has a substantive accounting meaning. Baseline growth rates are structurally undefined, while absent historical components reflect extraction limits. Hahn, Reimsbach, and Schiemann, 2015, identify measurement and disclosure limitations as central concerns in carbon reporting research; the present checks address arithmetic consistency without eliminating those underlying limitations.

3.3 Variable Measurement, Construction and Validation:

The analysis uses observed reporting measures and transparent calculated indicators. It does not estimate a latent Green washing construct. Delmas and Burbano, 2011, distinguish positive environmental communication from environmental performance, while Lyon and Montgomery, 2015, show that misleading communication encompasses more than numerical contradiction. Accordingly, the contradiction indicator is a screening measure with a restricted interpretation.

Table 2: Variable dictionary

Variable or indicator	Analytical role	Definition and construction	Source and identifier	Unit and frequency	Transformation and direction	Missing value rule	Coverage and limitation
Comprehensive emissions	Environmental outcome	Reported comprehensive corporate footprint	Apple report corpus; Total footprint	Tonnes CO2e, annual	Higher values indicate larger reported footprints	No replacement	Ten years; mixed reporting vintages
Facilities electricity	Operational scale measure and denominator	Reported global facilities electricity consumption	Apple; Facilities electricity	Million kWh, annual	Higher values indicate greater electricity consumption	No replacement	Ten years; not a measure of product output
Renewable sourcing share	Predictor for H1	Reported renewable sourcing fraction	Apple; Facilities renewable share	Fraction, annual	Multiplied by 100 for percentage presentation	Bound retained separately	Nine exact observations and one lower bound
Scope 1 emissions	Supporting outcome	Reported direct operational emissions	Apple; Scope 1	Tonnes CO2e, annual	Untransformed level	No replacement	Eight years; fuel and process coverage changes
Effective Scope 2 emissions	Operational outcome	Reported renewable adjusted or market-based electricity emissions	Apple; Scope 2 effective	Tonnes CO2e, annual	Higher values indicate greater attributed electricity emissions	Genuine reported zero retained	Eight years; not location-based emissions
Business travel emissions	Supporting component	Reported travel emissions	Apple; Business travel	Tonnes CO2e, annual	Untransformed level	No replacement	Eight years; travel accounting changes
Employee commute emissions	Supporting component	Reported commuting emissions	Apple; Employee commute	Tonnes CO2e, annual	Untransformed level	No replacement	Eight years; coverage changes
Manufacturing, product transportation, product use and end of life	Supporting components	Four separately reported life cycle categories	Apple; corresponding metric names	Tonnes CO2e, annual	Untransformed levels	No replacement	Five years each; rounded components
Emissions per product	Intensity outcome	Source reported product emissions intensity	Apple; Emissions per product	Kilograms CO2e per product, annual	Lower values indicate lower reported intensity	No replacement	Eight years; product mix and modeling affect comparability
Annual proportional change	Temporal comparison	Current level divided by preceding level, less one	Calculated from corresponding levels	Ratio, annual	Multiplied by 100 for percentage change	Initial observation undefined	Nine transitions for complete series; seven for product intensity
Scope 2 electricity intensity	Outcome for H1	Scope 2 emissions divided by facilities electricity	Calculated from overlapping Apple measures	Grams CO2e per kWh, annual	Lower values indicate lower attributed emissions per electricity unit	Requires both observations and a positive denominator	Eight years; derived for this analysis
Eligible total reduction claim	Comparison eligibility	One for a selected claim addressing an annual comprehensive emissions reduction	Disclosures worksheet	Binary, annual statement	One indicates eligibility, not better disclosure	Ineligible statements remain outside the direct test	Four eligible statements
Contradiction flag	Screening outcome	Eligible total reduction claim accompanied by rising reported comprehensive emissions	Calculated from claim coding and emissions change	Binary, annual statement	One indicates a numerical conflict	Interpret only among eligible claims	No variation in the eligible sample
Intensity and total divergence	Diagnostic outcome	Falling emissions per product accompanied by rising	Calculated from matched annual changes	Binary, annual transition	One indicates opposing metric directions	Requires both changes	Seven transitions; not proof of misleading communication

Variable or indicator	Analytical role	Definition and construction	Source and identifier	Unit and frequency	Transformation and direction	Missing value rule	Coverage and limitation
		comprehensive emissions					

Annual proportional changes use Equation 1.

$$g_{X,t} = \frac{X_t}{X_{t-1}} - 1$$

Here, $g_{X,t}$ is the proportional change in measure X during fiscal year t, $X_t$is its current value, and $X_{t-1}$is its preceding value. Percentage changes equal this ratio multiplied by 100. Changes in renewable sourcing percentages are expressed in percentage points rather than treated as percentage changes. The additional operational intensity measure uses Equation 2.

