
**AI-ENABLED CARBON ACCOUNTING AND FINANCIAL
TRANSPARENCY**

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ABSTRACT

The urgent need to reduce climate change and move toward low-carbon economies has increased the demand for accurate carbon accounting and clear financial reporting. Artificial Intelligence (AI) has become an important tool that can improve the accuracy, speed, and reliability of measuring, reporting, and verifying carbon emissions. This study explains how AI technologies can strengthen carbon accounting systems and improve transparency in sustainability reports. By using tools such as machine learning, natural language processing, big data analytics, and blockchain systems, organizations can provide better environmental, social, and governance (ESG) information and reduce problems like greenwashing and lack of clear information. The paper uses a qualitative research method based on a review of recent academic studies, regulations, and industry reports. The findings show that AI helps estimate emissions more accurately, automates compliance reporting, and increases stakeholder trust through transparent data systems. However, challenges such as poor data quality, ethical issues, regulatory differences, and lack of common technology standards still exist. The study adds to research on sustainable finance by proposing a framework for AI-based carbon accounting and discussing its importance for policymakers, financial institutions, and corporate managers.

KEYWORDS: Artificial Intelligence, Carbon Accounting, Financial Transparency, ESG Reporting, Green washing.

INTRODUCTION

Climate change has become a defining economic and financial risk of the 21st century. International agreements such as the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement emphasize accurate greenhouse gas (GHG) measurement and transparent disclosure as critical tools for global decarbonization. Financial markets increasingly demand credible environmental data to guide investment decisions, assess climate risks, and allocate capital efficiently. Carbon accounting—the process of measuring, tracking, and reporting greenhouse gas emissions—has traditionally relied on manual estimation techniques and fragmented data systems. These methods often suffer from inaccuracies, reporting delays, and limited auditability. The emergence of AI technologies offers new opportunities to transform carbon accounting into a real-time, data-driven, and transparent system. Simultaneously, regulatory frameworks such as the Task Force on Climate-related Financial Disclosures (TCFD) and the International Sustainability Standards Board (ISSB) underscore the need for consistent and transparent climate-related financial disclosures. AI-enabled systems can bridge the gap between environmental data collection and financial reporting, thereby enhancing corporate accountability and investor trust.

This paper explores how AI strengthens carbon accounting processes and promotes financial transparency within sustainable finance ecosystems.

Review of Literature

➤ Carbon Accounting and Sustainability Reporting

Carbon accounting frameworks such as the Greenhouse Gas Protocol provide standardized methodologies for measuring Scope 1, Scope 2, and Scope 3 emissions. However, studies indicate that Scope 3 emissions (value chain emissions) remain difficult to measure accurately due to data fragmentation and supplier opacity. Research on sustainability reporting highlights issues of greenwashing, inconsistent ESG metrics, and lack of comparability across firms. Financial transparency requires verifiable and standardized reporting mechanisms aligned with global disclosure frameworks.

➤ AI in Environmental and Financial Systems

AI applications in environmental management include predictive climate modeling, satellite-based emission tracking, and automated compliance systems. Machine learning algorithms improve emission estimation accuracy by analyzing large datasets from sensors, IoT devices, and enterprise resource planning (ERP) systems. In finance, AI enhances risk assessment,

fraud detection, and regulatory compliance. Integrating AI with sustainability reporting can reduce information asymmetry and strengthen investor confidence.

Research Gap

Although prior research examines AI in environmental monitoring and ESG analytics separately, limited studies integrate AI-enabled carbon accounting with financial transparency frameworks. There is insufficient conceptual integration linking AI technologies to standardized financial disclosure systems and audit mechanisms. This study addresses this gap by proposing a unified analytical perspective.

Objectives of the Study

The study aims to:

- Examine the role of AI technologies in improving carbon measurement and reporting accuracy.
- Analyze how AI enhances financial transparency in sustainability disclosures.
- Identify challenges and ethical considerations in AI-enabled carbon accounting.
- Propose a conceptual framework linking AI, carbon accounting, and financial transparency.