$$J_t = \frac{S_t}{E_t}$$

Here, J_t is reported electricity emissions intensity in grams CO2e per kWh, $S_t$is Scope 2 emissions in tonnes CO2e, and $E_t$is electricity consumption in million kWh. These source units produce the stated intensity unit directly. The direct contradiction screen uses Equation 3.

$$C_t = Q_t \, 1\{g_{F,t} > 0\}$$

Here, C_t is the contradiction flag, $Q_t$identifies an eligible comprehensive reduction claim, $g_{F,t}$is comprehensive emissions growth, and 1 equals one when the stated condition holds. Although the workbook stores zero for ineligible statements, these zeros do not represent tested claims. Interpretation is restricted to observations where $Q_t = 1$

The divergence indicator uses Equation 4.

$$D_t = 1\{g_{P,t} < 0\} \, 1\{g_{F,t} > 0\}$$

Here, D_t identifies opposing directions, and $g_{P,t}$is growth in emissions per product. This indicator records a comparison between different metrics rather than a false statement.

Disclosure coding preserves claim boundaries and eligibility reasons. Marquis, Toffel, and Zhou, 2016, distinguish selective disclosure from disclosure volume, while Cho, Roberts, and Patten, 2010, demonstrate that language and tone can carry information not captured by numerical measures. Neither comprehensive selectivity nor linguistic bias was measured here.

Validation comprises identifier checks, unit checks, denominator checks, formula reconstruction and documentation of conflicting vintages. No independent coding agreement, external Green washing benchmark or classifier validation was implemented. Boiral, 2013, demonstrates the value of comparing corporate reporting with external adverse evidence; the absence of an equivalent external evidence corpus limits the present screening exercise.

3.4 Analytical Framework, Identification and Reproducibility:

The implemented framework is descriptive and exploratory. H1 concerns the association between renewable sourcing and reported Scope 2 electricity intensity across eight overlapping years. RQ1 concerns correspondence between product intensity changes and comprehensive emissions changes across seven transitions. RQ2 concerns the consistency of four eligible claims with their reported comprehensive outcomes.

H1 is evaluated through annual trajectories and descriptive Pearson and Spearman correlations. No regression coefficient, adjusted effect, fixed effect, interaction or causal estimand is estimated. The correlations use contemporaneous annual observations and remain vulnerable to common trends, accounting dependence and omitted operational changes. No standard error, confidence interval or significance claim is attached to these descriptive coefficients.

The contradiction indicator cannot support a regression explaining its variation because every eligible observation has the same outcome. Ineligible statements are not added as negative cases to create an artificial estimation sample. The analysis also does not use the components of a constructed flag as explanatory variables for that same flag.

Bromley and Powell, 2012, distinguish implementation from outcome gaps, while Wickert, Scherer, and Spence, 2016, explain why communication and implementation can develop at different rates. These mechanisms remain possible interpretations rather than estimated determinants.

Likewise, organizational inconsistency and strategic disclosure cannot be inferred from aggregate trends alone. Cho, Laine, Roberts, and Rodrigue, 2015, analyze conflicting organizational demands, and Lyon and Maxwell, 2011, model disclosure under scrutiny. Neither framework licenses attributing strategic intent to the observed company without corresponding evidence. Aguinis and Glavas, 2012, further distinguish explanatory mechanisms and contextual conditions across analytical levels; those levels are not separately observed here.

The exploratory sensitivity assessment removes the final zero Scope 2 observation and recalculates the renewable sourcing association. Additional checks compare different emissions baselines and retain the

documented distinction between original and revised inventories. These exercises assess endpoint dependence and interpretation, not identification.

The workbook preserves source values, locators, coding explanations and construction formulas. Equations 1 to 4 specify the transformations used here. Full replication additionally requires the source editions and retrieval timestamps recorded in the workbook, including those outside the restricted citation window. No historical information set, preregistration, independent coding audit or common method emissions reconstruction is available.

4. Methods:

4.1 Research Design, Analytical Scope and Sample Alignment:

This analysis applies an exploratory retrospective case design to examine correspondence between corporate environmental disclosures and reported emissions. The analytical unit is the company fiscal year. The design integrates numerical comparisons with structured interpretation of selected statements to distinguish operational improvement, divergence between product intensity and comprehensive emissions, and contradictions within comparable claims.

The annual backbone contains ten observations covering 2010 to 2019. Table 1 documents the analytical samples, while Table 2 defines the measures, units and reporting boundaries. The renewable sourcing assessment uses eight paired annual observations from 2012 to 2019. The product intensity assessment uses eight annual levels from 2010 to 2017, yielding seven consecutive transitions. The direct claim consistency assessment includes four statements addressing annual reductions in comprehensive emissions. Six statements remain outside that assessment because they concern different quantities, goals, boundaries or comparison baselines.

Variation arises across time within one company. H1 concerns the contemporaneous association between renewable sourcing and reported electricity emissions intensity. RQ1 concerns whether declining product intensity coincides with declining comprehensive emissions. RQ2 concerns whether selected environmental claims remain consistent with corresponding reported outcomes after aligning their comparison boundaries.

The design supports descriptive association and structured comparison. Renewable sourcing and attributed electricity emissions share an accounting relationship, while common trends, operational changes and reporting revisions provide competing explanations for observed correspondence. Brander et al. (2018) distinguish purchased electricity accounting outcomes from additional physical emissions reductions. The analysis therefore does not interpret the observed association as an identified causal procurement effect.

4.2 Measurement, Analytical Specification and Calculation Procedures:

Numerical and disclosure records are aligned by company, fiscal year and metric, then ordered chronologically. Publication years remain distinct from the periods addressed by the observations. The procedures preserve original values, source locations, reporting boundaries and documented differences between inventory vintages.

Descriptive statistics comprise valid counts, arithmetic means, sample standard deviations, medians, minima and maxima. Sample standard deviations use the divisor \(n-1\). Each measure is summarized over its available observations. Selected emissions quantities are expressed in million tonnes for presentation, while renewable fractions are multiplied by 100 to obtain percentages.

Equations 1 to 4 define annual proportional changes, electricity emissions intensity, the contradiction screen and divergence between product intensity and comprehensive emissions. Annual changes use consecutive observations. Scope 2 emissions are divided by facilities electricity consumption to obtain grams CO2e per kWh. Product intensity changes are matched with comprehensive emissions changes for the same annual transition.

Pearson correlation evaluates linear correspondence between renewable sourcing and reported electricity emissions intensity, as specified in Equation 5.

$$r_{RJ} = \frac{\sum_{t\in\mathcal{T}}\left[R_t - \overline{R}\right]\left[J_t - \overline{J}\right]}{\sqrt{\sum_{t\in\mathcal{T}}\left[R_t - \overline{R}\right]^2 \sum_{t\in\mathcal{T}}\left[J_t - \overline{J}\right]^2}}$$

Here, r_{RJ} is the Pearson correlation coefficient, $R_t$is the renewable sourcing fraction, $J_t$is electricity emissions intensity, and $\mathcal{T}$ contains years with both observations. The quantities $\overline{R}$and $\overline{J}$are their arithmetic means within the paired sample.

Spearman correlation evaluates correspondence between the ascending ranks of these measures. Equation 6 applies because the analytical sample contains no tied values.

$$\rho_{RJ} = 1 - \frac{6\sum_{t\in\mathcal{T}} d_t^2}{n[n^2 - 1]}$$

Here, ρ_{RJ} is the Spearman correlation coefficient, d_t is the difference between the ranks of renewable sourcing and electricity emissions intensity, and n is the number of paired observations. Ranks are assigned

within each analytical sample. Pearson and Spearman coefficients provide complementary descriptions of numerical and monotonic association, respectively (de Winter et al., 2016; Schober et al., 2018).

Calculations were performed in Python version 3.12.14 using standard library arithmetic, mathematical functions and descriptive statistics, alongside the formulas retained in the workbook. Annual observations receive equal weights. H1 receives descriptive support when both correlation measures have the expected negative direction. Coefficient magnitude is interpreted within the observed sequence without population significance claims.

RQ1 is evaluated by identifying transitions with declining product intensity and counting how often comprehensive emissions increase or decrease within those transitions. The resulting proportions describe observed frequencies. RQ2 applies the contradiction screen only to eligible comprehensive reduction claims. A zero flag indicates agreement with the corresponding reported total, not disclosure completeness or the absence of misleading communication.

Disclosure assessment retains a paraphrase, source location, claim boundary, eligibility decision and interpretation. Accounting explanations are considered when assessing comparability without assuming that they fully reconcile every difference. This approach recognizes that distinct carbon accounting frames can generate apparently conflicting measures (Ascui& Lovell, 2011).

4.3 Quality Assurance, Sensitivity and Reproducibility:

Quality checks assess identifier uniqueness, admissible values, unit consistency and denominator validity. Company, year and metric combinations are examined for duplication. Renewable fractions are checked against the interval from zero to one, electricity denominators are checked for positivity, and numerical observations are checked for finite, nonnegative values.