Scope of the Study

The study focuses on:

- Corporate carbon accounting systems.
- AI technologies such as machine learning, NLP, big data analytics, and blockchain.
- Financial transparency within ESG and climate-related disclosures.
- Regulatory frameworks influencing sustainability reporting.

The study does not conduct primary empirical testing but relies on secondary data and conceptual analysis.

RESEARCH METHODOLOGY

➤ Research Design

A qualitative, exploratory research design was adopted. The study uses a systematic literature review approach covering peer-reviewed journal articles, policy documents, and sustainability frameworks published between 2018 and 2025.

➤ **Data Sources**

Data were collected from:

- Academic databases (Scopus-indexed journals).
- Reports from organizations such as the World Economic Forum and International Energy Agency.
- Corporate sustainability reports.
- Regulatory publications.

➤ **Analytical Approach**

Content analysis was applied to identify recurring themes related to AI integration, carbon accounting challenges, and financial transparency mechanisms in various business reports.

AI-Enabled Carbon Accounting

➤ **Automated Emission Measurement**

AI algorithms process real-time data from IoT sensors, satellite imagery, and enterprise systems to calculate emissions accurately. Machine learning models can identify anomalies and detect underreporting patterns.

➤ **Emission Estimation**

AI enhances supplier-level data integration using predictive analytics and pattern recognition to estimate indirect emissions across complex value chains.

➤ **Natural Language Processing (NLP) in ESG Reporting**

NLP tools analyze sustainability reports to assess disclosure quality, detect greenwashing risks, and compare ESG statements with actual emission data.

➤ **Blockchain Integration for Transparency**

AI combined with blockchain ensures secure, immutable carbon records. This reduces data manipulation risks and enhances auditability.

➤ **Climate Risk Assessment**

AI-based scenario analysis models assess transition and physical risks aligned with TCFD recommendations, enabling better financial risk disclosures.

AI and Financial Transparency

AI enhances financial transparency in several ways:

- Real-Time Reporting: Continuous data integration reduces reporting lag.
- Audit Automation: AI-assisted audits improve reliability of sustainability disclosures.
- Risk Prediction: Predictive analytics identify potential climate-related financial risks.
- Fraud Detection: AI detects discrepancies between financial statements and environmental claims.

Enhanced transparency strengthens investor confidence and reduces capital costs for sustainable firms.

Challenges and Ethical Considerations

Despite its benefits, AI-enabled carbon accounting faces challenges:

- Data quality and availability issues.
- Algorithmic bias and model transparency concerns.
- Regulatory inconsistencies across jurisdictions.
- Cybersecurity risks in digital reporting systems.
- High implementation costs for small and medium enterprises.

Policymakers must establish AI governance frameworks to ensure responsible deployment.

Advanced Measurement Science in Carbon Accounting

➤ Emission Quantification Models

Carbon accounting rests on robust measurement theory. Traditional models typically use activity data $\times$ emission factors (e.g., fuel use $\times$ CO₂ factor). AI supplements this approach by:

- Nonlinear regression models that better handle complex emission determinants.
- Deep learning time-series forecasting that captures seasonality and operational shifts.
- Spatial analytics using satellite and remote sensing data for geographically distributed sources.

Example: Convolutional neural networks (CNNs) on satellite imagery can detect methane plumes and infer intensity — a task previously infeasible at scale (Zhang & Liu, 2024).

CONCLUSION

AI-enabled carbon accounting represents a paradigm shift in sustainability reporting and financial transparency. By automating emission measurement, enhancing disclosure quality, and strengthening audit mechanisms, AI contributes to credible climate-related financial reporting. However, technological innovation must be complemented by regulatory harmonization, ethical AI governance, and global standardization.

Future research should focus on empirical validation of AI-driven carbon accounting models and cross-country comparative studies to assess regulatory effectiveness.

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