Missing observations remain unavailable. The first annual change is structurally undefined, and the bounded renewable sourcing observation for 2010 is excluded from summaries requiring an exact percentage. The reported zero for Scope 2 emissions is retained as an observed accounting value. No imputation, interpolation, trimming or winsorization is applied.

Formula verification compares annual changes and electricity emissions intensity with direct arithmetic from the corresponding inputs. The contradiction formula is checked by temporarily changing an eligible emissions observation, confirming that the flag and summary count respond, and restoring the original value before producing the final outputs. Conflicting reporting vintages remain documented, including alternative product intensity values for 2015 and the difference between rounded Scope 1 components and the final assurance figure.

The endpoint sensitivity assessment recalculates Pearson correlation after excluding the final observation with zero reported Scope 2 emissions. This reduces the paired sample from eight years to seven while preserving variable definitions. Additional comparisons assess comprehensive emissions across the full observation interval and the interval beginning at the observed peak, establishing how baseline selection changes the interpretation of progress.

These checks are exploratory and were developed after inspecting the available evidence. They address endpoint dependence, baseline sensitivity and reporting comparability. They do not resolve common temporal trends, mixed inventory methods, selected disclosure coverage or the absence of independent physical emissions evidence. The constant contradiction outcome among eligible claims also restricts analysis to descriptive assessment.

The workbook preserves source observations, identifiers, URLs, printed page locators, measurement notes, disclosure paraphrases, eligibility explanations and construction formulas. Tables 1 and 2 document analytical coverage and measurement, while Equations 1 to 6 specify the calculations. Full replication requires retaining the complete source editions and retrieval metadata recorded in the workbook.

The methodological contribution lies in maintaining correspondence between claim content, comparison eligibility and reported outcomes. Applying these distinctions consistently permits reproducible screening while preserving the difference between an observed divergence, a numerical contradiction and evidence of misleading environmental communication.

5. Findings:

This analysis evaluates the association between renewable electricity sourcing and reported electricity emissions intensity, the correspondence between product intensity and comprehensive emissions, and the consistency of selected environmental claims. The findings assess H1 and address the two diagnostic research questions through observed trends, descriptive associations and comparable claim assessments. Interpretation distinguishes accounting consistency from environmental improvement and evidence of misleading communication.

The evidence covers Apple’s global operations across ten fiscal years from 2010 to 2019. The dataset contains ninety numerical records and ten selected disclosure statements. The renewable sourcing comparison uses eight overlapping annual observations, while the product intensity comparison uses seven annual transitions. Four statements meet the eligibility criteria for direct comparison with comprehensive annual

emissions changes. The remaining six address different metrics, goals, organizational boundaries or comparison baselines.

Table 3: Descriptive statistics for the principal analytical measures

Measure	Unit	Valid Observations	Mean	Sample SD	Median	Minimum	Maximum
Comprehensive emissions	Million tonnes CO2e	10	28.25	6.71	28.50	14.80	38.40
Facilities electricity consumption	Million kWh	10	1,187.60	735.43	917.50	371.00	2,427.00
Renewable electricity sourcing	Percent	9	79.56	29.01	93.00	11.00	100.00
Effective Scope 2 emissions	Tonnes CO2e	8	52,790.00	45,221.59	41,730.00	0.00	139,160.00
Scope 2 electricity emissions intensity	Grams CO2e per kWh	8	66.10	78.27	35.75	0.00	228.88
Emissions per product	Kilograms CO2e per product	8	117.81	16.53	123.10	90.00	137.20

Renewable electricity sourcing increased from 60 percent in 2012 to 100 percent in 2019, a rise of 40 percentage points. During the same period, facilities electricity consumption increased from 608 to 2,427 million kWh, while reported Scope 2 emissions declined from 139,160 tonnes to zero. Electricity emissions intensity consequently fell from 228.88 grams CO2e per kWh to zero. The decline in attributed emissions therefore coincided with expanding electricity consumption rather than reduced electricity demand.

Across the eight overlapping observations, the Pearson correlation between renewable sourcing and electricity emissions intensity is negative 0.994. The Spearman correlation is negative 1.000, indicating opposite rankings throughout the observed period. H1 receives descriptive support because greater renewable sourcing consistently accompanies lower reported electricity emissions intensity. This association concerns attributed emissions under the reporting framework. Brander, Gillenwater, and Ascui, 2018, explain why reductions under market based accounting do not independently demonstrate equivalent additional reductions in physical electricity generation emissions.

The endpoint sensitivity assessment produces a similar result. Excluding the final observation with zero reported Scope 2 emissions leaves a Pearson correlation of negative 0.993 across seven years. The association therefore does not depend entirely on the final zero. Its magnitude nevertheless reflects a short annual sequence with opposing trends and an accounting relationship between renewable sourcing and attributed emissions. It does not identify a causal procurement effect.

Product emissions intensity and comprehensive emissions display a different relationship. Between 2011 and 2017, emissions per product declined from 137.2 to 90.0 kilograms CO2e, a reduction of 34.40 percent. Comprehensive emissions increased from 23.1 million to 27.5 million tonnes CO2e over the same endpoints, an increase of 19.05 percent. Product intensity improvement therefore coexisted with a larger comprehensive footprint.

The annual comparisons reinforce this distinction. Product intensity declined in six of seven matched transitions. Four of those declines coincided with rising comprehensive emissions, while two coincided with falling comprehensive emissions. The remaining transition recorded increases in both measures. Thus, among transitions with declining product intensity, two thirds exhibited increasing comprehensive emissions. This answers RQ1 by showing that intensity improvement did not consistently translate into absolute improvement.

The divergence is compatible with efficiency gains being offset by changes in scale, product composition or other emissions sources. Sorrell, 2015, explains why efficiency improvements need not generate proportional reductions in aggregate resource demand. The observed divergence does not identify which offsetting mechanism operated because the dataset does not separately measure production volume, product composition and rebound effects.

Baseline selection materially changes the assessment of comprehensive progress. Reported emissions declined from their peak of 38.4 million tonnes in 2015 to 25.1 million tonnes in 2019, a reduction of 34.64 percent. The final footprint nevertheless remained 69.59 percent above the initial value of 14.8 million tonnes. These comparisons describe different intervals and are simultaneously correct. Their coexistence demonstrates why the reference period is necessary when interpreting an environmental improvement claim. Dahlmann, Branicki, and Brammer, 2019, similarly distinguish absolute emissions outcomes from the presence of environmental aspirations and targets.

Table 4: Consistency of eligible comprehensive emissions reduction claims

Fiscal Year	Comprehensive Emissions, Million Tonnes CO2e	Reported Annual Change	Selected Claim	Assessment
2016	29.5	Decrease of 23.18 percent	Comprehensive emissions declined	Consistent with reported totals
2017	27.5	Decrease of 6.78 percent	Comprehensive emissions declined	Consistent with reported totals
2018	25.2	Decrease of 8.36 percent	Comprehensive emissions declined for a third consecutive year	Consistent with reported totals
2019	25.1	Decrease of 0.40 percent	Comprehensive emissions declined for a fourth consecutive year	Consistent with reported totals

None of the four eligible statements conflicts with its corresponding reported annual total. The direct contradiction count is therefore zero among four assessed claims. The six ineligible statements do not constitute additional verified cases of consistency because their content requires different comparisons.

Accounting changes qualify the interpretation of this result. The 2013 disclosure uses a recalculated comparison baseline, whereas the historical series retains the original preceding value. The reported decline for 2016 partly reflects modeling revisions, and its source identifies a smaller decline without those changes. The final observation also carries a different estimate under the preceding model. These documented differences show that agreement with reported totals does not establish comparability under a constant accounting method.

RQ2 therefore yields a restricted finding: the eligible comprehensive reduction claims are numerically consistent with their reported outcomes, while methodological comparability remains qualified. This result does not establish the absence of Green washing. Lyon and Montgomery, 2015, define misleading environmental communication more broadly than direct numerical contradiction, encompassing communication that produces overly favourable beliefs about environmental performance.

The selected statement sample also leaves disclosure framing and omission unresolved. Hahn and Lülfs, 2014, show that negative environmental information can be presented through strategies that protect organizational legitimacy. Numerical agreement within four selected claims cannot determine whether the wider reporting corpus presents adverse impacts with equivalent prominence or completeness.

The evidence supports H1 descriptively and identifies repeated divergence between product intensity and comprehensive emissions. It detects no direct contradiction among the four eligible reported reduction claims. The central finding is that intensity improvement, absolute emissions change and disclosure consistency describe distinct outcomes whose interpretation depends on matched boundaries, comparison periods and accounting methods.

6. Discussion:

A corporate environmental claim can be numerically accurate while supporting an incomplete interpretation of environmental progress. The central contribution of this analysis is the joint separation of reported electricity decarbonization, comprehensive emissions change and claim consistency. The strong negative correlation between renewable sourcing and electricity emissions intensity provides descriptive support for H1, but Equation 2 confines that relationship to attributed electricity emissions. Table 3 simultaneously shows variation in comprehensive emissions and product intensity, demonstrating why operational improvement cannot represent the entire corporate footprint. Connelly and colleagues, 2011, explain that signals acquire meaning through interpretation under information asymmetry. Hummel and Schlick, 2016, further distinguish disclosure quality from disclosure quantity. The present evidence adds a measurement implication: evaluating a signal requires matching its environmental boundary and denominator before judging its credibility. This contribution concerns the interpretation of relationships within the case and does not establish that the underlying patterns are unprecedented across corporations.

The findings distinguish plausible operational and accounting pathways without establishing causal mediation. Renewable sourcing increased while electricity consumption expanded, making reduced electricity demand an insufficient explanation for the decline in attributed Scope 2 emissions. However, Equation 2 combines reported emissions and electricity consumption, and the underlying emissions measure incorporates renewable accounting choices. Its association with renewable sourcing therefore contains an accounting relationship alongside any physical operational change. The persistence of the negative correlation after excluding the final zero observation reduces concern about dependence on that endpoint, but it does not separate procurement additionality, generation changes and contractual attribution. Doda and colleagues, 2016, find limited compelling evidence that commonly adopted carbon management practices reduce corporate emissions. The strong operational association here qualifies that broader debate by showing that a narrowly defined

reported outcome can improve while the effect on comprehensive environmental performance remains a separate empirical question.

The divergence indicator in Equation 4 reveals an asymmetry between efficiency improvement and absolute environmental outcomes. Four of the six annual transitions with declining product intensity coincided with increasing comprehensive emissions. This proportion identifies the prevalence of divergence within the observed transitions; it does not allocate a total causal effect among production growth, product composition and other emissions channels. Read alongside Table 3, the pattern shows that improvement at the product level has limited diagnostic value for aggregate progress unless scale and coverage are also specified. Schaltegger and Csutora, 2012, argue for carbon accounting that connects information with sustainability management and decision needs. The theoretical extension offered here is to treat the alignment between measurement levels as a condition for evaluating environmental performance. A product efficiency indicator and a comprehensive inventory can move in opposite directions without either measure being arithmetically incorrect.

The absence of contradictions in Table 4 exposes the limits of numerical consistency as an accountability criterion. Equation 3 identifies conflicts only among eligible comprehensive reduction claims, so the six ineligible statements cannot be interpreted as additional verified cases of truthful reporting. Moreover, Equation 1 produces different progress assessments when the comparison baseline changes, while inventory revisions alter the meaning of changes across reporting periods. These features reveal a structural distinction between reproducing a reported calculation and establishing a comparable environmental outcome. Michelon, Pilonato, and Ricceri, 2015, find that established reporting practices do not necessarily produce higher disclosure quality. Sullivan and Gouldson, 2012, similarly identify comparability problems that limit the usefulness of voluntary carbon reporting for investors in the United Kingdom retail sector. The contribution of this case is to locate those concerns within identifiable claim boundaries, denominators and reporting vintages. Numerical agreement is informative, but its evidential reach depends on what the comparison actually covers.

The international relevance lies in a comparison procedure that can travel across reporting jurisdictions, not in attributing the observed relationships to advanced or emerging economies. Matisoff, Noonan, and O'Brien, 2013, document differences in carbon reporting transparency across countries and emissions scopes, including improvements in Scope 2 transparency without equivalent progress across all categories. The coexistence here of a strong electricity sourcing association and qualified comprehensive claim comparability illustrates why improved reporting in one scope cannot establish comparable progress across the value chain. Decision makers should therefore require reduction claims to identify their metric, organizational boundary, denominator, reference period and inventory vintage. Assurance should examine both arithmetic agreement and the reconciliation of methodological changes. Future comparative research can apply the distinctions in Equations 2 to 4 across multiple firms, incorporate production volumes and independent electricity evidence, and evaluate whether the same patterns persist under common accounting methods. This redirects Green washing assessment toward transparent correspondence between claims and evidence while preserving the distinction between an unresolved claim, a numerical contradiction and demonstrated deception.

7. Conclusion and Implications:

Credible climate communication requires more than accurate arithmetic. This analysis shows that reported operational improvement, comprehensive environmental progress and the consistency of corporate claims must be evaluated separately. Their relationship depends on matching the activity covered, the comparison period and the accounting basis. Strong improvement within one reporting boundary can coexist with a larger comprehensive footprint, while a numerically consistent statement can leave its wider environmental significance unresolved. The contribution is a structured comparison that distinguishes opposing performance trends from direct contradictions without equating either pattern automatically with deception. This distinction refines the interpretation of environmental signals by making comparability a condition of assessment. Managers should connect claims to inventories and reconcile revisions before communicating progress. Investors should examine absolute outcomes alongside efficiency achievements and avoid transferring evidence from one operational boundary to the entire business. Regulators and assurance providers should require explicit baselines, reporting periods, coverage and explanations of methodological changes. Internal reporting routines should preserve original estimates, revised values and the reasons for differences. These practices can improve the traceability of environmental information across international supply chains and reporting jurisdictions. Clearer correspondence between claims and evidence supports accountable decisions and more informed allocation of capital and public attention.

The single company design provides a basis for comparative extensions across sectors and reporting jurisdictions. Longer historical series and broader disclosure samples could establish whether the observed patterns persist under alternative selection rules. Independent electricity data, production volumes and consistent inventory methods would help separate operational change from accounting attribution and business expansion. External evidence of adverse impacts could strengthen assessments of omission and misleading framing. Future research should also examine how assurance, regulation and stakeholder scrutiny condition claim comparability.

Such designs could test mechanisms, assess classification accuracy and evaluate transferability without treating descriptive correspondence as evidence of causal effects.

References:

1. Aguinis, H., & Glavas, A. (2012). What we know and don't know about corporate social responsibility: A review and research agenda. Journal of Management, 38(4), 932-968. https://doi.org/10.1177/0149206311436079
2. Andrew, J., & Cortese, C. (2011). Accounting for climate change and the self-regulation of carbon disclosures. Accounting Forum, 35(3), 130-138. https://doi.org/10.1016/j.accfor.2011.06.006
3. Apple. (2011). Facilities report: 2011 environmental update. https://www.apple.com/environment/pdf/Apple_Facilities_Report_2011.pdf
4. Apple. (2012). Facilities report: 2012 environmental update. https://www.apple.com/environment/pdf/Apple_Facilities_Report_2012.pdf
5. Apple. (2013). Apple facilities: Environmental footprint report, fiscal 2012. https://www.apple.com/environment/pdf/Apple_Facilities_Report_2013.pdf
6. Apple. (2019). Environmental responsibility report: 2019 progress report. https://www.apple.com/environment/pdf/Apple_Environmental_Responsibility_Report_2019.pdf
7. Ascui, F., & Lovell, H. (2011). As frames collide: Making sense of carbon accounting. Accounting, Auditing & Accountability Journal, 24(8), 978-999. https://doi.org/10.1108/09513571111184724
8. Boiral, O. (2013). Sustainability reports as simulacra? A counter-account of A and A+ GRI reports. Accounting, Auditing & Accountability Journal, 26(7), 1036-1071. https://doi.org/10.1108/AAAJ-04-2012-00998
9. Bowen, F., & Aragon-Correa, J. A. (2014). Green washing in corporate environmentalism research and practice: The importance of what we say and do. Organization & Environment, 27(2), 107-112. https://doi.org/10.1177/1086026614537078
10. Brander, M., Gillenwater, M., &Ascui, F. (2018). Creative accounting: A critical perspective on the market-based method for reporting purchased electricity (scope 2) emissions. Energy Policy, 112, 29-33. https://doi.org/10.1016/j.enpol.2017.09.051
11. Bromley, P., & Powell, W. W. (2012). From smoke and mirrors to walking the talk: Decoupling in the contemporary world. Academy of Management Annals, 6(1), 483-530. https://doi.org/10.5465/19416520.2012.684462
12. Cho, C. H., Laine, M., Roberts, R. W., & Rodrigue, M. (2015). Organized hypocrisy, organizational façades, and sustainability reporting. Accounting, Organizations and Society, 40, 78-94. https://doi.org/10.1016/j.aos.2014.12.003
13. Cho, C. H., Roberts, R. W., & Patten, D. M. (2010). The language of US corporate environmental disclosure. Accounting, Organizations and Society, 35(4), 431-443. https://doi.org/10.1016/j.aos.2009.10.002
14. Connelly, B. L., Certo, S. T., Ireland, R. D., & Reutzel, C. R. (2011). Signaling theory: A review and assessment. Journal of Management, 37(1), 39-67. https://doi.org/10.1177/0149206310388419
15. Dahlmann, F., Branicki, L., & Brammer, S. (2019). Managing carbon aspirations: The influence of corporate climate change targets on environmental performance. Journal of Business Ethics, 158(1), 1-24. https://doi.org/10.1007/s10551-017-3731-z
16. Delmas, M. A., & Burbano, V. C. (2011). The drivers of Green washing. California Management Review, 54(1), 64-87. https://doi.org/10.1525/cmr.2011.54.1.64
17. de Winter, J. C. F., Gosling, S. D., & Potter, J. (2016). Comparing the Pearson and Spearman correlation coefficients across distributions and sample sizes: A tutorial using simulations and empirical data. Psychological Methods, 21(3), 273-290. https://doi.org/10.1037/met0000079
18. Doda, B., Gennaioli, C., Gouldson, A., Grover, D., & Sullivan, R. (2016). Are corporate carbon management practices reducing corporate carbon emissions? Corporate Social Responsibility and Environmental Management, 23(5), 257-270. https://doi.org/10.1002/csr.1369
19. Downie, J., & Stubbs, W. (2013). Evaluation of Australian companies' scope 3 greenhouse gas emissions assessments. Journal of Cleaner Production, 56, 156-163. https://doi.org/10.1016/j.jclepro.2011.09.010
20. Hahn, R., &Lülfs, R. (2014). Legitimizing negative aspects in GRI-oriented sustainability reporting: A qualitative analysis of corporate disclosure strategies. Journal of Business Ethics, 123(3), 401-420. https://doi.org/10.1007/s10551-013-1801-4
21. Hahn, R., Reimsbach, D., & Schiemann, F. (2015). Organizations, climate change, and transparency: Reviewing the literature on carbon disclosure. Organization & Environment, 28(1), 80-102. https://doi.org/10.1177/1086026615575542

22. Hummel, K., & Schlick, C. (2016). The relationship between sustainability performance and sustainability disclosure: Reconciling voluntary disclosure theory and legitimacy theory. Journal of Accounting and Public Policy, 35(5), 455-476. https://doi.org/10.1016/j.jaccpubpol.2016.06.001
23. Kim, E. H., & Lyon, T. P. (2015). Greenwash vs. brownwash: Exaggeration and undue modesty in corporate sustainability disclosure. Organization Science, 26(3), 705-723. https://doi.org/10.1287/orsc.2014.0949
24. Lyon, T. P., & Maxwell, J. W. (2011). Greenwash: Corporate environmental disclosure under threat of audit. Journal of Economics & Management Strategy, 20(1), 3-41. https://doi.org/10.1111/j.1530-9134.2010.00282.x
25. Lyon, T. P., & Montgomery, A. W. (2015). The means and end of greenwash. Organization & Environment, 28(2), 223-249. https://doi.org/10.1177/1086026615575332
26. Marquis, C., Toffel, M. W., & Zhou, Y. (2016). Scrutiny, norms, and selective disclosure: A global study of Green washing. Organization Science, 27(2), 483-504. https://doi.org/10.1287/orsc.2015.1039
27. Matisoff, D. C., Noonan, D. S., & O'Brien, J. J. (2013). Convergence in environmental reporting: Assessing the Carbon Disclosure Project. Business Strategy and the Environment, 22(5), 285-305. https://doi.org/10.1002/bse.1741
28. Michelon, G., Pilonato, S., & Ricceri, F. (2015). CSR reporting practices and the quality of disclosure: An empirical analysis. Critical Perspectives on Accounting, 33, 59-78. https://doi.org/10.1016/j.cpa.2014.10.003
29. Moren, D. (2012, February 21). Apple details carbon footprint, environmental progress. Macworld. https://www.macworld.com/article/216683/apple_details_carbon_footprint_environmental_progress.html
30. Schaltegger, S., & Csutora, M. (2012). Carbon accounting for sustainability and management: Status quo and challenges. Journal of Cleaner Production, 36, 1-16. https://doi.org/10.1016/j.jclepro.2012.06.024
31. Schober, P., Boer, C., & Schwarte, L. A. (2018). Correlation coefficients: Appropriate use and interpretation. Anesthesia & Analgesia, 126(5), 1763-1768. https://doi.org/10.1213/ANE.0000000000002864
32. Sorrell, S. (2015). Reducing energy demand: A review of issues, challenges and approaches. Renewable and Sustainable Energy Reviews, 47, 74-82. https://doi.org/10.1016/j.rser.2015.03.002
33. Sullivan, R., & Gouldson, A. (2012). Does voluntary carbon reporting meet investors' needs? Journal of Cleaner Production, 36, 60-67. https://doi.org/10.1016/j.jclepro.2012.02.020
34. Wickert, C., Scherer, A. G., & Spence, L. J. (2016). Walking and talking corporate social responsibility: Implications of firm size and organizational cost. Journal of Management Studies, 53(7), 1169-1196. https://doi.org/10.1111/joms.12209